Ministry for the Environment
Manatū Mō Te Taiao

REVIEW OF CLIMATE CHANGE POLICIES

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2 November 2005

Foreword

This *Review of New Zealand's Climate Change Policies* was conducted by a cross-departmental team involving representatives from the Treasury, Ministry for Economic Development, Ministry of Agriculture and Forestry, Ministry of Transport and the Ministry for the Environment. The Review was commissioned by Cabinet and the review team assembled by the Ministry for the Environment.

When the Government announced its climate change policy package in 2002, it was noted at the time that it would be important to regularly review the progress of the policy package and to continue to monitor innovative policy measures in other jurisdictions in order to assess how these could be of relevance to New Zealand.

The policy package required officials to provide annual reports that set out progress with existing policy and stated that more comprehensive reviews may be needed in 2005, 2007 and 2010.

1. In June 2005, following revised projections of New Zealand's greenhouse gas emissions during the Kyoto Protocol's first commitment period (2008-2012), a full review was commissioned by Cabinet.
2. Cabinet instructed representatives from a range of government departments to conduct a fundamental review of New Zealand's core objectives and policy approach. The resulting paper, with proposals for additional policy responses, was completed on 2 November and presented to the Minister Responsible for Climate Change Issues on 9 November 2005.
3. The Terms of Reference for the Review were wide-ranging, and sought advice on long-term options for climate change policy in New Zealand, as well as recommendations on how New Zealand should approach the more challenging task of meeting New Zealand's commitments under the Kyoto Protocol.
4. The Review is now informing the Government as it seeks to improve New Zealand's climate change policy to ensure we are able to address perhaps the most important environmental issue the world faces.

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1 Background to the review

1.1 The challenge of climate change and New Zealand

Climate change matters for New Zealand. New Zealand is vulnerable to the impacts of climate change through its coastline, the strong role of agriculture in its economy, its infrastructure, and its unique ecosystems. However, some sectors and regions could benefit under a modest amount of warming. In general, the balance between positive and negative impacts is expected to become more negative as the amount and rate of warming increases.

Globally significant changes, such as melting of ice sheets and associated sea-level rise and changes in ocean circulations, would impact on New Zealand just as they would impact on any other part of the world. Major disruptions associated with large-scale climate change impacts occurring elsewhere could affect New Zealand through diverting flows of goods, services and financial resources.

1.2 The United Nations Framework Convention on Climate Change

In 1993, New Zealand ratified the United Nations Framework Convention on Climate Change (UNFCCC). Most nations are parties to the Convention.

The UNFCCC sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. Under the Convention, governments:

- gather and share information on greenhouse gas emissions, national policies and best practices
- launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries
- cooperate in preparing for adaptation to the impacts of climate change.

1.3 The Kyoto Protocol

In 1997, parties to the Convention completed negotiations on the Kyoto Protocol. The Protocol shares the Convention's objective, principles and institutions, but significantly strengthens the Convention by committing so-called "Annex I Parties[1]" to individual, legally binding targets to limit or reduce their greenhouse gas emissions over the period 2008 to 2012.

[1] Annex I Parties are the industrialised counties, and countries with economies in transition (eg, Russia and the Ukraine).

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Only parties to the Convention that have also become parties to the Protocol will be bound by the Protocol's commitments. The individual targets for Annex I Parties add up to a total cut in greenhouse gas emissions of at least 5% from 1990 levels in the commitment period 2008 to 2012. New Zealand's target is 0% from 1990 levels. To date, 156 parties to the UNFCCC have become parties to the Kyoto Protocol.

New Zealand ratified the Kyoto Protocol in 2002. In its deliberations on whether to do so, Cabinet was advised that there were five reasons why it was in New Zealand's interests to become a party to the Kyoto Protocol (New Zealand Government, 2002d):

- increased climate change is predicted if global emissions of greenhouse gases continue to grow without constraint, with significant long-term adverse effects on the global economy, societies and ecosystems
- more than any other developed nation, New Zealand depends for its prosperity on a stable climate. For New Zealand, threats to human health, land and water quality, infrastructure, biosecurity and native ecosystems are also significant
- climate change is a global problem and effective action to counter it is beyond the ability of any single country. The Kyoto Protocol is the only viable international response. The Protocol provides a means by which, over the long term, the risks to New Zealand can be mitigated
- abandoning the Protocol would damage New Zealand's credibility and its reputation as a global citizen – not only in climate change fora but also over a wide range of international issues
- New Zealand's effectiveness in climate change negotiations means it is one of the few developed countries that stands to make a small net economic gain from the first Kyoto Protocol commitment period (CP1). Economic benefits are also likely to include technology and energy-efficiency improvements.

In relation to the last reason above, it was estimated that New Zealand would have a surplus of Kyoto "emission units", which it could sell to other countries. This was because it was expected that the offset provided by New Zealand's forest sinks as a result of forest plantings since 1990 would more than compensate for growth in gross emissions. That surplus was estimated at 50 million tonnes of CO_2-equivalent (50Mt CO_2e). This would be valued at $430 million at prevailing carbon prices.

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The policy response

In 2002, the Government agreed to a climate change policy package with the following key elements:

- a carbon tax on energy, industrial, and transport emissions, capped at $25 per tonne of CO_2e
- Negotiated Greenhouse Agreements (NGAs) for "at risk" large emitters
- Projects to Reduce Emissions (PRE), which would provide Kyoto units to induce projects that would generate additional emissions reductions
- industry and government funding of research in the agricultural sector.

Cabinet agreed that a review of climate change policies might be required in 2005 to confirm that New Zealand's policies will allow our international commitments under Kyoto to be met (New Zealand Government, 2002c).

1.4 Review of Climate Change Policies – background and scope

1.4.1 Background

In May 2005, the Ministry for the Environment completed revised projections of New Zealand's greenhouse gas emissions. These indicated that New Zealand would fall short of meeting its Kyoto Protocol target by 36Mt CO_2e. The Ministry for the Environment recently commissioned an independent review of these projections. The review confirmed that the methodologies employed to project emissions and sinks across the different sectors are generally sound and reasonable in their approach.

The Government considered that the significant change in the outlook for New Zealand meeting its Kyoto obligations justified an analysis of, and consideration of changes to, the current emissions-reduction goal[2] and the climate change policy mix. Further, in the context of this projected Kyoto deficit, the Government agreed that it was also important to clarify New Zealand's position on climate change goals **beyond** 2012.

The Convenor of the Ministerial Group on Climate Change took a paper to Cabinet in the first half of June 2005 (Climate Change Annual Report). Cabinet noted "that an in-depth review will be conducted, and reported back to Cabinet by 31 October 2005, on the current policy settings and objectives".

Terms of reference for the review were subsequently agreed by Ministers.

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[2] The Government's current strategic climate change goal is that "New Zealand should have made significant reductions in greenhouse gas emissions relative to "business as usual" and be set towards a permanent downward path for total gross emissions by 2012".

1.4.2 Objectives of the review

The Government agreed to the following four objectives for the review:

1 to identify, at a high level, an appropriate mix of policies that New Zealand should adopt to meet its obligations in CP1 of the Kyoto Protocol and beyond, including:

- the appropriate balance between further domestic climate change mitigation polices and the use of Kyoto flexible mechanisms such as International Emissions Trading
- the appropriate economic agent to undertake decisions about this balance; ie, whether some or all of New Zealand's climate change liabilities should be devolved from the Government to other economic entities such as firms and individuals
- how any devolution of New Zealand's emissions-reduction obligations should operate
- the broad direction of any further, or alternative, policies to mitigate New Zealand's emissions
- the implications of these policy choices for New Zealand's strategic climate change goal, including whether this goal needs updating

2 to identify the broad implications for New Zealand generally and, in particular, for other relevant Government key priorities such as sustainable development, economic growth, social inclusion, and labour market participation, of continuing with the current climate change policies or adopting any alternative or additional climate change policies that emerge in the course of the review

3 to identify the broad implications of New Zealand's revised emissions projections, and any consequential alternative or additional climate change policies that are recommended, for prospective negotiations on New Zealand's international climate change mitigation obligations beyond 2012

4 to recommend the necessary details of a New Zealand negotiating mandate and strategy for participation in the 11th Conference of the Parties to the UNFCCC and the 1st Meeting of the Parties under the Kyoto Protocol in Montreal in November 2005.

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1.4.3 Scope of the review

Objectives 1 and 2: New Zealand climate change policies and objectives

The review should examine, at the strategic level, the appropriateness, likely effectiveness, and costs and benefits of New Zealand's climate change policies, including:

- price-based policy and measures, including carbon taxes and emissions trading
- the incidence of climate change obligations – should obligations be held by governments or firms and individuals?
- forestry policy and measures

- agriculture policy and measures
- transport policy and measures
- non-transport energy policy and measures
- using the flexible mechanisms of the Kyoto Protocol – International Emissions Trading (IET), Joint Implementation (JI), and the Clean Development Mechanism (CDM).[3]

The review will assess current policy settings against an analysis of any feasible alternatives ("alternative policy settings" may involve augmenting current policies, replacing current policies, or a mix of both).

The review will assess the implications of confirming or changing the current objectives and policy package, including an assessment of the impact of adopting different emissions-reduction targets and strategies on other Government objectives, including, but not limited to, those set out under Objective 2.

Objectives 3 and 4: Climate change obligations beyond 2012

The review will examine the implications of known information on New Zealand emissions trends for any obligations that New Zealand may choose to adopt beyond 2012. In particular, the review will make recommendations on:

- New Zealand's preferences on how a post-2012 international climate change framework should be negotiated
- preferences around the different climate change "architectures" that are being identified and debated internationally
- those features of a climate change framework that are important to New Zealand, including any features that would be necessary to secure New Zealand's participation
- strategies for achieving these objectives internationally
- identification of risks in the post-2012 period and available mitigation strategies
- whether, and when, New Zealand should consider adopting a long-term climate change goal.

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1.5 Approach to the review

The review provides the Government with options for climate change mitigation policies. These include "economy-wide" measures such as carbon taxes and emissions trading. The review also provides mitigation options for specific sectors of the economy, such as transport, energy, and agriculture.

The intention of the Review of Climate Change Policies is to help the Government make some strategic choices about the direction of climate change mitigation policies in New Zealand. Depending on those choices, further work will be required to develop the detail

[3] For an explanation of these mechanisms, see footnote 9.

of the Government's preferred approaches. **For the most part**, the review avoids making specific recommendations on policy direction, or expressing a preference for a particular policy. Rather, it analyses the advantages and disadvantages of options, so providing a framework to help the Government consider which policies best serve the Government's objectives. In some areas, the review does make specific recommendations for further work, especially where there is a premium on that work commencing quickly.

The review is primarily concerned with climate change mitigation responses, and the economic impact of those responses. It does **not** seek to cover all climate change policy issues that are important to New Zealand. Specifically, the review does not consider:

- adaptation policies to deal with climate change in New Zealand
- the performance of New Zealand in measuring and reporting on our Kyoto Protocol commitments.

The review took as given that New Zealand would meet its existing obligations under the Kyoto Protocol in the period 2008 to 2012.

The review was undertaken by a project team[4] within the Ministry for the Environment. This team comprised officials from the following agencies:

- Ministry for the Environment.
- Ministry of Agriculture and Forestry (MAF)
- Ministry of Economic Development (MED)
- the Treasury
- Ministry of Transport (MOT).

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[4] The Project Team wishes to acknowledge the assistance it received from many officials from a number of other New Zealand Government agencies, including Ministry of Foreign Affairs and Trade, the Energy Efficiency and Conservation Authority, and Te Puni Kokiri.

2 International context

2.1 International framework and institutions

2.1.1 The United Nations Framework Convention on Climate Change (UNFCCC)

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty with the long-term objective of stabilising greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (man-made) interference with the climate system.

The UNFCCC was adopted at the Earth Summit in Rio de Janeiro in May 1992. It was the culmination of a series of meetings convened by the United Nations General Assembly in response to the First Assessment Report of the Intergovernmental Panel on Climate Change.

The UNFCCC sets out broad principles for responding to climate change and sets up a process through which governments can meet regularly. It encourages scientific research, sharing and exchange of technology and know-how, and education about the effects of climate change and how we must deal with them. The UNFCCC took effect on 21 March 1994. It has been ratified by 189 parties.

Parties to the UNFCCC are organised and grouped in different ways depending on the context: convention status, UNFCCC procedures, and negotiating groups.

Convention status

The UNFCCC divides countries into three main groups according to differing commitments: Annex I Parties, Annex II Parties and Non-Annex I Parties.

- **Annex I Parties** include the industrialised countries that were members of the Organisation for Economic Co-operation and Development (OECD) in 1992, which includes New Zealand, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States and several Central and Eastern European States. The membership of Annex I may be amended by a decision of the Conference of the Parties, or by parties to the Convention that are not part of Annex I declaring that they intend to be bound by the rules for Annex I Parties

- **Annex II Parties** consist of the OECD members of Annex I, but not the EIT Parties. They are required to provide financial resources to enable developing countries to undertake emissions-reduction activities under the Convention and to help them adapt to adverse effects of climate change. In addition, they have to "take all practicable steps" to promote the development and transfer of environmentally friendly technologies to EIT Parties and developing countries. Funding provided by Annex II Parties is channelled mostly through the Convention's financial mechanisms

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- **Non-Annex I Parties** are mostly developing countries. Certain groups of developing countries are recognised by the Convention as being especially vulnerable to the adverse impacts of climate change, including countries with low-lying coastal areas and those prone to desertification and drought. Least Developed Counties and Small Island Developing States are examples (see below). Others, such as countries that rely heavily on income from fossil fuel production and commerce, consider themselves vulnerable to the potential economic impacts of climate change response measures. The Convention emphasises activities that promise to answer the special needs and concerns of vulnerable countries, through provisions such as investment, insurance and technology transfer.

UNFCCC procedures

Parties to the UNFCCC are organised into five regional groups, in line with normal United Nations practice: the African Group, the Asian Group, the Eastern European Group, the Latin American and Caribbean Group, and the Western European and Other Group of States (WEOG; the "Other States" include New Zealand, Australia, Canada, Iceland, Norway, Switzerland and the United States of America). The five regional groups are used in the context of UNFCCC procedures; eg, nominations for election to positions.

Negotiating groups

Developing countries generally work through the Group of 77 (G-77) and China to establish and represent common negotiating positions. The G-77 was founded in 1964 in the context of the United Nations Conference on Trade and Development and now functions throughout the United Nations system. It has over 130 members. China is not officially a member of the G-77 but works closely with the group, and positions are often put forward jointly in the name of G-77 and China. The country holding the Chair of the G-77 (which rotates every year) often speaks for the G-77 and China as a whole in meetings. However, because the G-77 and China is a diverse group with differing interests on climate change issues, individual developing countries also intervene in discussions, as do other groupings within the G-77, including:

- the African Group

- the Alliance of Small Island States (AOSIS). This is a coalition of some 43 low-lying and small island countries, most of which are members of the G-77, that are particularly vulnerable to sea-level rise. AOSIS countries are united by the threat that climate change poses to their survival and frequently adopt a common stance in negotiations

- the group of Least Developed Countries (LDCs). This comprises the 48 parties classified as least developed countries by the United Nations. LDCs are given special consideration under the Convention on account of their limited capacity to respond to climate change and adapt to its adverse effects. Parties are urged to take full account of the special situation of LDCs when considering funding and technology-transfer activities

- oil-producing states. While not labelled as a group in the same way as those above, oil-producing states often support one another in discussions. Saudi Arabia often takes the lead.

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The 25 members of the European Union and the European Commission agree on common negotiating positions in advance. The country that holds the European Union presidency (which rotates every six months) then speaks for the group in meetings. The European Union is itself a party to the Convention and is represented by the European Commission, although it does not have a separate vote from its members.

The Umbrella Group is an informal grouping of non-European Union developed countries that cooperate within the UNFCCC process. The group was formed following negotiation of the Kyoto Protocol and has nine members: New Zealand, Australia, Japan, Canada, the United States, Iceland, Norway, the Russian Federation and the Ukraine. The informal nature of the grouping enables cooperation and common positions where possible, while also allowing for divergence of views to be fully respected. The informal motto of the group "working together, not bound together" reflects this flexibility. The group meets daily during UNFCCC meetings and has met intersessionally at times.

2.1.2 New Zealand obligations under the Convention

The UNFCCC, as originally framed, set no mandatory limits on greenhouse gas emissions for individual nations and contained no enforcement provisions. It is therefore considered legally non-binding.

Countries that have ratified the UNFCCC must take measures to address climate change, including:

- developing greenhouse gas inventories
- undertaking national or regional programmes
- preparing for adaptation to the impacts of climate change
- encouraging the development and diffusion of climate change technologies
- protecting and enhancing areas that remove carbon dioxide from the atmosphere (such as forest sinks)
- promoting, and cooperating in, education, training and public awareness related to climate change.

Developed countries, including New Zealand, are required to take the lead in modifying longer-term trends in anthropogenic greenhouse gas emissions. They must:

- put in place policies and measures to reduce the emission of greenhouse gases, with the aim of reducing greenhouse gas emissions to 1990 levels
- periodically communicate detailed information on their policies and measures to the secretariat of the UNFCCC, including projections of future greenhouse gas emissions and removals by sinks
- monitor and report on greenhouse gas emissions and sinks
- help developing countries address climate change through financial assistance and technology transfer.

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Parties to the UNFCCC are also required to consider actions to mitigate the impacts of climate change on small island countries, countries with low-lying coastal areas and countries with areas prone to natural disasters. New Zealand has a particular interest in advocating on behalf of vulnerable Pacific Island nations in this regard.

2.1.3 The Kyoto Protocol

When governments adopted the UNFCCC, they knew that its commitments would not be sufficient to seriously tackle climate change. At the first Conference of the Parties to the UNFCCC in March 1995, parties therefore launched a new round of talks to decide on stronger and more detailed commitments for industrialised countries. In 1997, the text of the Kyoto Protocol was adopted unanimously by the UNFCCC parties.

The Protocol sets targets for reductions in greenhouse gas emissions of Annex I Parties for CP1, which is 2008 to 2012. The combined emissions of Annex I Parties must be reduced to 5% below the level they were at in 1990. Developing countries are not required to reduce their emissions. The Protocol establishes an international emissions trading regime using emission units, requires Annex I Parties to adopt domestic measures to reduce emissions, and establishes reporting and compliance arrangements.

The Kyoto Protocol had to be signed and ratified by 55 countries (including those responsible for at least 55% of the developed world's 1990 carbon dioxide emissions) before it could enter into force. This was achieved after Russia ratified in late 2004, and the Protocol entered into force on 16 February 2005. A total of 156 countries and regional economic integration organisations have ratified the agreement, the United States and Australia being notable exceptions. New Zealand ratified on 19 December 2002. Only countries that ratify the Protocol are bound by it.

2.1.4 New Zealand obligations under the Protocol

Different countries have different emissions-reduction targets to achieve under CP1; ie, the period between 2008 and 2012 inclusive. New Zealand's CP1 target is to reduce its greenhouse gas emissions to the level they were at in 1990.

The Protocol establishes three “flexible mechanisms”: Joint Implementation, Clean Development Mechanism and International Emissions Trading. They are designed to assist developed countries in meeting their emissions targets at least cost. Under these flexible mechanisms, New Zealand has the opportunity to reduce emissions or increase greenhouse gas removals in other countries at a lower cost than might be possible through domestic measures in New Zealand, and use those emissions savings towards compliance with its target.

If New Zealand fails to reduce emissions to the target level, it will have a further opportunity to acquire sufficient Kyoto units through these flexibile mechanisms to make up the shortfall. Otherwise, the difference (plus a penalty) will be added to New Zealand’s targets in the second commitment period. The Kyoto Protocol envisages that consideration of subsequent commitments for Annex 1 Parties should begin in 2005.

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As a party to the Protocol, New Zealand is also required to establish an emissions unit register for holding and transferring emission units, a national system for estimating anthropogenic emissions, and a means of estimating current domestic carbon stocks (such as in forests) and future carbon stock changes.

2.1.5 International plurilateral and bilateral agreements

A number of multi-party international agreements are seeking to address climate change outside the UNFCCC framework.

Group of 8

The G8 is made up of the governments of Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States, plus the European Union. The United Kingdom has nominated climate change as a key issue for focus during its presidency term of the G8 in the second half of 2005.

At the Gleneagles Summit in July 2005, the G8 plus five major developing countries issued a statement setting out their common purpose in tackling climate change, promoting clean energy and achieving sustainable development. All the G8 leaders agreed that climate change is happening now, that human activity is contributing to it, and that it could affect every part of the globe. They recognised that, globally, greenhouse gas emissions must slow, peak and then decline. They acknowledged that this will require leadership from the developed world and resolved to take urgent action to meet the challenges faced.

A Plan of Action on climate change was developed and involved a commitment to action in several areas, including:

- promoting energy-efficient buildings and appliances
- encouraging the development of cleaner and more efficient vehicles
- supporting efforts to make the use of coal and other fossil fuels for electricity generation cleaner and accelerate the development of carbon sequestration technologies
- promoting the continued development and commercialisation of renewable energy
- supporting efforts to manage the impacts of climate change.

Asia-Pacific Partnership on Clean Development and Climate

Unveiled in July 2005, the Asia-Pacific Partnership on Clean Development and Climate is an agreement between the United States, Japan, Australia, China, India and South Korea to promote and enable the development, diffusion, deployment and transfer of existing and emerging cost-effective, cleaner technologies and practices. Unlike the Kyoto Protocol, the pact does not contain specific timeframes or enforcement provisions, but will aim to "promote economic growth while enabling significant reductions in greenhouse gas intensities". Further details are expected to be fleshed out at a first ministerial meeting of the six founding members.

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New Zealand/Australia and New Zealand/United States bilateral agreements

New Zealand has established climate change partnerships with Australia and the United States to enhance dialogue and practical cooperation on climate change issues. The partnerships predominantly involve collaboration at an implementation level. Key areas of cooperation with Australia include agricultural emissions abatement, energy efficiency, engagement with business and local government and working with Pacific Island countries to address regional challenges posed by climate change. Key areas of cooperation with the United States include technology development, carbon accounting registries, climate change research in Antarctica and product and process standards.

2.1.6 The science of climate change and the role of the Intergovernmental Panel on Climate Change

Recognising the issue of potential global climate change, the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988. It is open to all members of the United Nations and WMO.

The role of the IPCC is to assess the scientific, technical and socio-economic information relevant to understanding human-induced climate change, its potential impacts and options for adaptation and mitigation. It aims to provide comprehensive and unbiased scientific information to all governments as a basis for decision-making. Since its establishment, the IPCC has produced a series of scientific reports and technical guidance documents on greenhouse gas inventories, including a Summary for Policy Makers, which have become standard works of reference by policymakers, scientists, other experts and students.

One of the main outputs of the IPCC is a regular five- to six-yearly comprehensive assessment of current knowledge on the science of climate change, its impacts and adaptation options, and options to reduce net greenhouse gas emissions. The reports have tended to precede major international political decisions: the first assessment report in 1990 was followed by the signing of the UNFCCC in 1992, the second assessment report in 1995 was followed by agreement of the Kyoto Protocol in 1997, and the third assessment report in 2001 was followed by finalisation of the Kyoto Protocol rules and widespread ratification of the Protocol in 2002.

The fourth assessment report of the IPCC is currently in preparation and is due for completion and release in 2007.

In addition to regular assessment reports, the IPCC also produces so-called Special Reports on topics of scientific or technological interest, and Technical Papers that summarise specific issues. It further provides guidance on greenhouse gas inventory reporting and accounting at the request of the parties to the UNFCCC and Kyoto Protocol. The IPCC's guidance and best-practice reports usually become binding methodologies for greenhouse gas reporting once they have been accepted by the Conference of the Parties of the UNFCCC and/or the meeting of the Parties under the Kyoto Protocol.

Scientific information on climate change impacts and related greenhouse gas emissions and concentrations

The IPCC assessment reports have shown an increasing certainty about the occurrence of climate change and its attribution to human activities and the impacts of climate

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change. The scientific and economic analysis of the likelihood of climate change and the potential impacts is extremely complex. It involves three key elements:

- assumptions about future global greenhouse gas emissions
- modelling of climate processes, which capture the relationship between greenhouse gas emissions, the concentration of gases in the atmosphere and the resulting changes in temperature, climate and sea level
- the assessment of the impact of these changes on natural and human systems.

The IPCC has approached the issue of assumptions about future greenhouse gas emissions by projecting "business-as-usual emissions"[5] through the use of global scenarios of socio-economic, political and technological change over the next 100 years, which are described in its Special Report on Emission Scenarios (SRES) (IPCC, 2000b). The emission projections are based on models from a number of independent research groups with a common set of drivers for population growth, economic development in industrialised and developing countries, and development and transfer of technologies. The scenarios describe the possible development of the world along four story lines towards either economic or environmental sustainability goals, and with a focus on either globalisation or regional identification. The IPCC has not associated probabilities with any of these scenarios or temperature increases, but described the complete set of scenarios as spanning the **plausible** range of future emissions, excluding only "disaster" or "surprise" business-as-usual scenarios.

An alternative approach is to explicitly model the effect of stabilising greenhouse gas concentrations on the global climate. The UNFCCC does not specify any level at which greenhouse gas concentrations should be stabilised. The IPCC therefore used, in addition to business-as-usual scenarios, a range of possible stabilisation scenarios ranging from CO_2 concentrations from 450ppm to 1000ppm and also considering the effect of other greenhouse gases.[6]

The IPCC explored the implications of these various emission scenarios for climate change and the associated risks in its Third Assessment Report (IPCC, 2001a-d), along with options and costs of reducing greenhouse gas emissions to achieve stabilisation of greenhouse gas concentrations at a range of levels.

The estimated temperature increase by the year 2100 associated with business-as-usual scenarios ranged from 1.4ºC to 5.8ºC above average temperatures in 1990.[7] For business-as-usual scenarios, substantial further warming above these levels would be expected beyond 2100 (IPCC, 2001a, d; Hansen, 2005).

The IPCC identified five reasons for concern associated with the climate changes accompanying such projected temperature rises (IPCC, 2001b):

- risks to unique and threatened systems, such as coral reefs and individual species

[5] Business-as-usual means that no policies are implemented specifically to reduce greenhouse gas emissions. However, the scenarios do include policies that would result in emissions reductions as co-benefit to addressing other environmental, economic or social concerns (eg, reducing air pollution for health reasons, or developing renewable energy to reduce dependence on foreign oil).

[6] The presence of other greenhouse gases leads to additional warming that also needs to be taken into account when modelling the total effect of stabilising greenhouse gas concentrations on the climate.

[7] The lowest and highest temperature projections are for the lowest emission scenario and the climate model with the weakest response, and the highest emission scenario and the climate model with the strongest response, respectively.

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- extreme climate events, such as changes in the frequency and intensity of droughts, heat waves, floods and storms

- global distribution of impacts; ie, whether only some or most regions of the world would be negatively affected by warming

- aggregate impacts; ie, the overall economic and/or social impacts, and the total number of people negatively affected

- the risk of large-scale and possibly irreversible shifts in the climate system, such as a sudden shift in ocean circulations or melting of ice sheets.

In light of the subjective judgements required to define "dangerous" climate change, the IPCC did not suggest a specific level of warming that might need to be avoided, but limited itself to outlining the identified risks for different levels of climate change that could occur during the 21st century under different emission scenarios. The risks generally increase with higher levels of global warming and with the rate of the warming (IPCC, 2001a, b, d).

Recent additional scientific studies and findings

Substantial scientific work over the past five to six years, following on from the IPCC's last major report, has focused on providing a clearer sense of possible thresholds, to associate major changes in particular ecosystems such as coral reefs to specific degrees of warming, and to better quantify the risk of large-scale changes for any given amount of warming.

A number of recent studies suggest that warming of a few degrees above current levels would lead to clearly identifiable negative impacts for specific ecosystems or regions, including increasing risks of globally significant and possibly irreversible impacts such as changes in ocean circulations and melting of polar ice caps. Examples of such larger-scale and high-impact events with non-negligible probability are outlined below:

- current evidence suggests that a shut-down of the thermohaline circulation during the 21st century may have a probability of between about 5% and 60%, depending on the rate and magnitude of warming and the ocean circulation model. A rapid reduction or even shut-down of the thermohaline circulation would affect the climate and ecosystems in northern Europe, particularly during winter (Vellinga and Wood, 2002; NRC, 2002; ISSC, 2005)

- there is increasing evidence about the vulnerability of the Greenland ice sheet to even modest amounts of warming. A number of studies suggest that irreversible melting, albeit over hundreds to thousands of years, may occur for global warming levels of about 1.5ºC to 2ºC or more above 1990 levels. Melting of the Greenland ice cap would lead to an additional global sea-level rise of up to 7 metres (IPCC, 2001a; Gregory *et al*, 2004; Hadley, 2005; ISSC, 2005)

- a study of the current and projected impacts of climate change on the Artic region, supported by the eight countries with Arctic territories, found that the climate changes already being observed in the Arctic are among the largest on Earth, and are projected to become much greater in future. The changes are expected to have a profound impact on unique individual species, ecosystems, and human societies in

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the Arctic region. Major changes in the Arctic climate, and resulting changes in snow and ice cover, are also expected to have global effects (ACIA, 2004).

A recent expert symposium summarised that "surveys of the literature suggest increasing damage if the globe warms about 1ºC to 3ºC above current levels. Serious risk of large scale, irreversible system disruption, such as reversal of the land carbon sink and possible destabilisation of the Antarctic ice sheets, is more likely above 3ºC." (ISSC, 2005).

Stabilisation of greenhouse gas concentrations to meet possible temperature targets

Given such possible effects of different levels of warming, a key scientific question is what concentrations of greenhouse gases would lead to what degrees of warming in the long term. Answers to this question are complicated by two factors:

- climate models cannot predict with certainty how much the world will warm for a given level of greenhouse gas concentrations, but can only give a range of probabilities for a range of temperature outcomes
- temperature and, in particular, sea level will continue to rise for hundreds to thousands of years after greenhouse gas concentrations have stabilised due to the inertia of the climate system.

Current climate model studies suggest that if CO_2 concentrations were stabilised during the 21st century at 450ppm, the world would warm by about 1.2ºC to 2.4ºC above current levels by 2100, but could warm between 1.5ºC and 3.9ºC above current levels over the next several hundred years. Higher concentrations of greenhouse gases would lead to a higher probability that any given temperature level may be exceeded (IPCC, 2001d; den Elzen and Meinshausen, 2005; ISSC, 2005).

Issues around the analysis of climate change and its impacts

There is growing international consensus around the science of climate change, with the IPCC reports and methodologies generally deemed to be the most authoritative and comprehensive summaries of current knowledge. A large number of independent scientific bodies have expressed their confidence and support for the processes and scientific findings of the IPCC, including the Royal Society of New Zealand and the United States National Academy of Sciences (*Science*, 2001; NAS, 2001). The IPCC's peer review processes and the balance of representation of experts across countries and relevant areas of expertise contribute to the credibility of its work. In areas where there is no clear scientific agreement, the IPCC generally describes the different approaches or models and their differing answers, or describes the range of uncertainty associated with specific projections.

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In some areas, there is ongoing debate within both the scientific and policy communities about the extent to which sound conclusions can be drawn from the currently available scientific evidence. These areas include the extent to which the full impacts of climate change and their costs can currently be estimated and the extent to which the IPCC's business-as-usual emission scenarios span the full range of possible and plausible future emissions. In particular, in recent years there has been significant international discussion on whether the assumptions and methodologies underlying the scenarios for population and economic growth, especially in developing countries, and technology development and transfer are robust.

Aspects of these issues were recently considered as part of an inquiry by the House of Lords in the United Kingdom on the economics of climate change. In its report, the House of Lords highlighted the continued elements of debate around aspects of climate change and expressed concern about a number of aspects of the IPCC analysis and processes, including identifying the need for the links between projected economic change in the world economy and climate change to be more rigorously explored and the need for more rigorous assessment of particular impacts.

The continued debate around scientific and economic analysis of climate change points to the need for New Zealand to continue to engage in international processes to encourage objective and robust assessment of climate change, its impacts and adaptation and mitigation options, and to ensure the New Zealand-specific expertise and information is reflected in IPCC reports. New Zealand scientists are routinely contributing to IPCC reports as authors and reviewers. In addition, the New Zealand Treasury, along with a number of OECD countries, is sponsoring a workshop to be held by the OECD in January 2006, which will consider aspects of economic methodologies underpinning business-as-usual emission scenarios.

Advances in climate science and their impacts, and economic modelling of the costs of impacts and mitigation options, can be expected to reduce the uncertainties associated with climate change projections and responses. However, for the foreseeable future, policy choices will need to continue to be made in a risk management framework that deals with uncertainties and probabilities, rather than absolute predictions about concrete climate events.[8]

2.2 Emissions trends and mitigation responses in selected countries

2.2.1 New Zealand's unique set of challenges

New Zealand faces a unique set of challenges with respect to domestic emissions mitigation. Both the composition and concentration of our emissions differs quite markedly from those of other Annex I countries, and this impacts on the range of available mitigation options.

[8] This situation can be compared with managing the risk of, for example, aircraft engine failure. Engineering cannot predict a specific date and time at which a plane's engines will fail. It can only provide probabilities for a failure to occur at any given time. Governments, airlines and passengers have to decide at what point the risk of failure outweighs the benefits of operating planes and of more stringent safety controls.

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Methane emissions from enteric fermentation, combined with nitrous oxide emissions from agricultural soils, account for almost half of New Zealand's total gross emissions. The comparable figure for the European Union is just 12%. The significance of agriculture in our emissions profile reflects our traditional comparative economic advantage in pastoral land-use activities. This stems from both our resource endowments (temperate climate) and historical trade policies. Agriculture alone contributes around 4.5% of GDP, and total primary-sector produce accounts for around two-thirds of our total exports. The significance of these emissions presents a particular challenge, as cost-effective mitigation options are currently limited.

Other countries with similar emissions contributions from agriculture (such as Argentina) are not only Non-Annex I countries (and hence not facing binding commitments over CP1), but represent some of our key export competitors. Given that New Zealand is a price-taker on the international market, mitigation policies and measures that increase costs to our agricultural producers therefore raise competitiveness and profitability issues for our domestic producers.

For most Annex I countries, carbon dioxide accounts for over 75% of gross emissions. In New Zealand, it accounts for just 46%. This reflects the significant contribution of renewable energy sources (in particular, hydro) to our electricity generation. While the contribution of new renewables (in particular, wind) is projected to increase, the fact that our electricity supply is already relatively low in emissions intensity by world standards means that the scope for mitigation from fuel switching is more limited than for many other countries.

New Zealand's energy use has been shaped by our resource endowments and associated policy background. Our natural energy resources (abundant hydro and coal resources) have contributed to our low electricity prices to date. Combined with historical policies directed at encouraging the manufacturing sector, this has, in turn, attracted energy-intensive industries such as steel and aluminium. Our primary sector also relies heavily on energy for processing and transportation. As a result, our economic structure is focused on producing high energy-intensity commodities. So, while the contribution of CO_2 to our total emissions is low by world standards, our scope for reducing these emissions through structural change appears to be more limited, or at least more gradual, than that of other countries.

The unique profile of our emissions and the high concentration of these in difficult areas has implications for the range of mitigation options available, and the associated costs of domestic mitigation. Together with the particular structure of our economy, this has ramifications for the trade-off between securing domestic emissions reductions and other objectives such as economic growth. While these tensions are becoming increasingly apparent in a number of other Annex I countries, this trade-off is possibly more stark for New Zealand.

In regard to our Kyoto obligations, these challenges are compounded by the 1990 baseline. In 1990, New Zealand was emerging from a period of low growth, associated with significant economic reforms and restructuring. Since then, our growth has been higher than many other Annex I countries, and indeed higher than expected when we ratified the Kyoto Protocol. The 1990 baseline therefore means we begin at a trough and span a period of strong growth – from New Zealand's perspective, an unfortunate confluence of factors.

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A further unique feature of New Zealand is the significance of plantation forestry as a land use. New Zealand's liability under the Kyoto Protocol is potentially vulnerable to changes in land use; specifically, the conversion to other land uses post-2008 of tracts of land that were forested in 1990. At the same time, under the Kyoto sink mechanism the afforestation of new areas since 1990 can be credited as sinks to offset emissions during the period of tree growth. However, when the forest is harvested, under the current rules there is a requirement to "pay back" these credits. Therefore, while plantation forestry is expected to assist New Zealand in meeting its Kyoto obligation, the importance of this land use pre-1990, the changing relative economic returns to forestry and the temporary nature of sinks present particular complexities for New Zealand climate change policy over the longer term.

2.2.2 Annex I countries

This section describes emissions profiles and projections and climate change policies in selected Annex I countries. Annex I countries are broadly industrialised economies. Those Annex I countries that have ratified the Kyoto Protocol have emissions reduction obligations under the Protocol to the UNFCCC. These issues are described in more detail in Section 2.1.1.

United States

Emissions profile and trends

The United States is the world's largest economy, accounting for over one-quarter of the global economy. The United States is also the world's largest energy consumer and the largest greenhouse gas emitter. In 2002, the United States emitted over 6,900Mt CO_2e of greenhouse gas emissions, approximately one-fifth of global emissions. The United States' emissions profile is shown in the graph below. Total energy emissions (comprising electricity and heat, manufacturing and construction, transportation, other fuel combustion and fugitive emissions) add up to 85.3% of overall emissions.

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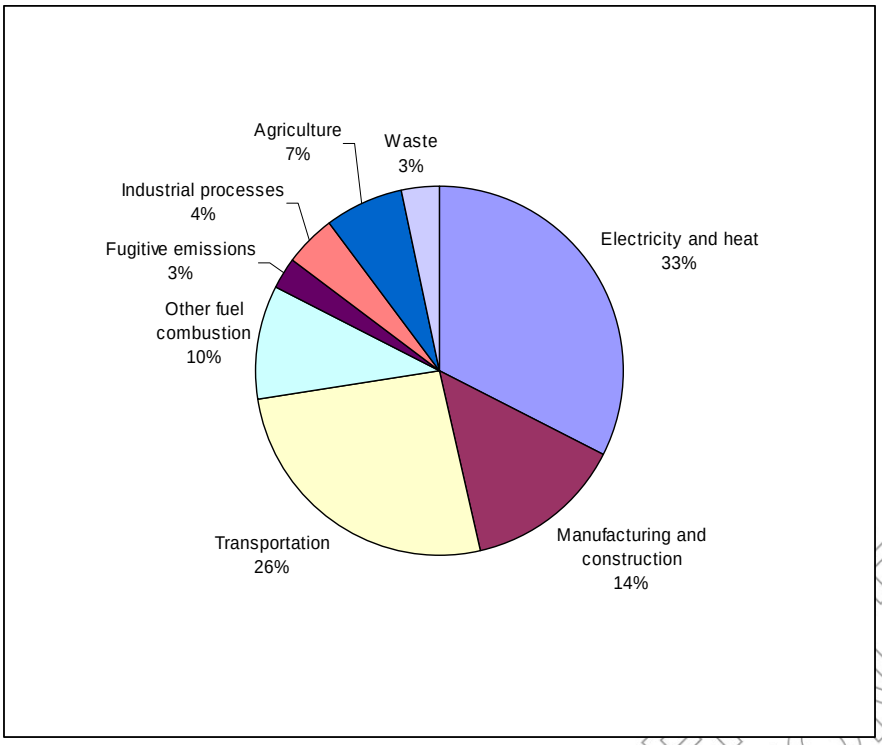
Figure 1 - Greenhouse Gas Emissions by Sector in the United States 2002



Source: World Resources Institute (http://cait.wri.org/)

Between 1990 and 2002, the growth of the United States economy meant that emissions grew by 1.0% per year even though emissions intensity declined. Approximately 85% of United States energy is produced through fossil fuel combustion. The remaining 15% comes from renewable sources such as hydropower, biomass and nuclear energy.

Total United States greenhouse gas emissions are projected to increase by 43% between 2000 and 2020, reflecting continued growth in the economy, while emissions intensity (emissions per unit of GDP) is projected to continue to decline during this period. From 2000 to 2020, energy-related CO_2 emissions are projected to increase by 37%, compared with cumulative projected economic growth of 80%. It is anticipated that oil will remain the most used fuel, continuing to account for around 40% of total primary energy consumption over the projection period.

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Mitigation responses

While the United States has not ratified the Kyoto Protocol, its Government has placed a strong emphasis on research and development of new technologies to reduce emissions. Energy efficiency is also considered a priority. Key actions to reduce emissions, as reported in the United States' third national communication to the UNFCCC in 2002, include:

- promoting greenhouse gas reductions through the development of cleaner, more efficient technologies for electricity generation and transmission, including supporting the development of renewable resources such as solar energy, wind power, geothermal energy, hydropower, bioenergy and hydrogen fuels

- promoting the development of fuel-efficient motor vehicles and trucks, research and development options for producing cleaner fuels, and implementation of programmes to reduce the number of vehicle miles travelled

- implementing partnership programmes with industry to reduce emissions of carbon dioxide, including through use of combined heat and power

- voluntary partnership programmes promoting energy efficiency in commercial, residential and government buildings through technical assistance, as well as the labelling of efficient products, new homes and office buildings

- conservation programmes aiming to reduce agricultural emissions, sequester carbon in soils, and offset overall greenhouse gas emissions

- reducing greenhouse gas emissions from energy use in federal buildings and the federal transportation fleet.

The United States is seeking to work with other countries to share and disseminate information on technologies internationally, and has established the International Partnership on the Hydrogen Economy and the Carbon Sequestration Leadership Forum to coordinate international efforts in these areas.

The 2006 Budget proposed $US5.5 billion for climate change programmes, including the Climate Change Technology Program, the Climate Change Science Program, and climate change-related international assistance programmes. The Budget also proposed energy tax incentives that promote greenhouse gas emissions reductions totaling $US3.6 billion over five years. The incentives are designed to spur the use of cleaner, renewable energy and more energy-efficient technologies that reduce greenhouse gas emissions. The tax incentives include credits for the purchase of hybrid and fuel-cell vehicles, residential solar heating systems, energy produced from landfill gas, electricity produced from alternative energy sources such as wind and biomass, and combined heat and power systems.

Targeted incentives are also provided to encourage wider use of land management practices that remove carbon from the atmosphere or reduce emissions of greenhouse gases.

Australia

Emissions profile and trends

Australia's greenhouse gas emissions are shown in the graph below. Total emissions in 2002 equated to 517Mt CO_2e. Total energy emissions (comprising electricity and heat, manufacturing and construction, transportation, other fuel combustion and fugitive emissions) add up to 71.8% of overall emissions.

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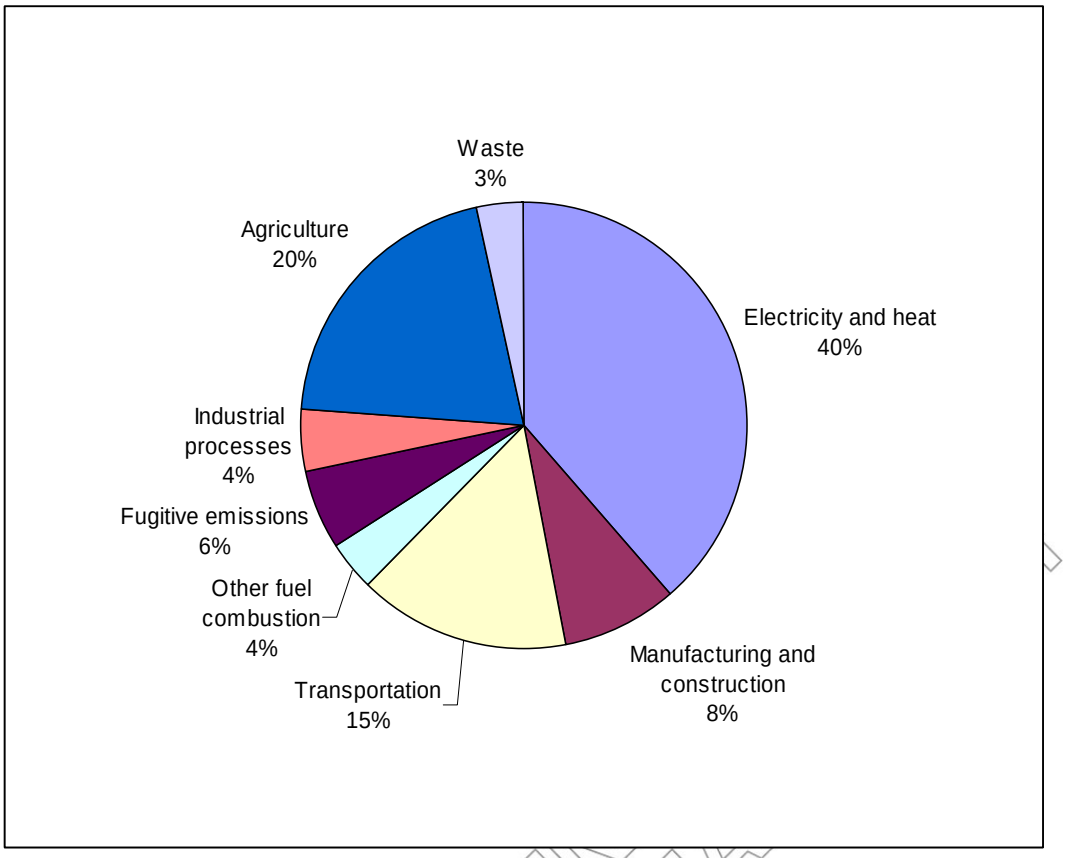
Figure 2 - Greenhouse Gas Emissions by Sector in Australia 2002



Source: World Resources Institute (http://cait.wri.org/)

Livestock are the principal source of emissions within the agricultural sector. Land-use change and the forestry sector are a net source of emissions in Australia rather than a net sink (although this is not represented in the graph above).

Australia is very dependent on fossil fuels for energy – they account for nearly 94% of Australia's energy inputs. Australia has an abundant coal resource and, consequently, its reliance on coal for energy (in particular, brown coals or lignites) is double the OECD average. This is exacerbated by limited hydro-resources, and public and environmental concerns preventing the use of nuclear energy.

Between 1990 and 2002, Australia's emissions grew by 1.7% per annum. Based on projections reported in Australia's third national communication to the UNFCCC in 2002, emissions across all sectors are estimated to reach 580Mt CO_2e in 2010 – a 16% increase over 1990 levels. The projection of emissions includes greenhouse gas abatement from policy measures that are projected to deliver, in aggregate, a reduction of 59Mt CO_2e in 2010.

Australia has not ratified the Kyoto Protocol and therefore is not bound by its emissions targets. Nevertheless, an assessment of Australia's emissions projections according to Kyoto target rules shows that over the period 2008 to 2012, emissions will be 11% above 1990 levels on average, indicating that Australia would exceed its Kyoto target of 8% above 1990 levels.

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Mitigation responses

Australia has established a whole-of-government Commonwealth agency – the Australian Greenhouse Office – to coordinate climate change policy and deliver greenhouse programmes. It has developed a strategic framework of policies and measures for advancing its domestic greenhouse action across all sectors of the economy – the National Greenhouse Strategy. Under the National Greenhouse Strategy, 86 individual measures are grouped into eight sectoral "modules" and reflect a broad range of policy approaches, from voluntary action and strategic investment to regulation and market measures.

Mitigation programmes include:

- the $AU400 million Greenhouse Gas Abatement Program (GGAP) established in 1999, which supports large-scale, cost-effective and sustained abatement by industry and the community

- the Greenhouse Friendly Program, a voluntary certification and labelling initiative designed to engage consumers on climate change issues and greenhouse gas abatement

- strategies to improve the efficiency of energy supply and use, including efficiency standards to move fossil-fuel electricity generators toward best practice, an Energy Efficiency Best Practice Program for key sectors, minimum energy-efficiency standards in the Building Code of Australia, and comparative energy labelling and minimum energy-performance standards for domestic appliances, commercial products and industrial equipment

- the Mandatory Renewable Energy Target, which was introduced in 2000 and requires wholesale energy purchasers to purchase increasing amounts of electricity generated from renewable sources, towards a target more than 50% above 1997 levels of renewable energy generation by 2010

- a National Green Power Accreditation Program established by a number of state and territory governments, under which electricity customers can elect to pay a premium to their energy retailers for the supply of electricity generated from renewable sources

- rebate programmes for solar hot water heaters, implemented by several states and territories

- a fuel consumption labelling scheme introduced by the Commonwealth in January 2001, under which all new cars sold in Australia are required by law to carry a fuel consumption label on the windscreen at the point of sale

- Commonwealth programmes (costing $AU83 million) aimed at increasing the use of alternative fuels, especially CNG and LPG, especially in medium-to-heavy road vehicles

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- a strategic framework for greenhouse and agriculture, being prepared under the auspices of the Commonwealth's Greenhouse and Agriculture Taskforce, which will identify priority actions, information needs and abatement options for key agricultural industries.

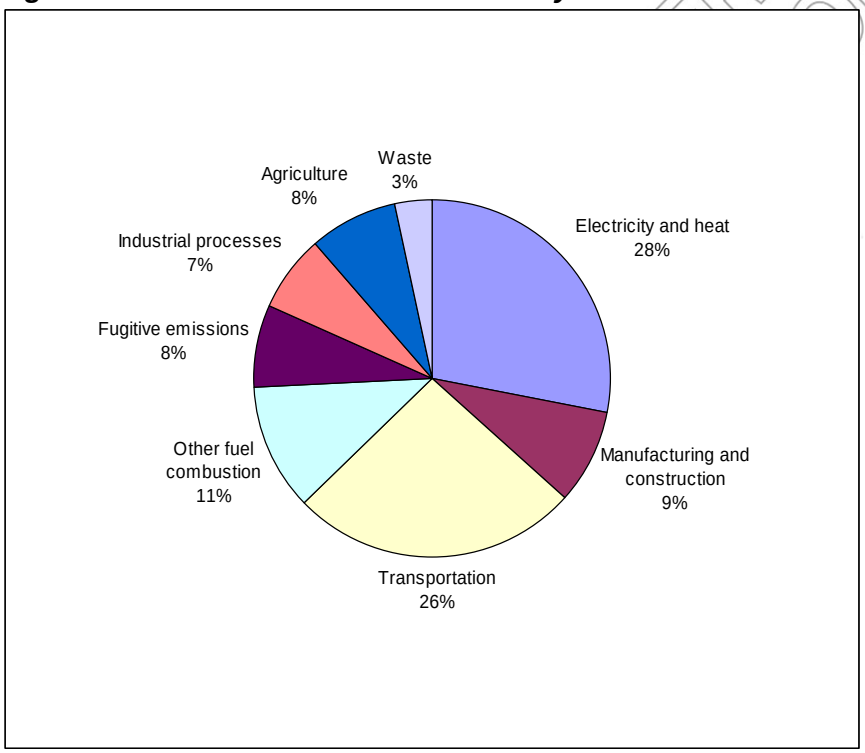
Significant resources are dedicated domestically to developing emissions-reducing technologies. The Cooperative Research Centre for Greenhouse Gas Technologies researches the logistic, technical, financial and environmental issues of storing industrial carbon dioxide emissions in deep geological formations. The Cooperative Research Centre for Clean Power from Lignite aims to develop technologies to reduce greenhouse gas emissions from lignite-fired power stations while enhancing Australia's international competitiveness from low-cost energy.

Canada

Emissions profile and trends

Canada's greenhouse gas emissions are shown in the graph below. Total emissions in 2002 equated to 725.2Mt CO_2e. Total energy emissions (comprising electricity and heat, manufacturing and construction, transportation, other fuel combustion and fugitive emissions) add up to 81.7% of overall emissions.

Figure 3 - Greenhouse Gas Emissions by Sector in Canada 2002



Source: World Resources Institute (http://cait.wri.org/)

On a *per capita* basis, Canada ranks ninth in the world for carbon dioxide emissions due to a variety of factors, in particular its energy-intensive economy. Between 1990 and 2002, Canada's emissions grew by 1.5% per annum. Significant economic and population growth played major roles in this emissions growth.

Based on projections reported in Canada's third national communication to the UNFCCC in 2002, emissions across all sectors are estimated to reach 705Mt CO_2e in 2010 – a 16% increase over 1990 levels. Canada's commitment under the Kyoto Protocol is to reduce anthropogenic greenhouse gas emissions to 6% below 1990 levels during the 2008 to 2012 commitment period.

Mitigation responses

In April 2005, Canada's Government released a new national climate change plan, *Moving Forward on Climate Change: A Plan for Honouring our Kyoto Commitment*. The plan combines regulatory, negotiated, and incentive-based approaches. It anticipates mandatory emission intensity caps for major greenhouse gas-producing sectors, but also relies heavily on government-funded purchases of emissions reductions, both domestically and through the Kyoto Protocol's flexibility mechanisms. Key elements of the plan are described below:

- the Large Final Emitters System is a mandatory market-based programme aiming to reduce emissions to 45Mt below business-as-usual in the mining, manufacturing, oil, gas and thermal electricity sectors, which account for roughly half of national emissions. The cost of compliance is capped at $CA15 per tonne of CO_2e (approximately $US13). Specifics, including emissions allocation among sectors and companies, are still to be determined. Companies investing in technological research and development through a new GHG Technology Investment Fund will be eligible for emission credits (up to 9Mt total), which can be used to meet their targets

- in a memorandum of understanding with the Auto Sector, auto manufacturers agreed to reduce carbon dioxide, methane, nitrous oxide, and hydrofluorocarbon emissions from light-duty passenger cars and trucks by 5.3Mt or 6% below business-as-usual by 2010 (in line with a previous government pledge to achieve a 25% efficiency improvement)
- through a new Climate Fund, the Government intends to purchase 75Mt to 115Mt of reduction credits a year, up to 40% of the total reduction needed in CP1. Priority will be given to domestic reductions from farmers, forestry companies, municipalities, and other sources (including Large Final Emitters that do better than their targets). Purchases will be made on a competitive basis. Reductions also will be purchased through the Kyoto mechanisms, with safeguards against the purchase of so-called "hot air". The Government agreed to allocate $CA1 billion per year over the next five years and projects funding of $CA4 billion to $CA5 billion during 2008 to 2012

- a new Partnership Fund will support government-to-government agreements at the federal, provincial and territorial levels to jointly pursue emissions-reduction projects, including short- and long-term climate change technology investments and infrastructure development. The Government has agreed to allocate $CA500 million per year over the next five years and anticipates that this funding of $CA2 billion to $CA3 billion could result in 55Mt to 85Mt annual reductions in 2008 to 2012

- a quadrupling of the Wind Power Production Incentive will provide $CA200 million over the next five years to achieve a projected 4,000 MW increase in wind generating capacity. The Renewable Power Production Incentive will provide $CA97 million over the next five years to increase capacity from small hydroelectric, biomass, tidal, and other renewable sources by a projected 1,000 MW. Other incentives include increasing the capital cost allowance to 50% for highly efficient cogeneration equipment and other renewable technologies. Incentives, tax measures, and related provincial measures are expected to result in a 15Mt annual reduction in 2008 to 2012.

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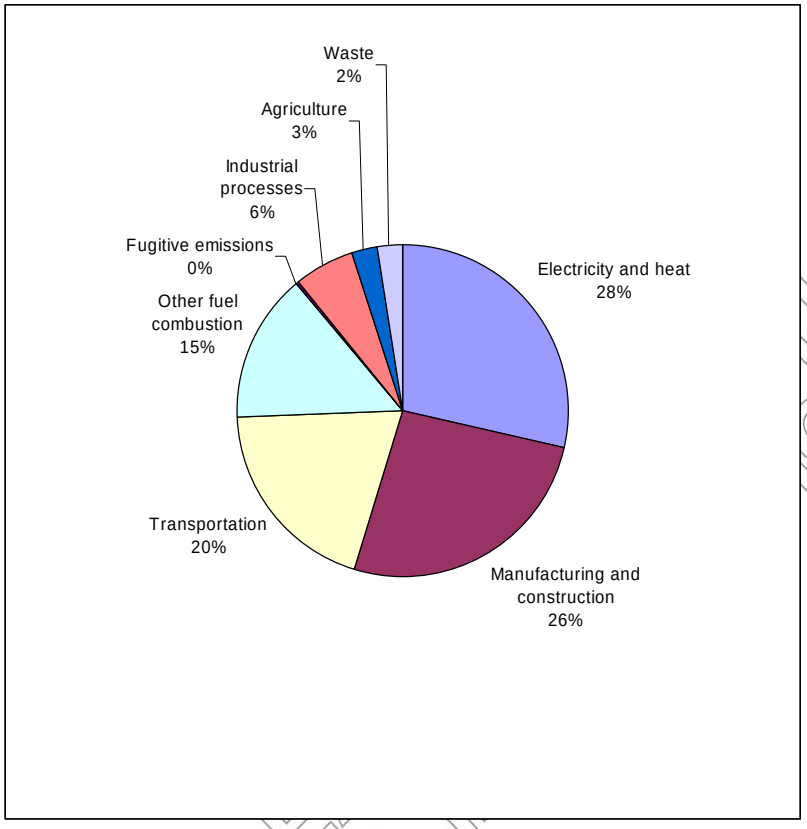
Japan

Emissions profile and trends

Japan's greenhouse gas emissions are shown in the graph below. Total emissions in 2002 equated to 1,330.8Mt CO_2e. Total energy emissions (comprising electricity and heat, manufacturing and construction, transportation, other fuel combustion and fugitive emissions) add up to 89% of overall emissions.

Figure 4 - Greenhouse Gas Emissions by Sector in Japan 2002



Source: World Resources Institute <http://cait.wri.org/>

Between 1990 and 2002, Japan's emissions grew by 1.0% per annum. Based on projections reported in Japan's third national communication to the UNFCCC in 2002, emissions across all sectors are estimated to decrease to 1,317Mt CO_2e in 2010 – a total increase of less than 1% over 1990 levels. Under the Kyoto Protocol, Japan is required to reduce emissions by 6% from 1990 levels during CP1.

Mitigation responses

The Global Warming Prevention Headquarters was established in Japan in 1997. A new strategy *Guideline for Measures to Prevent Global Warming* was concluded in March 2002. The guideline stipulates more than 100 policies and measures designed to help Japan meet its Kyoto commitment. Measures include:

- promoting technology development in the industrial sector and distributing results
- promoting the introduction of high-performance industrial furnaces
- promoting energy-management systems in large-scale office buildings, through regulatory measures

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- promoting high-efficiency water heating in residential and commercial premises
- accelerating the development and distribution of low-emission vehicles, including clean-energy vehicles
- improving traffic flow by introducing Intelligent Transport Systems
- improving the efficiency of freight services, including the promotion of modal shift to shipping
- promoting the use of public transportation
- supporting market introduction of photovoltaic power generation, solar thermal utilisation, wind power generation, waste power generation and biomass energy
- subsidising the cost of converting old coal-fired power generation to natural gas generation
- promoting nuclear power generation
- aiming to halve the volume of waste disposed in landfills
- promoting research and development in energy-efficient steel production processes and chemical processes, energy-efficient electric appliances, and a high efficiency electricity distribution system
- promoting a range of energy-efficient measures, including changing incandescent lighting to fluorescent lighting, efficient refrigerator use, and other general behaviour change.

European Union

Emissions profile and trends

The European Union consists of 25 individual countries (the EU-25). Under the Kyoto Protocol, the European Union has elected to receive an overarching emissions target for CP1 and distribute emissions allowances under this target among member countries. The European Union's greenhouse gas emissions are shown in the graph below. Total emissions in 2002 equated to 4,123.3Mt CO_2e. Total energy emissions (comprising electricity and heat, manufacturing and construction, transportation, other fuel combustion and fugitive emissions) add up to 81.2% of overall emissions.

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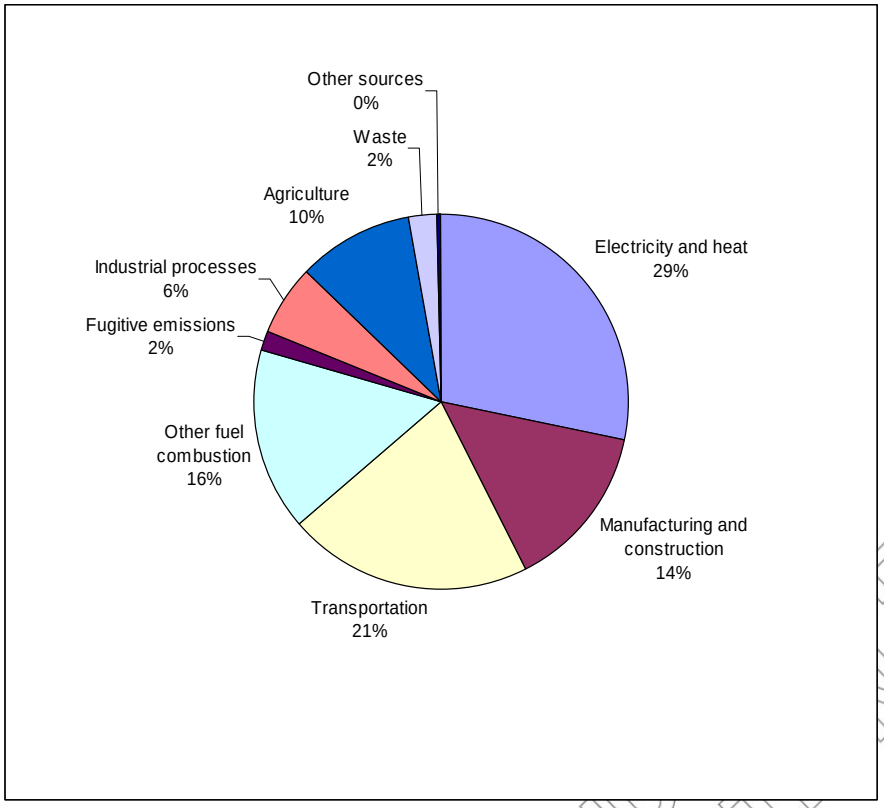
Figure 5 - Greenhouse Gas Emissions by Sector in the European Union 2002



Source: World Resources Institute (http://cait.wri.org/)

Between 1990 and 2002, the European Union's emissions decreased by 0.2% per annum. Large increases of CO_2 emissions from transport were outweighed by reductions from fossil-fuel combustion in energy and manufacturing industries. CH_4 emissions account for 9% of total European Union greenhouse gas emissions and decreased by 17% between 1990 and 1999. The main reasons for declining CH_4 emissions were reductions in solid waste disposal on land, the decline of coal mining and falling cattle numbers.

Based on projections reported in the European Union's third national communication to the UNFCCC in 2002, emissions across all sectors are estimated to reach 4,190Mt CO_2e in 2010 – almost no change from 1990 levels. The European Union's aggregate target under the Kyoto Protocol is to achieve average annual emissions 8% below 1990 levels for 2008 to 2012.

Mitigation responses

Key points agreed by the European Union Council on future action include:

- a commitment to limiting temperature increases to 2ºC
- supporting continued use of market mechanisms (eg, the European Union Emissions Trading Scheme) in a future regime
- identifying the reduction of greenhouse gases from bunker fuels as urgent
- recognising the UNFCCC as the vehicle for moving forward on a future framework.

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Since the launch of the European Climate Change Programme, a considerable number of European Union measures have been adopted. Most importantly, the European Union has implemented an emissions-trading scheme covering approximately 50% of CO_2 emissions in the EU-25, notably of the energy-intensive sectors, so as to achieve emissions reductions in the most cost-effective and flexible way. In addition, the "linking directive" establishes the provisions and rules for enabling economic operators to use credits from JI and CDMs for compliance within the emissions-trading scheme.

Further actions on climate change include:

- undertaking an inventory and review of energy subsidies in the member states, with consideration to compatibility with climate change objectives
- supporting renewable energy sources through the new directive and by ensuring adequate support in the liberalised energy market
- using market instruments; eg, through the adoption of proposals for energy taxation
- promoting energy saving on heating and cooling in buildings
- environmental agreement with industry on energy efficiency and reducing specific emissions
- proposing a comprehensive approach to aviation emissions, including research into cleaner air transport, better air-traffic management, the removal of legal barriers to taxing aircraft fuel, and including aviation in the European Union Emissions Trading Scheme
- highlighting climate change as a major theme of European Union policy for research and technological development and in the coordination of research in the member states.

Norway

Emissions profile and trends

Norway's greenhouse gas emissions are shown in the graph below. Total emissions in 2002 equated to 55.3Mt CO_2e. Total energy emissions (comprising electricity and heat, manufacturing and construction, transportation, other fuel combustion and fugitive emissions) add up to 66% of overall emissions.

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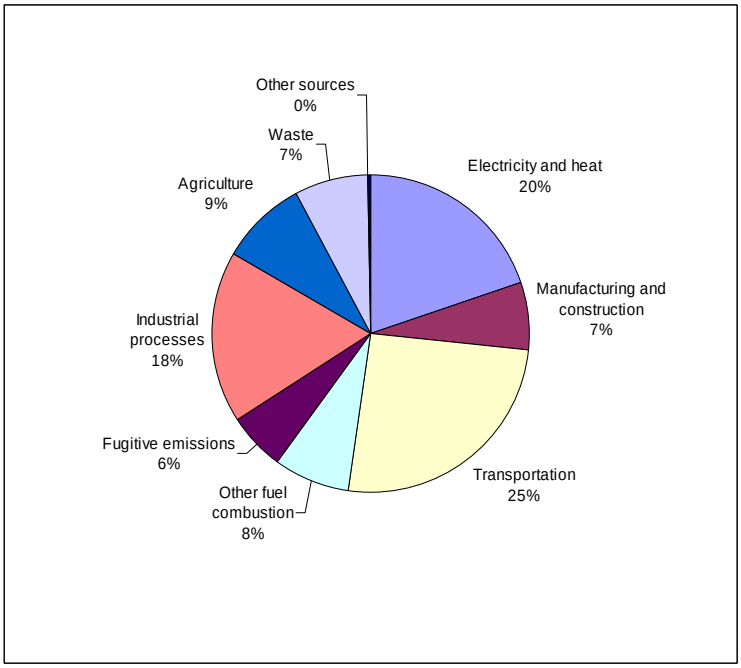
Figure 6 - Greenhouse Gas Emissions by Sector in Norway 2002



Source: World Resources Institute (http://cait.wri.org/)

In 2002, petroleum and other fossil fuels accounted for 37% of Norway's domestic energy use (including transport), hydropower accounted for 56% and other renewable energy sources accounted for about 7%.

Between 1990 and 2002, Norway's emissions increased by 0.5% per annum. The increase is mainly explained by general economic growth, which has resulted in higher CO_2 emissions from most sectors. Since electricity is generated almost exclusively from hydropower, emissions from stationary combustion are dominated by industrial sources.

Based on projections reported in Norway's third national communication to the UNFCCC in 2002, emissions across all sectors are estimated to reach 63.2Mt CO_2e in 2010 – an increase of 22% over 1990 levels. Norway's target under the Kyoto Protocol is to achieve average annual emissions 1% above 1990 levels for 2008 to 2012. The increase in greenhouse gas emissions from 1990 to 2010 is mostly driven by an increase in CO_2 emissions, which alone are expected to rise by 36%. Consumption of petroleum products is expected to grow at about 0.5% per year from 1999 to 2010. Consumption of electricity is assumed to grow at about 1% per year during this period. The rate of energy efficiency improvement varies between sectors but is assumed to average about 1% per year.

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Mitigation responses

The first Norwegian measure that directly addressed greenhouse gas emissions, a tax on CO_2, was introduced in 1991. This tax is still in force and covers about 65% of CO_2 emissions at various rates up to NOK315 per tonne ($US35). High rates apply to petrol and activities on the continental shelf, and lower rates on the use of mineral oils. Exemptions apply mainly to emissions from energy- and emissions-intensive industries that are exposed to international competition. A tax on final waste treatment was introduced in 1999. One reason for this was climate change concerns. The tax discourages landfilling and encourages energy recovery from waste.

Discharge permits pursuant to the *Pollution Control Act* are required for major industrial developments. Permits have been granted for three combined-cycle gas-fired power plants, but the developers have still not decided whether to make the investments. The Government has stated that it wishes to create a framework that would promote a "CO_2-free" solution for these plants, and incentives are provided through exemption from the electricity tax. No further permits will be granted for the development of fossil-fuelled power plants before CP1 under the Kyoto Protocol.

An electricity tax offers incentives for most users to use less electricity and thus discourages the installation of new capacity based on fossil fuels. Wind power is subject to the electricity tax at half the normal rate and, like other new renewables, it is exempted from the investment tax. There are also grant schemes for new renewables and for energy-efficiency measures. In the 2002 supplementary white paper on climate policy, the Government introduced a target of a 25% reduction of the use of mineral oils for heating in 2008 to 2012 compared with 1996 to 2000.

In the transport sector, fiscal and CO_2 taxes on fuels provide the strongest incentive to limit emissions. The purchase tax also provides an incentive to buy lighter, more energy-efficient vehicles. There are extensive subsidies for public transport. From July 2002, car producers have been obliged to include information on fuel efficiency and CO_2 emissions in their marketing. The Government plans to expand this to other types of vehicles. Funds have been allocated to encourage research, development and testing into alternative fuels, electric and hybrid vehicles.

Most greenhouse gas emissions from energy- and emissions-intensive industries are not subject to the CO_2 tax. However, measures have been taken that have significantly reduced emissions from aluminium, magnesium and fertiliser production. The Government has proposed that emissions from these industries that are currently not subject to the CO_2 tax should be included in a mandatory domestic emissions-trading scheme from 2005.

One of Norway's objectives is to increase the use of new renewable energy sources, and the Government will develop a strategy for the use of renewable energy sources instead of petroleum for heating.

Russia

Emissions profile and trends

Russia's greenhouse gas emissions are shown in the graph below. Total emissions in 1999 equated to 1873.5Mt CO_2e. More recent data on Russian emissions is not yet available. Total energy emissions (comprising electricity and heat, manufacturing and construction, transportation, other fuel combustion and fugitive emissions) add up to 90% of overall emissions.

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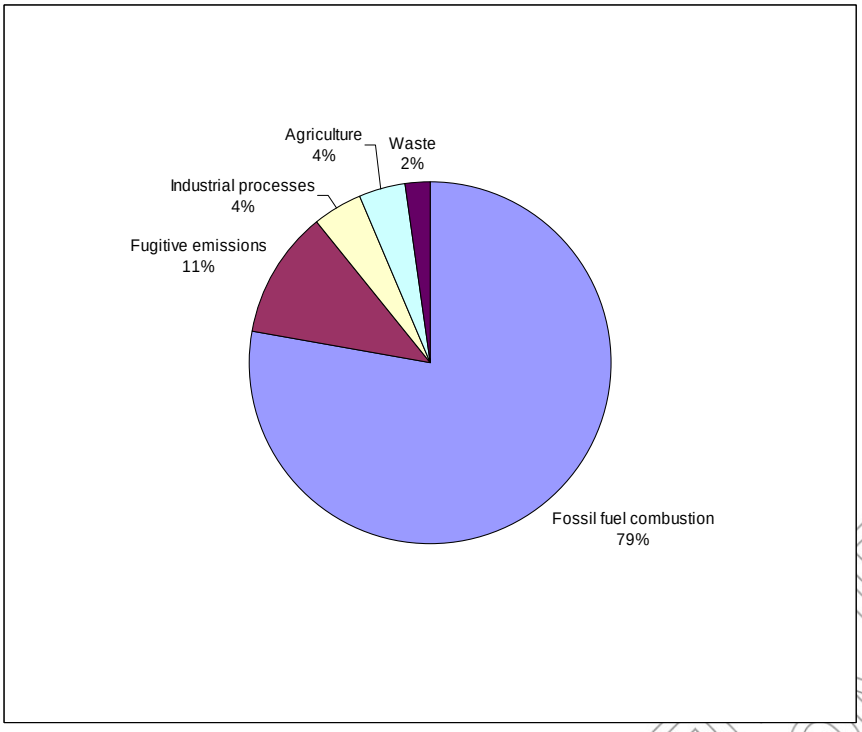
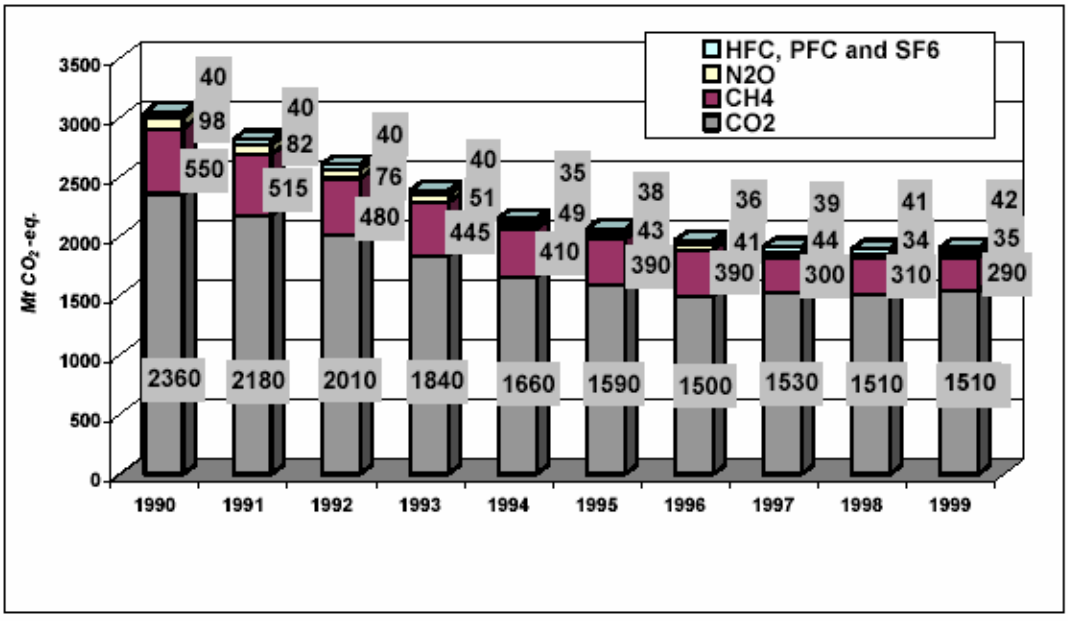
Figure 7 - Greenhouse Gas Emissions by Sector in Russia 1999



Source: Third national communication of the Russian Federation

Between 1990 and 1999, Russia's emissions decreased by over 1,100Mt CO_2e , largely due to the closure of emissions-intensive heavy industries over this period. Emissions trends between 1990 and 1999 are illustrated below. While CO_2 emissions have fallen, the carbon intensity of the Russian economy remains high **[withheld under OIA s6(a)]**

Figure 8 - Absolute Change in Russian Greenhouse Gas Emissions 1990-1999



Source: Third national communication of the Russian Federation

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Based on Russia's third national communication to the UNFCCC, Russia's CO_2 emissions are projected to equal between 75% and 89% of 1990 levels at 2010. Projections of other fossil fuels have not been undertaken. Russia's target under the Kyoto Protocol is to achieve average annual emissions equivalent to 1990 levels for 2008 to 2012.

Mitigation responses

Russia's programme for mitigating greenhouse gas emissions is at a formative stage. Due to the dominance of CO_2 emissions from fossil fuels in Russia's emissions profile, it has stated a focus of its strategies will be on reducing CO_2 from electricity generation. In 2000, the *Basic Provisions of the Energy Strategy for Russia for the Period to 2020* was approved by the Government. The key aim for the strategy is to seek the most efficient utilisation of natural resources and energy for improving the quality of life of the population. More generally, substantial increases in the energy efficiency of the economy is considered among the core tasks in achieving social and economic recovery for Russia. Russia is also seeking opportunities to mitigate emissions in the agriculture and forestry sectors, including improving soil fertility in Russia, and improving systems for the collection, storage and use of animal manure.

2.2.3 Assessment

In reviewing the emissions profiles of Annex I countries, it is evident that emissions are generally energy-based. Among the countries reviewed, energy emissions accounted for between 66% (Norway) and 90% (Russia) of total emissions. New Zealand, and to a lesser extent Australia, vary from this trend with significant contributions coming from agricultural emissions (as is the case with many Non-Annex I countries).

Looking across Annex I and Non-Annex I countries, it is clear that the emission of greenhouse gases is distributed unevenly across the world. A dozen countries (including both developed and developing) account for around three-quarters of the world's carbon emissions. Global emissions are also projected to continue to grow. The World Energy Outlook predicts carbon dioxide emissions will increase internationally by 63% between 2002 and 2030. This emphasises the importance of a few large emitting countries in moving towards a global climate change solution.

The United States is the world's largest emitter, accounting for approximately one-fifth of global emissions. United States emissions are projected to increase by 43% between 2000 and 2020 - consistent with anticipated emissions trends in many other Annex I countries. Engaging the United States and other Annex I countries in international climate change efforts will continue to be vital.

While carbon dioxide emissions in Russia are likely to grow during CP1, emissions will remain below 1990 levels due to the heavy economic recession of the 1990s. Aggregate emissions from the European Union are projected to remain steady through to 2010, although this will still exceed the Kyoto target of an 8% reduction on 1990 levels. Increased emissions are likely in several individual European Union countries. **[withheld under OIA s6(a), s9(2)(g)(i)]** In some countries, including Canada and New Zealand, this position has prompted reviews of domestic measures. A number of countries are also developing strategies for purchasing emission units to make up their anticipated Kyoto shortfall.

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Policies targeting emissions reductions in Annex I countries cover a broad range, including:

- price-based measures (including international emissions trading)
- regulations
- grants
- researching and adopting new technologies
- labelling and promoting energy savings among households and the transport sector
- voluntary industry targets.

While the United States and Australia have not ratified the Kyoto Protocol, they are directing significant domestic resources to a climate change solutions. Policies are focused on energy-efficiency improvements and energy-technology developments.

The United States and Australia were founding members of the *Asia-Pacific Partnership on Clean Development and Climate*, which aims to promote the use of technology development in achieving a global solution to climate change, while protecting economic growth. The United States also leads the *International Partnership on the Hydrogen Economy* and the *Carbon Sequestration Leadership Forum*, coordinating international efforts in developing and diffusing these technologies.

2.2.4 Non-Annex I countries

Emissions information collection and reporting present very significant challenges for Non-Annex I countries. Many Non-Annex I countries have only recently submitted their first national communication to the UNFCCC, and some of these communications report only on 1994 data. Authorities have noted particular difficulties in collecting reliable estimates of agricultural and land-use change emissions. This issue affects the feasibility of applying any kind of quantitative target and reporting requirement on developing countries. Establishing the domestic knowledge and reporting systems that would allow this would be a significant undertaking.

To date, the focus of developing countries' mitigation measures has been on non-price measures, including:

- education and awareness raising, sometimes through the formal education system
- the creation of standards, including vehicle emissions performance standards and building-efficiency standards
- the use of energy-efficiency labelling, such as of appliances.

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Some developing countries have emphasised the importance of technology development in achieving future emissions mitigation. China and India are forecast to continue to rely on coal for energy generation, while the contribution of renewable energy to their total energy supplies is expected to decline through to 2030. Although overall energy intensity in both countries is also forecast to decline by around 2.3% a year, this will not be sufficient to significantly curb emissions growth. Developing and transferring technologies that allow more efficient use of fossil fuels, or the offsetting of emissions through the sequestering of carbon, are therefore likely to be critical factors in curbing emissions growth.

This section presents information on emissions and climate change responses in selected Non-Annex I countries.

Argentina

Emissions profile and trends

Argentina has a similar sectoral emissions profile to New Zealand, as shown in the graph below. Total energy emissions (comprising electricity and heat, manufacturing and construction, transportation, other fuel combustion and fugitive emissions[9]) add up to 50% of overall emissions.

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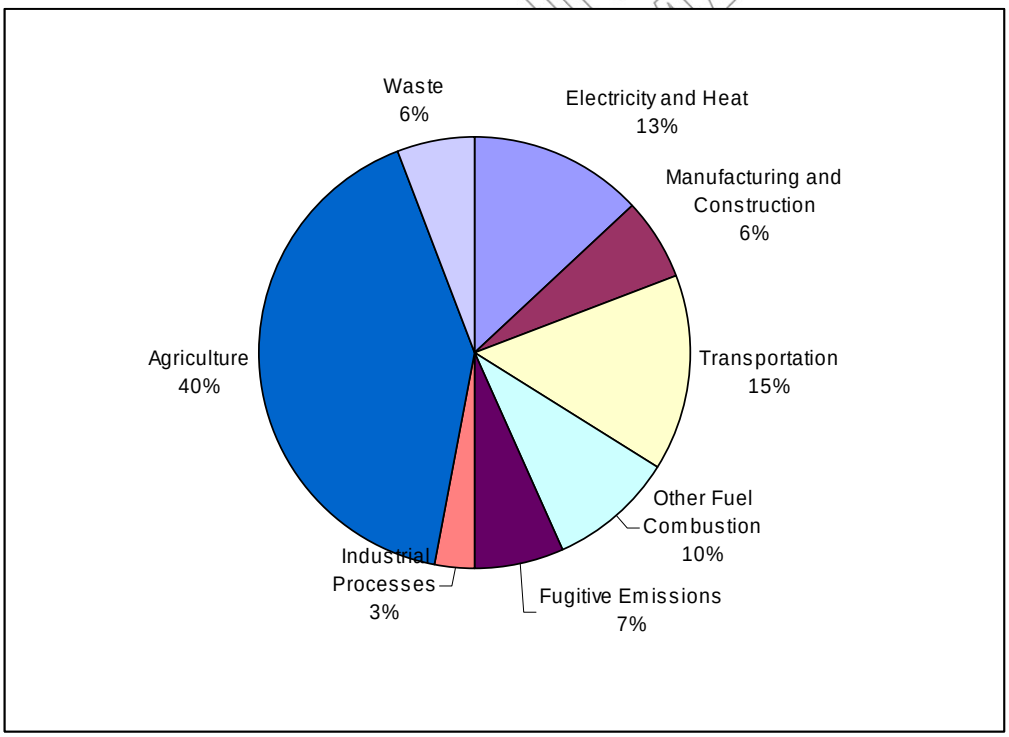
Figure 9 - Greenhouse Gas Emissions by Sector in Argentina 1997



Source: World Resources Institute (http://cait.wri.org/)

[9] Fugitive emissions are unintended leakages of greenhouse gases during their processing, transmission and/or transportation, or during their use; eg, CFCs from refrigeration leaks.

In comparison, New Zealand's emissions in 2003 comprised 43% from energy, 49% from agriculture, 5% from industrial processes and 2% from waste. Argentina's total emissions in 1997 were around four times greater than New Zealand's 2003 emissions, although Argentina's emissions *per capita* and emissions intensity still remain well below the OECD average.

Natural gas is the primary means of electricity generation in Argentina. As in New Zealand, bovine cattle are the principal source of emissions from the agricultural sector.

Between 1990 and 1997, Argentina's gross emissions increased by 21%, although the growth rate eased towards the end of this period. This easing resulted from a move to more efficient electricity generation derived from more environmentally sound technologies (eg, a move to combined-cycle plants), the replacement of road vehicles with more efficient ones, and a reduction of the cattle population.

A 1999 study published by the UNEP projected that Argentina's energy greenhouse gas emissions would grow by an average of 3.5% per year between 1994 and 2020 under a business-as-usual scenario. It is estimated that this average growth rate can be reduced to 2.6% if a variety of mitigation measures are employed.

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Mitigation responses

Existing and contemplated policies that will contribute to emissions abatement include:

- improving energy efficiency by facilitating the adoption of efficient technologies
- replacing the use of fuel oil with natural gas in combined-cycle power stations
- encouraging the development of forest plantations to provide carbon sinks
- adopting financial support measures to promote the development of wind energy
- resolving to progressively reduce natural gas emissions from oil wells
- encouraging flaring of methane emissions from sanitary landfills, rather than combustion
- reducing emissions from the agricultural sector by improving the production system with better diets and managing an increased proportion of animals in confined conditions
- promoting "no till" and "low till" land-use practices to reduce fuel consumption for agricultural purposes
- examining potential hydroelectric power opportunities to offset or replace thermal generation
- contemplating the use of co-generation plants as a mitigation option for industrial activities
- promoting the use of compressed natural gas in the transport sector.

Argentina sees the CDM[10] as a significant opportunity for emissions mitigation and currently has around 75 projects in the pipeline.

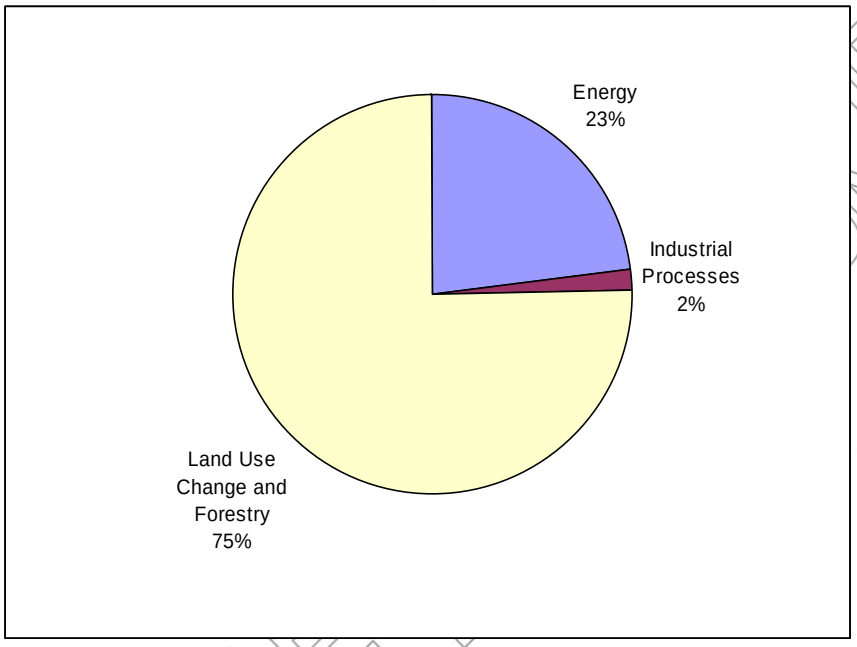
Argentina has established a dynamic greenhouse gas emissions target based on its GDP. The aim of such a target is to allow Argentina to continue its socio-economic progress while still providing a goal for emissions reductions.

Brazil

Emissions profile and trends

The majority of Brazil's greenhouse gas emissions are carbon dioxide. Brazil's carbon dioxide emissions profile is shown in the graph below.

Figure 10 - Carbon Dioxide Emissions by Sector in Brazil 1994



Source: Brazil's national communication to the United Nations Framework Convention on Climate Change (2004)

[10] The Clean Development Mechanism is one of three Kyoto flexible mechanisms.

Joint Implementation (JI) is a project-based mechanism designed to assist Annex I countries in meeting their emission reduction targets through joint projects with other Annex I countries, meaning that JI projects can only be implemented between capped industrialised countries. One or more investors (governments, companies, funds etc) will agree with partners in a host country to participate in project activities which generate Emission Reduction Units (ERUs), in order to use them for compliance with targets under the Kyoto Protocol.

The Clean Development Mechanism (CDM) is a similar instrument, but based on agreements between Annex I and Non-Annex I (or developing) countries. Both JI and CDM offer possibilities for project-based emission reduction "credits", referred to as "emission reduction units" for JI and "certified emissions reductions" for transfer of credits from Non-Annex I countries envisioned in CDM.

International Emissions Trading (IET) is a flexibility mechanism of the Kyoto Protocol which allows the trade of Assigned Amount Units (AAUs) among Annex B countries. This activity may be delegated by national governments to entities within their jurisdictions so that international trading between entities will occur. This will adjust each nation's "pool" of AAUs.

Of the land-use change and forestry emissions, 96% were from forest conversion to agricultural activities. Low-energy emissions arise from Brazil's low overall energy intensity and high proportion of renewable energy. In 2000, around 94% of electricity delivered to the national grid was from hydroelectric sources. Of the remainder, a significant amount was produced with nuclear energy (around 1.5%) and biomass (around 3%). Generation of electricity in the country emits almost no greenhouse gases.

Since the oil shocks of the 1970s, ethanol (manufactured from sugarcane) has been used in Brazil as a transport fuel, both blended with petrol and as a pure alcohol in specially designed vehicles. In 2002, biofuels provided 13% of road transport fuel. Sugar-cane bagasse and charcoal are used in industry in place of coal, which results in significant emissions savings. Overall, Brazil's energy system is one of the least carbon intensive in the world.

Between 1990 and 1994, overall emissions in Brazil grew by 5%, largely based on a 16% growth in emissions in the energy sector. The World Energy Outlook projects that Brazil's energy-related carbon dioxide emissions will double by 2030, albeit from a low base.

Mitigation responses

Brazil's government runs a number of programmes to improve energy efficiency and conservation. Programmes include PROCEL, which aims to reduce electricity waste and promote the adoption of more energy-efficient technologies; CONPET, which aims to rationalise the use of oil and gas products without affecting levels of activities in economic sectors; and PRODEEM, which aims to supply electricity to isolated communities from local renewable sources.

Natural gas is a growing energy source in Brazil and incentive policies have been developed to encourage its use where this will avoid the use of other emissions-intensive sources (such as fuel oil), including in thermal electricity generation. In the domestic production of natural gas, a programme has been initiated to reduce the degree of gas flaring, which will also reduce carbon dioxide emissions.

Attempts have been made to expand education, public awareness and training on climate change issues. The National Environmental Education Programme aims to promote broad education of environmental issues in Brazil, and the "PROCEL in schools" and "CONPET in schools" programmes aim to expand the awareness of teachers and students on the importance of using electricity, oil products and natural gas efficiently. Government-operated websites on climate change also contribute to increasing public awareness.

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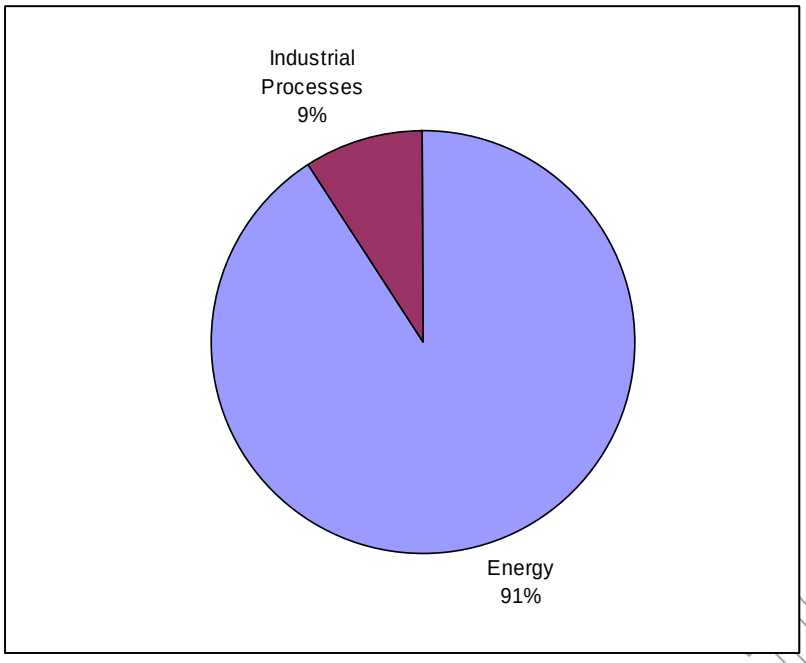
China

Emissions profile and trends

China is the second-largest economy and the second-largest consumer of primary energy in the world (after the United States). It currently accounts for 12% of global GDP and primary energy demand. In 1994, China's total greenhouse gas emissions equated to 3,650 million tonnes of carbon dioxide equivalent, also making China the second-highest greenhouse gas emitter. Carbon sinks and land-use change offset around 400 million tonnes of carbon dioxide. Around 73% of total emissions were carbon dioxide. China's carbon dioxide emissions profile is shown in the graph below.

Figure 11 - Carbon Dioxide Emissions by Sector in China 1994



Source: The People's Republic of China Initial national communication on Climate Change (2004)

About 80% of China's electricity production is derived from fossil fuels, predominantly coal. China is the highest consumer of coal in the world. Most of the remaining generation comes from hydro. Poverty and lack of access to modern energy are still widespread in China. In recent times, acute power shortages have hampered economic development. Demand for energy is projected to continue to grow strongly. Significant new electricity plant development (primarily powered by coal) is being progressed and is expected to continue.

The World Energy Outlook 2004 forecasts that China's demand for coal will continue to expand, accounting for 53% of the worldwide increase in coal demand through to 2030. Use of nuclear generation in China is also predicted to grow strongly. Overall, China's dependence on energy imports is projected to increase.

Continuing population growth and increased urbanisation, economic development and consumption, and a continued reliance on coal, mean that greenhouse gas emissions in China are likely to grow significantly in the future. The World Energy Outlook projects emissions growth of 2.8% per year through to 2030. China is predicted to overtake the United States as the largest emitter of greenhouse gases by around 2025.

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Mitigation responses

Since the 1980s, the Chinese Government has carried out wide-ranging reforms in the energy sector to promote technical progress and increase the sector's efficiency. Other policies that will contribute to emissions abatement include:

- introducing finance, credit and taxation incentives to reduce consumption of energy and other resources by the industrial sector
- setting development goals and policies for energy development and conservation
- introducing policies and measures to foster the development of new, renewable energy, including wind, small-scale hydro, biogas, solar and geothermal technologies in rural areas
- establishing energy-efficiency standards, labelling and certification processes and launching a national energy conservation publicity week
- establishing standards for energy conservation in the building and construction sector
- developing and applying substitute fuels for motor vehicles, including gas-powered vehicles
- conserving and improving pastures and forest lands, including establishing loans for afforestation
- introducing administrative regulations, policies and criteria for waste management to help prevent pollution from waste treatment
- implementing programmes to improve education, training and public awareness on climate change, predominantly through the education system.

China is a founding member of the recently formed Asia-Pacific Partnership on Clean Development and Climate, which aims to develop and share climate change mitigating technologies.

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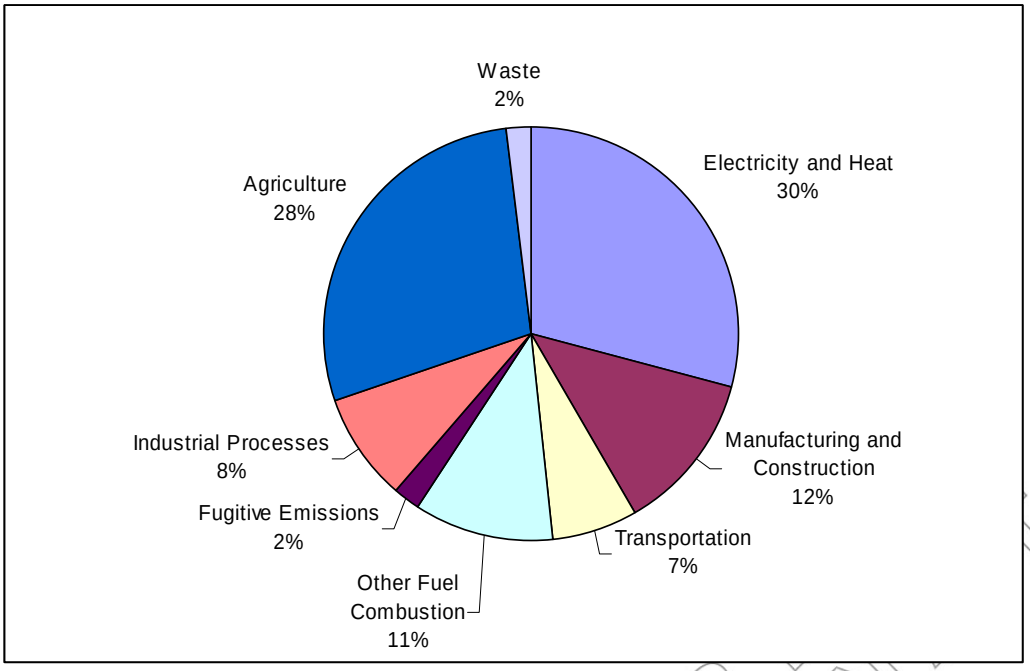
India

Emissions profile and trends

India has the world's second-largest population and fourth-largest economy. Its economy grew at a rate of almost 6.6% per year during the 1990s, nearly doubling in size over that time. Energy use grew even faster, at a rate close to 7%, while the demand for electricity grew at 8% per year. Despite this growth, India's *per capita* electricity use averaged only one-sixth of the world average in 1994. Its *per capita* carbon dioxide emissions also rank among the lowest in the world, averaging 4% of the United States *per capita* carbon dioxide emissions in 1994 and 23% of the global average.

India's greenhouse gas emissions profile is shown in the graph below. Total energy emissions (comprising electricity and heat, manufacturing and construction, transportation, other fuel combustion and fugitive emissions) add up to 61% of overall emissions. A total of 70% of India's energy is derived from fossil fuels, with coal making up 47% of commercial energy use.

Figure 12 - Greenhouse Gas Emissions by Sector in India 1994



Source: World Resources Institute <http://cait.wri.org/>

The World Energy Outlook projects that India's use of coal and nuclear energy will grow significantly, as will its dependence on energy imports. Carbon dioxide emissions are projected to grow at 2.9% per year to 2030, more than doubling over this period.

Mitigation responses

Education and public awareness on the efficient use and conservation of energy has been a key focus for India, with a number of government ministries undertaking publicity campaigns, establishing best-practice resource centres and running training programmes. Other policies that will contribute to emissions abatement include:

- establishing a Bureau of Energy Efficiency to promote energy efficiency and conservation, and setting energy-efficiency targets for motors, lighting and energy-intensive industries

- undertaking regulatory reforms to promote competition in the electricity, petroleum and coal markets, to help enhance the technical and economic efficiency of energy use, and to encourage investment in the development of natural gas infrastructure to replace more carbon-intensive forms of energy

- promoting the use of renewable energy through financial support to hydroelectric developments and upgrading existing hydro stations, using solar photovoltaic power systems for a variety of decentralised applications and extending distributed solar, hydro and biomass generation to rural and remote areas

- improving transport fuels, including unleaded petrol and low-sulphur petrol and diesel, introducing a programme to blend 5% ethanol in petrol, and making CNG and LPG available in some cities

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- introducing vehicle emissions performance standards (in 2000) and increasing these to European-level norms for new cars and passenger vehicles in major cities (in 2002)

- introducing agricultural initiatives focused on improving the energy efficiency of irrigation, improved animal feeds and digesters, and rationalisation of power tariffs and

- introducing initiatives to maintain or enhance existing forest land for ecological reasons, including afforestation programmes by government power organisations..

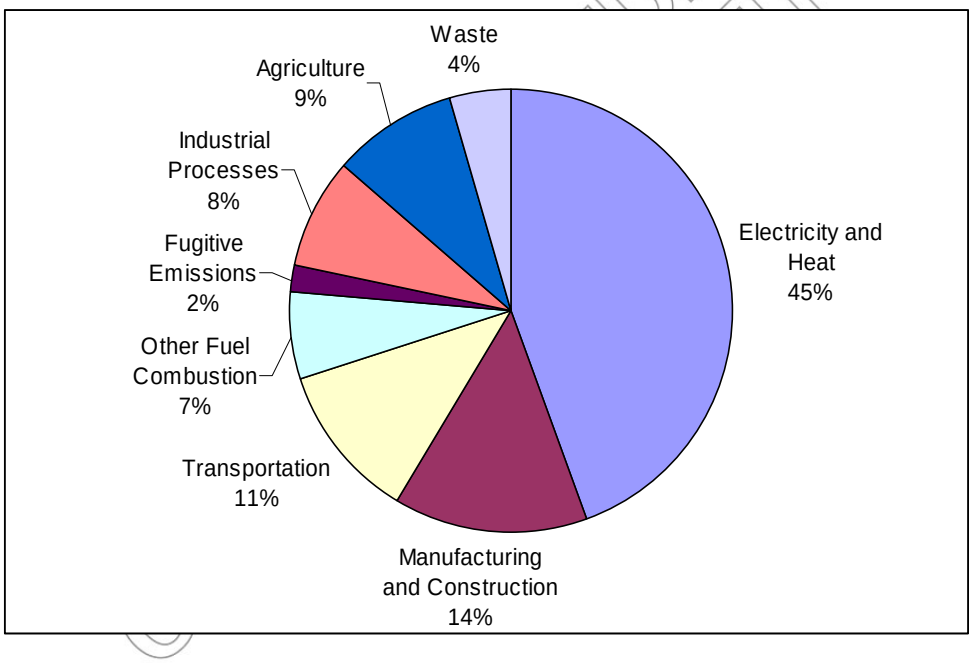
India is a founding member of the recently formed Asia-Pacific Partnership on Clean Development and Climate, which aims to develop and share climate change mitigating technologies.

South Africa

Emissions profile and trends

South Africa's greenhouse gas emissions profile is shown in the graph below. Total energy emissions (comprising electricity and heat, manufacturing and construction, transportation, other fuel combustion and fugitive emissions) add up to 78% of overall emissions.

Figure 13 - Greenhouse Gas Emissions by Sector in South Africa 1994



Source: World Resources Institute <http://cait.wri.org/>

The high level of emissions from energy relates to the high energy intensity of the South African economy, which is dependent on large-scale primary extraction and processing, particularly in the mining and minerals industries. Coal currently provides 90% of the energy for electricity generation and is expected to continue to be the dominant source of electricity until 2040, given South Africa's abundant reserves. Total emissions increased by 9% between 1990 and 1994.

Mitigation responses

South Africa has stated that its approach to specific greenhouse gas mitigation measures is currently (in 2000) at only an exploratory phase. It has identified that the major potential for domestic mitigation is in the energy sector and has identified a national target for energy-efficiency improvements of 12% by 2015. The intention is to meet this target through a mix of economic instruments and regulatory tools, as well as energy-management programmes. A voluntary target of a 10,000 GWh contribution of renewable energy by 2013 has also been set, to be produced mainly from biomass, wind, solar, small-scale hydro and bio-fuels.

Existing programmes aim to foster the development of off-grid energy sources, including solar, wind and solar water heating. For existing fossil-fuel generation, technologies are being investigated and developed to make coal-fired power stations less polluting and more efficient.

The South African Government has acknowledged the need to increase general awareness of climate change and build the government sector's capacity to consider this issue. The formal education system has been identified as a potential means for creating awareness of climate change and creating a future shift in attitudes.

An *Air Quality Act* was passed in 2004, which provides a regulatory framework to set emission standards for priority pollutants including greenhouse gases. Public transport measures are being investigated, including introducing incentives to use bio-fuels. The use of building-standard regulations to improve energy efficiency is being examined.

Assessment

In reviewing the emissions of Non-Annex I countries, it is clear that emissions profiles vary considerably across countries. Agriculture and land-use change often play a more critical role for developing countries than for developed (which tend to generate most emissions from energy). These emissions profiles are fundamentally tied to the economic structure, comparative advantage, energy resources and level of development of these countries (such as the mining industry in South Africa, the use of bio-fuels in Brazil, agricultural emissions in Argentina).

Emission intensities in developing countries tend to be well below those in developed nations, as illustrated below.

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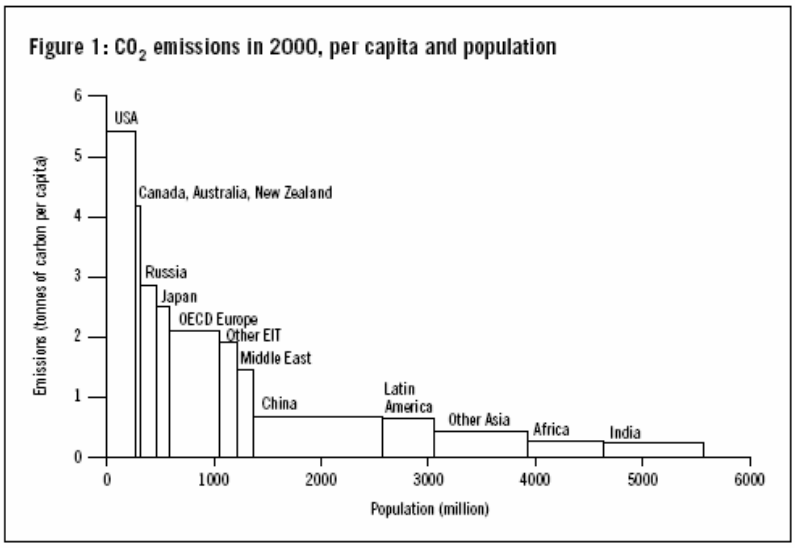
Figure 14 – CO_2 Emissions in 2000, per Capita and Population



Source: Grubb, M (2003) "The Economics of the Kyoto Protocol". *World Economics* 4(3), July to September 2003

This figure also illustrates the significant potential for global emissions growth if developing-country emissions intensities climb towards industrialised world levels. For most countries reviewed, projections indicate that continued growth in total emissions can be expected for the next 25 years. The significant and increasing contribution of China and India, in particular, to total global emissions has considerable implications. These two countries currently contribute approximately 15% and 5% of global emissions respectively, and their total emissions are projected to double between 2002 and 2030. Engaging developing countries, including China and India, in slowing the growth of their emissions in the future will therefore be critical to achieving the UNFCCC's ultimate goal of stabilising the climate.

In general, New Zealand as an Annex I member is faced with greater pressures to take actions to address the issue of climate change. However, New Zealand also competes with developing countries in some international markets. This creates a risk that some New Zealand firms may experience relative losses of competitiveness as a result of being subject to more stringent climate change measures than firms in other countries. However, other factors such as labour or raw-material costs will typically be stronger determinants of competitiveness. This issue may arise most often in relation to price-based measures, which can directly increase firms' costs.

Development needs of Non-Annex I countries may create a tension with emissions reductions. India and South Africa in particular have highlighted that climate change is just one of a number of pressing issues they are trying to address, including poverty eradication, providing basic services (including energy, water, education and health services) and moving to a market-based economy. **[withheld under OIA s6(a)]** These characteristics need to be taken into account in any future consideration of climate change responsibilities.

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In the absence of specific emissions targets, Non-Annex 1 countries have continued to seek viable emissions-reduction opportunities. Countries reviewed have all acknowledged the considerable threat posed by climate change and their desire for a solution through international actions. However, an overriding view remains that constraining developing-country emissions should not be at the expense of economic growth and that developed countries need to take the lead in actions to address climate change.

2.3 The future: Possible post-2012 frameworks and implications for New Zealand

Summary

This section:

- summarises approaches to a post-2012 international framework for climate change that have been developed in an array of international think-tank dialogues
- identifies some key issues of interest for New Zealand.

It concludes that:

- two distinct approaches – "top-down" and "bottom-up" – are apparent from these dialogues
  - top-down approaches seek to define emission targets in the near term based on long-term climate change outcomes and assume an international framework based around binding emission targets for industrialised countries
  - bottom-up approaches generally focus on technology development and sector-specific policies and measures
- some of the ideas that have been explored contemplate significantly more stringent emission reductions than New Zealand is required to meet during the first Kyoto commitment period
- the evolution of a post-2012 international framework will entail important risks and opportunities that need careful management as New Zealand engages in international processes.

While there is clear international support for the UNFCCC to continue as the primary forum for intergovernmental discussion on climate change, there is currently no agreement by parties to the Convention to begin considering future action beyond 2012. "Post-2012" or "beyond-2012" are commonly used to describe future action on climate change, with 2012 being the final year of CP1. The future of intergovernmental commitments delivered through the UNFCCC is uncertain beyond that point. Under Article 3.9, the Kyoto Protocol requires Parties to initiate consideration of future commitment periods in 2005

In the absence of formal UNFCCC consideration, many ideas for a post-2012 international climate change regime have been developed in an array of informal think-tank "dialogues"

– often involving government experts acting in an individual capacity – or through workshops and publications by independent research institutes. These think tanks, with some exceptions (eg, the Pew Center) tend to focus on how to achieve multilateral engagement under the framework of the UNFCCC. Some of these ideas were also explored in a recent discussion paper prepared by the Canadian Government in its capacity as host of the forthcoming United Nations Climate Change Conference (Environment Canada, Foreign Affairs Canada, 2005).

2.3.1 Possible post-2012 frameworks

Most of these dialogues have recently been summarised in work by the Pew Center and the OECD (Pew Center, 2004; OECD, 2005a). Two broad groupings of mitigation ideas can be seen:

- top-down approaches focusing on long-term outcomes and emission targets
- bottom-up approaches focusing on technology and supporting policies, voluntary agreements and partnerships.

Top-down approaches: long-term outcomes and emission targets

This first grouping of ideas generally sits within a quantitative or top-down approach. This approach is generally based on explicit consideration of aggregate global greenhouse gas emissions over some time period, guided by views (and underpinning science) about the risks of climate change associated with greenhouse gas concentrations in the atmosphere.

This type of approach generally assumes that all (or most) industrialised countries take on fixed and binding emission targets, but developing countries do not. An international carbon market (perhaps with some price-cap mechanism) is sustained through international emissions trading. In some countries, targets might be taken on at a sub-national level. There has also been discussion of what role agreements between sector-specific transnational companies might play as part of such a framework.

This core policy framework is then supplemented by various ideas for how developing countries might be engaged. These generally are a mix of ideas for policies and measures plus some form of evolution or transformation of the CDM. Proposals for economy-wide emission-intensity targets and dynamic sectoral "crediting baselines" are being actively analysed and discussed in a range of fora. Beyond general agreement that the concept has merit, discussions have encountered a number of difficulties in trying to make the concept work in practice. There are also some ideas for fully including developing countries in an overall targets and trading framework in this next step of the international regime; eg, under some kind of emissions- per-capita formula that provides developing countries with surplus allowances. But these face many political obstacles.

Supporters of this approach to seeking multilateral agreement generally also believe that it is urgent that emissions in the coming one to two decades need to be reduced significantly from current trends and projections. This reflects an assessment that if this is not done, options to eventually stabilise atmospheric greenhouse gas concentrations at required low levels will have been foregone or will become prohibitively costly. It also reflects the concern that critical thresholds in the climate system could be crossed with severe global effects that cannot be reversed, even if greenhouse gas concentrations are reduced later.

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Top-down approaches are generally based around an explicit long-term climate change goal, expressed either as a maximum-acceptable temperature rise or as a target for the stabilisation of greenhouse gas concentrations (expressed in CO_2 or CO_2-equivalent (CO_2e)). Working backwards from such long-term targets, short-term emission goals are derived as necessary milestones along the way (den Elzen and Meinshausen, 2005).

Bottom-up approaches: technology and supporting policies and measures

The second grouping of ideas generally does not sit within a quantitative, top-down frame or its attendant timing concerns. These ideas tend to be of a "policies and measures" nature; eg, agreements to adopt specific technology uses over time (such as in the transportation or power generation sectors) or to adopt managed low-carbon price paths (such as through harmonised carbon charges or price-capped domestic emissions trading schemes). While some of these ideas may be framed as quantitative in nature, the metric is not emissions in general and specifically not about aggregate global emissions, except perhaps in the very long-term sense. Some proponents of these ideas still see a role for a carbon market. This might be created, for example, by a projects-like "offsets" approach, where commitments to specific policies and measures can be met by some other action, perhaps in another country. Moreover, at a domestic level, countries could choose the policy of a cap-and-trade emissions-trading scheme for some of their emission sectors. It may also be possible for these schemes to be linked with schemes of other countries or regional groups. Many technology-based approaches tend to aim for climate change outcomes as well as co-benefits in the area of energy security, air pollution and reduced resource consumptions.

The label generally put to this second grouping of ideas is "bottom-up". This is because an overall outcome is more likely to emerge from a mosaic of domestic, bilateral and perhaps regional initiatives. These approaches are generally not framed against the objective of achieving an explicit emissions target within a particular timeframe. Further, an overarching multilateral agreement per se is not normally envisaged. Some experts who favour this "policies and measures plus market" approach share the assessment commonly underpinning the top-down approach that there is an urgent need to address climate change. However, they consider that a negotiation process leading to a top-down outcome is not feasible in the near term, citing the difficulties experienced with Kyoto. In this view, a bottom-up approach, with substantive non-binding undertakings by those who are party to it, may be the more achievable short- to medium-term solution (OECD, 2003).

Approaches to obligations and commitments

Both top-down and bottom-up approaches have explored a broad range of targets and other obligations that countries might be asked to adopt. Binding emission targets could take any number of forms, but three of the most commonly discussed are: absolute (fixed) national emissions targets (as in the current Kyoto Protocol regime), dynamic intensity targets (eg, expressed as a ratio of emissions to GDP) and per-capita emissions targets. Technology agreements could spell out coordinated approaches to research and development funding, market development, and joint demonstration projects. Policies and measures might include pledges by countries towards adopting certain standards or percentages of low-emitting technologies, which may or may not be combined with broader market mechanisms (OECD, 2005a).

The role of adaptation in future agreements

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The past years have seen an increasing push for considering adaptation in the UNFCCC and possible post-2012 regimes. Developing countries are seeking greater emphasis on adaptation as part of any future international agreement, given the limited resources they have to manage adverse impacts of climate change and their typically lower per-capita emissions. Success in balancing adaptation and mitigation efforts and expectations is generally seen as crucial to the success of any future multilateral negotiations. Any successful future adaptation framework will very likely require support by Annex I countries for adaptation in developing countries through multilateral funds, targeted support mechanisms for capacity building and climate modelling, and specific assistance for the most vulnerable countries. Think tanks are only beginning to consider the possible role of adaptation in future agreements and how to ensure efforts and needs are measurable and comparable between countries (OECD, 2005a, 2005b; CCAP, 2005).

Different vulnerabilities and perspectives of developing countries on adaptation also mean that the most vulnerable developing countries, such as low-lying Pacific Islands, could begin to argue for mitigation actions in future agreements not only by developed countries but also by large developing countries. Clear statements of this kind have already been made in fora outside the UNFCCC (eg, in the 33rd Pacific Islands Leaders' Forum), but are yet to appear in formal climate change negotiations.

2.3.2 Possible post-2012 frameworks: issues for New Zealand

Taking a broad-brush look at the many possibilities for post-2012 being discussed mostly offline, but beginning to be raised by some parties in more formal discussions, it is possible to distil some key issues of interest to New Zealand.

Top-down approaches and implied emission targets

Much of the work emerging from (mostly European) think tanks brings a top-down approach to post-2012 frameworks (Climate Action Network, 2002; German Advisory Council on Global Change, 2003; International Task Force on Climate Change, 2005).

The official policy goal of the European Union to limit global warming to less than 2°C above pre-industrial levels implies that global greenhouse gas concentrations would need to stabilise at 450ppm CO_2e to provide a 50/50 chance of not exceeding this target. Such long-term goals are used to derive medium-term emission targets of 15% to 30% below 1990 levels by 2020 for Annex I countries, but would also require major developing countries to limit their further emissions growth (den Elzen and Meinshausen, 2005).

Other long-term targets based on higher temperature targets, or higher risk of exceeding the temperature limit, would result in less stringent medium-term emission targets (Wigley 2004). However, most plausible long-term targets would still require ongoing and significant emissions reductions in the medium and long term.

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[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

To date, the New Zealand Government has taken no formal position on the desirability of a specific long-term temperature or concentration target in future climate change agreements.

Developing countries and competitiveness

The discussion of top-down approaches has not contemplated developing countries taking on, at least for the foreseeable future, targets that could restrict their economic growth. The possibility of providing developing countries with positive incentives has been raised; eg, through "no lose" targets. However, for this to be effective, developed countries would need to take on more stringent binding targets.

[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

To date, New Zealand has advocated that future agreements would require "broad and balanced participation by all major emitters", by implication including key developing countries. The criteria for "broad and balanced participation" have not, however, been specified.

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[withheld under OIA s6(a), s9(2)(g)(i)]

[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

Annex I and Non-Annex I framework and differentiation

Much of the work under way in think tanks has taken as a given the principle of "common but differentiated responsibilities" within the UNFCCC, with the Annex I and Non-Annex I classification being a key aspect of this. While there has been some examination of possible ways to differentiate within Non-Annex I – mostly centred on how groupings of countries might "graduate" from easy to more difficult commitments over time – there has been very little consideration of possible differentiation within Annex I. One paper that has considered this grouped New Zealand with a number of other Annex I countries in a middle tier of future commitments. The United States and Australia were in the first (hardest) tier.

[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

Adaptation

Future agreements are likely to involve greater and more comprehensive efforts to support adaptation.

[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

Land use, land-use change, and forestry (LULUCF)

There is often little consideration of how LULUCF might fit into possible frameworks. The issue is considered difficult and complex and other sectors are receiving far greater attention. To date, LULUCF has been an important focus for New Zealand, given the value of sinks in helping New Zealand meet its obligations in CP1.

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New Zealand is currently actively engaged in technical and policy discussion on LULUCF. Continued engagement will take time and resources.

Emissions *per capita*

Emissions *per capita* are used in some proposals as an indicator on which to base various commitments. New Zealand does not come out positively on this scale, largely due to its high share of agricultural emissions.

Existence of a carbon market

A particular feature of the Kyoto Protocol is that it has supported the emergence of a market for greenhouse gas emissions. The existence of binding commitments has driven the development of the European Emissions Trading Scheme System. Moreover, the Kyoto arrangements provide for flexibility mechanisms that allow for the sale and purchase of emissions reductions, facilitating the identification and exploitation of the lowest-cost emission-reduction options.

[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

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[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

New Zealand has been a strong advocate of international market mechanisms in the design of the Kyoto Protocol.

2.3.3 Conclusion

The uncertainty surrounding the international framework for climate change post-2012 is apparent from the divergence between the top-down and bottom-up ideas that have to date been explored outside the formal UNFCCC processes. This uncertainty presents particular challenges in framing domestic climate change policy.

[withheld under OIA s9(2)(g)(i), s9(2)(j)]

Section 6 discusses a possible position and strategy for the forthcoming UNFCC Conference of the Parties in Montreal.

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3 New Zealand domestic context

3.1 New Zealand's emissions profile and the economy

Summary

This section:

- describes the composition of New Zealand's emissions and compares this with other countries' profiles
- explores the growth in New Zealand's emissions since 1990
- given the growing role of carbon dioxide in New Zealand's emission profile, explores the link between energy and economic growth
- considers the relationship between economic growth and emissions, comparing New Zealand's experience with that of other key Annex I countries.

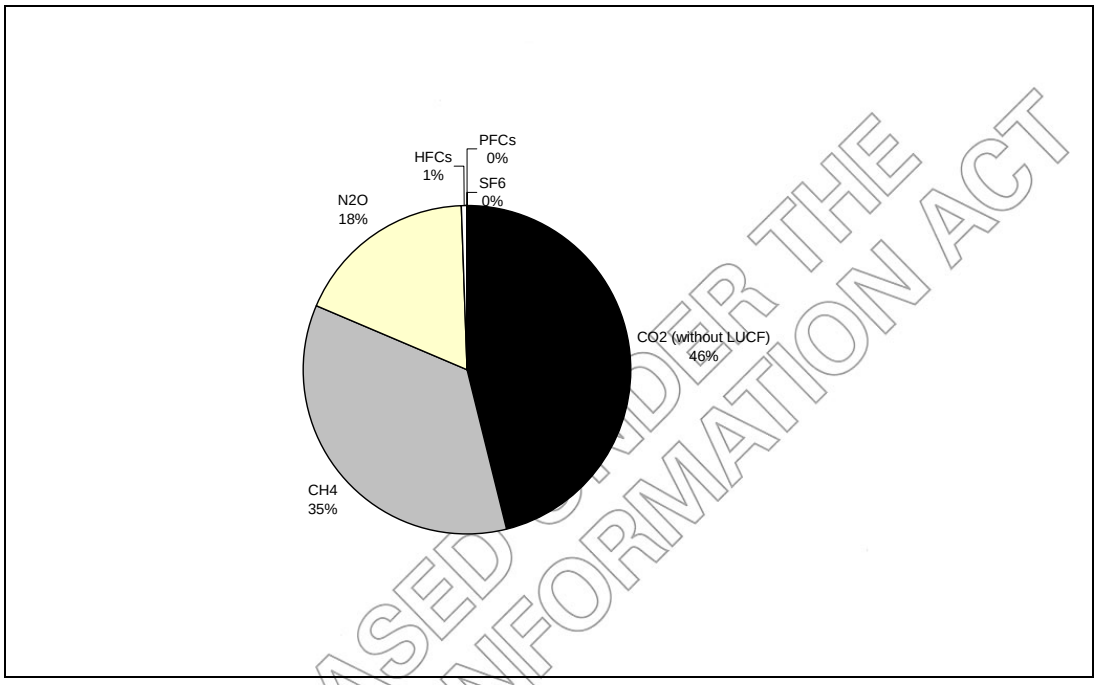
It concludes that:

- New Zealand's relatively high proportion of methane and nitrous oxide and low share of carbon dioxide is unique by international standards, reflecting the importance of our pastoral-land activities and the relatively large contribution of renewable energy sources to our electricity generation
- emissions growth since 1990 has been strongest for CO_2 emissions, which increased by 2.5% per annum, largely driven by road-transport emissions
- strong growth in methane emissions from dairy cattle was partly offset by reductions in other sources of enteric fermentation and in methane emissions from waste
- energy use is closely related to the level of economic activity
- a country's scope for decoupling emissions and GDP growth depend on the nature of its comparative economic advantages, the contribution of technology and the impact of external events (such as outbreaks of bovine foot and mouth disease)
- these avenues for decoupling are not necessarily applicable to the New Zealand context.

3.1.1 New Zealand's unique emissions profile

In 2003, the most recent year for which full data is available, New Zealand's total greenhouse gas emissions were 75,345 Gg CO_2e. This measurement is not used outside of this section, so it is anomalous. Usually tonnes and Mt are used Figure 15 shows the composition of emissions by gas. In 2003, carbon dioxide (CO_2) comprised 46.0% of New Zealand's gross emissions, methane (CH_4) 35.4% and nitrous oxide (N_2O) 17.9%. Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) accounted for some 0.5% of gross emissions.

Figure 15 - New Zealand's Greenhouse Gas Emissions by Gas 2003



Source: Ministry for the Environment (2005) *New Zealand's Greenhouse Gas Inventory 1990-2003*

Table 1 compares New Zealand's profile with that of other selected countries, highlighting its uniqueness among Annex I countries. New Zealand's profile is more closely aligned with that of Argentina, a Non-Annex I country. For the majority of Annex I countries, CO_2 accounts for more than 75% of gross emissions, with methane and nitrous oxide playing a correspondingly less important role. Among Annex I countries, Ireland most closely matches New Zealand, but CO_2 emissions still account for nearly 67% of its total emissions.

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Table 1 - Emissions Profiles for Selected Countries 2002

Country	CO_2	CH_4	N_2O
	% of Total Gross Emissions		
Argentina	46.8	31.6	21.7
Australia	68.6	23.8	6.8
Canada	79.0	12.9	7.3
European Union	82.0	8.5	7.9
Finland	84.8	6.2	8.3
Germany	85.4	8.2	5.5
Ireland	66.6	18.6	14.2
Japan	94.1	1.5	2.7
New Zealand	**46.0**	**34.5**	**17.9**
Russian Federation	80.4	15.5	1.9
United Kingdom	84.9	7.0	6.5
United States	83.6	8.6	6.0

Sources: UNFCCC Greenhouse Inventory Database (see <www.wri.org>) and New Zealand's Greenhouse Gas Inventory 1990-2003. Data for Argentina is for 1997 and for New Zealand, 2003

Underpinning the uniqueness of New Zealand's profile is the importance of methane emissions from enteric fermentation and nitrogen emissions from agriculture soils. In 2003, these two sources accounted for 48.5% of New Zealand's total gross emissions. Table 2 shows that while Ireland is most closely aligned with New Zealand, emissions from these two sources accounted for only some 24% of its total emissions in 2002, half the proportion for New Zealand. For the European Community, emissions from these sources accounted for some 12% of total emissions and for Australia, some 16% of total emissions.

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Table 2 - Importance of Methane Emissions from Enteric Fermentation and Nitrous Oxide Emissions from Agriculture Soils for Selected Countries 2002[11]

Country	CH_4 Emissions from Enteric Fermentation	N_20 Emissions from Agriculture Soils	Total of two sources
	% of Total Gross Emissions		
Argentina	19.3	20.5	39.8
Australia	12.3	3.7	16.0
Canada	2.6	4.1	6.7
European Union	4.1	8.4	12.5
Germany	2.6	3.1	5.7
Ireland	13.8	10.4	24.2
Japan	0.5	0.6	1.1
New Zealand	**31.3**	**17.2**	**48.5**
United Kingdom	2.7	4.2	6.9
United States	1.7	4.2	5.9

Sources: UNFCC Greenhouse Gas Inventory Database (<www.wri.org>) and New Zealand's Greenhouse Gas Inventory 1990-2003. Data for Argentina is for 1997 and for New Zealand, 2003

The other particularly notable feature of New Zealand's profile is the relatively low share of emissions accounted for by carbon dioxide from energy industries (including electricity generation), which reflects the very significant role of hydroelectricity in New Zealand's energy supply. In 2003, carbon dioxide emissions from energy industries accounted for some 10% of New Zealand's total emissions. As shown in Table 3, this contrasts markedly with Australia, where these accounted for 38% of total emissions in 2002. In the European Union, they accounted for 27.3% of total emissions, but the situation varies among member countries. For example, in Norway, hydroelectricity is important in explaining the lesser role of carbon dioxide emissions from energy industries in its emissions profile.

[11] Data for other selected countries can be supplied.

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Table 3 - Importance of CO_2 Emissions from Transport and Energy Industries for Selected Countries 2002[12]

Country	CO_2 Emissions from Transport	CO_2 Emissions from Energy Industries
	% of Total Gross Emissions	
Argentina	14.1	12.8
Australia	14.2	38.1
Canada	24.8	27.3
European Union	20.4	27.8
Germany	17.4	35.2
Ireland	16.3	23.5
Japan	19.2	28.6
New Zealand	**18.3**	**10.1**
Norway	24.2	19.7
United Kingdom	19.4	30.7
United States	25.5	32.4

Sources: UNFCC Greenhouse Gas Inventory Database (<www.wri.org>) and New Zealand's Greenhouse Gas Inventory 1990-2003. Data for Argentina is for 1997 and for New Zealand, 2003.

Table 3 shows that the significance for New Zealand of CO_2 emissions from transport is within the range of other Annex I countries. These emissions account for some 18% of New Zealand's emissions, which is somewhat lower than in the United States, Canada and Norway, where CO_2 emissions from transport account for between 24% and 29% of total emissions. In the United Kingdom, CO_2 emissions from transport account for some 19% of total emissions and in Australia, 14%.

New Zealand's unique emissions profile has implications for the range of emission mitigation options currently available to New Zealand and the likely cost of domestic mitigation relative to some other countries. Effective and low-cost mitigation options have not yet been identified to address either methane from enteric fermentation or nitrous oxide from soils.

A further significant source of emissions is transport. As with other countries, the increasing trend in transport emissions will not be easily addressed in the short term. Because future developments in transport technologies will largely occur overseas, New Zealand's potential for mitigation in this respect will depend largely on the availability and uptake (as opposed to development) of any cost-effective new technologies. Overseas experience can also assist in scoping policy options and effectiveness.

[12] Data for other selected countries can be supplied.

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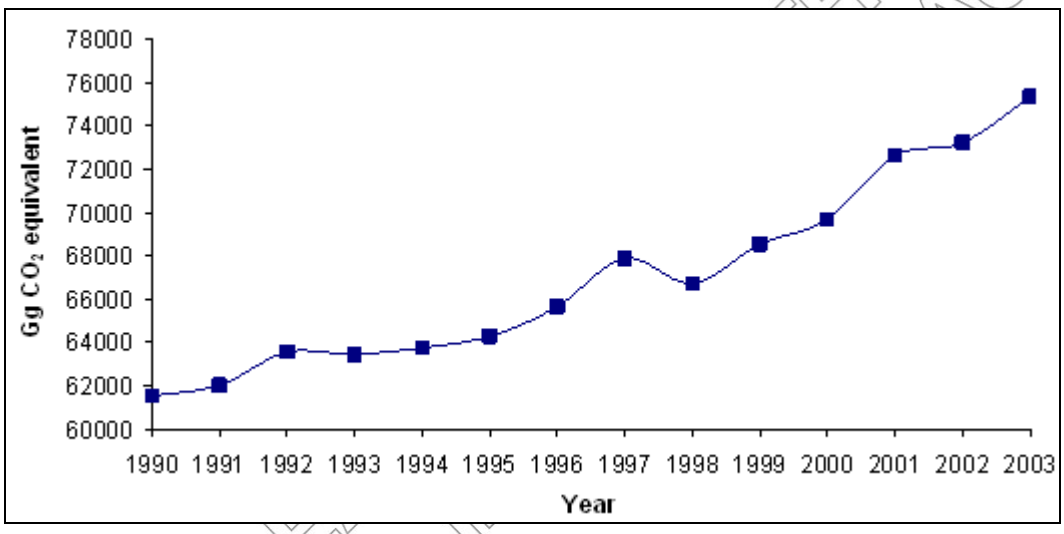
Overall, the particular profile and the high degree of concentration of New Zealand's emissions means that we face a limited range of viable mitigation options in the short term.

3.1.2 Emissions trends since 1990

In 2003, total gross emissions were 22.5% above the 1990 base level of 61,525.43 Gg CO_2 equivalent, representing an annual average growth rate of 1.6% per year.

This rate of growth is likely, however, to overstate the underlying growth trend. An important feature of New Zealand's emissions is significant year-to-year fluctuations arising from the importance of hydro in electricity generation. In dry years, it is necessary to use thermal stations, which use gas and coal, to supplement hydro- electric generation. The rise in emissions in 2003, apparent in Figure 16, was attributable, in part, to this dry-year factor.

Figure 16 – New Zealand's Total Greenhouse Gas Emissions 1990-2003



Source: New Zealand's Greenhouse Gas Inventory 1990-2003

Figure 17 shows the trend in emissions by gas type. Over the 1990 to 2003 period, carbon dioxide emissions have grown most rapidly and were 37.1% higher than in 1990. This is equivalent to an average growth rate of 2.5% per year. As indicated above, this is likely to overstate the underlying trend, given the dry-year factor in CO_2 emissions from public electricity generation. Nitrous oxide emissions grew on average by 2.0% per year and methane emissions by 0.4% per year.

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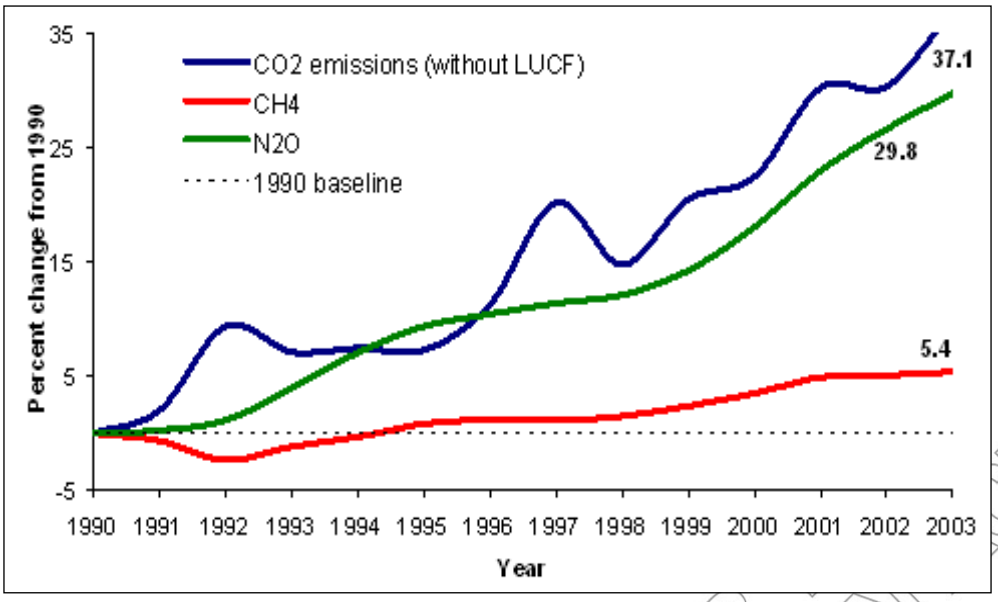
Figure 17 – Change in New Zealand's Emissions of CO_2, CH_4 and N_2O 1990-2003



Source: New Zealand's Greenhouse Gas Inventory 1990-2003

Carbon dioxide

A major driver in the growth of carbon dioxide emissions is the growth in transport emissions. These increased, on average, by 3.7% per year. Data for 2004 indicates a somewhat slower level of growth in 2004, marginally pulling down the average annual growth rate to 3.6% per year. It is, however, too early to say whether the lessening in transport emission in 2004 is the start of a trend.

The most important driver of transport emissions has been increased emissions from road transport, with this source accounting for some 89% of the increase in emissions. In terms of fuel source, diesel accounted for some 67.3% of the increase in transport emissions, and petrol some 28.2%. This suggests that increased road freight, together with the growing share of diesel vehicles in the passenger transport fleet, have been important contributing factors.

CO_2 emissions from energy industries have increased, on average, by 1.8% per year between 1990 and 2003. Emissions from thermal electricity generation increased, on average, by 4% per year. Contributing factors are increased demand for electricity, and the substitution since 2001 of coal for gas in thermal generation because of the sharp decline in the Maui gas field and the 2003 dry-year factor.[13] The strong growth in emissions from thermal electricity generation has been offset to some extent by the closure of synthetic petrol production facilities in 1996, with these having accounted for 1,488 Gg of CO_2 emissions in 1990.

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[13] Recently released data for 2004 indicates that emissions from thermal energy generation fell sharply in 2004, decreasing by 4.6%.

Manufacturing and construction accounted for an increase of 1,302 Gg in CO_2 emissions from 1990 to 2003, or a growth rate of 2% per year. The major source of growth has been emissions from natural gas consumption in the manufacture of methanol. Emissions from this source increased from 367 Gg CO_2 in 1990 to 2,013 Gg in 2002, and then fell by more than 50% in 2003 because of the decline in the availability of low-price natural gas. Recent MED data suggests a further marginal decline in 2004.

Carbon dioxide emissions from industrial processes increased from 2662 Gg in 1990 to 3470 Gg in 2003, or some 2.1% per year. This has reflected a general trend of growth in iron and steel production, aluminium, cement and urea. There was, however, a particular increase in emissions from iron and steel production in 2003.

Methane

The 0.4% average annual increase in methane emissions results from the offsetting effects of divergent trends in emissions from enteric fermentation and from waste. Emissions from enteric fermentation grew, on average, by 0.7% per year, with this offset in part by the 2.9% per year reduction in waste emissions.

The increase in emissions from enteric fermentation reflects the changing pattern and intensification of the agriculture sector, particularly as a result of the shift in land use towards dairying. Emissions from dairy cattle increased by 52.3% over the period as a result of increased dairy cattle numbers and increased emissions per animals (related to the increased productivity of herds). Emissions from sheep fell by 18.9% in total, reflecting a reduction in the sheep population (down 31.95%), offset in part by increased emissions per animal (up 19.4%). Emissions from non-dairy cattle and deer have also increased as a result of population growth and increased emissions per animal.

Nitrous oxide

Nitrous oxide emissions grew on average by 2.0% per year, accounting for an increase of 3,000 Gg CO_2 equivalent. Over half of the growth in these emissions is attributable to increased use of synthetic nitrogen fertiliser, from 51.786 tonnes in 1990 to 298,380 tonnes in 2003. The remainder is attributable to increased animal production of nitrogen, which in turn is a result of the increased intensity of agriculture and associated changes in the population structure (increased dairy cattle) and the increased nitrogen production per animal.

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3.1.3 Energy and economic growth in New Zealand

Historical context

New Zealand's economic history and associated policy background has shaped its structural composition and energy use. Our natural resources (in particular, abundant hydro and coal resources) have meant that the economy has historically enjoyed relatively low energy costs. This has, in turn, attracted energy-intensive industries. The supplementation of tariffs with import licences in the 1930s assisted New Zealand's growing manufacturing sector. Through the mid-twentieth century, the economy witnessed the resulting industrial developments in sawmilling, pulp and paper making, steel, oil refining and aluminium smelting (Briggs, 2003).

Historically, Britain's free trade policy, combined with New Zealand's temperate climate, meant that from the nineteenth century, primary products from New Zealand could be sold to the prospering British economy at competitive prices despite the associated transport costs. Our current economic structure still reflects these historical roots, with our comparative advantage lying in producing commodities that require high energy intensity either in processing or in transportation.

Dairy, forestry and meat products all require extensive movement of bulky, heavy goods around the country, and when processed further in New Zealand, require considerable further inputs of energy. In 2001, the New Zealand Institute of Economic Research (NZIER) reported that New Zealand agriculture requires 4,500 kJ of energy per dollar of GDP. The transport and storage sector uses around 20,000 kJ per dollar, and primary food manufacturing (dominated by dairy and meat processing), 7,000 kJ.

Drivers of energy-demand growth

There are a number of key determinants of growth in energy use:

- **economic growth**. As an input into production, energy use is closely related to the level of economic activity. Evidence for New Zealand suggests that there is a one-way causal relationship from GDP to energy consumption (Fatai *et al*)[14]

- the **economic structure of industry**. The relative energy intensities of industries and their contribution to economic growth will impact on the growth in energy demand. Structural composition is important to bear in mind when interpreting cross-country comparisons of energy intensity

- the **price** of energy, in terms of different energy sources and types and also relative to other production inputs. The effect that price changes will have on demand depends on own- and cross-price elasticities, and hence the extent to which energy can be substituted with other inputs (capital, labour)

- **technological change**. Generally speaking, we may expect new capital equipment (eg, plant, machinery, vehicles) to be more energy efficient than old stock. In this respect, energy demand is influenced by the turnover of capital stock (and appliance stock in the residential sector). New investment growth is correlated with the economic cycle

- **Population growth** and **demographic change**. Population growth is itself a driver of economic growth and hence energy use. But changes in the demographic composition of the population, as well as societal changes, can also influence energy demand. For example, in developed countries, there is a trend towards larger houses and fewer people per household. Both these trends serve to provide upward pressure on residential energy-demand growth. Societal change can influence consumption patterns and lifestyles, which can impact on energy use in terms of the types of end use (eg, use of particular appliances)

- **Climate**. Climate impacts on energy use, such as for heating and air conditioning. Space heating represents the most significant residential energy end use in almost all International Energy Agency (IEA) countries (typically accounting for around 40% of total energy use), with climate being a key driver of this component. Other

[14] However, this analysis did not adjust for energy quality, which is thought to be crucial in correctly establishing the relationship.

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geographical factors (such as topography) are also likely to impact on total energy consumption (including transport fuel use).

Energy use is also affected by a variety of **intermediaries** in the production and consumption processes. Intermediaries include designers of new plant and machinery that will use energy, and architects of buildings whose occupants will use energy.

These intermediaries, acting in the broader context of a country's economic and policy history, contribute to the characteristics of **existing infrastructure**. Because infrastructure and large capital investments such as roading have a long life span, their impact on energy use can be apparent for many decades. Changes in major infrastructure are likely to be incremental and at the margin. These factors, as well as potentially long payback periods, can lead to inertia surrounding the energy use associated with existing infrastructure.

Historical trends in New Zealand's energy intensity

New Zealand's total energy intensity (measured by the ratio of energy to GDP) is relatively high by OECD standards, as shown by Table 4. However, it is important to note that this does not translate directly into a high carbon intensity. This is due to the contribution of hydro (and other low-emissions renewables) to our electricity generation.

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Table 4 - Energy and CO_2 Intensity of GDP for Selected Countries 2002

	Energy Intensity[15]	Carbon Dioxide Intensity[16]
Argentina	9,875	0.48
Australia	11,936	0.88
Canada	17,341	0.79
Chile	11,498	0.59
China	35,764	2.75
Denmark	3,920	0.26
France	5,998	0.22
Germany	5,269	0.31
Ireland	5,273	0.38
Italy	6,186	0.36
Japan	3,876	0.21
New Zealand	11,871	0.51
Norway	10,968	0.25
Poland	20,004	1.60
United Kingdom	7,039	0.41
United States	10,575	0.62

Source: Energy Information Administration 2004, *International Energy Annual*

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New Zealand's energy intensity increased between 1987 and 1993, and has since been declining. To gain a better understanding of changes in energy intensity within an economy, it is useful to separately identify the contribution from:

- structural change; ie, change in the composition of economic activity within an economy
- technical changes resulting from replacing or retrofitting old technology with more energy-efficient equipment (and management processes)
- energy-quality changes in both a thermodynamic[17] and an economic sense.[18]

[15] BTU per 1995 US dollars at market exchange rates (BTU = British thermal units, the quantity of heat required to raise the temperature of one pound of water from 60 to 61 degrees Fahrenheit at a constant pressure of one atmosphere).

[16] Metric tons of carbon dioxide per 1000 1995 US dollars at market exchange rates. Relates exclusively to CO_2 from the consumption and flaring of fossil fuels.

Research undertaken by Lermit and Jollands (commissioned by Energy Efficiency and Conservation Authority (EECA) (EECA, 2001)) quantified the relative contribution of these three factors for the 1987 to 2000 period (excluding for the residential sector). Their analysis suggests that the increase in energy intensity between 1987 and 1993 was primarily attributable to declining technical efficiency. Between 1993 and 2000, the improvement in energy efficiency was attributable to improvements in technical efficiency, a shift in the structural composition of the economy away from energy-intensive activities and, to a lesser extent, improvements in energy quality, mainly due to improvements in the quality of liquid fuels.

There has been debate about the underlying drivers of the observed decline in technical efficiency between 1993 and 2000. Lermit and Jollands suggested this was attributable to the slow growth in investment. The period was characterised by economic recession and major restructuring, and concurrent weak performance in the manufacturing sector. Subsequent analysis by NZIER queries this explanation. (NZIER, 2003b). It points to two reasons why intensity is unlikely to increase as a result of low investment growth:

- the proportion of capital stock replaced in any year, even in a year when economic growth is high, is relatively low
- even in years when investment growth is low, the level of investment is still positive and has been more than enough to offset depreciation, thereby lifting the total capital stock.

The Lermit and Jollands analysis does, nonetheless, highlight the significance of the general macroeconomic cycle for short-run energy-efficiency change. During periods of poor economic performance, investment growth will slow, limiting the improvements in energy efficiency from new, more energy-efficient capital. Capacity utilisation appears to be a likely driver of changes in the technical effect. When capacity utilisation drops (especially when economic growth is sluggish), any fixed energy requirements will represent a higher proportion of total inputs, serving to increase energy intensity. The converse is true for high capacity utilisation, which itself may spur new capital investment (to expand capacity). Other contributing factors are likely to include the relative prices of other substitutable inputs (including labour), the cost of capital (and hence of new investment) and energy prices themselves.

NZIER analysis confirms this short-run relationship between energy efficiency and capacity utilisation, finding that capacity utilisation (measured by the capital/output ratio) tends to account for most of the changes in the technical effect. In the long run, they find that energy use is related to the capital stock, and that as New Zealand's capital stock has grown over time, it has become more energy efficient. However, because new investment represents a very small proportion of the total capital stock, these improvements have been very gradual.

Lermit and Jollands' decomposition analysis was updated in 2003 (EECA, 2003) to explore changes in energy intensity between 2001 and 2002. The revised methodology used is documented in a report to the Energy Efficiency and Conservation Authority (EECA) (Lermit, 2001). In this update, they decompose growth in energy use into the following components:

[17] The scientific/engineering definition relating to the physical relationship between energy inputs and outputs.

[18] Derivation of quality co-efficient for New Zealand shows electricity to be the consistently highest-quality energy input over time, followed by geothermal, liquid fuel (including petroleum), gas and finally solid fuel (coal).

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- structural effect (as previously)
- activity effect, capturing changes in sectoral-level economic activity levels
- underlying energy-efficiency effect (effectively, the technical effect, with the activity and wealth effects stripped out)
- wealth effect, isolating changes due to GDP growth (ie, the value of output).

The residential sector is also modelled and decomposition here includes isolation of the impact of climate (a weather effect).

This analysis shows that between 2001 and 2002, economy-wide energy use grew 1.4%. GDP growth over this period was 3.4%. Energy-efficiency improvements are calculated as being 1.85% for the year, which is above the National Energy Efficiency and Conservation Strategy target for this period (1.67% on a compound growth basis). Efficiency gains came largely from the transport sector; gains were also recorded in the commercial and industrial sectors. Efficiency in the residential sector appears to have declined, and the primary sector also registered a deterioration (located in the agriculture, mining and fishing industries).[19]

In regard to the residential sector, between 1991 and 1998, residential energy use declined *per capita* by 5%, and per m^2 of floor area by 9%. EECA attributes this trend to a range of factors, including the northward population drift (hence warmer climate), increased turnover of the domestic appliance stock, higher domestic electricity prices and a higher proportion of new homes (which are better insulated and fitted out with more efficient heating equipment). They also point to trends towards more energy-efficient domestic practices such as washing laundry in cold water and increased use of microwaves for cooking.

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[19] Transport includes both freight and passenger (private) transport.

New Zealand's energy intensity *per capita* is low compared with other developed countries. New Zealand has the lowest residential energy use *per capita* in the OECD, despite having larger-than-average houses (by floor area). EECA suggest that this is largely due to New Zealand's temperate climate, resulting in relatively low amounts of energy used for space heating. Moreover, New Zealand households tend not to heat (or air condition) their entire house. This latter factor could suggest a trade-off in terms of comfort or welfare, which is perhaps mitigated by the moderate climate. It may also be, in part, an income-related effect (with New Zealand having relatively modest income *per capita* compared with its OECD counterparts). Given the possible combination of factors at play, it is difficult to predict likely future trends in this sector.

3.1.4 Greenhouse gas emissions and economic growth

New Zealand experience since 1990

A major driver of the rising trend in New Zealand's emissions has been the growth in the economy since 1990. New Zealand's economic performance improved significantly over the 1990s, following a period of major economic restructuring and deregulation. From mid-1991, the economy grew strongly, with particularly buoyant output growth between 1993 and 1996. While the latter half of 1997 and early 1998 saw the economy slip briefly into recession, the following year saw a recovery in broad-based growth, with the economy growing 4.4% in calendar year 1999 and 3.5% in 2000. Overall, the New Zealand economy averaged 3% annual average growth over the 1990 to 2003 period.

Although the New Zealand economy diversified over this period, New Zealand's economic growth remained reliant on exports of commodity-based products as a main source of export receipts, and 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.

While the greenhouse gas intensity in GDP fell at an average rate of 1.4% per year over this period (see Figure 18), this was outstripped by economic growth, leading to a significant increase in the absolute level of emissions. In effect, New Zealand achieved only limited decoupling of emissions and economic growth.

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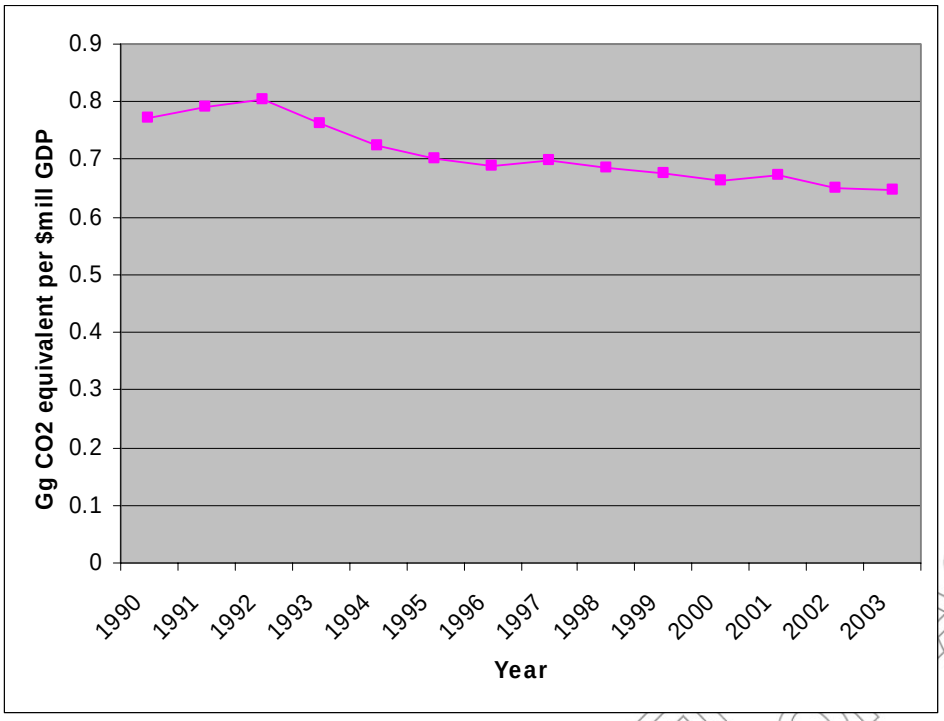
Figure 18 – New Zealand's Greenhouse Gas Intensity of GDP 1990-2003



Source: Statistics New Zealand; Greenhouse Gas Emissions New Zealand's Greenhouse Gas Inventory 1990-2003

International experience

There is no unequivocal relationship between emissions and GDP growth, either across countries or over time. The chart below plots annual average growth in greenhouse gas emissions and GDP over the 1990 to 2002 period for a selection of Annex I countries.

Ireland is a clear outlier, with its strong GDP growth over the period (averaging 7.8% per annum) likely to have been a significant driver of its relatively high growth in emissions (2.1% per annum). New Zealand sits at the high end for both variables, alongside Australia and Canada.

However, a number of Annex I countries appear to have achieved some success in decoupling emissions growth from economic growth. The United Kingdom, Germany, France and Sweden have all reduced their greenhouse gas emissions at the same time as their economies have continued to expand (albeit more slowly than New Zealand's).

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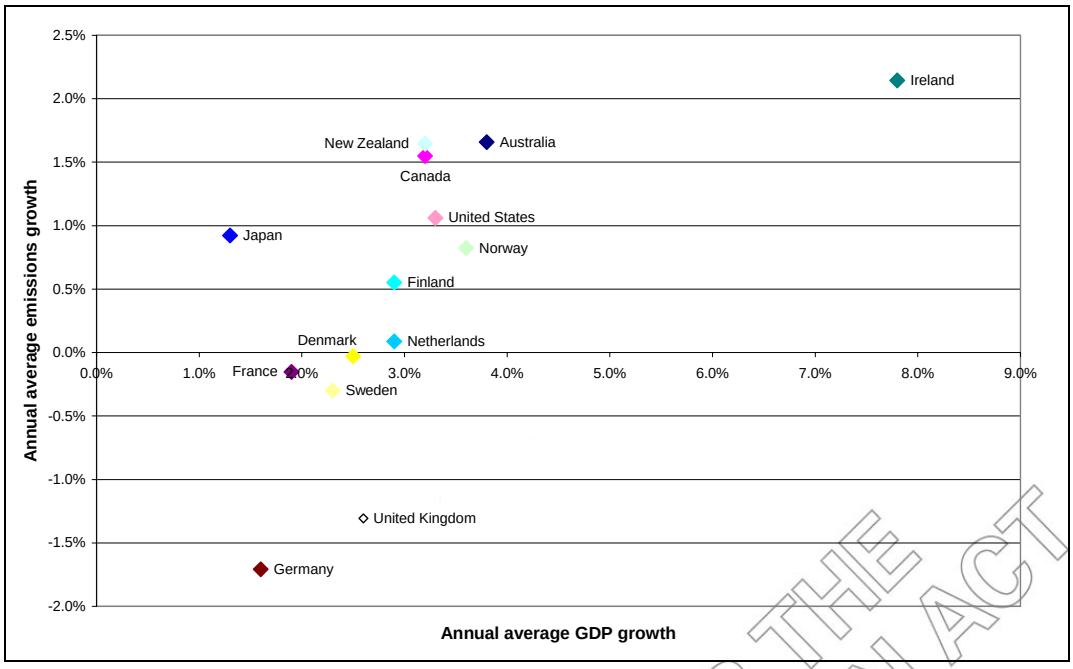
Figure 19 - Growth in Emissions and GDP for Selected Countries 1990-2002



Sources: Emissions data from UNFCCC Greenhouse Inventory Database (www.wri.org); GDP data from World Development Indicators 2004

How have they achieved this? Perhaps the best way of investigating this is by sector, or source of emissions.

Germany and the United Kingdom have both achieved reductions in CO_2 emissions and (due to the composition of their total greenhouse gas emissions) this has driven their overall improvement in emissions. In the United Kingdom, a major contributing factor has been the switch from coal to natural gas and nuclear in electricity production. In Germany, this has been assisted by efficiency improvements in its coal-fired power stations.

More broadly, structural change is likely to have assisted reductions in energy intensity (and hence in CO_2 emissions) in many countries. The shift in developed countries towards a more services-oriented economy is generally assumed to aid decoupling of economic and emissions growth, to the extent that service sector industries are less energy (including transport) intensive. For instance, the OECD (2004) sees the relative decoupling of transport sector and emissions growth in the United States resulting from the structural shift from low-value raw-material production (such as fossil fuels, basic chemicals and cereals) towards more high-value-added industries (such as electronics and textiles) as having reduced economy-wide transport intensity.

In the United Kingdom, the services sector has expanded rapidly over the last decade or so, while the agriculture sector has contracted. Germany has also seen strong service-sector growth, coupled with a declining industrial sector. This is likely to have contributed to their decline in emissions.

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However, the relationship between structural change and emissions growth is far from clear. For instance, Mulder and de Groot (2004) examined energy use in 14 OECD countries over a 27-year period. They found that structural change in the economy has a significant positive effect on energy intensity in some countries and a negative effect in others.

Mitigation from structural change depends crucially on, among other things, the composition of service-sector industries (such as their transport intensity) and the sources of fuel (including indigenous energy resources). The nature of a country's comparative economic advantage will directly impact on the scope for emissions mitigation through structural change.

A number of European countries, including the United Kingdom, Germany and the Netherlands, have achieved reductions in methane emissions from reductions in stock numbers. In the European Union, dairy cattle numbers were, on average, 26% lower in 2003 than they were in 1990, and sheep numbers 12% lower[20]. Underlying these trends have been changes in the European Union common agriculture policies and nitrate directives, as well as the outbreak of foot and mouth disease resulting in stock reductions in the United Kingdom.

Even more significant has been the reductions in methane emissions from waste and fugitive emissions in these countries. For example, the United Kingdom has achieved reductions from the implementation of methane recovery systems at landfills and reduced emissions from coal mines.

Reduced stock numbers in European countries have also contributed to declines in nitrous oxide emissions. In recent years, use of synthetic fertilisers there has reduced, partly as farmers have readjusted their operations in response to changes in European Union farm policies. An additional factor has been the European Union nitrate directive, which has involved controls and restrictions on the use of fertiliser and application of manure.

In summary, international trends between emissions and GDP growth have varied over time and across countries, according to circumstances and opportunities. A country's scope for decoupling emissions from economic growth depends on a range of factors, including the nature of its economic comparative advantages, its energy resources, the policy context, the contribution of technology and the impact of external events (such as outbreaks of foot and mouth disease). New Zealand's prospects for decoupling emissions and economic growth are explored in Section 4.1.1.

3.2 New Zealand's current climate change policy settings – background

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[20] European Environment Agency (2005) *Annual European Community Greenhouse Gas Inventory 1990-2003 and Inventory Report 2005* <http://reports.eea.eu.int/technical_report_2005_4/en>

3.2.1 Current New Zealand climate change policy objectives and expected outcomes

The context for the development of the current climate change goal and policy

The Kyoto Protocol was the first stage of what was expected to be an ongoing process with uneven coverage of nations with targets. In 2002, there was uncertainty about whether the Protocol would enter into force; eventual Russian ratification meant it entered into force on 16 February 2005. Another uncertainty was around the international price of emissions. It was anticipated that the European Emissions Trading Scheme would generate an emission price and other markets might evolve and progressively link.

These uncertainties meant that it was important to take a long-term view, and that policy design needed to reflect a prudent risk-management approach incorporating a phased transition and emphasising positioning for future commitment periods. It was expected that an international cost of carbon would not emerge until close to or in CP1, affecting consideration of a transition to emissions trading. The Protocol does not restrict domestic policy options, and it was considered that the expected availability of forest sink credits would facilitate flexibility in the domestic response. It was recognised that there are competing interests and objectives in domestic policy.

The New Zealand Government (2002d)[21] noted that the Kyoto Protocol was the first binding step in controlling greenhouse gases and that it signalled a long-term change in how the world thinks about key resources. The Government concluded that collective action was required and that the Government needed to show it was serious about aiming for real reductions in emissions. In addition, it noted that consultation and modelling indicated that policies that imposed high costs on emissions could significantly affect some sections of the economy and, at the same time, increase overall global emissions. It was anticipated that by CP1, all sectors of the economy would (in one way or another) contribute to reducing New Zealand's greenhouse gas emissions.

The goal behind the current policy and its expected outcomes

The current climate change goal is 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."

At the time that it was set, the Government stated that the expected outcomes of the goal were that[22]:

- New Zealand will be on a path to reshaping its energy use
- there will be an increased rate of technology uptake of renewable energy, energy efficiency, and lower emissions production
- all sectors will be addressing emissions and positioning themselves greenhouse-wise on world markets
- research findings to date will have been transferred to agricultural practice

[21] Paragraphs 2 and 3.
[22] New Zealand Government (2002d), Annex 1.

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- new buildings, dwellings, plant, vehicles and machinery will be at the optimal edge of efficiency
- there will be a population knowledgeable about greenhouse gases and taking responsibility for them.

Subsidiary principles to be met by policies introduced to achieve the goal

Policies to achieve the climate change goal had to meet four principles[23] based around the need for:

- environmental integrity
- flexibility (because of future uncertainties)
- consistency with a growing and sustainable economy
- avoiding disadvantaging the vulnerable in society.

1 **Policies must result in permanent reductions in emissions over the long term (environmental integrity)**. This principle was driven by the need to achieve real and sustainable emissions reductions across all commitment periods, for both international credibility reasons and as preparation for the longer term. Avoidance of emissions leakage and achieving permanent changes in behaviour were also objectives underlying this principle.

2 **Policies need to be responsive to the changing international context and enable emitters to have time to adjust (flexibility)**. This principle reflected the uncertainty (in 2002) of the international framework, technological development and New Zealand's changing emissions profile. Policies were to be globally focused in anticipation of wider acceptance of targets. Policy was to accommodate a shift over time from the situation where all sectors of the New Zealand economy could not be exposed to the full cost of emissions (because many countries would not have binding targets) to a situation where progressively more of the economy would be exposed to the full emissions price as it became clear that countries currently without targets would take on targets and gradually expose their economies to the international price of carbon.

3 **Policies need to be consistent with a growing and sustainable economy.** It was recognised that competitiveness of industries (including new entrants) over time remained important. The policies were expected to move progressively to a full cost on emissions when global competitiveness issues had been addressed. Also, policies were to avoid inappropriate distortional effects on investment and were to promote economic opportunities from climate change.

4 **Policies will not disadvantage the vulnerable in our society.** The final policy principle was that lower socioeconomic (or vulnerable) groups should not have to bear the burden of change arising from implementing Kyoto Protocol commitments or climate change policies.

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[23] The most detail about the rationale behind the four principles is in New Zealand Government (2002d), Annex 1.

Price measures

While the foundation policies (ie, policies that are relevant to climate change but that were either already in place or undertaken for other reasons – see Section 3.2.7) were considered to be a sound base upon which to build, it was recognised that they would be insufficient to enable New Zealand to meet its obligations. Because introducing a price is pivotal to the Protocol, the introduction of a domestic price instrument was central to the new policies.

Key issues considered when developing the price measures included:

- the importance of providing incentives and signals in the pre-2008 period that longer-term adjustment was necessary
- the extent that the economy should be exposed to the world price in CP1 and the timing of the introduction of any price measures
- what sectors of the economy should be covered by the price instruments
- issues around retention of sink credits and associated liabilities by the Crown versus their devolution to the private sector.

Polices to reflect the nature of the domestic economy

It was recognised that climate change policy had to reflect the specific characteristics of the New Zealand economy. This analysis resulted in the economy being separated into four groups based on: competitiveness, ability to respond to a price signal, any specific sector characteristics, and impacts upon the ability to recycle revenue.

The economy was grouped into four categories as follows:

- a **competitiveness-at-risk group** comprising energy-intensive industries that would find adjustment difficult if they were to face a cost of emissions in CP1. These export (and some import substitution) industries face a choice of closing (or reducing output) and changing location to a country with no controls on greenhouse gas emissions, often called carbon leakage
- a **general energy-users group** including less energy-intensive industries, institutions and households for which energy is not a major cost. Hence, this group is not at risk. The group represents about one-quarter of total greenhouse gas emissions but about two-thirds of CO_2 emissions and is expected to respond to the carbon tax
- **on-farm agriculture**, a major economic sector that contributes just over half of New Zealand's greenhouse gas emissions through methane and nitrous oxide emissions. Agriculture shares many characteristics of the competitiveness-at-risk group, along with some differences. Farmers have no clear way to reduce methane and nitrous oxide emissions other than by reducing stock numbers and measurement of these emissions on the farm is technically very difficult
- an **"others" group** of sectors where cost-effective abatement opportunities (synthetic gases) are lacking or emission measurement is difficult (waste), affecting the ability to adapt to an emission cost in the short term.

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Current policy package

The policy package approved in 2002 comprises Foundation Policies and New Policies, as set out below.

Figure 20 – Policy Package Components

New Policies	
Pre-commitment period	**First commitment period**
	• Introduction of an emissions charge from 2007. The charge will approximate the international price of emissions but will be capped at $NZ25 per tonne of CO_2e (inflation-adjusted). • The charge will apply to emissions from energy supply and use, process emissions and fugitive energy emissions, unless exempted or rebated through a NGA. • Further work is required to determine whether the emissions charge will be applied to emissions from domestic bunker fuels used in shipping and aviation. • Retain option to introduce emissions trading if conditions permit (ie, there is a stable international market, and the price is reliably under $NZ25 per tonne of CO_2e). • Redistribute all revenue from climate change policies back into the economy; eg, through the tax system and climate change projects/programmes. • Retain sink credit assets and liabilities. • Cap deforestation liabilities at 21Mt CO_2e. • Mechanisms to encourage forest sinks, including a mechanism to encourage permanent protection of forest sinks.
• Investigate possible additional policy for SMEs.	
• NGAs for competitiveness-at-risk firms.	• NGAs for competitiveness-at-risk firms.
• Projects to incentivise emissions reductions.	• Projects to incentivise emissions reductions.
• Industry-funded research for the on-farm agriculture group. Retain option to apply research levy.	• Industry-funded research for the on-farm agriculture group. Retain option to apply research levy.

• Voluntary handling programmes for HFCs and PFCs, linked with the Montreal Protocol programmes (except for HFCs in aerosols). • Industry agreement to work together and share information to limit leakage of SF_6. • Rely on New Zealand Waste Strategy for methane emissions from waste. Review in 2005. • Amend RMA to remove regional council ability to directly control greenhouse gas discharges through consents and plans	• Policy for synthetic gases and methane emissions from waste, dependent on outcome of review in 2005.

Foundation Policies

• National Energy Efficiency and Conservation Strategy (NEECS), including renewable energy target. • The New Zealand Waste Strategy. • The New Zealand Transport Strategy. • Public Awareness Programme.	• Partnership between local and central government. • Research. • Business Opportunities Programme. • Growth and Innovation Framework. • Adaptation to the effects of climate change.

Expected impact on emissions

In 2002, when the climate change policy package was approved, it was estimated that achieving the NEECS targets would reduce emissions during CP1 by about 20Mt CO_2e. This estimate included the effect of the carbon tax and PREs, as they were two of the most important measures that were to be used to achieve the NEECS targets. It was also estimated that the waste strategy would reduce emissions during CP1 by about 5Mt CO_2e.

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3.2.2 *Price-based instruments – carbon tax and NGAs*

The central policies in New Zealand's climate change policy 2002 package are a carbon tax and NGAs.

Carbon tax

In 2002, the Government decided that the climate change policy package would include a greenhouse gas emissions charge (carbon tax). In April 2005, the implementation details of the carbon tax were confirmed. Under current government policy, from April 2007, the carbon tax will apply to New Zealand's emissions from fossil fuel-based energy supply and use and industrial processes, and fugitive energy emissions of carbon dioxide, methane and nitrous oxide.

The rationale for the carbon tax is stated as: to require all sectors of the economy to begin to factor the cost of emissions into their decisions in order to assist New Zealand to fulfil its Kyoto obligations and to prepare the New Zealand economy for a smooth transition to more challenging commitments after 2012. It was considered that this would best be achieved by introducing a carbon tax on as broad a base of greenhouse gases as possible, and doing so earlier rather than later.

As announced, the carbon tax is set at $15 per tonne of CO_2e for CP1 unless the international price of carbon deviates substantially and on a sustained basis from this level, although the tax will be capped at $25 per tonne of CO_2e for this period.

The tax aims to provide a price signal motivating the adoption of least-cost options for reducing emissions. With the tax applied to fossil fuels, activities that draw on carbon-intensive energy sources will be relatively more expensive than those that draw on cleaner energy sources. Responses to the tax are expected to take a wide variety of forms, including investment in more fuel-efficient technology, improved logistical planning, and the substitution of renewable energy sources for fossil fuels.

The intention is to apply the tax as high in the supply chain as possible, as this will result in the smallest number of liable parties, ensure comprehensive coverage and minimise the administration and compliance costs of the tax. In general, this will mean taxing liable products when first sold by a producer or when imported.

At $15 per tonne of CO_2e, the carbon tax is estimated to increase prices by approximately 3.5 cents for a litre of petrol, 4 cents for a litre of diesel, $1.33 for one gigajoule of sub-bituminous coal, 79 cents for one gigajoule of natural gas and between 0.7 and 1.1 cents per kilowatt hour for residential electricity.[24]

Estimates of the macroeconomic impact vary according to the modelling technique and assumptions, but a small but negative impact on economic activity (measured by GDP) is expected. The Consumers Price Index is likely to increase when the tax comes into force, mainly through retail petrol and electricity prices (about 0.1% from the petrol price rise and 0.1% to 0.2% from the electricity price rise).

A carbon tax of $15 per tonne of CO_2e is expected to raise approximately $600 million (GST inclusive) per annum (plus or minus $50 million) while approximately $240 million (GST inclusive) per annum (plus or minus $50 million) will be needed to give firms with NGAs relief from the tax. Revenue from the charge will be recycled through a package of changes to the business tax regime.

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[24] "Implementing the Carbon Tax: A Government Consultation Paper" (2005).

When the decision to proceed with a carbon tax was made, it was noted that emissions trading would almost certainly be more efficient than a tax if there was a functioning international emissions market that New Zealand could link into. Officials undertook to continue monitoring the situation with a view to considering a move to a domestic emissions trading regime once the international emissions market was more developed.

NGAs

Under NGAs, New Zealand firms whose international competitiveness will be affected by the carbon tax can apply to negotiate an agreement with the Crown whereby they receive a full or partial exemption from the tax in exchange for agreeing to move towards the world's best practice in emissions management.

The objective of the NGA policy is to mitigate the risk of economic production moving (or "leaking") from New Zealand without any corresponding global reduction in greenhouse gas emissions. At the same time, NGAs seek to reduce emissions or the intensity performance of applicant firms to assist New Zealand in meeting its Kyoto obligations in CP1.

To be eligible to enter NGA negotiations, a firm has to demonstrate to the Crown that its output is internationally traded and the climate change policies of competitor countries are less stringent. If the firm meets this criterion, the final eligibility decision is based on consideration of whether:

- a \$25 CO_2e carbon tax will have a significant impact on the firm's competitiveness (through meeting a threshold in relation to the firm's costs, profits, or weighted average cost of capital)
- there is expected to be a net national benefit in an NGA being negotiated with the firm.

The final decision on a firm's eligibility is the responsibility of the Minister of Finance and the Convenor of the Ministerial Group on Climate Change. If a firm has satisfied the test for eligibility, the Crown will make an offer to enter negotiations to agree an NGA.

Under the original policy agreed in 2002, key issues for negotiation were the level of exemption from the tax, the applicable world's-best-practice emissions target, penalties for non-compliance, flexibility provisions for meeting targets, and monitoring and enforcement.

In early 2005, a review of the NGA policy was carried out, as experience to date had shown that NGAs had taken longer to complete and the negotiations had been more complex and costly than originally envisaged. Key issues decided in this review included:

- a standard end date for all NGAs of 2012
- the increased use of standardised text for an NGA
- the development of a streamlined process to determine the "world's-best-practice" level of emissions for the firm
- the use of an automated procedure to calculate a firm's emissions target pathway, rather than this being a matter for negotiation between the Crown and the firm
- removing the principle that NGA firms should expect to be "held harmless" from all material and reasonably quantifiable impacts of the carbon tax.

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Officials are estimating the level of pass-through of the carbon charge in the electricity, coal, gas, petroleum and LPG markets. This work will feed into the calculations to determine the refund each NGA firm will receive.

As of mid-August 2005, two NGAs had been concluded (with the New Zealand Refining Company and OceanaGold), eight firms had been found eligible to negotiate and applications from 12 firms were under assessment. The first 14 firms that applied for NGAs cover a range of major New Zealand energy users and represent approximately 55% of electricity used by New Zealand's industry. In addition, 15 expressions of interest had been submitted, four of which were from industry groups or associations.

The cost of carbon tax relief under the NGA policy is estimated at $240 million (GST inclusive) per annum, with a range of plus or minus $50 million per annum. Estimating the cost of the relief to be provided to NGA participants is complex, with a major uncertainty relating to the extent of the pass-through of the carbon tax for electricity.

3.2.3 *Energy policy*

Key policy instruments in the energy sector include the announced carbon tax and the use of NGAs. Both these measures were discussed in Section 3.2.2. In addition to these policies, a number of complementary energy sector measures are in place that impact on energy emissions, as discussed below.

PREs

The Government has developed the PRE programme to support initiatives that will reduce emissions of greenhouse gases over CP1. As well as aiming to reduce New Zealand's greenhouse gas emissions, the programme contributes to capacity building in renewable energy and improving energy efficiency.

Emission units are awarded to projects that produce emissions additional to business-as-usual. These units help bring forward projects that would not otherwise be economic. Successful projects are identified based on the request ratio – ie, the number of units requested relative to the CP1 abatement delivered. Firms awarded units are able to sell them on the international market.

In theory, the allocation of units is costless as they are awarded only to projects that are additional to business-as-usual and delivered only after the actual emissions reductions have been verified. The Crown is simply awarding units that it would have otherwise had to use towards compliance with Kyoto obligations.

The current project portfolio comprises 42 projects selected through two tender rounds held in 2003 and 2004 and an early projects process. Projects awarded emission units to date have been predominantly energy-related and include wind farms, small-scale hydroelectricity generation, geothermal-electricity generation, bioenergy and landfill gas projects. The first tender round gave priority to projects that contributed to the near-term security of New Zealand's electricity supply, although this criterion was removed for the second tender round. A third tender round is currently under consideration.

Energy-intensive businesses

For energy-intensive New Zealand businesses that do not meet NGA international competitiveness criteria or that may not have adequate resources to enter into an NGA application and negotiation, an "energy-intensive businesses" policy has been developed to assist them in adapting to the carbon tax. Energy-intensive businesses are defined as those that spend more than 8% of costs on energy.

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The energy-intensive businesses policy aims to meet the following objectives:

- greenhouse gas emissions resulting from energy use by small and medium enterprises are reduced on a cost-effective basis
- the competitiveness of small and medium enterprises is not diminished by a carbon tax
- firms that are adversely affected by the charge are able to adjust to the new policy environment.

The policy also aims to contribute to other government objectives, including energy efficiency, electricity security, sustainable development, and growth and innovation. It involves 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 a carbon tax and energy efficiency.

Implementation will proceed in two stages, depending on funding. 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.

Nine industries have been identified as being energy intensive: wood processing, food processing, basic metals, non-metallic industries, paper and paper products, glasshouse crops, fishing, irrigated dairying, and irrigated arable crops. 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.

Energy Efficiency and Conservation Authority programmes

The Government established the Energy Efficiency and Conservation Authority (EECA) in 2000 to encourage energy efficiency and the development of renewable energy. EECA developed the National Energy Efficiency and Conservation Strategy (NEECS) in 2001, which establishes two high-level national targets:

- a 20% improvement in economy-wide energy efficiency by 2012
- an increase in renewable energy supply to provide a further 30 petajoules (PJ) of consumer energy in the year 2012.

Guided by the NEECS, EECA undertook a range of programmes to encourage the uptake of energy-efficiency and conservation measures.

EECA programmes include:

- Emprove - which provides grants for energy audits to high-energy-use businesses, as well as general information on how businesses can improve energy efficiency
- building regulations – which facilitate the efficient use of energy and the use of renewable energy in buildings through changes to the Building Code

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- residential housing – which includes a grants scheme focused on fitting insulation in low-income households and an audit scheme for higher-income households
- renewable energy to the grid – which promotes the use of renewable energy to potential and existing electricity generators
- market development renewable energy – which encourages the uptake of small-scale renewable energy technology through grants, information provision and education, and supporting market research
- energy efficiency of products – which regulates standards for energy performance of appliances and includes mandatory and voluntary energy performance labelling regimes
- EnergyWise Councils – a partnership aimed at improving energy efficiency and the uptake of renewable energy in local government and their communities. EnergyWise Councils works alongside the Communities for Climate Protection programme, a global programme that allows councils to benefit from international best practice and experience in reducing emissions.

The first review of the NEECS was initiated in early 2005 and is being led by EECA. The review will provide an opportunity to evaluate New Zealand's progress and consider additional steps to address energy demand and supply options, including long-term behavioural change and technology development. It is anticipated a replacement NEECS strategy will follow the review.

Electricity Commission programmes

The Electricity Commission, established in 2003 to regulate the operation of the electricity industry and markets, is also tasked with promoting and facilitating the efficient use of electricity. The Commission has initiated a number of pilot programmes to deliver electricity efficiency:

- a trial of practical strategies to improve the efficiency of electric motor systems in New Zealand industry
- a study of opportunities to improve the functioning of compressed air systems to enhance industrial energy efficiency
- a project seeking to replace the use of incandescent lamps with energy-efficient lamps in Canterbury
- a project installing energy-efficiency measures in Auckland households and undertaking energy audits to demonstrate achievable savings
- a project testing an incentive to remove old, inefficient fridges in Waikato and replace them with new, efficient models.

The lifespan of these pilots ranges from three months to eighteen months. They will be reviewed on completion.

Resource Management Act 1991

Consideration of climate change has been incorporated in resource management law. The Resource Management Act 1991 (RMA) requires particular regard to be given to the national benefits derived from the use and development of renewable energy and the efficient use of energy, and the impacts of climate change. The Act was also amended to

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remove any obligation on councils to regulate the emission of greenhouse gases in resource management decisions, as this is expected to be dealt with through national-level policies such as the carbon tax.

Electricity-market regulations

Two sets of electricity-market regulations may impact on climate change outcomes. Regulations to require electricity retailers to offer low-fixed-charge tariff options to domestic consumers were introduced in 2004. While primarily aimed at improving the affordability of electricity for low-electricity users, these regulations will also allow users to benefit financially from low electricity use, thereby creating incentives for electricity (and consequently emissions) savings. The regulations require:

- electricity retailers to make available a tariff option that includes a fixed charge of not more than 30 cents plus GST per day
- electricity distributors to charge for lines services to domestic consumers on low-fixed-charge tariff options at not more than 15 cents plus GST per day
- domestic consumers on a low-fixed-charge tariff option to pay less than on other tariff options if electricity consumption is less than 8,000kWh per year.

Distributed generation is expected to play an increasingly important role in meeting electricity demand as the cost of smaller-scale and new renewable technologies continues to decline. Distributed generation is often, although not exclusively, based on renewable sources of energy such as solar and wind. Facilitation of distributed generation, where based on renewable energy, will therefore reduce the overall emissions intensity of the energy sector.

Electricity distribution companies (which operate the lines to which distributed generation needs to connect) appear to have weak incentives to effectively facilitate distributed generation. Industry self-governance arrangements have made insufficient progress in addressing this issue. The Government therefore intends to draft, consult on and introduce regulations that will provide for:

- a formal inquiry process, in order to obtain information on connection possibilities or constraints for particular locations
- application forms to be available and application decision timeframes
- access to compulsory dispute resolution when agreement on connection cannot be reached or an application is declined
- rules for network charges for various sizes of distributed generation.

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3.2.4 *Forestry and land-use change*

Forestry scene-setting

Commercial planted forests

New Zealand has a forest resource that is a crop rather than a product of a natural ecosystem. This provides flexibility to manipulate and manage the resource. Productivity and quality gains have resulted from New Zealand's strong forestry research and development capability. New Zealand recognises the important role that forests can play

as sinks and reservoirs of greenhouse gases. As at 1 April 2004, there were 1.82 million ha of sustainably managed planted forest in New Zealand. The predominant species is *Pinus radiata*.

More recently, there has been a decline in commercial forestry plantings, which has been driven by a combination of factors. These include: a relatively strong New Zealand dollar; substantial increases in shipping costs; tough international market conditions; and competition for land from alternative uses (which has pushed up land prices). There are no indications that the level of new planting will increase under current market conditions.

Indigenous forests

New Zealand indigenous forests represent a considerable reservoir of carbon. It is not known whether this reservoir is expanding or shrinking; ie, whether it is a sink or a source, but work is under way through the Carbon Monitoring System to monitor changes in indigenous forests.

Indigenous forests occupy 6.256 million ha, of which 5.187 million ha are owned by the Crown. A further 1.069 million ha of natural forest is privately owned; half by Maori. Of this, 124,000ha is considered commercially viable for wood production under current market conditions. Less than 0.005% of New Zealand's total commercial wood production is from indigenous forests.

"Kyoto" and "non-Kyoto" forests

Under the Kyoto Protocol, a clear distinction is made between forests established before 1990 (termed "non-Kyoto forests") and forests established from 1 January 1990 (termed "Kyoto forests").

A system to manage Kyoto forest sinks would provide the means for:

- New Zealand to receive additional emission units ("sink credits"), based on the increase in carbon stored in Kyoto forests over CP1 (2008 to 2012)

- obligations to be placed on "responsible parties" to hold sufficient emission units to offset CO_2 released into the atmosphere through harvesting or deforestation of Kyoto forests.

A system to manage non-Kyoto forests would provide the means for:

- obligations to be placed on responsible parties to hold sufficient emission units to offset emissions of CO_2 into the atmosphere over 2008 to 2012 from deforestation since 1990, where the land is not replanted but converted to some other land use

- credits to be gained (potentially) under Article 3.4 for management of non-Kyoto forests.

Current government policy for sink credits and deforestation

When the preferred policy package was announced in April 2002, it was assumed New Zealand would be a net seller of emission units in CP1. Although sink credits would cover all excess emissions, it was considered that sinks were a temporary offset and not a permanent solution.

Deforestation liabilities occur when forest land is changed to another land-use type. Initially, these were to be capped nationally at 5% of the area of forest expected to be harvested over CP1. Individual forest owners would not face a deforestation liability

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provided the total liabilities to the Crown stayed within a cap of 5% of each year's harvest. If it became apparent that the cap might be breached during CP1, the Government would have the option of lifting the cap or developing policy to allocate deforestation activity within the proposed cap.

The consultation process in 2002 on the preferred policy package raised concerns about the adequacy of the quantitative limit (or cap). Stakeholders thought that this cap was insufficient.

It was therefore decided that the cap would be increased to approximately 10% of the forests expected to be harvested during CP1 (21Mt CO_2e). Officials considered a cap of this magnitude would exceed all reasonable expectations of deforestation rates during the commitment period, and would therefore alleviate the risk of a cap creating a perverse incentive to deforest early.

If deforestation exceeds expectations, the Government has indicated that it will consider its policy options to manage emissions within the cap, including addressing issues such as: how deforestation rights within the cap will be allocated, how to monitor and enforce the deforestation cap, and what actions it will take if the cap is exceeded.

Permanent Forest Sinks Initiative

The Government also instigated a mechanism to create incentives for creating permanent forest sinks. The Permanent Forests Sinks Initiative is a mechanism that would involve landowners receiving sink credits in proportion to the carbon sequestered in their forests. The forest land would be covenanted and managed to create a permanent protection forest.

The Initiative is a contract (registered against land titles) between the Crown and a landowner in perpetuity, and binding on future landowners. Under the contract, the Crown agrees to provide an amount of tradable carbon emission units equal to the amount of carbon sequestered by new forests on a given block of land over CP1. Landowners receive returns only after the amount of carbon sequestered has been measured and verified. All costs and risks associated with the release of the carbon from a stand are borne by the landowner. Landowners are also liable for ongoing monitoring, verification and administrative costs.

Limited harvesting is permitted under the Initiative. Legislation to enact the Permanent Forests Sinks Initiative is currently before the House of Representatives.

The Initiative has wide-ranging benefits beyond climate change, including retiring marginal land, biodiversity enhancement, soil and water conservation, and improved flood protection.

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Monitoring carbon stocks

A significant commitment has been made in the collection of data on the stocks of carbon sequestered in forests. Although principally designed for carbon accounting and reporting for climate change purposes, the data gathered by the New Zealand Carbon Accounting System and the Carbon Monitoring System will also help meet some of the Government's other international reporting obligations (eg, the Montreal Process and the Convention on Biological Diversity).

The information is also a prerequisite for New Zealand's ability to claim and trade sink credits.

New Zealand Carbon Accounting System

A carbon accounting and reporting system is being developed for New Zealand's managed forests. The New Zealand Carbon Accounting System comprises five modules: natural forests (indigenous forest and scrublands); planted forests (both pre- and post-1990 plantings); the soil carbon-monitoring system; land-use monitoring; and a database to store all point and spatial data and provide an accounting and reporting function.

Carbon Monitoring System

The Carbon Monitoring System is for indigenous forest and scrublands and will be fully in place by May 2007. It comprises 1,400 grid point locations to identify permanent plots.

Other policies

Forest-industry initiatives

The Government noted (POL Min (03) 26/10 refers) that without measures additional to the above policy package, the decision to retain sink credits and liabilities, including capped deforestation liabilities, would have the following consequences:

- New Zealand generally under-investing in new forest planting, leading to forgone economic benefit from additional carbon sequestration
- higher agricultural emissions than would otherwise be the case, as new forests tend to displace agriculture
- fewer sink credits being generated in the future, perhaps limiting the Government's ability to utilise forest sinks to manage future risks and liabilities and protect New Zealand's competitive position
- increasing emission liabilities as a result of relatively higher rates of deforestation during CP1.

To address these issues, the Government agreed to assign a proportion of the credits, or an equivalent value, to provide incentives, including generic incentives, to retain and enhance forest sinks. These incentives formed the Forest Industry Framework Agreement (FIFA). Initiatives under this package included market access, bio-energy, labour and skills, and market development.

The forest industry has had difficulty in accepting the FIFA, because of issues around deforestation and the Government's retention of sink credits. Towards the end of 2004, the Forest Industries Council, the Forest Owners Association and the Farm Forestry Association put forward a new, amended proposal that suggested the Government address industry development and carbon policy issues separately.

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The Forest Industry Development Agenda (FIDA) is the result of that proposal. It includes the majority of the development initiatives included in the FIFA agreement. The FIDA is not concerned with carbon policy issues. The Government has announced that $18 million will be invested to develop the industry.

Non-climate policies with climate co-benefits

In addition to the above policies, there is a range of other policies and programmes that can contribute positive climate change outcomes from forestry. These include: the East Coast Forestry Project; implementation of the Biosecurity Act 1993; and sustainable development frameworks (such as the RMA and soil conservation/land management work undertaken by regional councils).

Many other non-climate policies and programmes contribute to climate change outcomes, including: implementation of Part IIIA of the Forests Act 1949; work by the Queen Elizabeth the Second National Trust; and forestry research by Crown Research Institutes and universities. The Sustainable Farming Fund investigates such issues as biosecurity, conservation biology, forest ecology, forest soils and silviculture of indigenous forests.

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Current policy package for LULUCF

In 2002 and 2004, the Government made decisions on climate change and forestry. These included:

- retaining all the sink credits from Kyoto forests and their associated liabilities, at least for CP1

- protecting Kyoto forest owners from any deforestation or harvesting liabilities at any stage where the Crown has retained the forest sink-credit asset

- should the Government decide to devolve forest sink credits in future, devolvng associated deforestation and harvesting liabilities only in proportion to the credits received by the Kyoto forest owner

- assigning a proportion of the credits (or an equivalent value) to provide incentives for establishing and enhancing sinks deforestation liabilities of the non-Kyoto forests, provided these remain within a cap equal to 21 million tonnes of CO_2 equivalent. This is the carbon that would be released by the deforestation of approximately 10% (originally set at 5%) of the area of forest reaching maturity during CP1. In relation to non-Kyoto forests, the Government will:

    - consider its policy options (in the unlikely event that deforestation may exceed expectations) to manage emissions within the cap. This includes addressing issues such as:
        - how deforestation rights within the cap will be allocated
        - how to monitor and enforce the deforestation cap
        - what actions the Government will take if the cap is exceeded

    - consider the deforestation policies for non-Kyoto forests for he scheduled review of climate change policies national rules on forests in the Kyoto Protocol are further clarified

- establishing a mechanism to encourage the establishment of permanent protection sinks (the Permanent Forest Sinks Initiative). The Initiative has been proposed to encourage permanently converting land to forest. Legislation is currently before the House to implement the Initiative

- considering further whether it should elect any additional sink activities under Article 3.4 of the Kyoto Protocol (eg, forest management, revegetation, crop and grazing land management) before 2007 (dependent on availability of carbon accounting data).

3.2.5 Agricultural non-CO_2 emissions

Policy in this area consists of:

- exempting agriculture from emission charges
- co-funding research into mitigation options
- improving inventory.

Exempting agriculture from emission charges

Under the current policy package, agricultural non-CO_2 emissions are exempt from any emissions charges or other compulsory mitigation measures until 2012, for three key reasons (New Zealand Government 2002c):

- the risk to the international competitiveness of the sector and risk of carbon leakage if domestic output reduces (being similar criteria to those for exemptions under NGAs)
- the apparent absence of significant mitigation options (which means that the likely effect of a price measure would be structural adjustment in the sector rather than stimulation of more efficient means of production)
- the difficulty of measuring emissions at farm level (which means that a price measure would not effectively stimulate increased efficiency at that level).

Co-funding research

At the same time, the sector agreed to invest in research to develop cost-effective mitigation options. Following negotiations with industry and further consultation with the farming sector about funding arrangements, a memorandum of understanding on funding arrangements and research responsibilities based on the pastoral greenhouse gas research strategy was signed between the Government and an industry consortium, the Pastoral Greenhouse Gas Research Consortium (PGGRC).[25]

The goals of the research strategy underpinning the memorandum are:

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

The target of the research strategy is to have safe, cost-effective greenhouse gas abatement technologies that will lower total New Zealand ruminant methane and nitrous oxide emissions by at least 20% compared with the business-as-usual emissions level by the end of the Kyoto Protocol's CP1; ie, 2012 (Leslie and O'Hara, 2003).

Reductions in inventory uncertainties and improving verification

[25] https://www.pggrc.co.nz/pggrc.asp?type=mou

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The Government also funded agricultural inventory research, spending $2.75 million between June 2001 and June 2005. The research programme identified areas of deficiency and undertook work to move the agricultural inventory to a "Tier 2" reporting format, as required under IPCC Good Practice Guidance for key sources. This objective has been achieved.

Despite improvements to the inventory, the estimated uncertainty of absolute non-CO_2 emissions for any given year remains high. Based on a Monte Carlo estimation of uncertainties undertaken for emissions in the year 2002, the uncertainty of total methane emissions was estimated at about ±50%, while the uncertainty for nitrous oxide was estimated at about +73/-50% (Ministry for the Environment, 2005b).

However, the uncertainty surrounding the change in emissions since 1990 is much smaller, since many of the uncertainties are systematic errors that partially cancel when projected emissions during CP1 are compared with 1990 levels. The uncertainty as calculated from the inventory reporting guidelines (UNFCCC, 2004) and Good Practice (IPCC, 2000a) shows overall uncertainty in the trend of emissions to be ±4.9%. The uncertainty introduced into the trend of total emissions by nitrous oxide from agricultural soils is ±1.3%, and the uncertainty for methane from enteric fermentation is ±2.6%.

Based on the current understanding of the non-CO_2 inventory and projections in animal numbers and efficiencies, emissions from the agricultural sector are projected to range from 38.5Mt to 42.0Mt CO_2e per annum over the commitment period, with a mean of 40.4Mt per annum.

The main issues for future development of the agricultural non-CO_2 inventory are:

- to ensure it remains up to date with evolving international best practice and requirements imposed by the UNFCCC process
- to ensure the inventory and related tools for monitoring and verification are able to accurately capture and represent any mitigation activities that may be undertaken within the sector regarding non-CO_2 emissions.

The relevance of these inventory requirements, and work that may be required to achieve these objectives, are discussed in more detail in Section 4.7

3.2.6 Transport

Transport policy framework – introduction

Institutional arrangements for transport in New Zealand are divided between central government and local government. Central government provides the framework for policy and rule-making, transport investment and funding, and the regime for transport-user charging. The Crown is also involved as an owner of transport infrastructure and assets. Local government owns infrastructure and assets (eg, roads, port assets), is responsible for funding and maintaining infrastructure and administering public transport, and is also responsible for developing, maintaining and implementing strategic transport plans.

The following sections provide detail on the way in which climate change policies have overlaid, and impacted on, the existing transport framework.

The Climate Change Policy Package and Foundation Policies

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The New Zealand Climate Change Policy Package and accompanying "Foundation Policies" were released in stages during 2001 and 2002. The Foundation Policies were the National Energy Efficiency and Conservation Strategy (NEECS), released in two parts in 2001 and 2002, and the New Zealand Transport Strategy (NZTS) released in 2002. The NEECS and the NZTS were developed independently, but designed to be complementary to the Climate Change Policy Package.

For the transport sector, the most significant measure announced to date is the $15 per tonne of carbon tax from 2007, which would apply to the use (within New Zealand) of all petroleum-based transport fuels: diesel, fuel oil, jet fuel, aviation gas, LPG, CNG and petrol. Petroleum fuels used for international transport would be excluded.

In addition, the implementation of NGAs and the Energy-Intensive Business Policy has some implications for transport. For example, NGAs can cover transport that is directly part of the industry's operation (eg, use of mining trucks). In the Energy Intensive Business Policy, some transport – particularly road haulage and transportation of tourists – is covered. This policy provides enterprises with financial assistance available through energy audits and demonstration pilots.

National Energy Efficiency and Conservation Strategy

The NEECS is enshrined in legislation, in the Energy Efficiency and Conservation Act 2000. It sets out objectives, policies, targets and associated measures to improve energy efficiency and the uptake of renewable energy. One of the six objectives of the strategy is to reduce CO_2 emissions, and transport is one of five areas in which an Action Plan was developed.

The NEECS established economy-wide targets for energy efficiency and the use of renewable energy sources by 2012. These targets are not mandated; rather, they are regarded as aspirational.

Nevertheless, it was expected that these targets would increasingly be incorporated into, and be supported by, other government policy areas, and that all sectors would contribute to them according to the opportunities available within those sectors; eg:

- the target of 20% improvement in economy-wide energy efficiency by 2012. With transport responsible for over 40% of consumer energy, achievement of the target would require a significant improvement in the efficiency of transport energy use
- the target of 30 PJ of renewable energy, with an indicative target of 2 PJ established for transport. The target of 2 PJ is equivalent to about 1% of New Zealand's total domestic transport energy use for 2004.[26]

Responsibilities for implementing the NEECS are spread between a number of government departments and agencies.[27] The main measures for transport are listed below, with lead agencies in brackets:

- investigate road pricing policy (MOT)

[26] Total energy consumed by transport in 2004 was 210 PJ. New Zealand, Ministry of Economic Development (2005)

[27] Note that since 2001, some of the lead agencies have changed: the Ministry of Transport has taken over work on fuel consumption information and Land Transport New Zealand was previously known as Transfund.

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- improve the effectiveness of funding alternatives to roading (MOT, Land Transport New Zealand)
- facilitate and promote travel demand initiatives (EECA, Land Transport New Zealand, local government)
- investigate vehicle efficiency standards (MOT)
- investigate and deploy vehicle fuel consumption information (EECA)
- facilitate eco-efficient vehicles into public and private fleet (EECA)
- develop a renewable energy transport fuels programme (EECA and MOT).

The Ministry for the Environment and the oil and motor industries provide support.

Although the Action Plan for transport identified some timelines for report-backs and the development of proposals, many of the measures were described as "ongoing". The programmes identified were not prioritised and there were no specific targets for the different activities within them.

The NZTS

The NZTS was released in 2002. It takes a sustainable-development approach to transport policy, addressing modal roles and different users' needs. The strategy vision is that "by 2010 New Zealand will have an affordable, integrated, safe, responsive and sustainable transport system". Recognised within the strategy is the need to integrate and manage multiple objectives.

The NZTS has five objectives:

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

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The environmental-sustainability objective encompasses the need for more energy-efficient modes of transport and the need to reduce greenhouse gas emissions from the transport sector. There is also a potential synergy, where some actions to address access and mobility and public-health objectives can also result in CO_2 emissions reductions.

Before the NZTS, transport funding and operational agencies had a focus on "safety and efficiency at reasonable cost". The subsequent enactment of the Land Transport Management Act 2003 has helped to embed the concepts of the strategy into the development of national and regional work programmes. Transport agencies must reflect

the shift to the new "sustainable transport" paradigm within their policy and operational outputs. The Act provides for long-term planning of transport networks, integrated transport infrastructure, a multi-modal approach to the sector, and new mechanisms for funding roads. This has particularly flowed through to the funding regime administered by Land Transport New Zealand, and the further development of integrated Regional Land Transport Strategies prepared by local government.

Key to the NZTS (supported by the Land Transport Management Act 2003) is that it is a way of working rather than an action plan. The focus is on meeting environmental, social and economic objectives and all five objectives must be considered. The strategy does not identify specific short- and long-term work programmes, although it does identify some initiatives under each of the objectives as examples.

Complementary and other transport strategies

More recent developments that build on the principles of the NZTS are found in the Government's "Sustainable Energy" Discussion Document, released in October 2004. It included objectives for energy policy and "ways forward" for transport. It did not, however, confirm or develop any policies specifically for transport.

Other government strategies include:

- "Getting there – on foot, by cycle", released in February 2005, which supports active modes of transport

- the National Rail Strategy, released in May 2005. Following the national rail network being brought back into public ownership in 2004, and the subsequent commitment of $200 million in asset investment and maintenance, the strategy sets out the Government's rail policy objectives and priorities for action over the next 10 years.

CO2 emissions reductions as a co-benefit of other policy objectives

Reducing use of petroleum-based transport fuels, as well as reducing CO_2 emissions, also assists in achieving other government objectives.

There are also other government objectives where actions taken to achieve the objectives increase CO_2 emissions. This is because increased transport is integral to achieving those objectives (eg, where the emphasis is on improved access and mobility). National policy documents that affect transport include: Growing an Innovative New Zealand, the New Zealand Tourism Strategy, the New Zealand Health and Disability Strategies, and the New Zealand Waste Strategy. These are noted in the NZTS and highlight the multiple objectives in managing transport.

In summary, although there are tensions between government objectives for transport, there are also significant co-benefits for other environmental and social objectives.

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Table 5: Summary of Other Policy Objectives' Positive and Negative Effects on Transport CO_2 Emissions

Policy Area	Positive Effects (reinforces CO_2 emissions reduction)	Negative Effects (indirectly leads to increased CO_2 emissions)
Road safety	Speed-control policies will reduce aerodynamic drag losses on vehicles and improve fuel efficiency Safety of vulnerable road users (eg, walkers, cyclists, motorcyclists) will improve	Meeting vehicle-safety concerns may result in increased weight and reduced fuel efficiency
Growth and innovation	An emphasis on high value-added production will lead to lower CO_2	In itself, economic growth translates to higher consumer spending on transport services and fuels Strong pattern of increased discretionary expenditure on transport services is created
Urban area design	People-friendly urban areas will emphasise low CO_2 travel modes	Large investments in transit systems/ facilities may not give net CO_2 benefits over the short term
Health and welfare	Physical exercise message reinforces low CO_2 forms of travel (for short distances) Vehicle-emissions controls that target inefficient vehicles will have small CO_2 emissions benefit	Providing access and mobility for the transport-disadvantaged may increase fuel use
Urban air quality	NES[28] for air generally supports more efficient engine combustion and lower CO_2 emissions Biodiesel use reduces particulate emissions	Some technologies to reduce toxic emissions can increase fuel use
Energy security	Fuel savings/conservation will give commensurate reductions in CO_2	Incentives for oil exploration will tend to reinforce status quo regarding CO_2

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[28] NES = National Environmental Standard developed under the Resource Management Act 1991. The air NES sets ambient air standards for toxic emissions.

3.2.7 Foundation and other non-price policies

Foundation policies

These policies were already in existence in 2002 and had been established primarily for reasons other than climate change. However, they were expected to contribute to climate change outcomes.

The Government's **Growth and Innovation Framework** is designed to focus the Government and New Zealand business on an innovative, knowledge-driven approach to business development. This is to prepare New Zealand businesses to operate in a global market where greenhouse gas emissions increasingly have a cost and innovations and new technologies are required. This process is expected to create significant business opportunities in parts of the economy (and increased costs in others). "Climate-friendly" processes could also become an element of competitive advantage.

The **National Energy Efficiency and Conservation Strategy (NEECS)** was released in 2001. The NEECS has two high-level targets:

- a 20% improvement in economy-wide energy efficiency by 2012
- an additional 30 PJ of renewable energy above 2000 levels by 2012.

When the strategy was developed, it was estimated that achieving these targets would contribute emissions reductions of about 20Mt CO_2e during CP1, but it was noted that their achievement would depend on relevant programmes and actions being adequately funded and carried out. NEECS programmes and policies have been outlined in Section 4.4.

The **NZTS** includes an aim of environmental sustainability. Relevant transport policies have been outlined in Section 3.2.6.

At the time of the confirmed policy package, officials were aware that although synthetic greenhouse gases accounted for less than 1% of total emissions, imports (and hence emissions risk) were increasing rapidly. It was considered that appropriate policy interventions could yield significant reduction in emissions risk. Both of the policies set down for the pre-commitment period (voluntary handling programmes for HFCs and PFCs and an industry agreement to limit leakage of SF_6) have been implemented. Officials will soon advise the Government on whether these gases should now be regulated or be the subject of further non-regulatory policy initiatives.

In the confirmed policy package, the **New Zealand Waste Strategy** was relied on to create the incentives needed to reduce emissions and to reduce the variability across the country's waste facilities. A review of the success of the Waste Strategy was undertaken in 2004 and another is planned for 2006. Use of a waste levy was considered in 2003, but it was decided at that time to focus on developing a framework product stewardship approach to key waste streams instead. In addition, a National Environmental Standard for landfill methane was developed and came into force in 2005 to help manage greenhouse gas emissions. The Waste Strategy, along with current trends in the sector, was expected to reduce methane emissions from waste by 5Mt CO_2e during CP1 (this is 36% below 1990 levels).

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Public awareness programmes have been developed and implemented to increase awareness of climate change and to assist New Zealanders in taking actions to reduce greenhouse gas emissions and make a difference. The 4 Million Careful Owners programme has included two outreach campaigns and a website linked from the Government's climate change website (www.climatechange.govt.nz). It generated increased awareness, as measured in surveys. Other elements of the programme include advertising, promotion, community education and partnership programmes with key groups.

Local government and the **RMA** are also important foundation policies. Local government in New Zealand is a large sector and undertakes a wide range of activities related to infrastructure and service provision (eg, roading, water and waste). It also has important regulatory and planning powers and plays a community leadership role. The Ministry for the Environment has partnered with Local Government New Zealand and EECA to promote the international Cities for Climate Protection model to councils.

There were many requests to clarify the role of the RMA in mitigating greenhouse gas emissions at a regional or local level. In March 2004, the RMA was amended by the Resource Management (Energy and Climate Change) Amendment Act to remove regional councils' ability to directly control greenhouse gas emissions through resource consents and regional plans. This put into law the Government's preference that industrial emissions be dealt with through national policies (as described above). This in no way limits councils' ability to reduce greenhouse gas emissions in the community through other means (eg, voluntary programmes and measures) and in their own operations.

The same Amendment Act made other amendments designed to:

- encourage energy efficiency
- ensure that renewable energy is given due weight in consent decisions
- direct local authorities to consider the effects of climate change in their day-to-day activities.

Policies to assist New Zealand in **adapting to climate change impacts** are also considered part of the foundation policies. They are not considered in this Review, as adaptation is not within its scope.

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4 Policy choices

4.1 Overall Mitigation Prospects

4.1.1 "Decoupling" emissions and growth – what are the prospects of reducing emissions (or slowing their growth) without reducing output?

Summary

This section investigates the prospects for New Zealand to reduce emissions growth without reducing economic growth.

It concludes that:

- New Zealand's scope for reducing gross emissions without reducing output is limited by our comparative advantage in emissions-intensive industries and our already high proportion of renewable energy
- although there is some potential in productivity improvements (eg, with respect to electricity efficiency), this does not represent a panacea for reducing the level of emissions in the long term.

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The scope for New Zealand to "decouple" emissions growth from economic growth depends on a number of factors, including:

- the composition of future economic activity (ie, structural change)
- the resulting level of energy demand
- the fuel mix through which future energy demand is met
- productivity improvements (with respect to emissions-producing processes)
- the availability and uptake of emissions-reducing technologies and innovation.

The opportunities around innovation, technology and research are discussed in detail in Section 4.3. In this section, we look at the projected level and composition of economic growth under business-as-usual assumptions.[29]

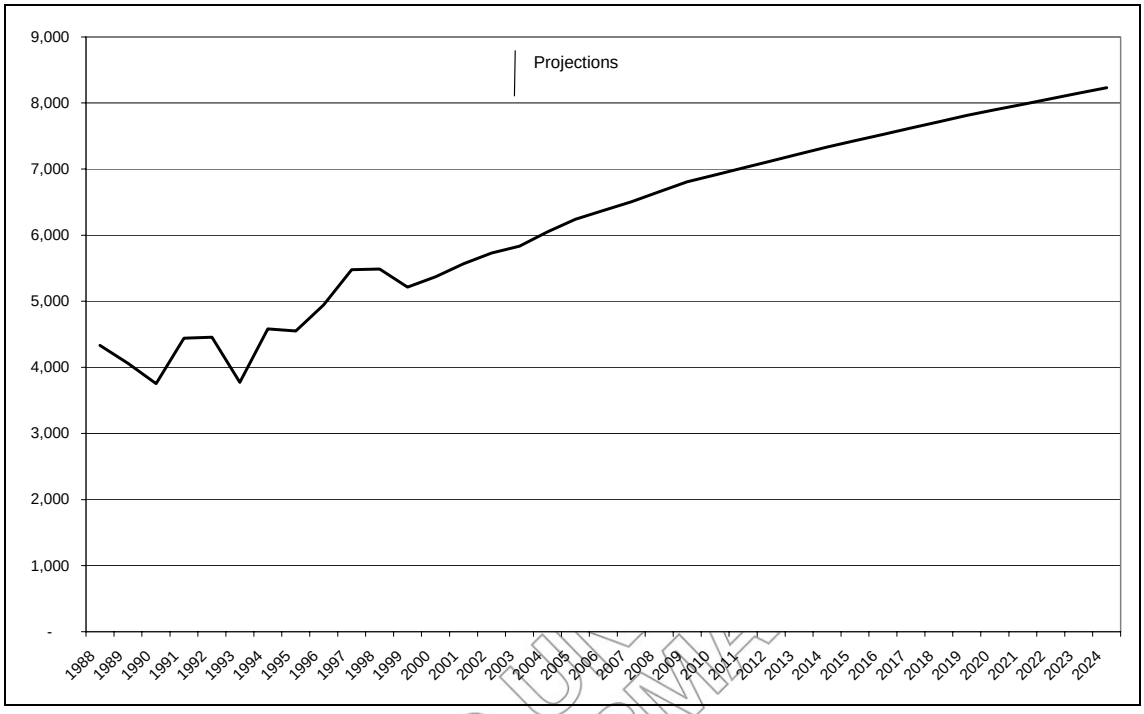
Structural change

NZIER's industry GDP projections show New Zealand's services sector becoming relatively more important over the next 15 years, at the expense of both the manufacturing and primary sectors (NZIER, 2005).

[29] Note that in our discussion on the structural composition of GDP, we use projections by NZIER. The business-as-usual GDP projections used in the preparation of the Government's net emissions position projections are sourced from the Treasury. For the purposes of this discussion, the variations in growth rate assumptions are not significant.

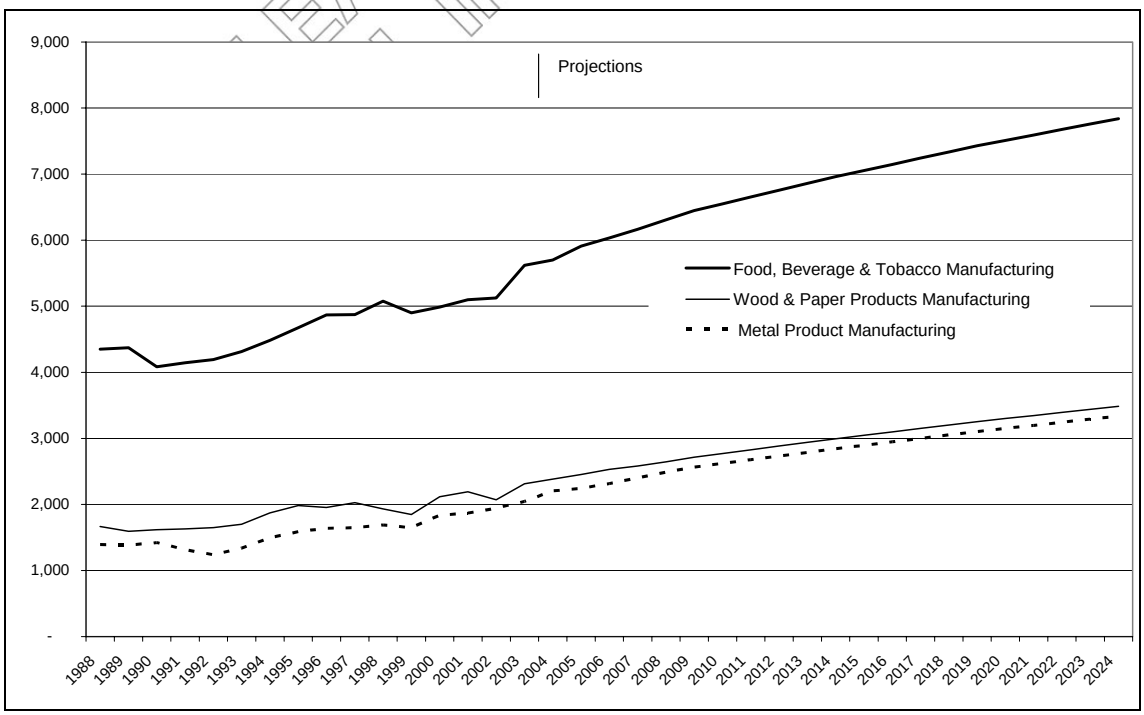
However, this is only part of the story. What matters for emissions levels is the **level** of activity within these sectors. The following charts show the projected level of activity in selected industries. The expected growth in the (emissions-intensive) transport sector is particularly marked. NZIER (2003a) concludes that decoupling of household transport use and economic growth is unlikely to occur in the next 50 years.

Figure 21 - Real GDP – Agriculture ($ millions, 1995/96 dollars)



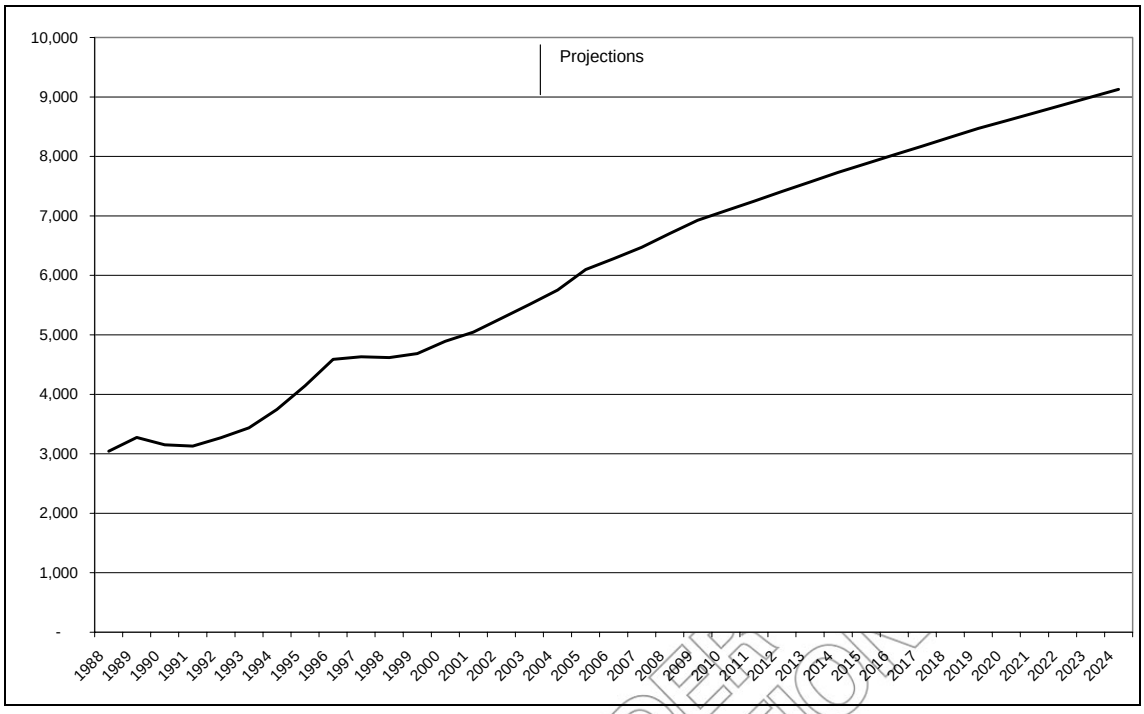
Source: NZIER *Quarterly Predictions* March 2005

Figure 22 - Real GDP – Selected Manufacturing Industries ($ millions, 1995/96 dollars)



Source: NZIER *Quarterly Predictions* March 2005

Figure 23 - Real GDP – Transport ($ millions, 95/96 dollars)



Source: NZIER *Quarterly Predictions* March 2005

Notes: It should be noted that this definition of "transport" refers to the economic industry of "transport and storage". This includes companies whose main purpose is transportation (such as delivery companies). It excludes transport consumption by other companies, and personal (household) vehicle use. It thus underestimates the total level of transport activity in the economy.

To make a significant departure from these projected industry trends would imply the New Zealand economy moving away from its areas of comparative advantage. New Zealand's comparative advantage lies in primary production, and a selection of manufacturing industries. Many of these are, by their very nature, energy intensive (eg, dairy processing, and cement and steel manufacturing). This is a feature both of our resource endowments and economic development.

Although the economy has diversified over recent years, a sudden or substantial structural shift – to the less energy-intensive services sector – is unlikely, with change continuing to be gradual. Although New Zealand's manufactured exports grew strongly in the early and mid-1990s, there is now greater competition from Asian manufacturers, particularly China. However, there may be niche markets in which New Zealand can work. The growth of China will work on the demand side as well, fuelling global demand for our exports (in particular, primary products).

There are some service-sector industries, such as tourism, where it is projected we will continue to expand. But New Zealand's comparative advantages are likely to remain in (energy-intensive) primary-related sectors. In this respect, our potential for substantial declines in energy intensity may be more modest than that of other developed countries. A key factor likely to impact on the degree of structural change is that of prices, particularly electricity prices. As noted above, relatively cheap electricity has helped shape the development of New Zealand's economic structure. The cheap hydro sources

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have now largely been exploited. Combined with the introduction of the carbon tax, we are likely to see rising energy prices over coming years. This may create an incentive for structural adjustment. However, any fundamental structural responses to rising electricity prices will be gradual.

There is also the question of how energy-intensive our service-sector industries are. We know that a key component of tourism, for instance, involves transporting international visitors from Auckland down the country through our "top five" destinations. With our long, narrow geography, this suggests that even this service-based industry is likely to be relatively emissions intensive. This compares with service-sector growth in, for instance, the United Kingdom, which has been focused in low-emissions industries such as finance.

Moreover, as Panayotou (2003) notes, while production patterns of developed countries tend to grow cleaner over time, consumption patterns continue to be as environmentally burdensome as ever. This points to a tension between decoupling from structural economy change and further coupling from income (and hence consumption) growth.

A further factor that may diminish any improvements from structural change is the prospect of increased capital intensification. The New Zealand economy is now close to full employment, with high labour utilisation rates and economy-wide labour shortages. As the population ages over the next few decades, pressure on the labour force will increase as the working-age population becomes an increasingly smaller percentage of the total population. This is likely to push up wages, making capital relatively more attractive to firms, and leading to increased capital accumulation. Notwithstanding that newer capital is likely to be more energy efficient, growth in the **stock** of capital is likely to place upward pressure on energy use.

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Energy demand

Fuel mix

In terms of decoupling emissions from energy use from economic growth, sources of **renewable energy** need to be available – not only on an economically competitive basis, but also in a practical sense. Oxley and Macmillan (2004) note a number of particular drawbacks associated with various renewable energy sources. For example, wind requires back-up capacity, and connection to the grid at low voltage (which adds to the cost of systems control and operation). Wind also fluctuates randomly, providing variations in output that can cause problems to the power system and the electricity market.[30] And while geothermal and biomass are competitive with respect to generation costs, their associated capital costs are likely to remain high. On this basis, Oxley and Macmillan predict a limited role for renewables in displacing fossil fuels.

The sources of new hydro generation in New Zealand look to be limited, as most of the major resources have already been developed. As a share of total electricity generation, the contribution of hydro is expected to drop from 65% to 56% by 2025 (see Figures 24 and 25, below).

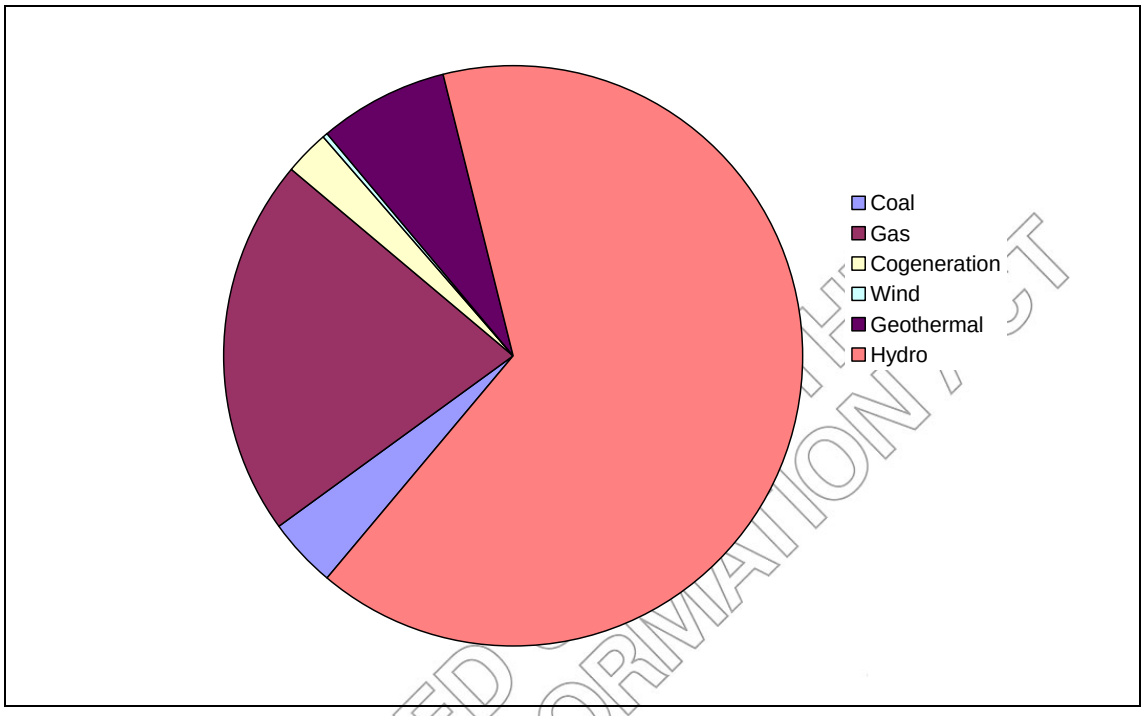
Wind energy is expected to exhibit strong growth. While this growth is off a low base, it is expected to increase in relative significance, to comprise 5% of New Zealand's electricity

[30] Report by the system operator to the Electricity Commission (2005) "Manawatu wind generation: observed impacts on the scheduling and dispatch process."
<http://www.electricitycommission.govt.nz/opdev/comqual/windgen/ReportWindAnalysisFinal.pdf>

supply by 2025. A recent report commissioned by MED and EECA suggests that the technical and operational capacity could be substantially higher than this – up to around 20% of market share.[31]

Geothermal supply is expected to nearly double over the projection period, to comprise around 15% of electricity supply by 2025. However, the emissions gains from this growth look set to be offset by the decline in gas (from 21% to 15% of electricity supply).[32]

Figure 24 - Electricity Generation by Fuel 2000 (TWh pa)



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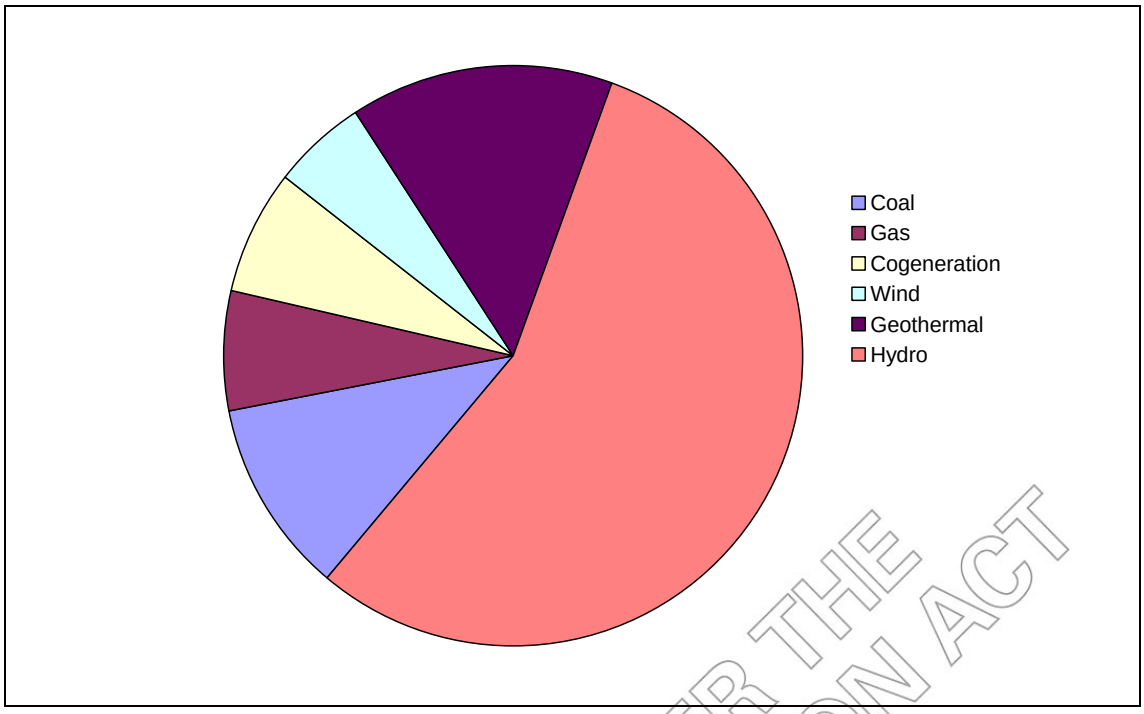
[31] Energy Link and MWH NZ (2005) "Wind energy integration in New Zealand." Report to MED and EECA, May 2005. <http://www.med.govt.nz/ers/electric/wind-energy/summary/index.html>

[32] MED is currently updating these projections. Preliminary results suggest that the growth in hydro will be weaker than previously projected, due to some projects being more expensive than originally anticipated (and hence will comprise a lower proportion of total electricity generation than suggested here). On the other hand, wind generation projections are likely to be scaled up, as technologies appear to be more cost-effective than previously projected.

Figure 25 - Electricity Generation by Fuel 2025 (TWh pa)



Source: MED *Energy Outlook to 2025* (2003)

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Productivity improvements – energy efficiency

The international evidence on the causes of decoupling is mixed. There is some evidence that energy efficiency has contributed to decoupling energy use from economic growth. However, there is also significant evidence that this decoupling is due to changes in economic structure, energy quality and the extent of value-adding in the economy.

It is important to note that even with decoupling, total gross emissions can still rise. Energy efficiency (and productivity improvements more generally) are not a panacea. Moreover, efficiency gains (eg, in the production sector) will make these goods relatively cheaper, increasing purchasing power and hence increasing demand. If these products are normal goods, then this income effect can result in a "rebound effect", offsetting some of the gains from improved efficiency.

As discussed in Section 3.1.3, the latest data shows that New Zealand's economy-wide energy-efficiency improvements were 1.85% over the year 2001/02. Efficiency gains came largely from the transport sector; gains were also recorded in the commercial and industrial sectors. Efficiency in the residential and primary sectors declined.

Although these estimates indicate we are currently on track with the annual targets under the NEECS[33], it is not clear whether we can continue to achieve annual gains of a similar magnitude. Research by NZIER (2003b) suggests it would be challenging.

Because the new capital investment in any period represents such a small proportion of the total capital stock, the efficiency gains from new, more energy-efficient equipment will be gradual. And although the economy has diversified over recent years, gains from a

[33] The NEECS target is for 2% energy efficiency gains per year (1.67% per annum on a compound growth basis).

sudden or substantial structural shift to less energy-intensive industries look to be limited. New Zealand's comparative advantages are likely to remain in (energy-intensive) primary-related and niche manufacturing industries.

Further efficiency gains in the residential sector may also be constrained. Continued population growth, combined with trends towards smaller households and larger houses could swamp the impact of individual efficiency efforts and policies (such as improvements to the Building Code and the introduction of energy-performance standards on appliances). Income growth could also spur increased energy use *per capita*.

A bottom-up perspective – electricity efficiency

Macro-level, top-down analysis suggests that significant emissions mitigation through energy efficiency will be very difficult to achieve. On the other hand, bottom-up analysis of energy-efficiency potentials typically identifies a range of opportunities – in many cases, representing cost-effective potentials that would result in win-win outcomes for both economic efficiency (through improved productivity) and environmental outcomes. Why the apparent disjunct?

Top-down analysis relies on past trends to project future energy efficiency and energy demand. Bottom-up analysis, on the other hand, uses estimates of potential future savings to project future possibilities. These potentials are based on what makes economic sense – that is, estimates of measures whose benefits exceed their costs (over some time period). The key to unlocking the gap between the economic possibilities and what the market is actually likely to do is in understanding the barriers to uptake, and creating incentives for, behavioural change.

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Potentials Analysis – Electricity Efficiency

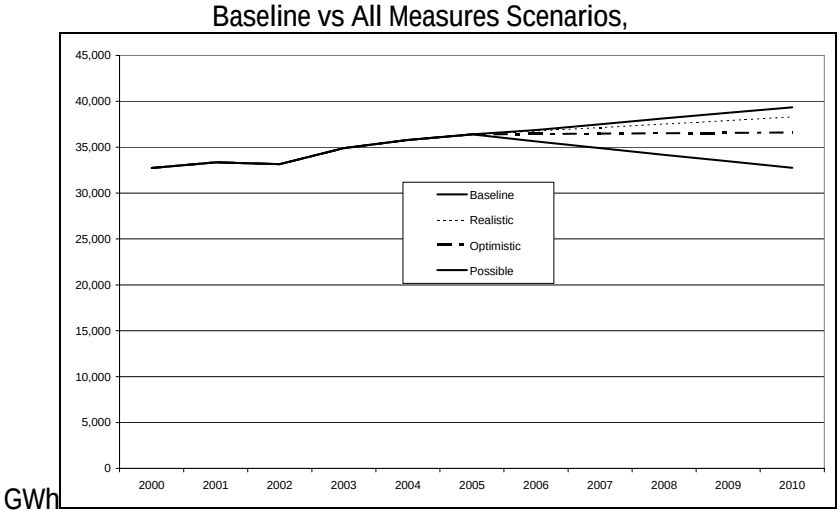
The Treasury recently commissioned work to assess the potential for electricity savings from efficiency measures.[34] This bottom-up analysis looked at measures according to electricity end use, and included both commercial/industrial and residential demand. Three scenarios were modelled:

- **possible** – those measures that are cost-effective (ie, their direct implementation costs are less than the cost of investment in new generation and/or transmission capacity)
- **optimistic** – a subset of the "possible" measures, which assumes uptake of measures that are relatively hard to encourage people to implement
- **realistic** – assuming uptake of those measures that represent "low-hanging fruit" and are relatively easy to get people to implement.

The results showed that there is considerable potential for achieving load reduction via energy-efficiency measures. Economically justifiable measures represent around 22% of current consumption (built up over five years). The realistic savings are considerably lower, at around 6.5%. A comprehensive energy-efficiency programme that included all identified measures could be expected to reduce electricity demand growth from an average of 1.6% per annum to around 1.0% per annum over the next five years.

The chart below shows these projected savings against MED's baseline electricity demand projections.

Figure 26 - Potential Electricity Efficiency Gains



Source: MED, Lermit (2005)

[34] The quantitative analysis was undertaken for Treasury by Jonathan Lermit, a Wellington-based independent energy consultant.

The biggest potential gains in total demand reduction relate to motive power (more efficient motor drives), water heating, lighting and refrigeration. The best value-for-money measures are in:

- **lighting** (replacing incandescent bulbs with compact fluorescents)
- **pumping** (replacing constant speed drives and power pumps with variable speed drives)
- **electrical and refrigeration** (replacing the existing stock of electrical and electronic equipment with more efficient models, and the existing stock of fridges with better-insulated models).

This analysis did not attempt to convert these potential electricity-demand savings into emissions reductions. It would be possible to apply emissions factors (based on MED's projections of fuel mix) to do this extrapolation. As much of the additional electricity generation is expected to be delivered from new renewable fuels, the big gains in terms of emissions mitigation would be under the "possible" scenario, as this taps into existing generation sources.

Transport

Transport is particularly important from a climate change (and broader environmental) perspective, as it is rapidly growing and dominated by non-renewable fuels.

NZIER (2003a) considered the issue of decoupling transport activity, as measured by kilometres travelled, and economic activity in Zealand. Analysis of a variety of measures gave mixed results – possibly suggesting some decoupling since the mid-1990s at a modal level (although they note that it is difficult to draw firm conclusions). It is also difficult to draw conclusions on the basis of this analysis because kilometres travelled as a proxy for transport activity will not account for other factors that impact on emissions, such as engine size and efficiency and loading.

In regard to general drivers of growth in transport activity, the NZIER report concludes that increasing activity comes from growth of the commodity and tourism sectors, as well as increases in the number of vehicles in the fleet.

The following aspects of the generic drivers identified in Section 3.1.3 are likely to affect the future profile of New Zealand's transport emissions:

- demographic change – the proportion of the population aged 35 to 54 is projected to increase over the next few decades. This age cohort is characterised by higher-than-average spending on road transport
- the domestic uptake of more fuel-efficiency technologies, which will depend on, *inter alia*:
    - the speed and extent to which fuel-efficiency improvements are incorporated in vehicles from source countries (and the profile of New Zealand's source countries)
    - the potential for consumer preferences (eg, for larger, more powerful vehicles) to dilute gains from efficiency improvements, and the changing nature of these preferences

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- the rate of turnover of the fleet and the extent to which the second-hand market delays the benefits of technological advances

- the introduction and uptake of biofuels.

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4.1.2 Energy

Summary

This section assesses the "economic potential" for emissions reductions in the energy sector in the medium term through:

- reducing overall demand for energy in the residential, commercial and industrial sectors
- reducing the emissions intensity of the energy supply mix; ie, growing the proportion of renewable energy in New Zealand's energy supply
- adopting technologies to sequester energy-sector emissions.

It concludes that:

- there are substantial and worthwhile gains available from energy-efficiency improvements in the residential, commercial and industrial sectors, based on EECA's assessments of "economic potential"
- in each of these sectors, general trends are pushing up overall demand for energy. Improvements in energy efficiency may therefore be likely to achieve reduced growth in energy demand, rather than an absolute reduction in energy use
- substantial changes to the emissions intensity of the supply mix appear unlikely, given the already high proportion of renewable energy used in electricity generation and the fact that many major hydro generation opportunities have already been taken up. Some further renewable energy, including small-scale plants, can nevertheless be developed economically in the medium term
- carbon sequestration and hydrogen technologies offer potential for neutralising emissions from the energy sector in the longer term, although significant impacts are not expected to occur by 2020.

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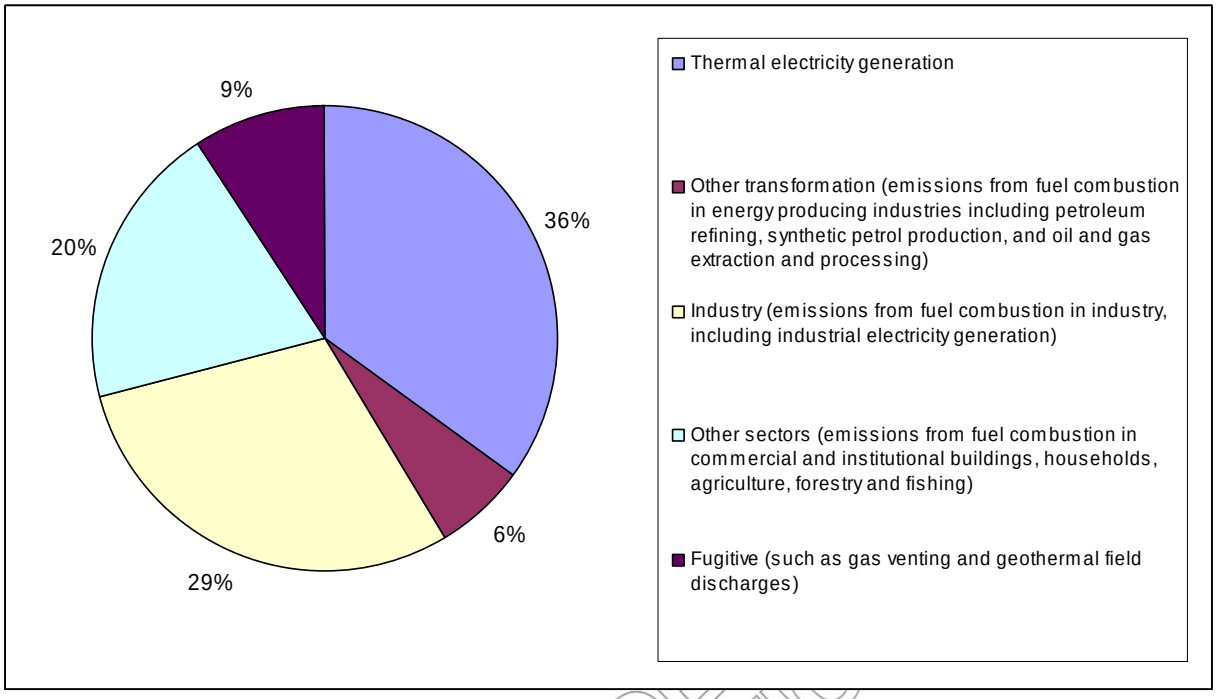
As noted in 3.1.3, New Zealand's energy intensity is relatively high compared with other OECD countries, due to low energy prices resulting in a historical comparative advantage in energy-intensive manufacturing industries. However, as a result of New Zealand's reliance on renewable energy (particularly for electricity generation[35]), this has not translated to a commensurately high greenhouse gas emissions intensity.

Total energy (non-transport) emissions in 2004 were 17.3Mt CO_2e, approximately a quarter of New Zealand's overall emissions. Recent SADEM projections by the MED indicate that energy emissions will grow to 22.2Mt CO_2e in 2020, although this may be reduced to 20.9Mt CO_2e with a range of climate change and energy-efficiency measures in place. A sub-sectoral breakdown of emissions from the non-transport energy sector is displayed below.

[35] In the year to March 2005, close to three-quarters of electricity generated was from renewable sources, predominantly hydro.

Figure 27 - Emission of Greenhouse Gases from the Energy (Non-transport) Sector 2004, by Sub-sector



Source: MED, New Zealand Greenhouse Gas Emissions 1990-2004

This section will examine the potential to achieve emissions reductions from the energy sector in the medium term (to 2020) and, where possible, draw on information on the relative cost at which emissions reductions are achieved. It will explore, in turn, the potential to reduce energy emissions through:

- reducing the overall level of demand for energy; eg, through energy-efficiency and conservation measures
- reducing the emissions intensity of the energy supply mix
- sequestering emissions from the energy sector; ie, carbon sequestration.

Reducing demand for energy

Total demand for energy in New Zealand has a range of determinants:

- population and demographics
- climate and weather
- structural composition of the economy
- economic growth
- technology development
- uptake of energy-efficiency measures.

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Population, demographics and the climate are exogenous to the energy system and outside a reasonable scope for climate change policies.[36]

In the longer term, the structural composition of the economy has a significant influence on energy use and emissions, although it would be inappropriate to directly target structural change solely for the purposes of emissions reductions. Rather, changes to the structure of the economy are likely to result from the incorporation of a domestic carbon price. For example, a carbon price may slightly increase the profitability of investing in service-sector industries relative to energy-intensive manufacturing industries, although it is likely a carbon price would need to be set at a high rate for noticeable structural shifts to occur.

Although the economy has diversified over recent years,[37] a sudden or substantial structural shift to the less energy-intensive services sector is considered unlikely – any change will continue to be gradual. Substantial reduction in energy use from structural change therefore looks to be unlikely (certainly in the medium term).

Economic growth is a key determinant of energy use. In many countries, a strong historical linking between economic growth and energy demand is evident, although the relationship is more complex. As Section 3.1.3 discusses, during periods of poor economic performance, investment growth can slow, limiting the rate of improvements in energy efficiency from new, more energy-efficient capital. Poor economic performance can also lead to decreased capacity utilisation, resulting in fixed energy requirements representing a higher proportion of total inputs, thereby increasing energy intensity.

The application of more energy-efficient technologies, on both the supply side and the demand side, can also have a significant impact on total energy use. New Zealand is largely a taker of international technologies in this area (public funding for research into mitigating greenhouse gas emissions in the energy sector is relatively limited, at approximately $1.8 million per annum (Ministry for the Environment, 2004e)), making international linkages and collaboration key activities. The development of new technologies and their impact on New Zealand's energy emissions is therefore difficult to influence (at least until the technology is available to New Zealand at a commercial cost).

The focus of policies seeking to reduce demand for energy is therefore on energy efficiency and conservation. Energy-efficiency gains will not necessarily translate proportionally to energy-emissions reductions. This is particularly noticeable for electricity use, where up to 75% of New Zealand's generation comes from renewable sources.

In the short term, emissions savings from reduced electricity use will depend on the marginal **existing** generation; ie, the generation plant that will be the first to cease or reduce generating capacity in response to reduced demand. In the case that the marginal generation is based on fossil fuels, energy-efficiency gains would have a significant effect on emissions.

In the longer term, emissions savings will depend on the marginal **new** generation; ie, the new generation plant that will be delayed as a result of improved economy-wide efficiency. MED modelling suggests this will be mainly renewable in the short term (up to 10 years out) and coal thereafter. Sustained, economy-wide improvements in energy efficiency will ultimately assist in reducing energy-sector emissions, although the extent and timing depend on the cost and viability of coal and gas in comparison with renewables.

It is also important to be cautious of potential "rebound effects" from energy-efficiency improvements. For example, energy-efficiency gains can decrease the cost of producing

[36] Although, ultimately, influencing changes to the climate is the key aim of climate change policies.

37 A decomposition of the decrease in the energy intensity of the New Zealand economy between 1993 and 2000 has shown it was partially attributable to a shift away from energy-intensive industries.

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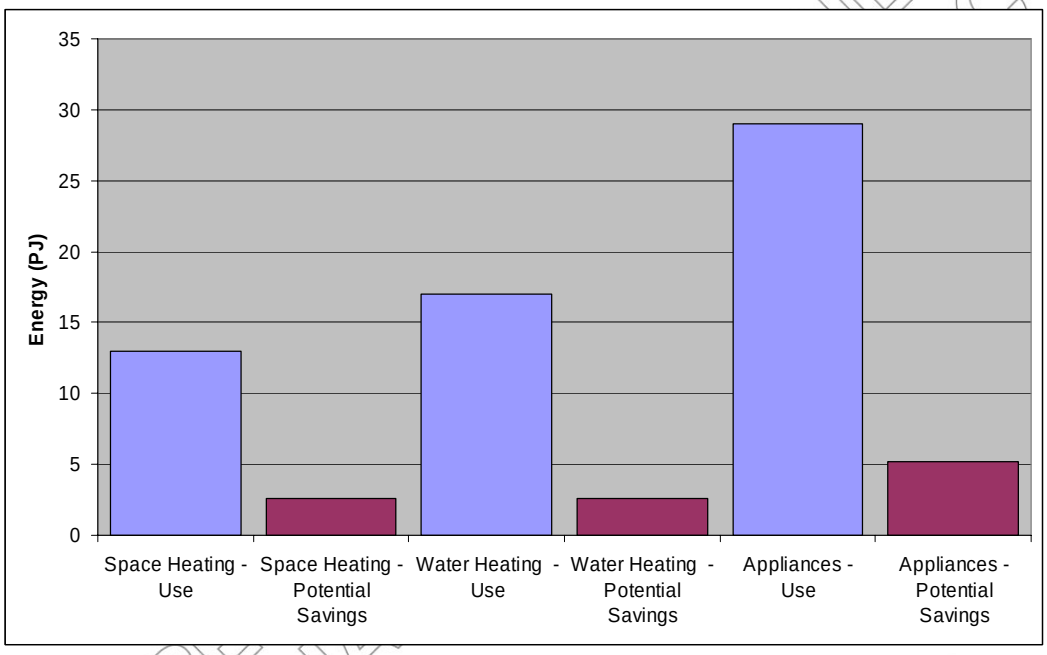
goods, making them cheaper, increasing real income and thereby increasing demand. The end result may be some offset of the gains in improved efficiency (although, clearly, significant benefits of energy efficiency still exist).

Potential energy-efficiency improvements in the residential, commercial and industrial sector will now be explored. Note that these sectoral classifications vary to those displayed in Figure 27 above.

Residential

EECA estimates there is scope to save 18% of current residential energy use by 2012 through energy-efficiency measures, a savings of around 10 PJ per annum[38]. A further breakdown of potential residential energy savings is displayed below. EECA's estimates indicate that improving the efficiency of appliances provides significant potential for energy savings.

Figure 28 - Residential Energy-efficiency Potentials in 2012 (Compared with 2002 Energy Use)[39]



Source: EECA

[38] Energy use in the residential sector refers to the energy used by people living in five major types of dwellings: private homes, rented homes, apartments, flats and mobile homes. It does not include the energy used in commercial accommodation such as hotels, nor does it include energy used for transport purposes.

[39] Estimates displayed in these graphs are based on the "economic potential" of energy-efficiency improvements, indicating the gains from all cost-effective opportunities available with current technology, rather than the opportunities that will be taken up. Economic potential is derived using an engineering-economic analysis. Realising these potentials will depend on overcoming market barriers and failures. Note that the assumptions and results of the economic potential estimates are to be reviewed under the review of the NEECS currently taking place.

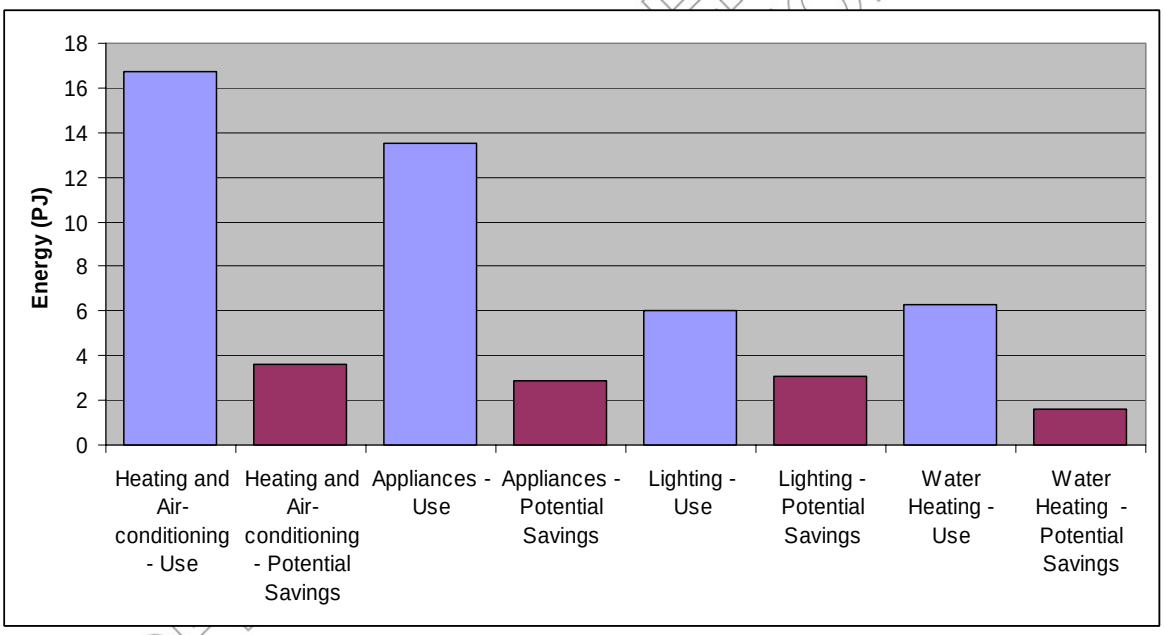
New Zealand's current residential energy use *per capita* is the lowest in the OECD, thought to be caused by New Zealand's temperate climate and a tendency not to heat entire homes (or to heat them to less-than-adequate temperatures). This results in relatively low amounts of energy used for space heating. Some potential for a "rebound effect" from energy-efficiency gains in space heating is thought to exist, ie, as the cost of heating homes decreases due to improved efficiency, homes will be heated more.

Gains in residential energy efficiency will have to contend with broader trends pushing up overall residential energy use, including continued population growth and trends towards smaller households (in terms of occupants) and larger houses (in terms of floor area). Therefore, improved efficiency may be more likely to lead to a curbing of energy growth rather than absolute reductions in energy demand (and therefore emissions).

Commercial

EECA estimates that 26% of 2002 commercial energy use could be saved by 2012 through energy-efficiency measures[40]. This represents the greatest proportional savings of any sector, and an absolute saving of around 11 PJ per annum. A further breakdown of potential commercial energy savings is displayed below. Heating and air-conditioning are shown to represent the greatest potential savings.

Figure 29 - Commercial Energy-efficiency Potentials in 2012 (Compared with 2002 Energy Use)



Source: EECA

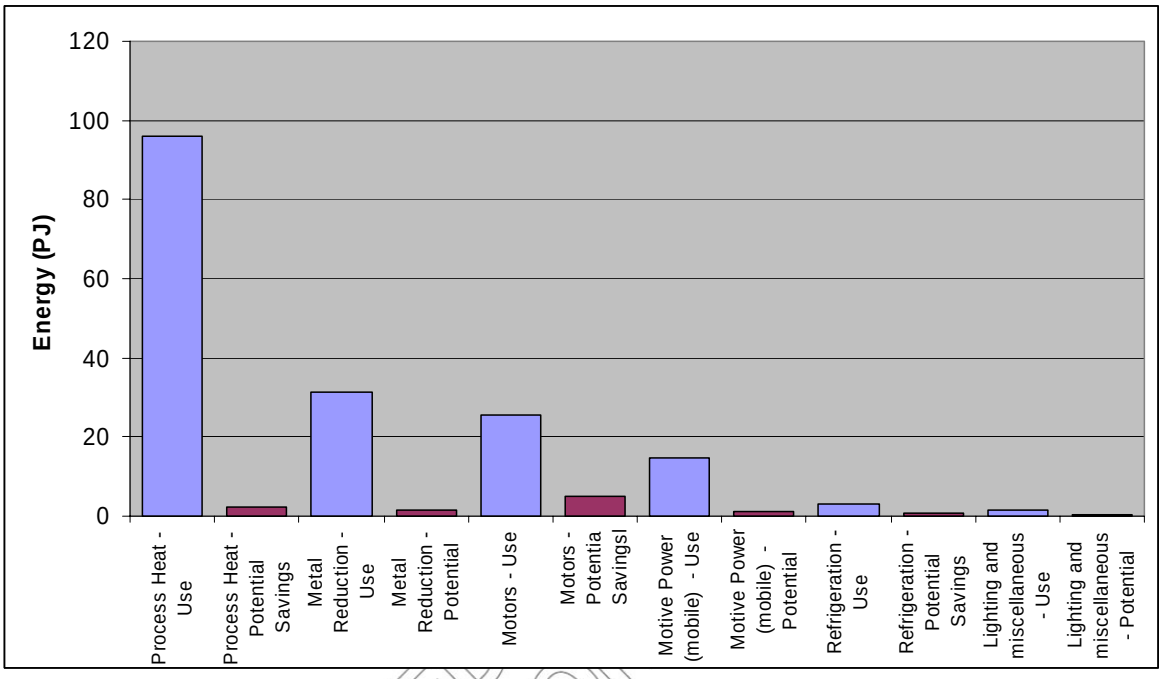
Again, gains achieved through energy efficiency will contend with overall growth in energy demand in this sector, including growth in overall building space as well as demand for higher-quality accommodation, which may entail greater energy requirements. Energy-efficiency improvements may therefore curb demand growth, rather than achieving absolute reductions in the medium term.

[40] Energy use in the commercial sector comprises all activities not commonly classified as residential, farming, industrial or commercial transportation. It includes activities related to trade, finance, government and local government services, health, education, real estate, commercial services and tourism.

Industrial

EECA estimates the industrial sector could save 6% of 2002 energy use by 2012 through improvements in energy efficiency[41]. Although this is the smallest proportional savings of any sector, total potential savings equal 11 PJ, due to high total energy use by industry. Improving the efficiency of motor drive systems is thought to present the greatest potential energy savings.

Figure 30 - Industrial Energy-efficiency Potentials in 2012 (Compared with 2002 Energy Use)



Source: EECA

Changes to the efficiency of industrial energy are normally gradual, given the sector's reliance on large capital investments with relatively slow turnover. Incremental rather than radical improvements in energy efficiency can therefore be expected.

A significant proportion of industrial energy use comes from non-electricity sources, such as direct use of coal and gas for process heat. This form of energy is directly relevant to industries such as dairying, meat and wool, forestry, minerals and food processing. Non-electricity industrial energy generates emissions almost as great as those from electricity generation in New Zealand.

Castalia (2005) notes that industries such as dairying have undertaken major technological improvements in recent times, resulting in more efficient energy use, while other sectors continue to have potential for improvement. However, it is noted that while greater efficiencies per unit of energy may continue to be achieved, overall growth in demand for energy in processing industries is likely to continue, given output expansions in these sectors.

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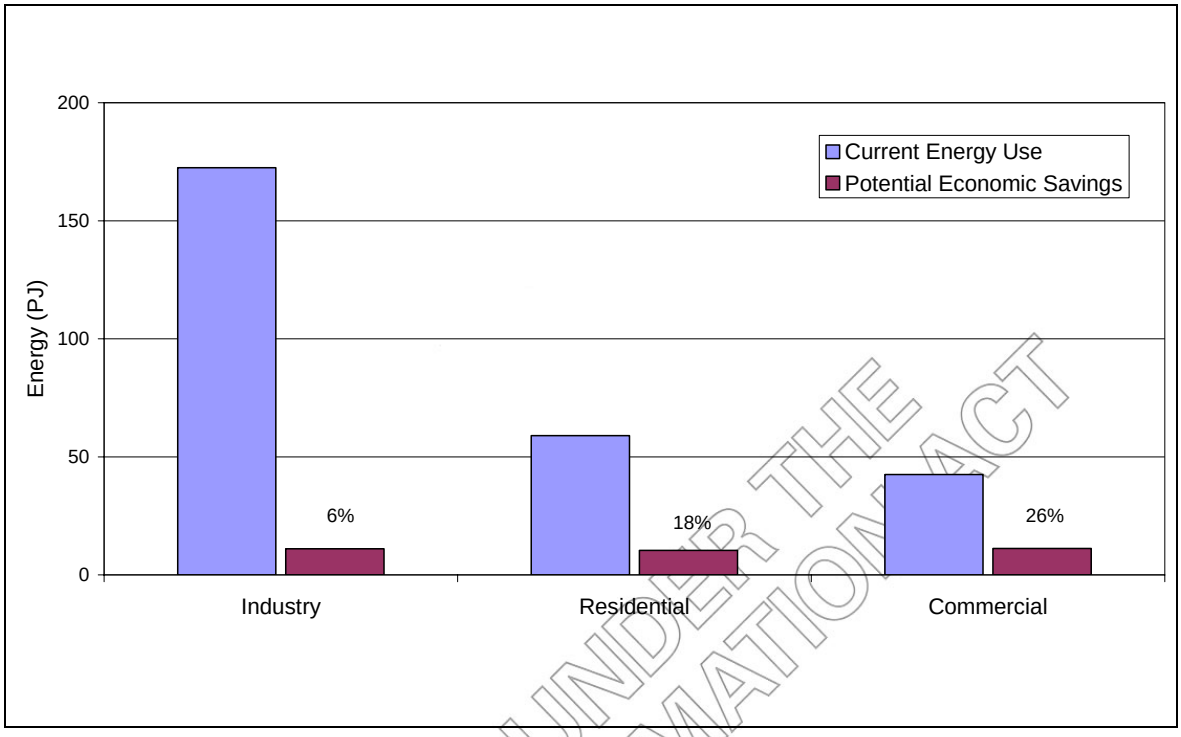
[41] Energy use in the industrial sector comprises textiles; publishing and printing; wood, pulp, paper and printing; energy supply; basic metals and non-metals; chemicals, construction, etc. Enterprises like food processing, mining and meat processing are also included in this sector.

Overall

An overall sectoral comparison of energy-efficiency potential is shown below.

Figure 31 - Sectoral Energy-efficiency Potentials in 2012 (Compared with 2002 Energy Use)



Source: EECA

EECA's current estimates demonstrate that there is potential to improve energy efficiency in each sector. The industrial sector has the highest energy requirements overall, although opportunities to achieve absolute energy reductions between sectors are thought to be roughly equal (such as 10 to 11 PJ). Energy-efficiency improvements are ultimately likely only to help curb New Zealand's energy emissions, rather than to achieve gross energy and emissions reductions.

While explicit cost estimates have not been made of achieving the energy savings outlined above, opportunities are based on the principle of "economic potential"; ie, the gains from all cost-effective opportunities available with current technology, assessed using an engineering-economic analysis. However, various market barriers prevent these economic opportunities being taken up. A suite of government programmes aims to address market barriers to energy efficiency, and these are described and assessed in Section 4.4.

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Reducing the emissions intensity of the energy supply mix

Restricting future emissions from the energy sector can be achieved by altering (proportionally) the emissions intensity of the energy mix. This will involve shifting from more intensive to less intensive fossil fuels (ie, coal to gas) or shifting from fossil fuels to renewable energy. In 2004, New Zealand's primary energy supply totalled 766 PJ (including transport energy), of which around 240 PJ was based on renewable fuels. Main determinants of the energy mix are the availability of resources and the cost at which they can be converted to energy.

In early 2005, East Harbour Management Services estimated the potential additional renewable resource available to New Zealand to 2015. Results are displayed in the table below. Note that renewable transport fuels were not considered as part of this assessment.

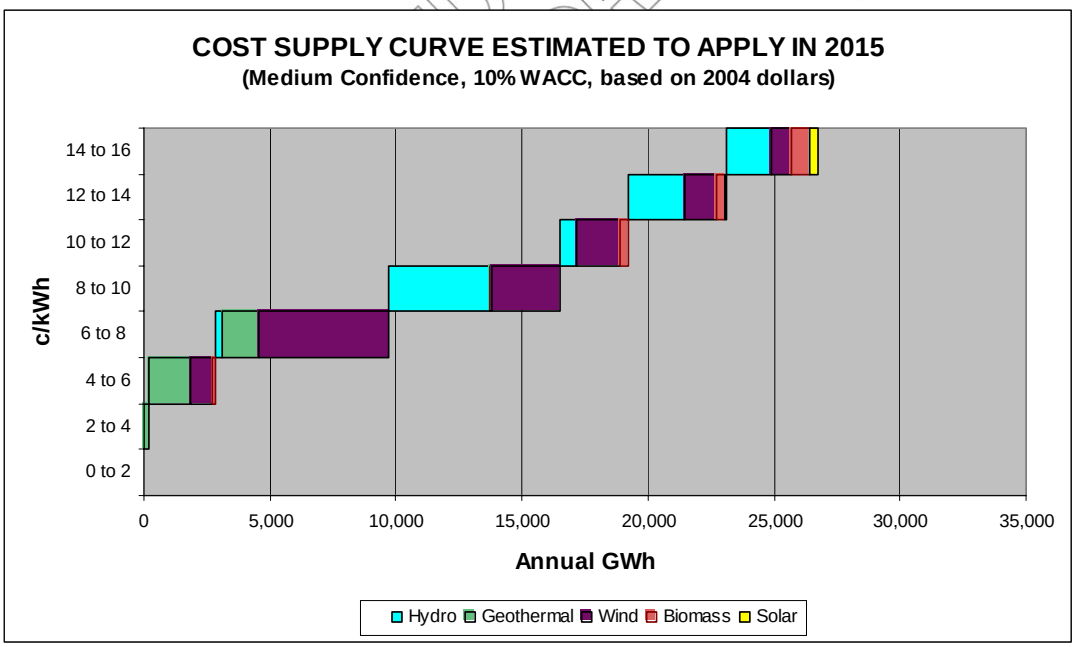
Table 6 - Potential Renewable Energy Available to New Zealand to 2015

Resource	PJ per year[42]
Hydro	32
Geothermal	82
Wind	45
Woody biomass	21
Landfill gas biomass	0.4
Solar	0.9
Total	**181.3**

Source: East Harbour Management Services (2005) "Availabilities and costs of renewable sources of energy for generating electricity and heat."

Some significant renewable energy opportunities evidently remain, particularly in relation to geothermal energy. However, the cost of renewable energy sources will ultimately determine to what extent they are taken up relative to fossil fuel energy over this time period. The diagram below illustrates the estimated generation cost at which new renewable electricity opportunities will be taken up. In comparison, the current marginal price of generation in New Zealand is around 5 to 7 cents per kWh. The supply curve indicates there are likely to be strong, cost-effective opportunities for developing significant wind and some hydro resource by 2015. Those opportunities at the higher end of the cost curve (12 to 16 cents per kWh) are less likely to be developed.

Figure 32 - 2015 Electricity Cost Supply Curve by Technology



Source: East Harbour Management Services (2005) "Availabilities and Costs of Renewable Sources of Energy for Generating Electricity and Heat."

[42] Based on medium confidence and at a cost of less than 16c/kWh for electricity and $25/GJ for heat.

In the electricity sector, renewable energy currently accounts for a significant proportion of generation (in the year to March 2005, 74% of New Zealand's electricity supply was from renewable energy). A summary of projected electricity generation through to 2020, based on recent SADEM modelling by the MED, is displayed below, with renewable energy shaded.

Table 7 - SADEM Projections of New Electricity Generation to 2020

	Level of generation (TWh)		**% of generation**	
	2005	**2020**	**2005**	**2020**
Hydro	24.95	24.95	63	50
Geothermal	2.77	5.47	7	11
Wind	0.71	4.90	2	10
Coal	4.31	7.06	11	14
Cogeneration	1.07	3.33	3	7
Gas combined cycle	5.64	4.07	14	8
TOTAL	**39.51**	**49.8**	**100**	**100**

Source: MED

A roughly steady proportion of renewable energy in the total electricity mix is projected through to 2020 (from 72% of the total mix in 2005 to 71% in 2020). No new hydro generation is projected, although this is offset by growth in geothermal and wind energy.

Castalia (2005) estimates the onset of new electricity generation plant to 2012 below. The table indicates that roughly equal contributions from renewable and fossil fuel energy might be expected in new generation plant in the next seven years.

Table 8 - Castalia Projections of Possible New Generation Plant in New Zealand to 2012

Plant name	**Type**	**MW**	**GWh**	**Date**
Manapouri	Hydro	25	158	2004
Te Apiti	Wind	90	355	2004
Wairakei Extension	Geothermal	14	118	2005
Manapouri II	Hydro	16	105	2005
Kiwi Cogen	Gas	15	100	2006
Huntly e3p	Gas	365	2,560	2007
Invercargill	Wind	180	550	2008
Marsden Cogen	Gas	84	690	2008
Makara Wind Farm	Wind	24	95	2008
Coal - WC Rail to Chch	Coal	50	130	2009
Canterbury Wind Farm	Wind	50	150	2009
East Coast Wind Farm	Wind	75	275	2009

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Lower Waitaki	Hydro	260	1,500	2009
Stockton Coal Plant	Coal	150	985	2009
Tararua Expansion	Wind	100	395	2009
Kawerau	Geothermal	150	1,200	2010
Marsden Coal	Coal	320	2,000	2011
Mokai III	Geothermal	100	800	2011
Rotokawa II	Geothermal	150	1,200	2011
Belmont Wind Farm	Wind	120	473	2012
Dobson	Hydro	60	270	2012
Southland Lignite	Coal	380	2,650	2012
Wairakei Geothermal	Geothermal	180	1,400	2012

Source: Castalia (2005) "Greenhouse gas emission policies: Is there a way forward?"

Neither the SADEM or Castalia projections anticipate a significant change in the proportional contribution of renewable energy to New Zealand's electricity supply (although it should be noted that small differences in the cost of generation types make any modelled projections sensitive to price and cost changes). This is most likely due to the already large proportion of renewable energy and the fact that many of the available hydro generation opportunities have been taken up. The intermittent nature of renewable electricity (on an hourly, daily and seasonal basis) is considered to apply some level of technical constraint on the electricity system, and requires an accompanying baseload provided by fossil fuels to provide security of supply[43]. Coal is also projected to play an increasingly important role in both projections, making improvements in the energy intensity of electricity generation through to 2020 an unlikely prospect.

Greater exploitation of small-scale, off-grid, renewable generation (ie, distributed generation) may be an option to continue to grow the contribution of renewable energy to overall electricity supply and EECA is targeting the barriers to realising these opportunities in a number of its programmes.

In the longer term, the creation of hydrogen using renewable energy presents some potential to replace fossil fuel use in a diverse range of energy services, including electricity, process heat and transport. Clean hydrogen could also be produced using coal if it were combined with carbon sequestration technologies, which are discussed further below. While some limited trial use of hydrogen may be expected in the short term, it is not anticipated that hydrogen will have widespread use by 2020.

Sequestering emissions from the energy sector

Carbon dioxide capture and storage (CCS) is a process consisting of separating carbon dioxide from industrial and energy-related sources, transporting it to a storage location

[43] A 2005 report on wind energy integration in New Zealand found that technical constraints were somewhat less than previously thought and wind energy had the technical potential to provide between 20% and 48% of electricity to the national grid. This assessment did not take into account the economics of wind generation.

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and isolating it long term from the atmosphere (IPCC, 2005b). CCS can be applied to major point sources of carbon emissions, including fossil fuel energy facilities. In this sense, CCS can limit the ultimate release of carbon dioxide to the atmosphere and therefore its contribution to global warming. In the long term, CCS is considered to have potential to significantly reduce global emissions of carbon dioxide.

Carbon sequestration is currently feasible,[44] although the costs are high, particularly at the "capture" stage of the process. The recent IPCC special report on carbon capture and storage found that CCS is estimated to increase the cost of electricity production by between 2 cents and 7 cents per kWh, depending on the fuel, the specific technology, the location, and the national circumstances. This compares with the current marginal price of generation in New Zealand of around 5 to 7 cents per kWh. The current cost of offsetting one tonne of carbon dioxide using CCS technology in a pulverised coal plant is estimated to be between $45 and $100, well above New Zealand's current carbon tax rate of $15 per tonne of CO_2. These cost estimates indicate CCS technology is likely to be some way off commercial adoption in New Zealand. The viability of the technology will also depend on whether geologically suitable sites can be found for storage and whether the general public considers this approach environmentally acceptable.

Prospects of emissions reductions in New Zealand in the medium term as a result of carbon capture and storage are therefore considered low, although longer term, the potential of the technology may be significant.

Conclusion

EECA's estimates indicate there are substantial and worthwhile gains available from energy-efficiency improvements in the residential, commercial and industrial sectors, based on assessments of "economic potential". Among these sectors the total economic potential for energy efficiency improvements, based on EECA estimates, totals 32 PJ per annum at 2012. The incorporation of a carbon price signal into the economy and the development and commercialisation of more energy-efficient technologies would further increase the level of economic opportunities available. However, an "efficiency gap" traditionally exists between those opportunities that are judged economic and those that are actually taken up. The efficiency gap arises as a result of various information, financial, incentive and other barriers. Government policies have a role in addressing these barriers to uptake, and this role is assessed further in Section 4.4.

In each of the residential, commercial and industrial sectors, however, general trends (including household size, higher-quality commercial buildings, and industry expansion) are pushing up overall demand for energy services. Improvements in energy efficiency may therefore be more likely to achieve reduced growth in energy demand, rather than an absolute reduction in energy use. Some potential also arises for "rebound effects" from energy-efficiency gains, most significantly in the residential sector.

Substantial changes to the emissions intensity of the energy mix appear unlikely, given the already high proportion of renewable energy used in electricity generation and the fact that many of New Zealand's major hydro generation opportunities have already been developed. Growth in geothermal, wind and some hydro generation is expected, but coal development is also expected (although the development of coal generation is perhaps the most sensitive to the introduction of a carbon price). Small-scale renewables provide further potential to continue developing renewable energy.

[44] The IPCC special report on carbon capture and storage notes three industrial-scale storage projects are in operation: the Sleipner project in an offshore saline formation in Norway, the Weyburn EOR project in Canada, and the In Salah project in a gas field in Algeria.

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Carbon sequestration and hydrogen technologies offer significant potential for neutralising emissions from the energy sector, although the technologies require more development before the prospect of widespread commercial adoption is known. Significant gains from these technologies are therefore not assumed to occur by 2020, although they will be key technologies for New Zealand to track.

Overall, the key prospects to achieving emissions reductions in the energy sector lie in further encouraging the uptake of energy-efficiency technologies and practices, and encouraging the development of available renewable energy opportunities. Ensuring there are strong international research and development linkages will be important for allowing the adoption of more energy-efficiency and renewable-energy technologies.

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Summary

This section:

- describes trends in greenhouse gas emissions from transport
- describes projections of transport emissions to 2020
- reviews how the oil price might affect demand
- identifies change areas that can lead to a reduction in emissions
- briefly assesses the effect of current policy in New Zealand
- reviews what is happening internationally in transport and makes conclusions about application to New Zealand.

It concludes:

- transport emissions have been growing strongly, driven by economic growth and a relatively low oil price. Current transport demands, which are 99% reliant on oil, are strongly embedded in the economic and social fabric of the country
- there are priority areas to address, primarily road use, although aviation is recognised as a growth area
- internationally, transport policy involves a variety of policy measures and recognition of co-benefits. New Zealand has similar opportunities
- there is no evidence of a single or easy solution to transport emissions
- circumstances in New Zealand, such as geography, land use and importation of large numbers of pre-owned vehicles should be taken into consideration when assessing prospects to reduce emissions.
- Some opportunities exist to reduce transport emissions due to the availability of improved technology, use of biofuels feedstock, and behaviour change.

4.1.3 Emissions from transport

As noted earlier (Section 3.1.1), emissions from the "transport sector", as defined by the UNFCCC[45], make up 18.5% of New Zealand's annual greenhouse gas emissions in 2003. Transport, with its dependence on oil, is a significant emitter of carbon dioxide.

[45] The transport sector, as defined by the UNFCCC, includes transportation of goods and people for agriculture, industry, tourism, household uses, etc. It does not, however, include use of fuel for fishing. Fishing is included in the "other sector" category with energy, under "agriculture/forestry/fishing".

This section builds on the section on decoupling (Section 4.1.1). Growth in transport energy use is closely linked with economic growth. With prosperity, there is more travel and more demand for goods. In general, this is part of an improved quality of life. The challenge is not to curb people's mobility and access to goods and services, but to find more sustainable energy sources for transport and other ways of meeting people's transport needs.

This section looks at the mitigation prospects for different parts of the transport sector. It also describes the ways in which emissions reductions can be made in transport. These "change areas" are revisited in Section 4.5 as a basis for considering policy options.

Large contributors and growth areas

Transport-sector greenhouse gas emissions in 2003 totalled 13.8Mt CO_2e (Table 9).

Most of the transport emissions (87%) came from road transport. Rail, aviation and marine transport made up the balance, with aviation taking the greatest share at 8.4% of the total.

Table 9 - Transport-sector Energy Use and Emissions 2003

Transport End-use	PJ[46]	Emissions in 2003 (Mt CO_2e)	% of Transport Emissions
Road* - Light vehicles – households/other	87	5.7	41
Light vehicles – road fleets (eg, business, hire firms)	31	2.1	15
Heavy vehicles - road	63	4.3	31
Rail**	2.4	0.16	1
Aviation – passengers and freight**	17.2	1.16	8
Marine transport**	5.1	0.37	3
TOTAL	206	13.8	100

Sources: *Estimate based on TERNZ (2004a 2004b) **New Zealand, Ministry for the Environment (2005b)

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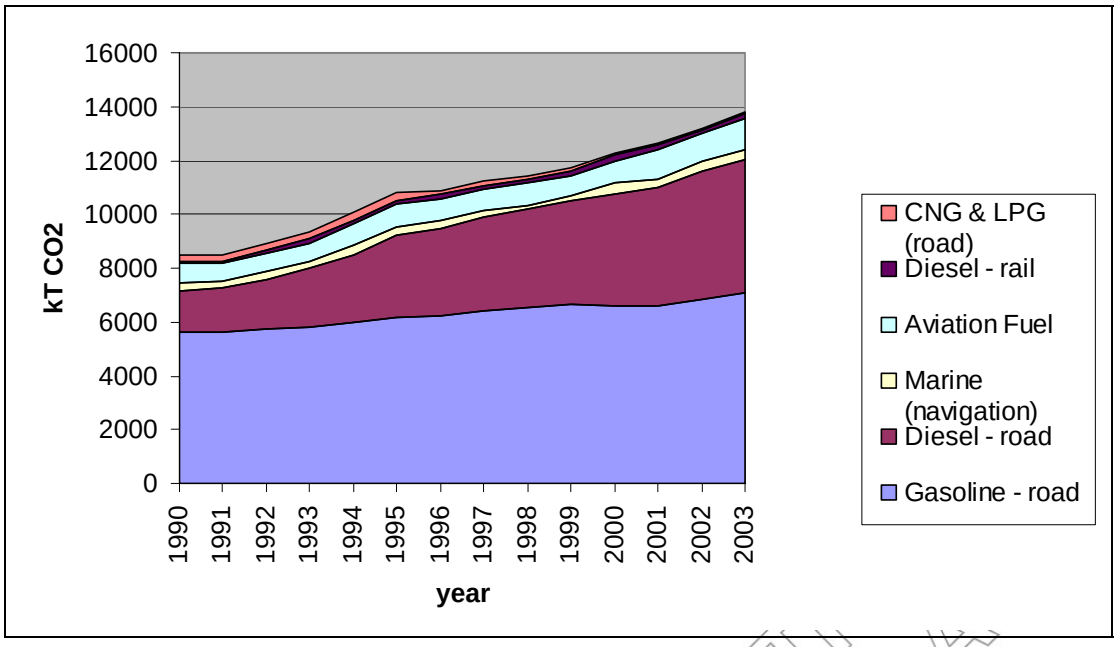
In terms of growth from 1990 to 2003, transport emissions have increased by 60% (Figure 33). Most of the growth has come from road transport, with diesel fuel use increasing by 215%, mainly through an increase in road freight and consumer preferences for diesel light vehicles. Petrol use rose by 26%. The other major growth area has been aviation (covering flights within New Zealand), which has recorded a 50% increase in emissions since 1990. This reflects strong growth in tourism and the increasing role of air travel for business and personal travel use.

[46] See Glossary.

Figure 33 - Growth in CO_2 Emissions from Transport 1990-2003



Source: New Zealand, Ministry for the Environment

In addition, a further 3Mt of CO_2 emissions resulted from international transport, 75% of which came from international aviation. Since 1990, international aviation emissions have grown by 66%. These emissions are currently not included within the Kyoto Protocol commitments.

The main drivers of transport emission growth have been:

- relatively stable (or declining in real terms) fuel prices across the period
- a strong transport component within the structure of GDP growth
- growth in vehicle numbers and a strengthening of long-term trends towards private motor vehicles as the predominant form of travel
- increased affordability and use of air travel
- little change in the overall efficiency with which energy has been used for transport
- no practicable alternative to oil products as the energy source for transport, hence no substitution with non-CO_2 energy sources.

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In terms of the proportion of total transport emissions resulting from different industrial, business and household uses, precise data on the split of transport fuels is not available. Guidance is, however, given though surveys - of fleet vehicles (heavy and light), household travel and visitors. The big users are:

- **heavy road freight,** which consumed around 30% of transport energy in 2003 (61 PJ). A typical truck might consume 30,000 litres a year, travelling 500,000 kilometres (CRL, 2005)
- **light vehicle fleets**, comprising business and rental companies. These make up 15% of total emissions, providing a targeted opportunity
- **household travel**, including regular trips to work, which compromises an important part of household travel (Land Transport Safety Authority, 2000)
- **tourists**, domestic and international, are high users of transport energy. It is estimated that transport energy contributes 73% and 65% of the total individual "energy bill" for domestic and international tourists, respectively (Becken et al, 2003).

An emissions split between rural and urban road use is not available. Estimated kilometres travelled could be a proxy. An estimate for 2001 suggests about 45% of travel is on urban roads (Ministry of Transport, 2005c). However, this is a coarse comparison because the short trip and stop-start nature of urban conditions means more fuel per kilometre is consumed. On the other hand, heavy vehicle use is more concentrated on rural roads. It is estimated that roughly 25% of emissions are produced in the Auckland region and 13% in Christchurch city (NIWA, 2001).

Limitations to targeting these areas are:

- large businesses, particularly those with international counterparts and management support for energy savings, will already be looking for fuel savings, so additional effort targeting such companies may not be cost-effective
- moving freight from road to rail or coastal shipping will occur only if the alternative mode is seen as competitive in price, goes to the appropriate destination and is suited to the goods being transported
- it is often difficult to provide alternatives to private motor vehicles in rural and sparsely populated areas
- changing behaviour is not necessarily a cheap policy option because many behaviours are ingrained habits supported by perceptions of status and "what's normal".

Projections of transport CO_2 emissions to 2020

Projections of future transport CO_2 emissions were updated in May 2005 through the Interim Update Report which served as the basis for the recalculation of New Zealand's Kyoto position (Ministry for Environment, 2005c). They are illustrated in Figure 34 below.

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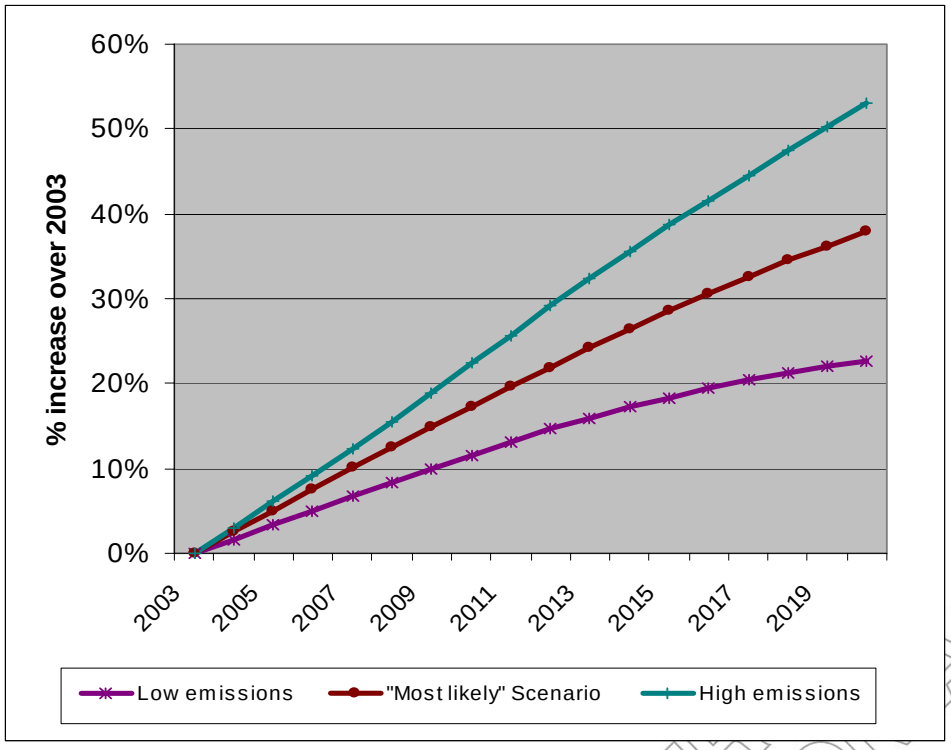
Figure 34 - Projected Increase in Transport CO_2 Emissions



Source: Ministry for Environment 2005c

In the "most likely" scenario, greenhouse gas emissions were forecast to grow by 22% from 2003 to 2012, and 38% from 2003 to 2020. "Low-emissions" and "high-emissions" projections were also developed, representing scenarios of low GDP growth/high oil prices and high GDP growth/low oil prices respectively.

The interim report was completed prior to the recent oil market instability, so the "most likely" scenario was developed under the assumption of relatively low, and stable, oil prices.

These projections assume that no additional measures to address transport emission are put in place. Of existing measures, only the effect of the announced carbon tax at $15 per tonne from 2007 is factored in. This is expected to raise fuel prices by 3% to 5%, but result in less than a 1% reduction in CO_2 emissions from transport.

Effects of recent market conditions on CO_2 emissions

Recent sharp increases in oil prices are likely to have an effect on forecast transport emissions. However, the review has not attempted to update this forecast. It will be updated in May 2006, in conjunction with the scheduled updated forecasts of New Zealand's net emissions in relation to its Kyoto target.

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The Treasury's *Pre-Election Economic and Fiscal Update* (PREFU) assumes that, in the March 2006 quarter, Brent oil prices will reach a quarterly average peak of $US59.10 per barrel. This is just over $US3 higher than the assumptions in the 2005 Budget (New Zealand Treasury, 2005). However, oil prices then gradually decline, reaching $US53.60 per barrel at the start of 2009. Treasury's March 2006 forecast remains below current[47] prices of $62.80. The PREFU oil price assumptions result in the price path of transport fuels to 2009 averaging some 20% to 25% higher than the price assumptions underpinning current projections. On the other hand, recent oil supply investments suggest a growing gap between supply and demand in the short term, which could drive oil prices down to $US40 per barrel or lower over this period (Cambridge, 2005).

The transmission mechanism between world oil prices and New Zealand greenhouse emissions from transport is complex. The impact of higher oil prices will transmit to domestic emissions by different mechanisms. The important ones are:

- New Zealand's economic growth
- modal and vehicle choices by New Zealand consumers.

Growth in real annual GDP is expected to slow from a peak of 4.8% in the 2004 calendar year to 2.2% in the March 2006 year, and 2.6% in the March 2007 year. The slow-down is primarily driven by the lagged effects of higher exchange and interest rates and a slowing in net migration flows. The higher oil price assumptions in the PREFU have not significantly altered forecast New Zealand GDP growth tracks to 2009.

The magnitude of recent higher oil prices points to this price effect slowing transport emissions growth. There is evidence, although primarily anecdotal at this stage, that prices have influenced travel patterns, vehicle purchase patterns towards more fuel efficient vehicles, and fuel switching to LPG for some motorists. Further work is required to determine the magnitude of this effect. Progress on this analysis should be incorporated in the May 2006 emissions forecasts.

Overview of mitigation prospects

In looking at the prospects of reducing transport emission, priority areas to address are primarily within the road sector, which is the largest contributor to emissions. Looking at other high-growth sectors such as aviation may also be worth future consideration. However, it is important when determining an appropriate policy response to consider the impact on other government objectives such as social cohesion and access.

Overseas, a range of measures is commonly utilised, building on the co-benefits of addressing transport and recognising localised travel patterns. New Zealand may have similar opportunities. However, we also have particular circumstances, such as our geography, land use, and importation of second-hand domestic Japanese vehicles, that should be taken into consideration when assessing the prospects to reduce emissions and appropriate policies. For example, restricting imports is likely to raise the average price of vehicles, which would restrict access to private transport by low-income New Zealanders.

The availability of improved technology, use of biofuels feedstock, and opportunities for behaviour changes provide some potential to reduce emissions from fossil fuel use.

Section 4.5 discusses the effectiveness of current policies and looks at opportunities for further effort. It includes some indication of policies that are likely to give the greatest gains.

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[47] London prices for November delivery, 3 October 2005 <http://futures.fxstreet.com>

Ultimately, an enduring solution to transport CO_2 emissions must rest heavily with the technical development of zero CO_2 or carbon-neutral energy sources. However, at this stage, there is no obvious or clear pathway to a successor to our oil-based energy system. Such a technological "fix" may also be a long time arriving and entail significantly higher costs. Therefore, the process for reducing CO_2 emissions from transport should, in general, seek reductions in emissions through both technology and transport behaviour in ways that are non-discriminatory and "least cost".

With regard to technological changes, the key points to note are:

- New Zealand is primarily a "technology taker" with respect to vehicle and fuel systems – we are largely dependent on the direction and pace of change being developed overseas

- within this overall constraint, policies (regulatory, fiscal or information based) can influence some aspects of the mix, such as the profile of vehicles imported, incentives for up-take of new technologies and the extent to which substitutes for petroleum-based fuels could be employed

- the speed of any new technology up-take is largely dictated by technology diffusion rates and the turnover of the transport fleet (ie, customer purchasing behaviour). For example, a large proportion of our vehicle fleet is aged seven to fifteen years , but vehicle use is weighted towards newer vehicles. It is estimated that the newer half of the vehicle fleet generates about three-quarters of fleet CO_2 emissions.

With regard to behavioural changes, the key points are:

- travel behaviour is largely determined by lifestyle, work, residential location and production-related factors

- in general, policy that attempts to achieve large changes in travel patterns is difficult to justify on CO_2 grounds alone. It is costly to obtain changes in lifestyle patterns. There are, however, a number of circumstances where there are CO_2 co-benefits from policies that seek to modify travel behaviour for other reasons

- behaviour change can be triggered or supported by infrastructure changes such as provision for other modes (public transport, walking and cycling), road design and urban layout

- price remains a strong influence on behaviour, although prices may need to increase significantly to trigger a response.[48] In the short term, behavioural responses to price are generally around changing trip patterns or modal shifting, while in the longer term, major capital purchases can be influenced (such as choice of vehicle or place of residence).

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[48] Based on Ministry of Economic Development's SADEM model fuel demand exhibits low elasticity to price – for a 1% increase in petrol and diesel prices, short-term demand is expected to decrease by 0.13% and 0.09%, and in the long term, by 0.25% and 0.20% respectively

Policy focus

In considering reducing transport CO_2 emissions, policy must focus on achieving change in one or more of three generic "change areas":

1. improve the energy efficiency of the transport task (eg reduce the energy required for shifting freight (tonne-kilometres) and passengers (passenger-kilometre)

2. change to lower-CO_2-emitting energy sources

3. reduce the transport task (either the rate of growth or in absolute terms).

The key "change actions" required include a mix of technological changes to vehicle and fuel systems, and behavioural changes to transport patterns by transport users. See Table 10 below.

Table 10 - A Framework for Considering Transport Emission Reductions

Generic "change areas"	**Key Actions Required**	**Example or Policy Measures***	
		Technological	**Behavioural**
1. Improve energy efficiency of the transport task	Improve technicalefficiency of the vehicle/ prime mover	Regular maintenance to manufacture's standards	Choose fuel-efficient diesels, hybrids, and efficient designs over less efficient options
	Increase use of more energy-efficient modes		Mode shift to walking, public transport, rail
	Improve operational efficiency of the transport task	Roading measures to reduce congestion Increase passengers or freight carried per load	Improve driver techniques
2. Change to lower-CO_2-emitting energy sources	Increase use of lower-carbon fossil fuels		Install and use LPG fuel systems
	Increase use of carbon-neutral fuels	Develop and make available bio-fuels	
	Shift to low/no-carbon energy propulsion systems	Electric propulsion (eg, rail, trolley buses, battery storage vehicles)	
3. Reduce transport task (either the rate of growth or absolute)	Reduce quantity of trip-making		Adopt telecommuting, trip-chaining
	Reduce average trip lengths		Locate closer to main destinations (eg, school and work)
	Reduce tonnage of goods carried	Processing to reduce weight, add value to products	

* Note that these examples are not exhaustive or in any priority order. Neither are they meant to imply that CO_2 policy should be directed in this way.

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Improving energy efficiency of the transport task

Improving the energy efficiency of the task can occur by shifting to less energy-intensive transport modes. Walking and cycling are the least energy intensive. For powered modes, the technical energy-efficiency of a mode is important along with the operational efficiency of the task completed (ie, the passengers or freight transported).

Technical efficiency: Fuel economy of engines has improved steadily over the past century. Internal combustion engines have become more efficient through innovations such as fuel injection systems and more recently "hybrid" systems using electric motors. Vehicle-design improvements include better aerodynamics, drive-train efficiency and the use of lighter materials. For road passenger travel, the availability of small diesel vehicles is beneficial. The fuel economy of trains, planes and ships has also developed.

Task completed (operational efficiency): For different transport trips a comparison measure is the fuel consumed per tonne/kilometre (for freight) or passenger/kilometre. For example, a vehicle carrying four people is more efficient than a single occupant. Ships are classically the most efficient and aircraft the least, but the level of occupancy or utilised freight capacity is important.

Making the most of the designed technical efficiency of the mode is also relevant. Particularly for road transport, changing people's driving behaviour (including checking tyre pressure and regular vehicle maintenance) can have a significant effect on vehicles with high fuel consumption per kilometre – ie, big trucks and buses. Also, driving conditions (eg, gradient, friction, level of traffic and stop/start driving) is important, again, particularly for vehicles with high fuel consumption.

In maximising the opportunities for efficient passenger transport, the focus will often be trips to and within urban areas, because that is where the majority of passenger trips occur – ie, to school and work. The availability of public transport, therefore, becomes important.

Energy sources

The fuel used to power the mode is relevant for greenhouse gas emissions.

LPG and CNG produce lower carbon dioxide emissions compared with petrol per unit of energy, with around 10% savings available. However, small LPG vehicles are not currently available so their use is limited to high-power, high-mileage uses. The CNG market shows no sign of recovering popularity following the decline in the late 1980s that was triggered by problems with fuel standards and the lower oil price at the time.

Use of electricity in some modes may provide a greenhouse gas benefit, depending on the source of the electricity. At present, about 70% of electricity generation in New Zealand is from renewable sources that are essentially low- or zero-CO_2. Electrification will provide net CO_2 benefits so long as marginal new electricity production and distribution has lower emissions per unit of energy required compared with fossil-fuelled engines.

Biofuels provide the best opportunity for New Zealand, because of the available feedstocks. We have raw materials, by-products of the dairy and meat industry, that can be converted into biofuels. Biofuels are considered to be carbon neutral because there is assumed to be a closed carbon cycle operating: carbon released during combustion is subsequently sequestered through the biological processes of producing the biofuels feedstock of plant and animal material.

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Liquid biofuels produced from renewable biological products are not currently commercially available in New Zealand.

Biofuels feedstocks that could be fully on line by 2012 are:

- domestic production of fuel grade bioethanol from whey to replace 0.3% to 0.5% of petrol consumption though petrol blends up to levels of 10%
- domestic production of biodiesel, primarily from tallow from the meat industry, to replace 5% of diesel, equivalent to around 5 PJ, most likely through 5% blends (B5).

Research shows that approximately another 5 PJ of bioethanol could be produced from other waste streams (paper, straw, waste kiwifruit material) (Waste Solutions Ltd, 2005). This is most likely to come on stream after 2012. The technology is available, but the costs of collection and production are unclear. This could give an annual biofuels component of 10 PJ per annum, the equivalent of around 5% of the fuel consumed annually by transport.

Other additional sources of biofuels could be available before 2012; eg, using coppiced willow and wood waste to produce ethanol. However, advice from EECA is that time is required for refining technical processes, raising capital and establishing production units. Other sources of domestic biofuels, such as algal oil or other crops, are on the horizon but at the research stage.

Compared with other countries that have biofuels, New Zealand has an advantage in that its sources of biofuels are by-products of the agricultural industry or waste products. This contrasts with production of biofuels from rape seed, sugar cane and other crops that generally have a high life-cycle energy demand.

Reduced travel

Reducing travel covers lowering the number of trips; eg, linking trips, reducing the length of trips through changing destinations and reducing the tonnage of goods carried.

There are some short-term mitigation prospects; eg, using teleconferencing to conduct a meeting instead of flying between cities, or just being smarter about combining trips and freight logistics. Other changes have a more long-term focus. Trip distance is often a function of place of residence and destination: generally, as cities sprawl, commuting times and distances increase along with fuel used. Such changes to urban form and the siting of services can, however, take time to evolve and affect travel behaviour.

Assessment of current policy settings for transport

Predicting future emissions reductions is difficult. There is little empirical evidence in New Zealand. There is also uncertainty about the potential longer-term effect of fuel price increases on transport behaviour.

As discussed in Section 4.5, policies have had very little “bite” in terms of emissions reductions. The two main reasons for the relatively low impact of current measures to date are:

- a number of policy initiatives are yet to be implemented – eg, the announced carbon tax and website information on vehicle fuel economy. Also, the recent very large increase in Government expenditure on public transport (where CO_2 emissions reductions are a co-benefit) is generally yet to be realised in terms of implemented action because of investment lag effects

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- policy actions that have been implemented have relatively low influence across the whole sector. For example, the EnergyWise Rally and walking school buses[49], although successful in their objectives, have limited foci.

While small in effect at this stage, the non-price measures such as information provision, provisions for biofuels and infrastructure developments are all useful building blocks for possible future activities.

The anticipated effects of the recent oil price increases have been instructive, but it will be a while before the behaviour changes resulting from the price rises are understood. If price rises are maintained, they are likely to have a greater impact on CO_2 emissions than the range of policies pursued to date.

Overseas experience with emissions mitigation

We can look to other countries to see the effectiveness of polices and also consider their application to New Zealand. The opportunities available to New Zealand from overseas experience may be tempered by our geographical situation and the fact that our economy specialises in transporting heavy, bulky produce around the world.

Globally, transport emissions have been increasing, driven by increases in kilometres travelled and vehicles – particularly private motor vehicles. Many developed countries, as well a number of developing countries, have fiscal, infrastructure, research, education and regulatory measures to target transport emissions. Generally, a portfolio approach is taken, recognising that action needs to occur on a number of fronts and also that multiple benefits can be achieved though reducing reliance on oil and the private motor vehicle.

The most cost-effective ways of reducing total CO_2 emissions from the transport sector are through measures affecting the cost of fuel, the cost of energy-inefficient vehicles or the efficiency of road haulage. However, it is recognised that radically different alternatives to today's technologies will be required and over the long term. Also, reducing the kilometres travelled will need to be a component of any successful policy package.

To date, no country has shown evidence of reducing total emissions from transport, although progress is being made in some areas – eg, improving the average fuel economy of the road fleet, as in the United Kingdom, or affecting the number of single-occupant vehicle trips through providing and incentivising alternatives. Typically, the fuel economy achieved by technical developments is outweighed by the increased consumer preference for larger cars. However, Europe and the United States appear to be doing better than New Zealand in the sense that their rates of transport emissions growth are lower than New Zealand's.

Policies

Pricing is a common tool used for fuel, vehicles, parking and road use. The price of fuel has been used to increase the cost of transport. For example, Norway has a CO_2 tax on fuelsand the United Kingdom used fuel excise to send a very strong price signal, with the result that around 75% of the cost of petrol at the pump is government tax (Grubb, 2003). In the United Kingdom, the change to the fringe benefit tax system is attributed with achieving significant improvements to vehicle purchase and use. The change corrected a perverse incentive that rewarded businesses for having vehicles that travelled the most kilometres. .

[49] See Glossary.

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Differentiated registration fees for first acquisition and regular annual fees have been put in place in many European countries. CO_2 emitted per kilometre, weight and engine output are used as differentiation characteristics. Empirical evidence is that the effectiveness of registration fees in these countries is not proven. Research in the European Union and the United States notes that the majority of improvements are associated with vehicle manufacturers improving the average fuel efficiency of the vehicles on the market, as opposed to customers choosing the more fuel-efficient vehicle (Covec, 2005a).

Where a country has large urban areas with significant congestion problems, road congestion pricing is seen as providing significant co-benefits through reducing transport greenhouse emissions (eg, in Australian cities and in London). Addressing congestion is seen as benefiting air quality, reducing travel time and assisting the form and functioning of cities (Canada, Institute for Research on Public Policy, 2004). Actual CO_2 benefits of such policies are, however, not easily calculated.

In regard to **energy supply**, many European Union countries, the United States and Australia have set biofuel targets – either sales targets or mandatory blends. Tax incentives for the use of biofuels are also common. Use of LPG and CNG is supported, primarily through tax rebates for grants for vehicle purchase or conversion (such as in Canada and Australia). India has policies for improving transport fuels, including lower sulphur content in petrol and diesel, a programme to blend 5% ethanol in petrol, and making CNG and LPG available in some cities (India, Ministry of Environment and Forests, 2004). Such policies, encouraging use of biofuels and alternative fuels, tend to be strongly supported by concerns about long-term petroleum oil supply. Brazil has the strongest biofuels programme, where ethanol production is supported by government assistance.

A focus on the **regular home-to-work trip** is common. Examples are compulsory work travel plans; tax benefits for employer-provided transport; support for car-poolers and public transport users; and ensuring that car use is not encouraged over public transport or cycling by the provision of subsidised car parks. In the United States, the "Bike Commuter Bill" gives employees who bike to work the same financial incentives as car-poolers and public transport users.

Generally, **investment in public transport** is seen as supporting climate change policies. For example, under an European Union funding scheme for 2000 to 2006, approximately €3 billion has been allocated for investments in public transport and rail networks in Ireland (Ireland, UNFCC, 2005) Strategy includes development of a new metro network , improvements in the availability and quality of the bus network (especially the Quality Bus Corridors), two new light rail lines (which became operational in 2004), new park-and-ride facilities, and measures to improve bicycle routes and traffic management.

Most countries show strong support for **technology** developments. For example:

- European, Japanese and Korean car makers' associations have committed to cut average CO_2 emission from new cars from 186 grams per kilometre in 1995 to 140 grams per kilometre in 2008/09

- the Australian government has an agreement with the automotive industry on a target of 6.8 litres per 100 kilometres (around 200 grams per kilometre) for petrol passenger cars by 2010. This represents an 18% improvement in the fuel efficiency of new vehicles between 2002 and 2010

- in the United Kingdom, Australia, the United States and other countries, there are grants for consumers and businesses towards the purchase cost of certain vehicles

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(including hybrids in some cases), conversion to alternative fuels and pollution-reduction equipment

- research and development funding is common. In the United Kingdom, up to £3 million of funding is available to support demonstrations of up to 150 low-carbon buses.

Interest in hybrid technology is lower in European Union countries than in the United States. In the European Union, many diesel vehicles on the market already fulfil the demand for high-efficiency vehicles. Although some governments (such as those of Japan and the United States) provide consumers with financial incentives to purchase hybrid vehicles, most do not. However, taxation policy in many European Union countries favours the use of electric cars. In Norway, the purchase tax on sales of electric cars was reduced to zero in 2001. This has reduced the price of electric cars by 25% (International Energy Agency, 2001).

Generally, the light passenger fleet is the target for increased fuel economy. It is assumed that business cost margins are sufficient to lead to fuel economy being a consideration in the purchase of heavy vehicles.

The focus on air quality, rather than fuel economy, is generally behind schemes to remove older vehicles from the fleet, such as the British Columbian volunteer "scrap it" scheme. This pilot programme provided a grant towards the purchase of a new car, bus passes or car-pooling initiatives (Covec, 2005f).

Communication and education campaigns often use the message of saving money alongside encouraging appropriate behaviours for climate change. The Canadian federal government launched the "Be Tyre Smart" campaign in 2003 – encouraging tyre inflation and maintenance practices to improve fuel efficiency and prolong tyre life. Fuel-efficiency labelling of new cars and biannual vehicle inspections (for air quality) are common supporting policies. For example, in Norway and Australia, car producers are required to include information on fuel efficiency and CO_2 emissions in their marketing and labels on windscreens at point of sale. Vehicle inspections are considered useful because they encourage regular maintenance.

In regard to **other modes**, aviation is recognised, particularly in Europe, as an area to focus on. It has recently been confirmed that aviation will be included in the European Domestic Trading Scheme.

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Conclusions and application to New Zealand

The importance of limiting the growth of GHG emissions from transport is well recognised in developed countries, but no single measure has been shown to address the problem. Transport policies are mixed and not focused solely on reducing CO_2 emissions. Co-benefits for air quality, congestion and oil security affect the mix of transport policies.

Significant efforts to improve the fuel economy of vehicle fleets through industry targets and fuel prices have, at least in Europe, helped reduce the growth rate of emissions, if not their absolute amount.

In New Zealand, our transport system reflects a small population distributed over two main islands with a combined length of 2,000 kilometres. A significant amount of trade occurs through shipping and air transport, building on early port settlements. Our towns generally developed alongside motorised transport, allowing for greater distances between home and destinations.

New Zealand is near the top of the world in its use of vehicles. For a population of just over 4 million, there are around 3.2 million registered vehicles on New Zealand's roads, 69% of which are cars. New Zealand does not manufacture its own vehicles. The majority are imported from Australia, Europe and Japan. Around 55% of new entrants into the fleet are second-hand cars from the domestic Japanese market.

In considering the appropriateness of using policies adopted overseas, the following is concluded:

- road-transport emissions are generally the main focus of climate change policy packages, particularly passenger-vehicle purchase and use and urban travel, so New Zealand is not unusual in this respect

- in New Zealand, transport needs *per capita* are likely to be greater than those in many other developed countries due to the way our towns have developed, low urban population densities and resulting land-use patterns. There may, therefore, be fewer opportunities to develop cost-effective alternatives to private vehicle use

- to date, New Zealand has not used fiscal measures to affect transport use. Our fuel price is relatively low and there is no differential pricing of vehicles by fuel economy. Experiences overseas may be relevant but because our starting point is different, local circumstances (such as our unusual fleet and use of road user charges for all diesel vehicles) are more likely to determine appropriate policy

- a focus on making the most of technology developments should be common to all countries, but the different circumstances need to be considered. Other countries have agreed fuel-economy targets with their local vehicle-manufacturing base. New Zealand does not have this opportunity, but it can manage new entrants to the fleet at the border and at the time of purchase

- when looking at congestion policies used overseas, it is clear that such policies are not employed solely for climate change benefits. Policies such as the cordon pricing in central London are also used to address localised concerns. In New Zealand, we would need to look at the appropriateness of such policies, given the make-up and issues of our urban areas

- provision of alternatives to single-occupancy vehicles is shown through the targeting of trips to work and the provision of public transport. These have generally come through investment or financial support. Similarly, in New Zealand, changes from our current patterns are likely to require specific targeting of certain trips and government assistance

- experience with education campaigns and information provision is likely to be similar around the world. In particular, it appears that even with provision of information on fuel economy, preferences for more powerful, bigger vehicles often offset the vehicle-technology gains. However, on the positive side, the co-benefits of saving money and better health are useful additions to any campaign

- use of biofuels and alternative fuels (LPG and CNG) is recognised as important for climate change policy and New Zealand would be in line with Europe and others in supporting these fuels

- increase in emissions from domestic aviation is common to New Zealand and other countries. Furthermore, as an island nation, New Zealand has a strong interest in aviation. With aviation now being included in the European Domestic Trading Scheme, there are indications that international policy on aviation is developing.

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4.1.4 Non-energy emissions from agriculture

Prospects for mitigation

It appears unlikely that actual on-farm methane emissions can be reduced more than fractionally by 2012 relative to business-as-usual. It is, however, possible that some mitigation tools may have reached a stage of "developed, tested and available in principle" by 2012. Continued research may reduce methane emission relative to business-as-usual by 2020. Sector growth strategies to increase productivity by 50% over the next 10 years (Dairy Insight 2004) imply that even substantial emissions reductions relative to business-as-usual may not lead to a reduction in gross methane emissions from agriculture out to 2020.

One of the key messages from research to date is that no single solution will be able to significantly reduce total agricultural greenhouse gas emissions, but may apply to only one or a few livestock types and related farming systems, and processes that lead to nitrous oxide and methane emissions. The overall effectiveness of any mitigation tool will also be limited if it is applied only on a fraction of farms, or is effective only during some seasons (Clark *et al*, 2001; PGGRC, 2005).

There are realistic prospects based on currently identified solutions to reduce nitrous oxide emissions by a few percent relative to business-as-usual by 2012, and more significantly by 2020. Widespread use of nitrification inhibitors, if combined with reduced use of nitrogen fertilisers and increased use of stand-off pads, may reduce nitrous oxide emissions relative to business-as-usual for the period from 2010 to 2020. However, the practicality of such emissions reductions depends on the results of further research and testing of the long-term effectiveness and environmental sustainability of nitrification inhibitors and possible similar future technologies, and the integration of specific mitigation management practices into normal farm operations.

Options for mitigation

Options to reduce non-CO_2 emissions from agriculture include:

- new technologies and forages that reduce methane production in the rumen
- new technologies that reduce the production of nitrous oxide in the soil from nitrogen deposited in urine and excreta and in nitrogen fertilisers
- farm management practices that reduce total nitrogen loading of soils through reduced fertiliser application or changes in stock management that minimise greenhouse gas emissions.

The potential for each of these mitigation options will be discussed in turn.

Methane

Most of the research to date has focused on increasing fundamental understanding of the processes that lead to methane production in the rumen. Several leads have been identified, but no cost-effective methane-mitigation technology for free-ranging animals has been proven either in New Zealand or elsewhere in the world (PGGRC, 2005).

The use of some alternative forages has the potential to reduce methane emissions by 10% to 20%. Their overall cost and sustainability, and consistency with New Zealand's climate and soils, is yet to be evaluated, but it is unlikely that alternative forages tested to date could simply replace existing standard pastures on a large scale. However, their

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further evaluation may offer clues to selectively breeding new pasture species that meet farm management and (current and future) climate conditions but also retain their methane-reducing properties. The time horizon for developing and introducing new pasture species is in the order of a decade or more, and the rate of adoption would be limited by the pasture renewal rates that farmers use and any associated changes in costs and farm productivity.

Apart from alternative forages, the feed additive sodium monensin has been shown to reduce methane emissions as a co-benefit to its main purpose of reducing bloat in lactating dairy cows. It achieves this by both reducing the feed intake of cows without reducing their milk production, and by reducing the amount of hydrogen produced in the rumen. Since monensin is normally fed only to lactating dairy cows for a limited period, it could be expected to deliver only a small reduction in overall methane emissions of, at most, 1% below business-as–usual (Sauer *et al*, 1998; McGinn *et al*, 2004).

Nitrous oxide

The most significant single impact on nitrous oxide emissions could come from the use of nitrification inhibitors, which desktop studies estimate could reduce total on-farm nitrous oxide emissions by up to 50%, while also reducing nitrate leaching by up to 20% (de Klein and Monaghan, 2005). Given their recent introduction into the market two years ago, data and knowledge about any long-term environmental effects are limited, and there are no systematic experimental studies of emission changes at the farm or catchment scale for a range of climates, soils and animal systems.

If nitrification inhibitors were applied on 50% of all dairy farms and were to sustainably reduce nitrous oxide emissions on those farms by 50% between 2010 and 2020, total non-CO_2 greenhouse gas emissions from agriculture would reduce by up to 3% relative to business-as-usual. The use of nitrification inhibitors appears marginally cost-effective to dairy farmers even when no price of greenhouse gas emissions is taken into account. Cost-effectiveness would decline for more extensive farming systems. The estimated emissions reductions do not take into account the possible increase in pasture productivity, which could offset reductions in nitrous oxide emissions through higher methane emissions from higher stocking rates.

Changes in farm management to reduce greenhouse gas emissions

Some emissions reductions could be achieved by better nutrient management and optimised fertiliser application. Fertiliser nitrogen was responsible for about 18% of total nitrous oxide emissions in 2003, growing to over 20% in 2010 and beyond. Better management of fertiliser use could also have co-benefits through reduced nitrate leaching and improved water quality.

Limiting the growth in nitrogen fertiliser use to below business-as-usual projections by 2010 and 2020 could further reduce nitrous oxide emissions. If fertiliser use were held constant at 2003 levels, total agricultural non-CO_2 emissions would reduce by 1.5% and 2.5% relative to business-as-usual by 2010 and 2020, respectively. However, there is insufficient information to estimate the extent to which fertiliser use could be reduced through improved management and nutrient budgeting tools without also reducing overall farm productivity. Cost-effective opportunities will differ between farms and depend on individual management practices and expertise, including the timing, forms and quantities of nitrogen fertiliser. Biosecurity risks such as clover root weevil may require replacement of the nitrogen previously fixed by clovers by fertiliser nitrogen to maintain previous productivity levels.

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Other farm management practices with the potential to reduce greenhouse gas emissions, mainly for nitrous oxide, include the use of stand-off or feed pads for wintering systems, and possible adjustments to seasonal timing of farm operations such as milking and slaughtering.

The total gains that are possible by such farm management changes are uncertain. Desktop studies have shown that reductions in nitrous oxide emissions, which could be up to 30% on a seasonal basis for some farms, could be offset by increases in methane and carbon dioxide emissions resulting from a more intensive management regime including greater reliance on supplementary feed. Recent research does indicate, however, that stand-off pads could achieve some nitrous oxide emissions reductions for relatively little extra costs and effort. These farm management changes would also have significant co-benefits in terms of reduced nitrate leaching into water ways (de Klein and Monaghan, 2005; de Klein and Ledgard, 2005).

Very little work has been undertaken to optimise total on-farm greenhouse gas emissions relative to overall production through adjustment of milking and slaughtering times, and variations in stocking rates. Consequently, the scope and cost of such management changes to reduce emissions is currently not clear.

Trade-offs and co-benefits of mitigation options

Reducing non-CO_2 emissions is likely to offer co-benefits in increasing productivity and reducing other environmental impacts. These co-benefits offer both positive and negative prospects for overall emission trends from agriculture:

- the presence of co-benefits in the form of improved farm productivity can lead to more rapid adoption of new technologies and practices

- the increased productivity associated with some mitigation options means that agriculture could become more intensified, with higher stock numbers and more intensive feeding regimes, so that overall sectoral growth offsets emissions reductions.

Desktop studies have shown that the use of nitrification inhibitors could reduce nitrous oxide by up to 50%, but some of these gains could be offset by an increase in methane emissions arising from increased pasture production and resulting higher stocking densities. The resulting possible intensification of farms means that while emissions per unit of product would decline, absolute emissions of greenhouse gases per animal and at the farm level could increase (de Klein and Ledgard, 2005).

This demonstrates that partial mitigation options can have positive outcomes in terms of emissions intensity (ie, emissions per unit of product, or emissions per value of total farm production), but may have perverse outcomes in terms of absolute emissions (de Klein and Monaghan, 2005).

Since the amount of arable land in New Zealand is limited, land prices and alternative land uses also provide an important mitigation incentive for the agriculture sector. Economic returns and mitigation policies, in particular for the forestry sector, will affect land-use and emission trends from agriculture. The effect of such policies is not covered here. Other land-use decisions such as subdivision of semi-rural areas for small “lifestyle farms” and urban sprawl can also affect emission trends.

Protection of landscapes of national significance and retirement of government-owned land for the purpose of biodiversity protection provide further indirect mitigation results. An example is the current high-country tenure review, which will probably retire large blocks of land currently under extensive sheep farming to native tussock vegetation.

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Projected emission trends

As outlined in Section 3.1.2, agriculture contributes the single largest share of any sector to New Zealand's total greenhouse gas emissions, and emissions of both methane and nitrous oxide have been increasing since 1990. This emissions growth is expected to continue into the future. Best estimates for projected emission trends for the sector as a whole to 2010 and 2020 are provided in Table 11.

Table 11 - Projected Non-CO_2 Emissions from Agriculture

	1990 kt CO_2e	**2003 kt CO_2e**	**2010 estimated kt CO_2e**	**2020 estimated kt CO_2e**
Projected Emissions	32,194	37,203	40,476 (38.5Mt – 42Mt)	43,801
Excess above 1990	0	5,009 (15.6%)	8,179 (25.4 ± 5%)	11,607 (36.1%)

Source: Draft New Zealand fourth national communication under the UNFCCC (2005)

The projections in Table 11 assume that no significant new mitigation technology is developed and implemented by 2012 or 2020, and that sector growth continues along historical lines. The projections therefore form a business-as-usual baseline. This baseline assumption needs to be assessed against two additional strategic goals stated by animal sector industries (Dairy Insight, 2004):

- increase total productivity by 50% by 2014, including increasing the amount of metabolisable energy per hectare and the amount of milk produced per cow

- reduce the net production of methane and nitrous oxide from New Zealand dairy farms by 20% by 2012 relative to business-as-usual.

Figure 35 provides more detail on the historical and projected changes in emissions for specific subsectors. The largest growth occurs in dairying, while emissions from sheep have declined up to now due to significant reductions in total sheep numbers. This latter trend is expected to be reversed over the coming years, despite relatively constant sheep numbers, due to the increasing productivity and emissions per head of sheep.

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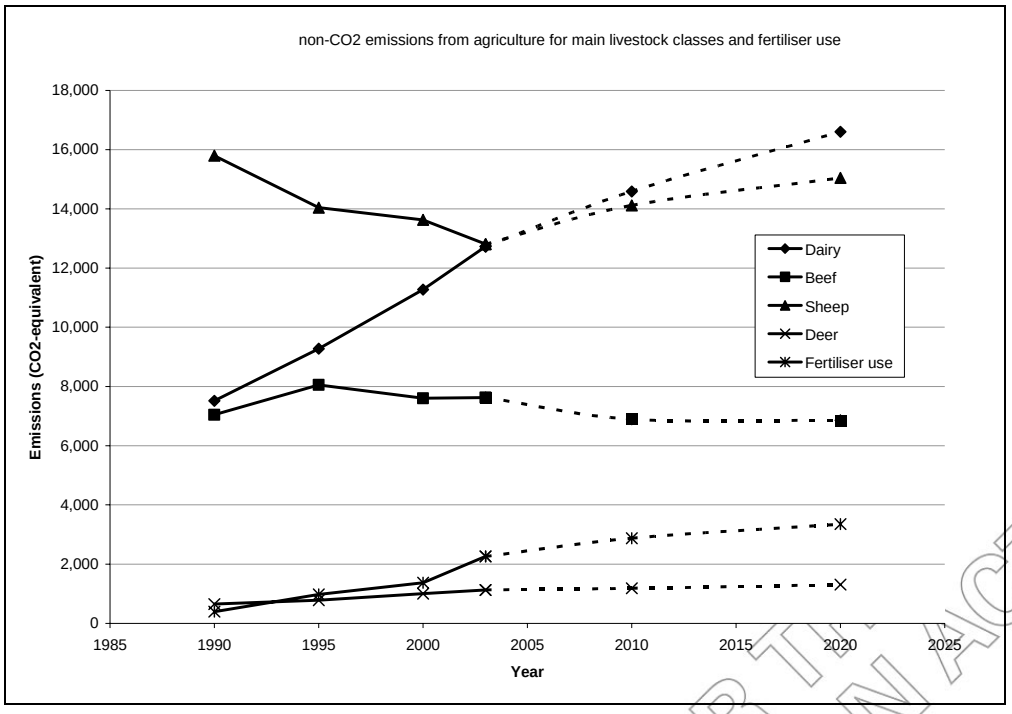
Figure 35 - Historical and Projected Non-CO_2 Emissions from Agriculture Sub-sectors



Source: Draft New Zealand fourth national communication under the UNFCCC (2005) and New Zealand, Ministry for the Environment (2005b)

4.1.5 Forestry and land-use change

Introduction

New Zealand has 6.256 million ha of indigenous forest and 1.82 million ha of planted production forest. Indigenous forests are managed primarily for conservation and recreation purposes. While the primary objective for most planted production forests is timber production, they also have significant environmental and recreation benefits.

It is currently assumed that New Zealand's indigenous forests are a relatively stable carbon reservoir. A national carbon-monitoring programme is being established to demonstrate this.

New Zealand's planted production forests, mainly comprising *Pinus radiata,* have removed and stored substantially more CO_2 over the period 1990 to 2003 than has been emitted through harvesting of both planted and indigenous forests.

The land-use, land-use change and forestry (LULUCF) sector represented the removal of approximately 30.3% (23Mt CO_2e) of all New Zealand's greenhouse gas emissions in 2003.

Production forestry planting rates

Production forestry planting rates have fluctuated significantly since afforestation programmes began in New Zealand in the 1920s. The average afforestation rate over the past 30 years has been 44,900ha per year. In the period 1992 to 1998, planting rates were high (averaging 69,000ha per year). Since 1998, the rate of new planting has declined and, in 2003, 19,900ha of new forest was established.

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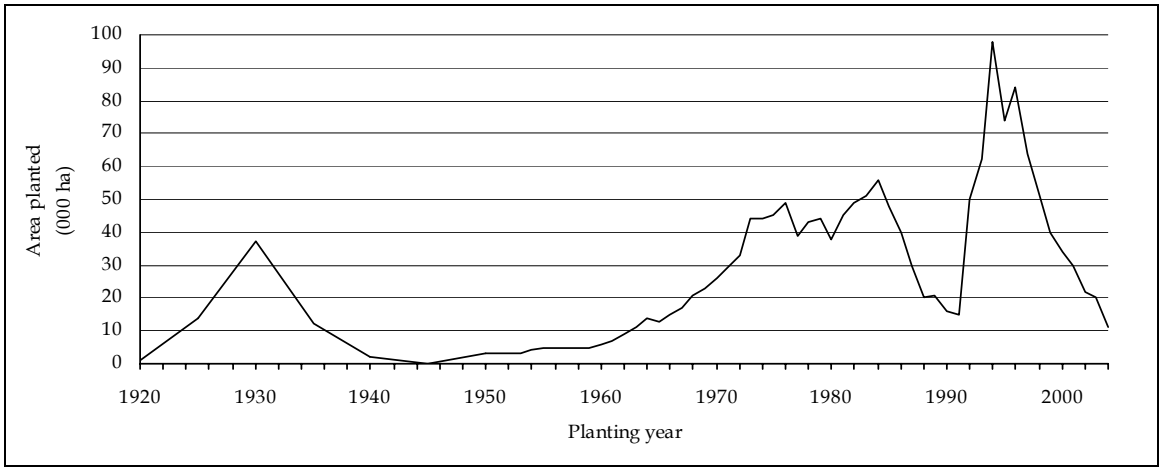
Figure 36 - Afforestation from Planted Production Forest



Source: MAF (2005)

New investment in commercial forestry is currently at a low level. It is provisionally estimated that just 10,600ha of new forest was established in 2004.

New Zealand had approximately 660,000ha of Kyoto forest (ie, forests planted after 1 January 1990 on land that was non-forest prior to that date) in 2004. In the short term, forest sink credits will offset harvesting and deforestation liabilities. New Zealand's projection for sinks over CP1 is a surplus of 67.8Mt CO_2e. This is the most likely scenario in the "Projected balance of units during the first commitment period of the Kyoto Protocol" (New Zealand Ministry for the Environment, 1995l) and is based on the inventory methodology and the best information available at the time of the projection.

The decline in new forestry planting has been driven by a combination of factors. These include:

- a relatively strong New Zealand dollar
- substantial increases in shipping costs
- tough international market conditions
- competition for land from alternative uses (which have pushed up land prices).

The first three factors have combined to give a very significant decline in stumpage (net return) to foresters and downward pressure on forestry valuations. Work undertaken by MAF shows that over the period 1994 to 2004, export prune log prices have fallen from a peak of $350 per tonne to around $190 per tonne. With a decline of this magnitude in prices received, there is no indication that the level of new planting will increase under current market conditions. These factors have created a decline in investor interest in the New Zealand production forest industry, but projections forward to 2020 are very uncertain.

However, forests are valued for more than their ability to sequester and store carbon.

They have co-benefits, such as:

- avoided agricultural emissions
- soil conservation, catchment control and water quality, and biodiversity

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- substitute materials for more emissions-intensive products
- a source of bioenergy.

A number of policies and programmes undertaken for reasons such as those outlined above also provide climate change benefits. These include the East Coast Forestry Project and sustainable-development frameworks and programmes (such as the RMA and soil conservation/land management work undertaken by regional councils).

Land-use change from forest to non-forest

A very recent phenomenon that is becoming more prevalent is the conversion of plantation forest land to other land uses (deforestation). Historically, very little conversion of plantation forest land has occurred in New Zealand. Implementation of the New Zealand Carbon Accounting System will provide more accurate data on deforestation.

Under current policy, the Government's deforestation liabilities during CP1 are capped at 21Mt CO_2e (this is based on 10% of the forest area due for harvest over CP1 being deforested). Officials' "best guess" of historic deforestation rates is that 2% to 4% of the area harvested each year is not replanted.

The downturn in the forestry sector since 2002 and strong agricultural commodity prices have increased interest in converting forest land to other land uses such as dairying, which is now a competing land use on flat, well-drained sites formerly considered marginal for agriculture due to soil fertility reasons.

As a consequence, the forest industry is concerned that there is a significant risk that the deforestation cap of 21Mt CO_2e will be breached and that deforestation liabilities will be passed on to foresters who deforest.

There is uncertainty surrounding the rules, targets and interpretation for deforestation beyond 2012 to 2020 (and further out). This means that the issues surrounding mitigation for deforestation become problematic, when the definition of "forest" for future commitment periods has not yet been determined.

Reliably predicting or even making reasonable estimates of future rates of deforestation is very difficult. This is because deforestation is driven by a large number of factors, which, in themselves, cannot be accurately forecast.

Conclusions

Uncertainty about the Kyoto Protocol's future rules, targets and interpretation beyond 2012 and out to 2020 means that assessing the forestry sector's mitigation prospects is difficult. At best it would be necessary to assume the same rules for contiguous commitment periods.

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Furthermore, uncertainty about the rates of afforestation, reforestation and deforestation in New Zealand is a major impediment to determining the prospects for mitigation out to 2020 for forestry. Better information is required to discern the new planting (afforestation and reforestation) and deforestation intentions of foresters. An improved understanding of the decision-making process of land-use managers in New Zealand is also needed.

In the short term, forest sink credits will offset harvesting and deforestation liabilities. New Zealand's projection for sinks over CP1 is a surplus of 67.8Mt $CO2_e$. In the medium term, out to 2020, (assuming similar rules over contiguous commitment periods) this surplus will be eroded as Kyoto forests are harvested.

Forests are valued for more than their ability to sequester and store carbon. Options that send positive afforestation and reforestation signals could be used to maximise their co-benefits.

Section 4.6 outlines some alternative policy options for the forestry sector to address the issues of afforestation, reforestation and deforestation. These options range from policies where the Government retains all benefits and liabilities to those where the Government devolves all benefits and liabilities. These options are assessed and further work proposed. Any further work should also include assessing the mitigation potential of those options.

4.1.6 Linkages between mitigation and adaptation

This review does not address the issue of climate change impacts on New Zealand. That is to say, it does not examine the impact of changes in rainfall patterns and temperature, increasing risk of floods and droughts, rising sea levels, and increasing frequency and intensity of extreme weather events on infrastructure, the agricultural sector, ecosystems and the built environment (New Zealand, Ministry for the Environment 2001, 2004a, 2004b; Mullan *et al*, 2005).

However, a number of greenhouse gas mitigation actions have clear links with the complementary need to adapt to the expected impacts of climate change. This section outlines those links to enable a full consideration of the co-benefits of both adaptation and mitigation measures, and of national or regional policies that could support both outcomes.

It also points to areas where mitigation-related decisions could potentially change the vulnerability of society or ecosystems to the impacts of climate change, or where adapting to the impacts of climate change could lead to changes in greenhouse gas emissions.

Synergies and mutual co-benefits of mitigation and impacts/adaptation

To some extent, there are feedback loops from climate change that should reduce the causes of climate change, stabilising the environment. A number of the expected impacts of climate change can have the positive effect of also reducing greenhouse gas emissions and/or increasing carbon sinks. For example:

- higher average winter temperatures would reduce winter heating demand
- greater snow melt and increased winter rainfall would lead to relatively greater storage levels in hydro lakes during winter, which should result in reduced interannual variations in CO_2 emissions from supplementary thermal power generation during winter

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- increased risk of erosion of hills and changes in economic agricultural viability of some regions could prompt greater rates of afforestation.

At the same time, a number of measures designed primarily to reduce greenhouse gas emissions can also make society, ecosystems and the economy more resilient against the expected effects of climate change. For example:

- higher levels of insulation in houses for energy-saving purposes improve resilience to summer peak temperatures and may reduce vulnerability to extreme weather events

- distributed generation systems using local energy resources are likely to be more resilient against failures of power systems due to weather.

Barriers, trade-offs and adverse effects

However, there is also scope for vicious circles in which climate change impacts add to the causes of climate change, leading to increased energy demand and greenhouse gas emissions, or increased risks to carbon sinks and renewable energy resources. For example:

- drier conditions in eastern regions could lead to increased energy demand from more irrigation systems

- higher peak summer temperatures are expected to lead to increased energy demand for air-conditioning systems

- changing areas for optimal primary production could lead to a greater distance between production areas and existing processing centres, resulting in increased demand for transport of raw products or the need to relocate processing centres

- higher temperatures and increased risk of drought could lead to increased biosecurity and fire risks to existing forest sinks

- an increase in more drought-resistant but lower-quality pastures could lead to increased methane emissions intensity from agricultural production

- increased interannual climate variability could increase occasions when low winter hydro lake levels need to be supplemented by additional thermal power generation

- expansion of forest sinks and bioenergy systems could increase vulnerability to the effects of climate change if the expansion is into areas that may become more susceptible to biosecurity risks, fire and drought under a warmer and drier climate.

What policies best capture co-benefits and avoid adverse spill-over effects between mitigation and adaptation?

The above section provides a qualitative outline of some of the co-benefits and adverse spill-over effects. Quantitative knowledge about the strength and importance of those links for sectors, regions and the economy as a whole is limited and depends on the specific issue under consideration.

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Generally, these linkages can best be incorporated into decision-making by ensuring that consideration of likely climate change becomes part of standard planning and risk-assessment practices. The Ministry for the Environment has produced a series of guidance documents that help stakeholders understand the likely changes in climate and to apply a sequential risk-assessment approach to evaluate whether these changes could materially affect their operations.

Such risk assessments are particularly important whenever decisions are made about long-lived infrastructure and assets that are exposed to climatic conditions in any way, or that provide a service to meet a climate-driven demand. Routine climate change risk assessments in planning processes by industry and local and central government would help avoid lock-in of technologies and practices that are vulnerable to hazards that could be exacerbated by climate change, or that rely on natural resources or energy supply and demand that could be significantly affected by climate change. An assessment of the relevance of climate change in the context of other drivers and pressures can usually be taken only at a local level, where priorities and risks can be appropriately weighed up (New Zealand, Ministry for the Environment, 2004c).

Current and future work by the Government in this area concentrates on:

- working with science organisations to increase the availability of appropriate research findings to central and local government and other sector groups
- ongoing provision of basic information to decision-makers on climate change impacts, adaptation options and the potential costs and benefits of preparing for climate change
- partnering with stakeholders and helping them use this information as appropriate.

Specific further technical work on links between the impacts of climate change and greenhouse gas emissions could include:

- improved modelling of the impacts of climate change on hydropower resources
- changes in energy demand in urban and rural areas under a changing climate, including climate variability and extremes
- assessing long-term viability of areas for optimal forestry and bioenergy production, and options to protect such investments against biosecurity, fire and drought risks.

Specific technologies that can assist adaptation to the effects of climate change should also be designed with greenhouse gas mitigation objectives in mind; eg, irrigation systems that minimise energy consumption, and breeding of new pastures that are adapted to higher carbon dioxide concentrations and drought conditions as well as assist in reducing non-CO_2 greenhouse gas emissions.

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4.2 Price-based measures

4.2.1 Context – international and domestic

Introduction

Emissions of greenhouse gases pervade the economy: they come from every industry sector, every business (including farms) and from every household. There are a number of possible policy approaches to reducing emissions, including legislation and regulation, government funding to set positive price signals, information and promotion to remove barriers and support voluntary initiatives, and taxes or trading mechanisms to establish the price (cost) of emissions. All of these policies will have different strengths and weaknesses, and no single policy will be able to resolve the challenges of climate change on its own. Hence, a well-designed climate change policy package is likely to involve a mix of negative and positive policies – a mix of "carrots and sticks". Likewise, there are limits to the ability of legislation and regulation alone to put controls on particular technologies or equipment or on setting firm-based, industry-based or household-based performance standards, even if the focus is on the largest emitters. Other things being equal, price-based instruments should have an important role in any climate change policy package.

The advantages of price-based measures in addressing environmental externalities are generally well rehearsed. Ekins and Barker (2001) surveyed literature on carbon taxes and carbon emission permits and concluded there is general agreement that market-based instruments of carbon control achieve a given level of emissions reductions at a lower cost than regulations. Sin and Kerr (2005) note that price-based measures are well suited to addressing homogeneous long-term pollutants such as carbon dioxide, as they allow maximum spatial and temporal flexibility and provide incentives to equalise the marginal cost of abatement across all firms and all sectors of the economy. The intention of price-based measures is to allow markets to determine the least expensive way of reducing emissions. The same effect would be impossible to achieve through a command and control system, as the Government would need marginal cost information for all regulated firms in order to make the appropriate decisions.

In practice, the desirability of different types and designs of price-based measures depends to a large degree on the context in which they are expected to operate. It is important to design a measure that is both sustainable and flexible over time to take into account changing contexts. This section discusses issues that need to be clarified to provide the context for soundly-based design and assessment of price-based measures.

Broad options for domestic mitigation policy

New Zealand is clear about its obligations to 2012 under the Kyoto Protocol and the review takes as a given that New Zealand will not resile from those obligations. However, as discussed in Section 2.3, there is considerable uncertainty about the international context post-2012. The review takes it as given that New Zealand should continue to participate in and contribute to the international discussions about regimes for post-2012.

One objective for New Zealand's domestic mitigation policy is to meet our obligations at the lowest cost. In this respect, the cost will include the economic and social impacts of the mitigation policies. This suggests a number of principles to guide policy design.

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A principle of good policy design is that policy should be sustainable, or robust, in the face of the changes that are likely in the medium term. This reduces the risk that they will be unstable over time and the need for governments to undertake substantive policy reviews within relatively short timeframes.

A second principle of good policy design is that, where there is uncertainty about the future, consideration should be given to the benefits and costs of delaying a decision. If a decision is made to delay, then there are choices ranging from doing nothing, through explicitly adopting a temporary policy, to adopting a policy that avoids commitments now but puts in place sustainable policies that can adjust to future events.

Taking into account the substantial uncertainty about the future, and these two principles, the Government has two main options in regard to price-based measures – a carbon tax or emissions trading. The relative merits of these two options are considered below.

In addition, the Government has three possible broad approaches to a carbon tax. These are assessed in detail in Section 4.3.3, and can be summarised as follows:

1 continuing the current policy settings (carbon tax reflecting international price and NGAs, with the option of changing to emissions trading at an appropriate time)

2 a low-level carbon tax, removing NGAs.

This approach is one that avoids significant early commitments but provides a stable policy framework for the future. It would also allow a transition to domestic emissions trading at some point in the future.

This would involve a policy package that, in the short term, does not require or expect significant slowing of the rate of growth of domestic emissions. It would put in place a set of policies that best positions New Zealand over the long term to significantly slow the rate of growth of, or reduce in absolute terms, domestic greenhouse gas emissions. The idea is that the core policies would be able to be adjusted (not completely recast) over time, as more information about the costs of emissions reductions in New Zealand and certainty around the international context became clearer. In practice, this would mean removing the current NGA/carbon tax policy

3 defer a market mechanism in New Zealand until at least 2013

This approach explicitly adopts a temporary policy package that avoids significant early commitments that, if made, might be regretted later.

This would involve replacing the current carbon tax and NGA regime with a “holding pattern” policy package for CP1 of the Kyoto Protocol. This package would not require or expect significant slowing of the rate of growth of domestic emissions. At an appropriate time, when there is better information about international regimes and their implications for New Zealand and the cost of emissions reductions in New Zealand, the Government would develop appropriate domestic mitigation objectives and adopt a policy package consistent with these.

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A risk-management approach is likely to be important, given the range and size of uncertainties about the future. It is also important to note that New Zealand's emissions are small relative to global emissions and that our domestic policy settings are unlikely to impact on global emission levels. However, there are differing levels of risk to the New Zealand economy, depending on the domestic policy choices made.

The economic impacts of mitigation policies are likely to include shifts in the composition of the economy, as some activities will become relatively more profitable and productive than others – eg, low-emissions activities may expand as emissions-intensive activities decline. Patterns of consumer demand may also shift – eg, consumers may choose to purchase more energy-efficient products. There will also be an international dimension, as the differing climate change commitments and policy responses in different countries will mean that some New Zealand exports will face stronger competition in export markets, and some New Zealand producers will face stronger competition from imports. At the same time, other New Zealand products are likely to be more competitive at home or abroad.

As many of New Zealand's competitors are unlikely to face a price on carbon for some considerable time, some parts of the New Zealand economy will face a greater exposure to this lower-cost competition, where the Government is unable to manage the price of carbon in our economy and where there are binding commitments on emissions levels.

These considerations suggest policy settings should be such that the Government can manage the price of carbon in the New Zealand economy in the short and medium term but the option of full participation in emissions trading is kept open in the longer term.

These factors also suggest that there may be a need for early strategic choices about the approach to those emissions that, if unchanged, would severely constrain New Zealand's ability to make substantial emissions reductions in the long term; eg, agricultural emissions, transport emissions and, possibly, emissions from the heating and cooling of buildings and from fossil-fuelled power stations.

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Emissions trading or a carbon tax?

The main types of price-based instruments are taxes (which apply a price to emissions) and permits (which limit emissions quantities[50]). New Zealand has currently opted for a carbon tax regime, although has left open the option of moving to domestic emissions trading such as a permit regime should the international emissions market develop sufficiently.

The key feature of a tax-based policy is that it sets the price of emissions (ie, the tax rate). Within a tax-based policy, therefore, there is no certainty about the volume of emissions to be undertaken. In contrast, under a permit-based scheme, there is the potential to set the volume of emissions and leave the market to determine the price. However, it is unlikely in a New Zealand context that the quantity of emissions would be controlled (see the section on emissions trading for more detail). There is, however, no certainty about the price involved, as this will be determined by a variety of factors in the emissions-permit market.

[50] A domestic permit regime linked to the international market would not limit the quantity of emissions, as permits could be purchased internationally.

Tax and permit systems can result in different emissions outcomes with different efficiencies. With a well-functioning international permit market, a permit regime is more likely to yield an optimal result, as permits adjust instantaneously to changes in the international permit price, while taxes require a government decision to change[51]. A permit regime would encourage industries to respond appropriately to changes in the world price of carbon, whereas under a tax system, any shock to the international permit price creates a disparity between the marginal benefits faced by firms (the tax rate) and the marginal benefit faced by New Zealand as a whole (the new international permit price).[52]

There are other important differences between a taxation system and a permit-based approach. In particular, if the Government wished to reduce the initial impact of the carbon price on firms that are already emitting, it could exempt emissions up to a specified threshold (under a tax system) or "grandparent" (ie, give free) permits up to the specified threshold (under a permit system), but the incentives faced by firms would not be the same in each case. Conventionally, tax thresholds have value to a firm only for as long as it is producing emissions, whereas permits are an asset that the firm does not lose if it stops producing emissions. This can be important for firms considering reducing their emissions.

A permit-based scheme is a far more complicated policy than a tax-based policy, so set-up costs, timeframes required, and overall difficulties are greater.

There is a need for high levels of public and political buy-in to both a tax-based policy and a permit scheme. The difficulties and timeframes involved in setting up a permit scheme imply that the need for widespread buy-in is even greater in the case of a permit scheme.[53]

Under some possible future scenarios (as outlined in Section 2.3), emissions trading may better serve the Government's objectives than a carbon tax would. Any proposed carbon tax option would ideally provide a good platform for a possible move to emissions trading in the future.

The implementation of either a carbon tax or emissions trading, or changing from a tax to trading, would be a major exercise for the Government, involving significant legislation. Ideally, such exercises would be undertaken infrequently, probably not more often than once a decade. This suggests that the likelihood of an emissions trading system, rather than a tax, best serving the Government's objectives within the next, say, 10 years should be an important consideration when deciding whether a tax or emissions trading, or neither, should be implemented in the short term. This question is addressed in Section 4.3.4.

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[51] Setting the optimal tax would also require government to have perfect information about factors such as price elasticities of demand and marginal costs and benefits, so, in practice, may not be achieved. However, a wide range of factors will determine how important optimality is, and how far a nearly optimal (well-designed) tax will differ from the optimal outcome.

[52] Sin and Kerr (2004) "Taxes vs permits: Options for price based climate change regulation."

[53] Especially as firms and individuals need to actively trade in a permit market for the market to operate effectively.

Broad options for maintaining international competitiveness

Internationally, countries are adopting a range of responses to reduce or slow the growth of emissions. In some cases, price-based measures are being applied – the European Union Emissions Trading Scheme being the most significant example – but, in general, a liquid international emissions market is yet to form and domestic price-based measures vary greatly in terms of coverage and rate.

In agriculture, it is very unlikely that many of New Zealand's competitors will face a price for their methane and nitrous oxide emissions within the next 15 or 20 years. This may also be the case for some industries with respect to their CO_2 emissions. This situation raises issues of international competitiveness for these industries[54]. In other industries, New Zealand may gain international competitiveness – eg, if we become world leaders in emissions-reduction or low-emissions technologies.

The current carbon tax/NGA policy links the level of the tax to the international carbon price, with a cap of $25 per tonne of CO_2e. The Government has decided that the initial level of the tax will be $15 per tonne of CO_2e. With a tax that starts as high as $15 per tonne and may rise to $25 per tonne, the impact on some emission-intensive activities is likely to be substantial in a situation where many of their competitors do not face such a price. Current climate change policy includes NGAs to address international competitiveness issues among other objectives.

NGA policy sets a firm-based threshold (usually 10% reduction in earnings before interest and tax) for eligibility to negotiate an NGA and thereby avoid a significant amount of the increased costs that eligible firms would otherwise face. The rationale for this is that, if such firms did not have the opportunity to negotiate an NGA, they would reduce (and in some cases cease) production in New Zealand and production would increase in other countries. This is referred to as "economic leakage". NGA policy is designed to minimise the risk of economic leakage.

[withheld under OIA s6(a), s9(2)(j)]

If the new production outside New Zealand were not less greenhouse gas intensive than the New Zealand production had been, there would be no associated reduction in global emissions. This is referred to as "carbon leakage". NGA policy is designed to address economic leakage, irrespective of whether it is accompanied by carbon leakage.

Markets and the economy are dynamic. Change is continually occurring in the economy in response to a host of both internal and external factors and, over time, some businesses and some sectors expand while others contract. Relative price changes are an everyday occurrence in business and responding to them is part and parcel of managing a business. A low-level tax on greenhouse gases that is increased gradually provides an alternative approach to managing the risks to New Zealand businesses and economic growth, rather than introducing a (higher) tax on greenhouse gases and offsetting this with NGAs (the announced approach).

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[54] Note that some other countries might reduce their agricultural emissions as a by-product of non-climate change policy changes. For example, changes to the European Union Common Agricultural Policy might reduce emissions in Europe.

The third option for addressing international competitiveness is to dispense with both a tax and emissions trading for the time being and reconsider these instruments at an appropriate time in the future, when there is more adequate information about international regimes and their implications for New Zealand and the cost of emissions reductions in New Zealand.

The "international carbon market"

Once commitments, or obligations, to reduce emissions have been agreed, allowing the parties to buy and sell emissions reductions will help to ensure that the emissions reductions are made at least cost. If there is a market for emissions reductions, parties for whom it would be costly to reduce emissions have the opportunity to buy cheaper reductions from other parties.

Over the last five years, several greenhouse gas emission markets have emerged, trading in a variety of carbon "products" (emission units or allowances). Some of these products can be used to fulfil obligations under the Kyoto Protocol, and others cannot; only the former (termed "Kyoto-compliant" units) are relevant to New Zealand's commitments under the Protocol. Kyoto-compliant units include AAUs (Assigned Amount Units – allocated to countries by the Kyoto Protocol), ERUs (Emission Reduction Units - generated by JI projects), CERs (Certified Emission Reductions – generated by CDM projects) and RMUs (Removal Units – generated by sink projects). The trading of ERUs and CERs is growing.

Earlier this year, the European Union established an emissions trading scheme (EU ETS) based on emission allowances for the period 2005 to 2007. These allowances (EUAs) are not Kyoto compliant.

There are two different circumstances under which New Zealand might participate in the markets for Kyoto-compliant units.

Where New Zealand's obligations have not been devolved to firms, the Government might seek to buy units to help meet its obligations (any purchasing by New Zealand firms would be driven by the opportunity to make a profit from trading the units). Purchase by the Government of units in the international markets needs to be considered as part of the Government's management of its Kyoto liability.

Where New Zealand's obligations have been devolved to firms, New Zealand firms, rather than the Government, would be potential purchasers of units.

In either case, New Zealand firms that had been allocated units under the PRE might seek to sell these units in relevant carbon markets.

In considering whether New Zealand should implement an emissions trading scheme, key features of international markets that need to be considered include:

- whether New Zealand firms would have relatively low transaction costs associated with buying and selling units
- whether New Zealand firms could access low-priced emission-reduction units from overseas
- whether the prices of relevant units would be reasonably stable.

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It would not be necessary to have an international market that covers all countries or all countries that have ratified the Protocol.

The "international price" of carbon in the New Zealand economy

How important is it that the "international price" is reflected in the New Zealand economy in the short term (to 2012) and in the medium term (to 2020)?

The Kyoto Protocol was structured to facilitate the emergence of an international market in emissions of the greenhouse gases covered by the Protocol (the international carbon market). Such a market has begun to develop and a variety of "carbon products" are now bought and sold in it. Of these carbon products, CERs, ERUs and AAUs are the most relevant to New Zealand, as these are the products that New Zealand could purchase to meet its obligations under the Protocol.[55]

A central principle of the current policy settings is that the carbon price in the New Zealand economy should reflect the international price. However, most of the options discussed earlier in this section involve a decoupling of the domestic price from the international price in the short term (to 2012), and some options would continue this into the medium term and perhaps even longer. Does this matter?

When New Zealand has specific quantitative commitments, as it does for CP1, the benefit of having the domestic price approximating the international price is that the Government would have to buy units on the international market only if it was cheaper to do so than to reduce emissions in New Zealand. If the domestic price were lower than the international price, there would be less reduction in domestic emissions and the Government would have to buy more units on the international market. In addition, the Government would pay more for some of those units than it would have cost emitters to make the reductions in New Zealand. This would mean that taxpayers would pay more and emitters would pay less to meet New Zealand's commitments. However, the benefit of a reduced fiscal cost would have to be weighed against any adverse effects from a reduction in international competitiveness and, ultimately, in economic growth. As long as New Zealand's commitment to fulfilling its obligations under the Kyoto Protocol was credible, it is unlikely that the country's international credibility would suffer if the domestic price of carbon were below the international price.

Beyond CP1, if New Zealand had specific quantitative commitments, the issues would be the same. However, if New Zealand did not have such commitments, and did not intend to have such commitments in the foreseeable future, there would be no benefit from having the domestic price reflecting the international price.

On the other hand, there could be a situation where New Zealand had no quantitative commitments but foresaw that it might well take some on in the future. In these circumstances, having a domestic price below the international price would mean that, if the domestic price was not ramped up to the international price before the commitment period, the Government would have to buy more units and pay more for some of them than it would have cost emitters to reduce the emissions in New Zealand. Again, emitters would pay less and taxpayers would pay more than if the domestic price were equal to the international price. This would have to be weighed up against the costs (in terms of loss of international competitiveness and possibly lower economic growth) of increasing the domestic price to equal the international price.

[55] The Government used CER and ERU prices when it recently put a value on the Crown's liability under the Kyoto Protocol.

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Is a concern for either global efficiency or global equity a reason for New Zealand emitters to face the international price of emissions? First, consider global efficiency. As New Zealand's contribution to global emissions is very small, the extent of the emissions reductions undertaken by New Zealand will not have a material impact on the quantity (or cost) of emissions reductions undertaken by other countries. And, as long as New Zealand is not a significant buyer in international carbon markets, the quantity of New Zealand purchases in international carbon markets will not change the price that other purchasers pay. That means that the price of emissions in New Zealand has no material bearing on global efficiency in emissions reduction.

Secondly, consider global equity. As long as there is a diversity of approaches to international regimes, and this is expected to be the case for the foreseeable future, comparisons of equity between New Zealand and other countries will be far more complex than whether or not New Zealand faces the international price(s) of emissions.

For these reasons, the possible constraints on increasing the tax up to the level of the international price of carbon do not give rise to material issues of global inefficiency or inequity.

Revenue recycling

In assessing the overall impact of a price-based climate change measure on New Zealand, it is important to recognise that revenue derived by the Government through the measure will not be removed from the economy entirely. Rather, revenue generated will be available for other government spending, which, in turn, will bring economic and social benefits. Decisions on how to recycle revenue will therefore influence the total impact of the price-based measure.

It is generally considered that using revenue to offset other distortional taxes assists in minimising adverse economic impacts of the price-based measure. Hoerner and Bosquet[56] undertook a comprehensive survey of literature assessing the economic impact of environmental tax reforms (predominantly focused on energy emissions). Based on 44 studies containing 104 distinct simulations of environmental tax reform, they found that where revenue from environmental taxes is used to reduce other distorting taxes, the economic outcome (in terms of impacts on both employment and GDP) is better than where revenue is not used for this purpose.

In general, it is considered undesirable for the revenue derived from a tax to be "tied" to spending on government initiatives in the same policy area. In the context of climate change, this will mean that revenue from a price-based measure should not be tied to funding other climate change policies and measures, despite the fact there may be intuitive appeal in developing a policy package of tax plus spending. There are two key elements to this argument:

- in general, government spending should be allocated on the basis of value for money, not source of revenue. Following a decision to recycle revenue from a price-based measure, the Government should look across all portfolios and all spending options to seek out the best value for money spending. This ensures highest total value is achieved from available government funds. Similarly, spending in portfolio areas should not depend on revenue generated in that area. For example, we do not spend

56 Hoerner, J A and B Bosquest (2001) Environmental tax reform: The European experience. Washington, DC: Centre for a Sustainable Economy.

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less on public education because it does not happen to have a related intervention that raises revenue

- furthermore, linking revenue to spending can create conflict. For example, connecting revenue from a price-based measure designed to discourage emissions to spending designed to encourage energy efficiency creates a conflict between effectiveness of the tax in changing behaviour (which will reduce revenue) and sustaining revenue to continue encouragement.

Under the announced carbon tax policy, revenue is to be recycled through a package of changes to the business tax regime, including changes to fringe benefit taxes and depreciation rules. No modelling of this specific recycling scenario has been undertaken, so it is difficult to estimate macroeconomic impacts. If a different price-based measure were to be adopted in the future, it may be worthwhile reviewing current decisions on revenue recycling to ensure they will minimise adverse economic impacts.

Three key messages from this are relevant to the assessments of price-based measures in subsequent sections:

- using revenue from a price-based measure to reduce other distortional taxes assists in minimising adverse economic impacts arising from the measure

- revenue derived from a price-based measure should generally not be "tied" to spending in that policy area, but should be allocated to the greatest-value use across portfolios

- decisions have already been made that revenue from the announced carbon tax will be recycled through a package of changes to the business tax regime. If a different price-based measure were to be adopted in the future, it may be worthwhile reviewing current decisions on revenue recycling to ensure revenue use will minimise adverse economic impacts.

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Transition to a lower-carbon economy

Significant reductions in global emissions of greenhouse gases by the middle of this century would reduce the risk of dangerous climate change. For this to happen, the major emitters in the world would have to be well advanced by then on a transition to lower-carbon economies.

New Zealand's emissions are so small in global terms that its emissions will have no effect on the rate of global emissions reductions (or increases). A key question, therefore, becomes: How much emission reduction should New Zealand undertake, over what time and at what cost?

If the Government decided that New Zealand, too, should make a transition to a lower-carbon economy over a long term, one important requirement for achieving a relatively smooth, least-cost transition would be to engender widely-held expectations that there will be a price of carbon in the New Zealand economy. This is discussed further in Section 4.2.3.

4.2.2 Assessment of current carbon tax and NGAs

Summary
This section assesses the current carbon tax and NGA regime against the following criteria:

- environmental impact
- economic efficiency
- economic and social impact
- sustainability and flexibility
- feasibility.

It concludes:

- the emissions-mitigation impact of the regime appears to be modest due to the relatively narrow coverage of the carbon tax, the general inelasticity of energy use in the short term (coupled with the relatively low price impact at the announced tax rate), the high proportion of renewable energy in New Zealand's electricity supply (and hence the reduced impact of electricity conservation on emissions levels), and the limited exposure of NGA firms to an emissions price
- the 2005 ABARE general equilibrium modelling showed that a global emissions price of $NZ13 per tonne of CO_2e would reduce New Zealand's GDP by 0.04% in 2010. This represents the best available estimate of the macroeconomic impact of the announced carbon tax. This impact is considered moderate
- the carbon tax exemptions applied to the agricultural sector and NGA firms create unequal incentives across the economy to reduce emissions and are therefore a significant source of inefficiency. These firms will not face the same incentives to develop or invest in improved business practices and technologies to reduce emissions as those paying the tax. This will affect New Zealand's ability to achieve abatement in the medium and long term at lowest cost
- establishing a price-based measure that is sustainable over the medium term (10 to 20 years) brings a number of advantages including reinforcing the price signal sent by the measure, improving regulatory and investment certainty, and avoiding transition costs. Due to the limited anticipated emissions reductions and economic efficiency issues outlined, it is considered the carbon tax/NGA regime is unlikely to be sustainable over such a period.

The objective of the carbon tax is to encourage the reduction of greenhouse gas emissions in New Zealand at least cost, while assisting the New Zealand economy to prepare for a carbon-constrained future. The tax will increase the cost of emission-causing activities so that it better reflects the environmental costs they impose on society.[57] Ideally, a tax will apply a uniform incentive on all emitters across the economy, thereby using the market to encourage uptake of lowest-cost emissions-abatement opportunities.

NGA policy aims to protect the international competitiveness of New Zealand firms by exempting them from the carbon tax in exchange for requiring them to move towards world's best practice in emissions management.

This section will assess the current carbon tax/NGA regime against the following criteria:

- environmental impact
- economic efficiency
- economic and social impact
- sustainability and flexibility
- feasibility.

Environmental impact

New Zealand's climate change policies can have both a direct and indirect impact on global environmental outcomes. Direct impacts will be very small. As New Zealand's contribution to global emissions is 0.2%, the impact of any change to New Zealand's emissions on the global climate is insignificant. The substantive environmental benefits of New Zealand's climate change policies are more likely to relate to indirect effects, including encouraging other countries to take action to reduce emissions, creating knowledge on good policy design and demonstrating the feasibility of price-based measures. These "international influence" effects are very difficult to attribute.

Despite this, it is considered that emissions-reduction potential is the most appropriate measure of the environmental impact of New Zealand's carbon tax/NGA regime. Reducing emissions is a key objective of any carbon tax and international influence could be based on the level of domestic emissions abatement New Zealand achieves.

Expected emissions reductions from the carbon tax

Under announced policy, the tax will apply to New Zealand's carbon dioxide, methane and nitrous oxide emissions from:

- fossil fuel-based energy supply and use
- industrial process emissions
- fugitive energy emissions.

[57] An example of a Pigouvian tax.

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It will also include perfluorocarbons (PFCs) that result from industrial processes (excluding refrigerants). It will not apply to:

- methane or nitrous oxide emissions from agriculture
- synthetic gases (other than non-refrigerant PFCs) from process emissions
- methane from the waste sector.

Agricultural emissions make up approximately half of New Zealand's emissions profile (see Section 3.1). The latter two sources make up a very small proportion of New Zealand's total emissions.

Firms that are assessed as competitiveness-at-risk can gain an exemption or refund of the carbon tax via NGA policy. Many of New Zealand's high-energy-intensity firms have applied for an NGA, and further applications can be received on a continuous basis. It is estimated that up to 40% of emissions subject to the carbon tax will receive an exemption through NGAs (although these firms will still be faced with an incentive to manage emissions at world's-best-practice levels).

Excluding NGA firms and agricultural emissions, it is estimated that the carbon tax will apply to approximately 30% to 35% of New Zealand's total emissions profile. This restricted coverage has a significant impact on the ability of the tax to achieve emissions reductions.

The key emissions activities exposed to the tax (excluding those activities likely to receive exemptions) will be transport and electricity generation. Transport activities facing the tax include all fossil fuel-based land transport, domestic aviation and domestic shipping, and account for approximately 20% of New Zealand's total emissions. Transport demand is typically unresponsive to minor changes in price in the short term. The MED SADEM model (Supply and Demand Energy Model), which projects medium-term responses in New Zealand's energy market, uses demand elasticity factors[58] of -0.13 for petrol and -0.09 for diesel; ie, a 13% and 9% reduction in demand for a 100% increase in price.

International studies of transport demand responsiveness show similarly low elasticity factors: Bohi (1981) estimated a demand elasticity factor of -0.2 for petrol in the United States in the short run, but a long-run elasticity of -0.7. Greater long-term responsiveness arises from the ability to shift fuel types, change the overall vehicle stock, and improve fuel efficiencies through technology development.

A $15 per tonne of CO_2e carbon tax is estimated to increase the price of a litre of petrol by 3.5 cents and the price of a litre of diesel by 4 cents (IRD, 2005). These price movements are within the bounds of standard market fluctuations in the price of transport fuels. Given typically inelastic demand for transport fuels, and the low price impact expected, dramatic reductions in transport energy use (and consequently emissions) are not expected. A considerably higher price increase might achieve more significant emissions reductions, especially in the longer term, although economic impacts of substantially increasing the cost of transport fuels are likely to be severe.

[58] These elasticity factors are derived from historical observation of the relationship between price and demand movement in New Zealand. However, they only estimate the impact of marginal price changes around the current price. Demand elasticity may increase as the price increases, so larger changes in price may have a greater effect.

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Electricity generation accounts for approximately 8% of New Zealand's total emissions. Reduced electricity use does not translate proportionally into reduced thermal emissions, given that 60% to 75% of New Zealand's generation is based on renewable, non-emitting sources.[59] Assuming most large industrial electricity users negotiate NGAs, residential electricity users and small and medium businesses will be the main electricity users facing the carbon tax.

The impact of the tax on electricity prices is estimated to be modest at approximately 1 cent per kWh (IRD, 2005) compared with the current residential price of electricity of around 17 cents per kWh. Like transport, demand for electricity tends to be relatively inelastic. The SADEM model uses a price elasticity factor of -0.15 for residential energy use (90% of which is electricity) and an even lower elasticity for industrial and commercial energy use. Cross price elasticities of a shift from electricity to various alternative fuels in the industrial and commercial sector range between -0.1 and -0.42.

Bohi (1981) estimated a short-run demand elasticity of -0.2 and a long-run demand elasticity of -0.7 for electricity use in the United States. Again, the long run brings the opportunity to respond through purchasing decisions (such as buying more efficient appliances) and technology development. Given the low estimated impact of the carbon tax on electricity prices, however, resulting electricity demand reduction (on those sectors it applies to) is not expected to be significant.

The carbon tax will also affect decisions on the operation of and investment in generation, as it will make carbon-intensive forms of generation relatively more expensive. The SADEM model projects that a large amount of gas generation will displace coal generation (at Huntly Power Station) in the period to 2010 as a result of a $15 per tonne of CO_2e tax, although the impact will reduce after this date as gas from New Zealand fields becomes increasingly expensive. Modelling of impacts is discussed in more detail below.

Industrial processing accounts for approximately 5% of New Zealand's total emissions and consists principally of emissions from the manufacture of steel, aluminium, urea, cement, lime and hydrogen, as well as oil and gas extraction. Industrial-process emissions are within the scope of the tax, although it is anticipated that most major sources of industrial-process emissions will be covered by NGAs and will therefore receive rebates or exemptions. Under the NGAs, these firms will still face incentives to manage their emissions at world's-best-practice levels.

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[59] In the longer term, emissions savings from reduced electricity demand will be dependent on the marginal new generation; ie, the new generation plant that will be delayed as a result of less demand. MED modelling suggests this will be mainly renewable in the short term (up to 10 years out) and coal thereafter.

Expected emissions reductions from NGA policy

In exchange for full or partial relief from the carbon tax, NGAs require firms to achieve world's best practice in emissions management by 2012. The agreements require firms to pay (in cash or emission units) for excess emissions if world's-best-practice targets are not achieved, and the Crown to transfer emission units to firms if additional emissions reductions occur (an example of a baseline-credit approach). Most NGA emissions targets are based on emissions intensity,[60] however, so gross emissions from NGA firms may still increase without penalty if the business is expanding its output. The use of an emissions-intensity metric for NGAs therefore places no constraint on growth in industrial production, but reduces the emissions increase associated with such growth.

Emissions intensity targets contrast with New Zealand's Kyoto Protocol obligations, which are based on aggregate emissions. A number of NGA firms are expected to expand production in the period to 2012, which may make it more costly for New Zealand to meet its CP1 obligations.

NGA negotiations to date indicate improvements in emissions intensity achieved through compliance with the agreements will be in the order of 7% or less from 2004 to 2012. If NGA firms fail to make the intensity improvements required, they will be obliged to pay the carbon tax or transfer carbon credits[61] to cover the excess emissions. In incorporating the impact of NGAs in SADEM modelling, MED estimates that NGAs will result in NGA firms reducing emissions by between 2% and 4% from business-as-usual from 2008 onwards.

In some cases, NGA firms already operate close to world's best practice in emissions management, as their energy intensity gives them a strong business incentive to use energy efficiently. For the most energy-intensive industrial sectors, given the existing importance of minimising energy costs and the relatively slow rate of technology change, projections of world's-best-practice emissions intensity tend to reflect gradual improvement rather than dramatic step changes. NGA target pathways tend to mirror this expected trend of gradual improvement.

Information from early applicants suggests that a significant level of investment may still be required to bridge even a small gap between current performance and world's best practice. Emissions-reductions benefits of such investment would be expected to endure post-2012.

Experience during negotiations has indicated the NGA process may be of value in raising awareness of the importance of emissions mitigation and energy efficiency among senior management at many of New Zealand's biggest emitting firms. Over a number of years, this can catalyse a valuable "attitude change" among influential business people, although quantifying resulting emissions reductions is not possible.

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[60] Emissions intensity is measured by the number of tonnes of CO_2e emitted per unit of production or output.

[61] NGA firms have the option to purchase international carbon credits to meet their NGA obligations; however, overseas investments in carbon credits will not reduce New Zealand's domestic emissions in the longer term.

Quantitative projection of emissions reductions

MED's SADEM model[62] projects that a $15 per tonne of CO_2e carbon tax (with exemptions applied to steel and aluminium production and forestry processing) coupled with NGAs[63] will decrease business-as-usual emissions by:

- **0.92Mt CO_2e per annum** in the energy (non-transport) sector by 2020 (0.90Mt CO_2e resulting from the carbon tax and 0.02Mt CO_2e resulting from NGAs). This equates to a 4% reduction on business-as-usual energy (non-transport) emissions. Despite the carbon tax/NGA regime, overall emissions from this sector are still projected to grow by 17% between 2005 and 2020

- **0.14Mt CO_2e per annum** in the transport sector by 2020 (all resulting from the carbon tax). This equates to a 1% reduction on business-as-usual transport emissions. Despite the carbon tax/NGA regime, overall emissions from this sector are still projected to grow by 36% between 2005 and 2020

- **0.08Mt CO_2e per annum** in the industrial processes and fugitive emissions sectors (all resulting from NGAs). This equates to a 2% reduction on business-as-usual industrial process and fugitive emissions. Despite the carbon tax/NGA regime, overall emissions from this sector are still projected to grow by 7% between 2005 and 2020.

Assumptions of the SADEM model are set out below.

	2005	2010	2015	2020
GDP (billion 2004 $NZ)	149.1	171.5	190.7	210.8
Oil Price (2004 $US/bbl)	50.00	50.00	46.66	43.33
Coal Price (2004 $NZ/GJ)	3.75	3.75	3.75	3.75
Exchange Rate ($NZ/$US)	.690	.600	.600	.600
Gas Discoveries (PJ/Year)	60	60	60	60
Population (million)	4.08	4.22	4.35	4.48

The overall impact of the carbon tax/NGA regime is therefore projected to be a 1.14Mt CO_2e reduction on business-as-usual emissions by 2020. This equates to 2.48% of energy emissions and 1.25% of total New Zealand greenhouse gas emissions in 2020.[64] A 1.25% reduction on business-as-usual emissions is considered to be modest, particularly given the carbon tax/NGA regime is the centrepiece of New Zealand's climate change policy package.

The modest impact is likely to be a result of the coverage of the tax, the inelasticity of demand of covered sectors, and the high proportion of renewable energy in New Zealand's electricity supply (and hence the reduced impact of electricity conservation on emissions levels). The use of emissions-intensity targets is also considered to limit the exposure of NGA firms to an emissions price.

Short-term (through to the end of CP1) emissions savings resulting from the carbon tax/NGA regime are likely to be greater than medium-term (to 2020) savings. The carbon tax yields its greatest impact through changes to electricity generation. It is expected that

[62] The SADEM model has recently been audited as part of an overall review of New Zealand's emissions projections for CP1. The audit found the SADEM model gives a reasonable overall depiction of the specifics of the New Zealand energy sector and is an appropriate tool for projecting energy-related CO_2 emissions over CP1. However, a risk was noted that future emissions forecasts from the SADEM model may change where work is planned to more accurately capture the energy demand arising from the transport sector.

[63] Emissions reductions resulting from NGAs are based on independent assumptions that are then incorporated into the model.

[64] Based on projections of total emissions in the draft New Zealand 4th National Communication under the UNFCCC (2005).

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the tax will result in the displacement of coal generation with gas generation through to 2010. As New Zealand gas reserves are run down and the price of gas increases, this impact is expected to diminish.

Using the mid-point of 2010, the carbon tax/NGA regime is projected to achieve emissions reductions of 13.45Mt CO_2e across the five years of CP1. At an emission unit price of $NZ8.56 (as used to estimate New Zealand's potential CP1 liability in the Crown accounts), this reduction would save New Zealand purchasing an additional $115 million worth of units to meet its CP1 obligations.

A higher tax rate would be likely to encourage a greater level of emissions reductions, particularly if rate increases were signalled well in advance and over a reasonably long timeframe. However, an increase in the tax rate will be accompanied by a corresponding increase in economic and social costs, and ultimately, the ability of the tax to achieve emissions reductions in its current form is limited by its relatively narrow coverage (taking account of NGA exemptions).

There is some support for New Zealand's relatively low projected emissions reductions in international ex-post studies of the impact of carbon taxes. Bruvoll and Larsen (2002) examine the effect of carbon taxes introduced in Norway between 1991 and 1999. A range of tax rates were applied across different fuels and activities (including petrol, gas and coal), although several industries with relatively high emissions were exempt. Minus exemptions, the carbon taxes covered about 64% of total carbon dioxide emissions in Norway. The average rate applied was $US21 per tonne of CO_2 (approximately $NZ30 per tonne of CO_2). Despite the high rate, the estimated effect of carbon taxes on national carbon dioxide emissions was a reduction of 2.3% over this period. This relatively small effect was thought to relate to the extensive tax exemptions and relatively inelastic demand in the sectors where the tax was implemented.

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Conclusion

Overall emissions reductions from the carbon tax/NGA regime look to be modest, at a 1.25% decrease on business-as-usual emissions by 2020. The modest impact is considered to result from relatively narrow coverage, the general inelasticity of energy use in the short term (coupled with the relatively low price impact at the announced tax rate), the high proportion of renewable energy in New Zealand's electricity supply (and hence the reduced impact of electricity conservation on emissions levels), and the limited exposure of NGA firms to an emissions price.

The tax is projected to result in some significant displacement of coal with gas in electricity generation through to 2010, although this effect diminishes as the price of New Zealand gas increases. Estimated emissions reductions as a result of the carbon tax/NGA regime are 13.45Mt CO_2e over CP1.

Ultimately, the ability of the tax to achieve emissions reductions in its announced form is considered limited, as the tax applies only to around a third of total New Zealand emissions (taking account of NGA exemptions).

Economic efficiency

In the context of climate change policy, an efficient price-based measure would mean:

- emitters have an equal incentive to find and apply the lowest-cost methods for reducing their emissions[65]

- all emitters have the same incentives to use all potential methods of reducing emissions (The Treasury, 1997).

Essentially, an efficient price-based measure would incentivise the least-cost emissions-reduction opportunities across the whole economy.

Breadth of coverage

The characteristics of New Zealand's particular tax regime will have a significant impact on its overall efficiency. As an efficient tax would provide all emitters with an equal incentive to find and apply the lowest-cost emissions reductions, breadth of coverage is an important consideration. Granting exemptions to a tax often implies that some firms could decrease emissions at lower marginal cost than others, yet are not required to do so (Sin and Kerr, 2005).

International experience supports this view. A review of partial carbon tax exemptions currently applied to industrial energy users in Sweden, Denmark and Norway found that they have serious implications for the theoretical efficiency advantages of using carbon taxes to reduce carbon emissions, and may be expected to increase the overall macroeconomic cost at which reductions are achieved (Ekins and Barker, 2001). Pizer *et al* (2005) find that applying substantial exemptions (including to industry) to an economy-wide cap-and-trade programme in the United States may double the costs at which abatement is achieved.

Sin and Kerr (2005) agree that, in general, exemptions cause inefficiencies but note the exception is where firms operate purely in a competitive international market and are unable to absorb or pass on any extra costs. Imposing costs on them will result in production and emissions simply moving offshore, which is a wholly undesirable outcome from a national-benefit perspective.

In CP1, exempting businesses from the tax (thereby foregoing potential emissions reductions) will result in the Government purchasing more (or selling fewer) permits on the international market. The Government has to recover these expenses through general taxation, which causes distortions in the economy. Conversely, a broadly based tax could result in significant revenue recycling through tax cuts in other areas, which could give New Zealand firms competitive advantage over their international competitors (Sin and Kerr, 2005).

In recognition of the limited opportunities to reduce emissions in the agricultural sector, methane and nitrous oxide emissions from farming have been excluded from coverage of the carbon tax in New Zealand. Agricultural emitters therefore will not face the same incentive to reduce emissions as those subject to the tax.

In the short run, this may not have a substantial impact, as there are thought to be few opportunities for low-cost abatement of agricultural emissions[66] (see Section 4.7). But in the long run, the agricultural sector will be subject to a lesser incentive than those sectors

[65] From a global efficiency viewpoint, New Zealand should incentivise emissions reductions up to the international price of carbon.

[66] Firms do tend to underestimate their potential opportunities for abatement before they face a price, however. Getting people to identify and exploit these opportunities is one of the main reasons for using a price-based measure.

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facing the tax to invent, innovate and invest in emissions-reducing technologies[67]. Under the announced carbon tax, we therefore cannot be sure that the least-cost opportunities for abatement will be adopted in the medium and long-term. Given that the exemption applied to agriculture accounts for around half of New Zealand's total emissions, this is potentially a significant distortion and may increase the overall costs at which abatement is achieved.

Furthermore, firms that successfully negotiate an NGA will receive an exemption or rebate of the carbon tax. NGAs require firms to meet world's-best-practice targets in emissions management and provide incentives to achieve (and exceed) their target. However, as NGA incentives apply to marginal emissions around a world's-best-practice target (which is based on emissions intensity rather than total emissions) the incentive is not equivalent to that faced by non-exempt sectors.

As with agriculture, in the short term, this may not have a significant effect on emissions reduction if it is assumed that NGA firms have relatively few low-cost abatement opportunities available to them. However, NGA firms will not be faced with the same incentive to invest in emissions-reducing technologies and seek out new ways of reducing emissions, which will affect the ability of the regime to achieve abatement at lowest cost in the medium and long-term.

Ekins and Speck (1999) studied the use of negotiated agreements applied to tax-exempt firms in the manufacturing sector in various European countries and found that, while better than nothing, these agreements did not send the signal to consumers and producers of the need for fundamental restructuring that would result from price increases under a price-based measure.

NGA policy

By providing for applications for and negotiation of tax exemptions on an individual basis, NGA policy can create incentives for strategic behaviour and lobbying. This reduces overall productivity and can make it challenging for the Crown to establish appropriate emissions targets and relief levels for NGA firms. NGA policy aims to reduce this risk through a robust eligibility procedure and through recent changes to the NGA process that allow for emission target pathways to be set formulaically, using an independent world's best-practice study, rather than through negotiations. However, some degree of strategic behaviour is inevitable and will result in efficiency losses.

Sin and Kerr (2005) also note that, due to the transaction costs of negotiating agreements, small firms are less likely to receive NGAs. This is inequitable and may shift production from small firms without NGAs to large firms with them at no environmental gain.

Conclusion

The announced carbon tax creates unequal incentives across the economy to reduce emissions, due to the exclusion of agriculture and NGA firms (although NGA firms will still face an incentive on marginal emissions around their target pathway). While this is not likely to have a significant detrimental impact immediately, given the relatively few current opportunities for abatement in these sectors, it does affect the incentive faced by

[67] Sinn and Kerr (2005) argue that, in relation to New Zealand, most new "clean" technologies are developed overseas and adopted by domestic firms. Consequently, incentives to invest may generally be more important than invention and innovation. However, New Zealand does engage in research and innovation in niche sectors. In the agriculture sector, for example, New Zealand may be as well placed as any to develop emission-reducing technologies.

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agriculture and NGA firms to invest in capital and develop new and improved business practices to reduce emissions in the future. This is likely to impact on the cost at which emissions abatement is achieved in the medium and long term.

Economic and social impact

This section will assess:

- macroeconomic impacts of the carbon tax
- competitiveness benefits of NGA policy
- trade implications of NGA policy
- sectoral and social impacts of the carbon tax
- compliance and transaction costs of the carbon tax/NGA regime.

Macroeconomic Impacts

Macroeconomic impacts of an emissions price in New Zealand can be estimated using a general equilibrium model. The 2005 Australian Bureau of Agricultural and Resource Economics (ABARE) general equilibrium modelling (discussed in detail in Section 4.9) included a scenario where:

- a global emissions price of $NZ13 per tonne of CO_2e would be faced by all Annex I countries, excluding the United States and Australia
- the emissions price would be applied to all sectors excluding agriculture, both internationally and in New Zealand
- New Zealand would need to abate (or purchase emissions units for) 7.7Mt CO_2e per annum during CP1 to meet its emissions target.

This scenario presents the closest approximation to New Zealand's current circumstances, including the announced carbon tax, of the scenarios modelled by ABARE. While no exemption from the emissions price was applied to emissions-intensive New Zealand firms under the scenario (as is occurring under NGA policy), international competitiveness risks are mitigated by the broad application of an emissions price among developed countries. The scenario did not assume revenue recycling of carbon tax revenue, which, can assist in reducing adverse economic impacts.

The modelling projected that a global emissions price of $NZ13 per tonne of CO_2e would reduce New Zealand's GDP by 0.04% in 2010.[68] Based on 2010 GDP of $171.5 billion (in 2004 $NZ; as assumed by MED's SADEM model), this equates to an impact of $69 million per year. The GDP impact results primarily from changes in output and trade in various energy-intensive sectors.

Iron and steel (-4.4%) and primary aluminium production (-4.3%) were projected to experience the greatest **output** reductions. Iron and steel **exports** were projected to decrease by 9.6% and primary aluminium **exports** were projected to decrease by 4.3%.

68 This is in comparison to the ABARE reference scenario where no climate change policies are implemented internationally.

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The impact on agricultural production was very small, given the exemption applied to agricultural emissions.

There is a variety of limitations associated with general equilibrium modelling. These limitations are outlined in detail in Section 4.9. In particular, the model assumes that structural adjustment within the economy is costless and takes place in a steady manner. In reality, it is known that this is not the case. In terms of timing, a review of the ABARE model stated that a "new long-run equilibrium industry configuration could take 10 to 20 years to complete, with many downside adjustments occurring faster than many upside adjustments" (Grimes, 2002). Effectively, this means that the costs in 2010 may be greater than those outlined in the results presented. Modelling results therefore need to be interpreted with caution. Nevertheless, the macroeconomic impact derived by the model presents the best estimate available of the anticipated impact of the announced carbon tax.

In 2001, Hoerner and Bosquet (2001) reviewed ex-ante modelling undertaken in a number of European countries of the economic impacts of various types of carbon and energy taxes. Although the coverage and rates of these taxes vary, this collation of results presents a useful comparison with New Zealand's modelled GDP impact. Based on 44 studies containing 104 distinct simulations, the impacts of environmental tax reform on GDP were shown to range from -5.0% to +2.5%.

The projected macroeconomic impact of a $13 per tonne of CO_2e global emissions price of a 0.04% reduction in GDP appears moderate for an environmental tax, based on the review of European taxes. However, it should be noted that a large proportion of the European modelling studies made assumptions around recycling tax revenue, influencing the range of modelling results. Revenue recycling will reduce the adverse economic impacts (or increase the positive impacts) of an environmental tax on the economy.

Given the difficulties in examining the economy-wide impacts of a set of individually negotiated emissions-reduction agreements, no attempts have been made to assess the macroeconomic costs of NGA policy.

Fiscally, a carbon tax of $15 per tonne of CO_2e is expected to raise approximately $600 million (GST-inclusive) per annum (± $50 million), while approximately $240 million (GST-inclusive) per annum (± $50 million) will be needed to give firms with NGAs relief from the tax.

A separate assessment at the time carbon tax policy was finalised found that the Consumers Price Index is likely to increase when the tax comes into force, mainly through retail petrol and electricity prices (about 0.1 percentage points due to the petrol rise and 0.1 to 0.25 percentage points due to the electricity price rise).

Competitiveness benefits of NGA policy

As noted in Section 4.2.1, the imposition of a carbon tax could result in "emissions leakage" in cases where New Zealand firms compete against foreign firms that are subject to less stringent climate change measures. In the case of internationally traded commodities, if New Zealand were to constrain its industrial production to reduce domestic emissions, and this production was displaced to other countries with less-stringent climate policies, then global emissions would actually increase despite the apparent reduction in New Zealand's national emissions inventory.

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It is considered that a carbon tax of $15 per tonne of CO_2e presents a real risk of emissions leakage in New Zealand. NGA policy aims to address the issue of emissions leakage by providing competitiveness-at-risk firms with relief from the tax in exchange for meeting world's-best-practice targets in emissions management.

[withheld under OIA s6(a), s9(2)(d), s9(2)(j)] These firms represent a significant proportion of New Zealand's industrial sector.[69] Data are not currently available on the expected collective contribution of NGA firms to New Zealand's GDP during CP1.

Some competitiveness issues may still arise as a result of the requirement under NGAs for firms to move to world's best practice in emissions management by 2012 and the consequential effect this adjustment will have on marginal costs of production. However, these issues are not as severe as they would be if exemptions were not granted.

Under current NGA policy, the Government must conduct an initial net national benefit assessment of entering into an NGA as a pre-condition to each eligibility decision. This net national benefit assessment is revisited prior to signing the final NGA. The net national benefit assessment comprises objective and subjective elements. The objective element focuses primarily on the net cost to the Government of granting carbon tax relief versus the total economic contribution of the applicant. The objective element is then rebalanced by consideration of subjective factors such as regional and investment benefits versus economic efficiency distortions (POL Min (03) 8/8). Therefore, the Government must conclude that each NGA generates a net national benefit before entering into an agreement.

In the context of New Zealand's goals for economic growth (including increasing New Zealand's *per capita* GDP to the top half of the OECD), reduced economic production among NGA firms would be undesirable, especially where there is no associated environmental benefit. Provided international efforts to apply stringent emissions-reduction incentives remain fragmented, it would be in New Zealand's best interests for any application of a domestic price signal at a level that would threaten firms' international competitiveness to be accompanied by some form of relief for international competitiveness-at-risk firms.

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[withheld under OIA s6(a), s9(2)(j)]

[69] The industrial sector (excluding mining activities) produced approximately 25% of New Zealand's GDP in 1998 (EECA, 2000).

[withheld under OIA s6(a), s9(2)(j)]

Sectoral and social impacts

As exemptions will be applied to agriculture and most large industrial firms through NGA policy, the carbon tax will be predominantly borne by small and medium businesses and domestic energy users.

In a survey of SMEs undertaken by PricewaterhouseCoopers (2004), there was a moderate level of concern among firms about the impact of the carbon tax. Those who expressed the strongest concerns were firms for whom exports were a significant part of sales and those who competed against imports. Both groups were particularly concerned about competing with non-Kyoto countries such as Australia and the United States. Companies that almost exclusively supplied domestic markets were relatively unconcerned.

The majority of SMEs (over 90%) are small firms that are not energy intensive and for whom the effects of a carbon tax will be small. Most will absorb the additional cost or pass it on.[70] A minority of larger firms may be adversely affected by a carbon tax because they spend a significant proportion of their operating costs on energy, cannot easily pass on cost increases, face limited options for improved energy efficiency, and would require major capital investment to take up these options. Typically, these firms include foundries, chemical manufacturers, tyre makers, wood processors, food processors, metal coaters, fertiliser manufacturers, and glasshouse crop growers.

The impact of a carbon tax and the response of these larger firms will vary. Some are capable of immediate improvements in energy efficiency that could mitigate the effects of a carbon tax in the short term. Others are already energy efficient and face limited and often expensive alternatives in the short term, for example, switching to alternative fuels (eg, from coal to gas or biomass). For some energy-intensive firms, particularly those that compete in export markets or against foreign imports, impacts are therefore likely to be more significant.

The Government has developed policies to assist with adjustment to the carbon tax for energy-intensive businesses that lack the resources to go through an NGA process. Policy measures include grants to assist with energy-efficiency investments and support for demonstration projects in energy-intensive industries. Information on improving business energy efficiency to reduce the impact of the carbon tax is also available on the Ministry for the Environment's website.

For domestic energy users, the total effect on households is likely to be approximately $4 per week (IRD, 2005). The 4 cents per litre increase in the price of transport fuel and 1 cent per kWh increase in the price of residential electricity are within the bounds of standard market price movements for both these services and are not anticipated to have significant adverse effects.

Creedy and Sleeman (2004) found that the distributional effect of a carbon tax on households is somewhat ambiguous. Households with relatively low total expenditure were found to spend a proportionately greater amount of their income on carbon-intensive

[70] Detailed data on the specific impacts of the tax are difficult to obtain, but estimates provided by a consultant for the New Zealand Vegetable Growers Federation show that for a Franklin farmer growing arable crops, energy (diesel plus electricity) accounts for 6.3% of total operating costs, and a carbon tax (at $25 per tonne of CO_2e) would increase this by 0.7%.

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commodities such as petrol and domestic fuel and power. However, substantial price increases are also anticipated in several commodity groups on which households with relatively high total expenditure spend proportionately more. Therefore, for a majority of household types, a carbon tax proves to be neither strictly progressive nor regressive.[71]

Kerr (2001) assessed the likely distributional effects in New Zealand of a carbon tax on petrol. The costs of a petrol tax were thought to fall almost completely on consumers, as a result of New Zealand's relatively competitive market for petrol. Using Statistics New Zealand's Household Expenditure Survey, it was found that a petrol tax would have slightly regressive impacts but might affect middle-income people most. This was especially true when adjustments for household size were made. This result, while based on limited analysis, was thought to be consistent with more detailed international studies.

In general, most sectors facing the carbon tax will not be significantly adversely affected by it. Energy-intensive businesses that are not of sufficient size or are not sufficiently affected to negotiate an NGA, are likely to experience more significant impacts, although a set of policy measures has been adopted to ease the transition for these firms. The impact on households is projected to be low and will not vary significantly with income levels, although analysis of the distributional effects of a carbon tax on petrol indicates middle-income groups could be those most affected.

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[71] Portions of the low-income group most vulnerable to increases in prices will receive some degree of compensation, as benefits and superannuation are adjusted to the Consumers Price Index and Family Support will be indexed to increases in the Consumers Price Index from 2008.

Compliance and transaction costs

The carbon tax will impose some administration and compliance costs on firms. In designing implementation details of the tax, the Government has aimed to minimise these costs by applying the tax upstream in the supply chain (therefore reducing the number of firms facing these costs) and, where possible, administering the tax via existing systems such as those for collecting excise duty, GST and the Energy Resources Levy.

Firms liable to pay the tax directly and NGA firms will be required to file regular returns to Inland Revenue. Other firms claiming rebates of the tax will do so in relation to one or more tax periods but will not have to file regular returns. Return filing will generally be electronic. A minimum threshold of $2,000 worth of emissions a year, calculated as if the charge were being applied, is proposed for applying the carbon tax to any taxpayer. In general, it is considered that administration and compliance costs associated with the carbon tax will not be onerous.

The process of applying for and negotiating NGAs can be time consuming and complex, and stakeholders have reported that these transaction costs act as a barrier to entry for some firms. The process has also been costly for both the firm and the Crown – the cost to the Crown of negotiating individual NGAs has been between $100,000 and $200,000.

In early 2005, the NGA policy was reviewed and the process was modified to reduce the time and cost involved. Key changes included the use of an automated procedure to calculate a firm's emissions target pathway, rather than this being a matter for negotiation between the Crown and the firm; the development of a streamlined process to determine the "world's-best-practice" level of emissions intensity; and the increased use of standardised text for NGAs. Early indications are that the NGA review changes will considerably simplify and speed up the NGA process.

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Conclusion

It is anticipated that the macroeconomic effect of the carbon tax will be small but negative. The 2005 ABARE general equilibrium modelling projected the impact of a $NZ13 per tonne of CO_2e global emissions price on the New Zealand economy. The assumptions under this scenario present the closest approximation to New Zealand's current circumstances, including the announced carbon tax. However, due to limitations with equilibrium modelling, caution is warranted in interpreting the results.

The scenario projected that New Zealand's GDP would decrease by 0.04% in 2010[72] as the economy undergoes some restructuring. This equates to an impact of $69 million in 2010. The iron and steel and primary aluminium industries were projected to sustain the greatest sectoral impacts. Under the announced policy package, these sectors are likely to receive exemptions from the carbon tax under NGA policy.

A review of modelling exercises that assessed the impact of various energy and emissions taxes on European economies showed a range of anticipated economic impacts from -5.0% to +2.5% of GDP. In the context of this range, the impact of an emissions price on New Zealand as projected by ABARE appears moderate.

[72] This is in comparison to the ABARE reference scenario where no climate change policies are implemented internationally.

Under the current policy package, NGA policy plays an important role in protecting New Zealand's international competitiveness. At the announced carbon tax rate, there is a real threat of economic and emissions leakage from New Zealand if NGA firms are not exempt. In the interests of New Zealand's goals for economic growth, any domestic emissions price set at a rate, and in a context, that would threaten New Zealand's international competitiveness should be accompanied by some form of relief for competitiveness-at-risk firms.

Those sectors facing the carbon tax will not be significantly adversely affected by it. Energy-intensive businesses that are not of sufficient size or are not sufficiently affected to negotiate an NGA, are likely to experience more significant impacts, although a set of policy measures has been adopted to ease the transition for these firms. The impact on households is projected to be low and will not vary significantly with income levels, although analysis of the distributional effects of a carbon tax on petrol indicates middle-income groups could be those most affected.

Compliance costs from the carbon tax are not thought to be overly onerous. Transaction costs are faced by the Crown and the applicant firm under NGA policy, although these costs are reducing significantly as a result of recent changes to the negotiation process.

Sustainability and flexibility

Importance of sustainability

Establishing a price-based climate change measure that is sustainable over 10 to 20 years has a number of advantages:

- stability reinforces the signal sent by a price-based measure that emissions will be part of the economy in the future, and therefore may promote effectiveness of the instrument

- stability gives investment certainty to firms on the price measures they will be operating under (many firms are making investment decisions that will last for 20 to 30 years)

- it avoids the cost of transitioning between regimes; eg, the Government and firms spend time and resources assessing how one regime will work, only to repeat the process with a new regime.

The adopted measure should allow for adjustment to meet more stringent or less stringent New Zealand emissions targets that might eventuate under any future international framework. If intended as a basis from which to move to a different regime, a clear transition path should be set out to ensure this transition can and will occur.

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Sustainability of carbon tax/NGA regime

A number of factors impact on the sustainability of the current regime:

- policy decisions on the application and rate of the announced carbon tax and the existence of NGA policy extend only until 2012. Firms therefore face uncertainty in terms of the climate change policies they will be subject to in the medium term. Under uncertainty, firms will be less likely to make appropriate decisions in relation to their carbon intensity, impacting on the effectiveness of the tax. Some NGA firms have identified this as a significant concern, given the long-term nature of their capital investments

- furthermore, the Government has indicated that the carbon tax may not be its preferred long-term price mechanism. The Cabinet paper setting design details of the announced carbon tax notes that, in a situation with a well-functioning international permit market, an emissions trading regime would almost certainly be more efficient than a carbon tax. In announcing the carbon tax, the Government reserved the right to move to a trading regime should the circumstances make it appropriate

- under the current regime, agriculture and NGA firms are exempt from the carbon tax. While few near-term emissions-reduction opportunities may be available for these sectors, in the medium-to-long term (assuming the current policy remains), these sectors will have a lesser incentive to invest in new capital and develop new business processes or products that reduce greenhouse gas emissions than those sectors subject to the carbon tax. As a result, lowest-cost options to reduce emissions across the economy may not be adopted. It also creates equity issues, as small New Zealand businesses and households continue to pay for their emissions while large industrial users and agriculture firms continue to be exempt

- the current carbon tax/NGA regime would not have New Zealand well placed to significantly increase emissions reductions to meet specific quantified targets should this be required under a future international framework or as a result of more specific scientific information becoming available on the emissions reductions required to stabilise the climate. As the tax applies only to around a third of New Zealand emissions, a ramp-up of the rate would be unlikely to achieve significant emissions reductions unless it was to a level that would create significant costs on the sectors it covered.

A number of aspects of NGA policy make it unsuitable as an ongoing solution to international competitiveness issues, should they continue for a further 10 to 20 years:

- the NGA process to date has involved significant time and resource costs for both the Crown and applicant firms. Despite the fact that the process has been recently streamlined, repeating this process on a regular (say, five-yearly) basis for each individual firm (potentially in addition to receiving intermittent re-applications from firms found ineligible) would seem to be a high ongoing transaction cost. A continuation of the current carbon tax/NGA regime in the medium term could also see a general increase in NGA applications as smaller firms find the relief offered to be worth the transaction costs

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- renegotiating NGAs may lead to strategic behaviour and lobbying by NGA firms, which would inhibit investment and abatement in the meantime. For example, firms may elect to defer investment in more energy-efficient capital until after future target pathways have been negotiated (although this may be addressed through recent changes to the process for setting target pathways). Strategic behaviour and lobbying lead to losses in productivity

- NGA targets are currently based on emissions intensity. A number of NGA firms are expected to increase overall production through to 2012, allowing for an increase in their absolute level of emissions. This has ramifications in moving to a possible environment where New Zealand is required to achieve more stringent emissions reductions.

It is therefore considered the current regime is unlikely to be sustainable over a period of 10 to 20 years.

Flexibility of carbon tax/NGA regime as a basis for transitioning to an alternative regime

The suitability of the current regime as a basis for moving to emissions trading will be influenced by the characteristics and rules of the trading regime (which itself may depend on matters such as linking rules established by the European Union for the European Union Greenhouse Gas Emission Trading Scheme). Points of obligation for emissions trading could remain the same as for the carbon tax – firms would simply be required to remit emission permits to the Government rather than issuing payment. Provided the carbon tax was adjusted to follow the international price of carbon, the cost to emissions-inducing activities of a tax and an emissions trading scheme (linked to the international market) would be approximately equivalent.

In moving to a new regime, pressure may be applied by firms currently granted exemptions for continued relief (particularly while equivalent overseas firms do not face similar measures). Under a trading scheme, this would likely involve the "grandparenting" of emissions units to NGA firms, perhaps based on their level of production at that time. Given that the current tax is applied upstream but exemptions (in the form of NGAs) are applied downstream, the current regime would most likely lead to a similarly structured trading regime (ie, a "mixed" emissions trading regime rather than a "pure" regime).

In practice, once the carbon tax/NGA regime has been established in New Zealand (with the associated policy development, legislative and political processes, including the process of negotiating NGAs) it seems likely it will remain in place for some time, at least through CP1; ie, heavy transaction costs in designing and implementing the current regime may lead to some inertia. The fact that a transition path to a future regime is currently not well defined may further exacerbate this.

Conclusion

Establishing a price-based measure that is sustainable over the medium term brings a number of advantages including reinforcing the price signal sent by the measure, improving regulatory and investment certainty, and avoiding transition costs.

The announced carbon tax would not have New Zealand well placed to significantly increase emissions reductions should this be required in the future, due to the exemptions

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applied to the agriculture sector and NGA firms. Furthermore, the NGA process may create ongoing transaction costs for the Crown and for firms, and may lead to strategic gaming behaviour. The Review concludes that the carbon tax as announced, and the NGA policy, are unlikely to be sustainable over the medium term.

Feasibility

A carbon tax applied to upstream sources of emissions (mainly producers and importers), and excluding the agriculture sector, is thought to be manageable to administer. Many administration details have been worked through as part of the policy development process, including identification of government agencies responsible for administering the tax. A number of complex implementation issues exist:

- applying emission factors to different streams of gas
- taxing fugitive gas and coal seam gas emissions
- taxing geothermal energy emissions
- taxing domestic aviation fuel
- applying the tax to existing stockpiles of coal or gas.

Consultation with stakeholders on many of these issues has been carried out and practical solutions have been identified or are being developed. These issues are likely to be present for any price-based measure.

Initial negotiations of NGAs were time consuming and costly for both the Crown and the firm, although the streamlined process established following the NGA review will significantly cut down the time and resources required. Also, officials (and consultants) have developed their expertise at processing NGAs, which assists in running a quick and effective process. Overall, NGA policy does take time and resources to implement, although experience has shown that the process is certainly feasible and will probably only improve. If NGA policy were to be continued beyond 2012, greater feasibility issues may be encountered as a result of the ongoing negotiations required.

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Conclusion

The carbon tax would be manageable to administer. The NGA process can be long and costly but is feasible in the short term and appears to be improving. The NGA policy is unlikely to be sustainable over the medium term – say, beyond 2012.

Overall conclusion

Likely emissions mitigation as a result of the carbon tax/NGA regime would be modest, due to relatively narrow coverage, the general inelasticity of energy use in the short term (coupled with the relatively low price impact at the announced tax rate), the high proportion of renewable energy in New Zealand's electricity supply (and hence the reduced impact of electricity conservation on emissions levels), and the limited exposure of NGA firms to an emissions price.

MED's SADEM model projects that a $15 per tonne of CO_2e carbon tax, coupled with NGAs, will achieve a 1.14Mt CO_2e reduction in annual emissions from business-as-usual by 2020. This amounts to 1.25% of anticipated total New Zealand emissions at this time.

During CP1, a total reduction of 13.45Mt CO_2e is projected over five years. At a price of $NZ8.56 (as used to estimate New Zealand's potential CP1 liability in the Crown accounts) for emission units, this reduction would save New Zealand purchasing an additional $115 million worth of units to meet its CP1 obligations.[73]

It is anticipated that the macroeconomic effect of the carbon tax will be reasonably moderate. The 2005 ABARE general equilibrium modelling projected the impact of a $NZ13 per tonne of CO_2e global emissions price on the New Zealand economy. The assumptions under this scenario present the closest approximation to New Zealand's current circumstances, including the announced carbon tax. The scenario projected that New Zealand's GDP would decrease by 0.04% in 2010[74] as the economy undergoes some restructuring, an impact of $69 million. This impact is considered moderate for an environmental tax, although due to a range of limitations associated with equilibrium modelling, caution is warranted in interpreting the modelling results.[75]

The carbon tax exemptions applied to the agriculture sector and NGA firms create unequal incentives across the economy to reduce emissions and are therefore a significant source of inefficiency. While this is not likely to have a significant detrimental impact immediately (given the relatively few current opportunities for abatement in these sectors), it does affect the incentive faced by agriculture and NGA firms to develop and invest in new and improved business practices and technologies to reduce emissions in the future. This will affect New Zealand's ability to achieve abatement in the medium and long term at lowest cost.

Establishing a price-based measure that is sustainable over the medium term (10 to 20 years) brings a number of advantages including reinforcing the price signal sent by the measure, improving regulatory and investment certainty, and avoiding transition costs. Due to the limited anticipated emissions reductions and economic efficiency issues outlined above, the carbon tax/NGA regime is unlikely to be sustainable over such a period.

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4.2.3 Alternatives – a modified carbon tax

Summary
This section:

- describes two broad approaches to primary price-based measures that could be adopted as alternatives to the announced carbon tax
- describes four possible modified carbon taxes and assesses them against each other and the announced carbon tax.

There are two main alternative approaches to the current carbon tax/NGA policy:

[73] Assuming a price of $NZ8.56 and a net CP1 deficit of 36Mt CO_2e, New Zealand would still need to purchase $308 million worth of units, despite these additional reductions.

[74] This is in comparison to the ABARE reference scenario where no climate change policies are implemented internationally.

[75] In particular, a review of the ABARE model (Grimes, 2002) stated that a "new long-run equilibrium industry configuration could take 10 to 20 years to complete with many downside adjustments occurring faster than many upside adjustments". Effectively this means that the costs in 2010 may be greater than those outlined in the results presented.

1 change current policy settings to a policy package that, in the short term, does not require or expect significant slowing of the rate of growth of domestic emissions, but that best positions New Zealand to significantly reduce the rate of growth of, or reduce in absolute terms, domestic emissions over the long term without requiring further substantial policy change for, say, the next 10 years. This approach avoids commitments now that might be regretted later, but is sustainable; or

2 change current policy settings to some other "holding pattern" policy package that, in the short term, does not require or expect significant slowing of the rate of growth of domestic emissions. Then, at an appropriate time in the future when there is adequate information about international regimes and their implications for New Zealand and the cost of emissions reductions in New Zealand, develop appropriate domestic mitigation objectives and adopt a policy package consistent with these. This approach avoids commitments now that might be regretted later by adopting a policy that is explicitly temporary.

The key differences between the two approaches are:

- the sustainability of the initial policy settings
- short-term messages given to investors and consumers about what might occur over the longer term.

Sustainability

Sustainability has three main aspects:

- the impact of the policy settings on the Government's objectives for economic growth and social cohesion
- the need to adjust, and the ease or difficulty of adjusting, the policy settings in the future in response to new information about, eg, post-2012 international regimes and the cost of mitigating emissions in New Zealand or elsewhere
- the costs of administering and complying with the policy settings once they are in place, including the opportunities for lobbying or gaming behaviour by firms and the ongoing time and effort this would entail for Ministers, officials and the private sector.

Messages about the longer term

Messages about the longer term contribute to the formation of expectations about the longer term. Those expectations influence investment decisions made in the shorter term and the strategies of businesses, government and households for the medium and longer term.

The Government's commitment to slowing the rate of growth of, or reducing, domestic emissions is an important driver of decisions about whether to invest now in research aimed at reducing the emissions intensity of economic activity or the consumption of emissions-intensive goods and services. A lack of tangible commitment by the Government to such objectives is generally interpreted by both private and public sector research-investment managers as a signal that investment to find ways of reducing domestic emissions is not a high priority. One effect of the Government ratifying the

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Kyoto Protocol was that it provided a clear signal to research-investment managers that the Government was serious about greenhouse gas emissions, at least until 2012.

Similarly, decisions made in the short term about long-lived, emission-intensive investments will have an important effect on the level of New Zealand's emissions in the medium to longer term and on the cost of slowing the rate of growth of, or reducing, these emissions over the longer term. Such investments include power stations, transmission lines, roads and railway lines, airports, ports, houses and urban development.

The message regarding the medium and longer term that is given by the first modified carbon tax approach (and the announced carbon tax) is: "It is quite possible that New Zealand will want to use a carbon tax to help significantly slow the rate of growth of, or reduce in absolute terms, domestic emissions in the medium and longer term."

In contrast, the message given by the second approach is: "We do not know, and do not think it is appropriate to give any indications now, about whether New Zealand will want to use a carbon tax as part of the policy response designed to significantly slow the rate of growth of, or reduce in absolute terms, domestic emissions in the medium and longer term."

For each of the two approaches, the review considers two options. The four variants (three are a modified carbon tax and one is a defer option) are summarised in Table 12.

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Table 12 - Modified Carbon Taxes

Once implemented, the measure is likely to remain in place beyond the short term; the measure signals that there is likely to be a price on all domestic greenhouse gas emissions over the longer term	**The measure is short term, with the expectation that it will be reviewed within a few years; the measure does not signal that there is likely to be a price on all domestic greenhouse gas emissions over the longer term**
Option 1a low-level, broad-based tax A low-level, broad-based greenhouse gas tax that is implemented in the near future and gradually increased over time	**Option 2a** defer a decision on price-based measures Do not proceed with the announced carbon tax/NGA policy; give a commitment that there will be no decision on a primary price-based measure for at least five years (ie, until 2011); defer implementation of a primary price-based measure until at least 2013
Option 1b broad-based tax (world price), targeted recycling A greenhouse gas tax (approximating the international price) with no exemptions, implemented in the near future, with the revenue used for targeted government assistance (energy efficiency and structural adjustment in the economy)	**Option 2b** tax industrial emissions above world's best practice A tax on large final emitters of CO_2 where the intensity of their direct emissions exceeds world's best practice for the industry; the tax would apply only to emissions above world's-best-practice levels

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Assessment criteria

To assess each option, a number of criteria need to be considered. These criteria reflect the overall objective of significantly slowing the rate of growth of, or reducing in absolute terms, domestic emissions in the medium and longer term. These criteria are outlined below:

- a key criterion is **the effect on domestic emissions in the medium and longer term (ie, beyond CP1)**, as this is ultimately the measure of success or failure. The messages about long-term policy directions and settings are likely to form a key part of this effect. However, it is important to recognise that any carbon tax is only one of a number of complementary policy measures that will be needed to meet this overall objective

- **the effect on domestic emissions in CP1** is not a key criterion. New Zealand does not have to reduce its emissions to meet its Kyoto commitments – it can cover any excess of emissions over 1990 levels by purchasing emission units on the international market. None of the options for a modified carbon tax considered in this section will have a large effect on domestic emissions in CP1. Section 4.9 addresses alternative approaches to meeting our commitments in CP1

- the **economic impact** of the different carbon taxes includes their coverage, the initial direct price impact, the longer-term impact on the economy (including dynamic effects), the effect on international competitiveness, the level of regulatory certainty, the administrative and compliance costs, and the fiscal impact, including their consistency with good tax-policy design

- the **sustainability, flexibility and feasibility** of the different carbon taxes will be heavily driven by their degree of broad political acceptance. Other aspects of this assessment include the ease of changing the policy settings once they are in place, whether some change of settings is necessary (or likely) and the ease of transition to an emissions trading system.

The effect on domestic emissions

None of the options considered will result in a large reduction in domestic emissions in the short term. No option would produce much response in the transport sector – demand for transport fuels is unresponsive to small changes in price and even the announced carbon tax (or the world price of carbon) would have only a small effect on the price of fuels compared with factors such as the price of oil or exchange rates. The low-level, broad-based tax and the tax on industrial emissions above world's best-practice options are likely to have an effect broadly similar to that of the announced tax on the emissions of NGA firms in CP1; the impact of the broad-based (world price), targeted recycling option would depend on the nature of the targeted government assistance. It is unlikely that any option would include agriculture or forestry in the short term (for the reasons below), so again, the effect will be the same as for the announced carbon tax, which also does not include these sectors.

The low-level, broad-based tax (**Option 1a**) and the broad-based tax (international price) with targeted recycling (**Option 1b**) have the potential to significantly reduce, or slow the growth of, domestic emissions in the medium and longer term.

Option 2a (deferring the decision on a price-based measure) and **Option 2b** (taxing industrial emissions above world's best practice) will not significantly reduce (or slow) domestic emissions in the medium and longer term. However, if the Government chose one of these options now, it could replace that option in due course with a price-based measure designed to achieve significant reductions in domestic emissions. It is not clear whether such a delay would make it more costly to achieve a given reduction in emissions in the future.

Any quantitative estimate of the extent of emissions reductions over the long term would depend critically on the assumptions made about emission-reducing technological development and up-take. Such assumptions would be arbitrary. The best that can be said is that a credible, consistent and gradually increasing price signal would provide an incentive for emission-reducing technological development in New Zealand and for the up-take of emission-reducing technologies from New Zealand or overseas.

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Economic impact

Coverage

In general, a broad coverage is likely to be more efficient and effective in reducing greenhouse gas emissions, as it minimises the scope for substitution between emitting activities on the basis of their tax treatment. The credibility of the policy implemented – in particular, over time – will also be important, as the effect on long-lived investment decisions will be a key channel through which the different options will affect the level of emissions. The overall size of the options – the level of the tax and its coverage – will also influence their likely impact.

Initial price impact

The initial price impact (eg, the amount by which the tax would increase the cost of coal or gas or petrol) is an indication of the magnitude of the initial shock to the economy. Over time, this impact will change as businesses and households respond to the higher cost. The low-level, broad-based tax (**Option 1a**), the taxing of large industrial emissions above world's best practice (**Option 2b**) and the deferral of a decision on a primary price-based instrument (**Option 2a**) would all have very modest, or zero, direct price impacts. The initial price impacts of the broad-based (world price) tax with targeted recycling (**Option 1b**) would depend on the nature and level of the targeted assistance and who received it.

Long-term economic impact

In the longer term, economies are dynamic, with continual expansion and contraction of individual businesses and of economic sectors. This change is driven by the ability to create new goods and services, by access to new markets (or loss of access to old markets) and by changes in the mix of goods and services that consumers purchase, which in turn is driven by changes in preferences, relative prices and incomes. Because New Zealand has an open economy, much of our economic activity faces international competition.

The pricing of greenhouse gas emissions adds a new price to the economic environment. The nature, mix and level of economic activity (as well as the level of greenhouse gas emissions) within all countries that price greenhouse gas emissions will change as a result. Those countries that can produce particular goods and services with a lower greenhouse gas emission intensity will have a comparative advantage and will tend to expand their production of those goods and services.

The most important measure of the economic cost to New Zealand of policies to slow the growth of, or reduce, global emissions is the impact on GDP *per capita*. The problem with focusing on the impact on particular firms or particular sectors is that that tells only part of the story. To get an accurate overall picture, we need to know where the resources that are no longer being used for one particular type of activity have gone, what they are now being used for and what value that is adding to our economic welfare.

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However, the movement of resources between sectors can be costly. Adjustment that is forced to take place too fast has costs, such as increased unemployment and the scrapping of assets before the end of their economic life. Because such costs can constrain economic growth, it is important to assess the adjustment impacts and costs that would be associated with different rates of the greenhouse gas taxes over time.

Economic modelling of taxes on CO_2 was done in 2001 (Infometrics 2001) and 2003 (ABARE 2003).

In the work by Infometrics, three rates of tax were examined ($NZ2.73 per tonne of CO_2, $NZ8.19 per tonne of CO_2 and $NZ13.65 per tonne of CO_2), together with five different ways of recycling the revenue (repayment of debt and four tax-reduction options). In each case, there was no price on carbon in the rest of the world. This work did not include a tax on agricultural emissions of methane or nitrous oxide.

The macroeconomic results were that when the revenue was used to repay debt, the aggregate impact on GDP was small: of the order of -0.1% for the tax at $8.19 and $13.65 per tonne, and less than that for the tax at $2.73 per tonne. When the revenue from the tax was recycled through reductions in other taxes, GDP showed at least a small increase in every case.

At the sectoral level, the model contained 32 industry groups and gave changes in industry gross output ($m) for each. The results indicated that the tax represented a small shock to most industries, with changes well under ±1%. The eight industries with the largest changes are detailed in Table 13.

Table 13 – Sectoral Effects of a Tax (Percentage Change from Business-as-usual)

	$2.73/t CO_2	**$8.19/t CO_2**	**$13.65/t CO_2**
Gas and oil exploration and production	-0.26	-0.91	-1.64
Electricity distribution and transmission	-0.35	-1.07	-1.75
Aluminium and other metals	-0.43	-1.28	-2.10
Other mining	-0.51	-1.51	-2.44
Petroleum	-0.53	-1.59	-2.61
Electricity generation – fossil fuels	-0.87	-2.54	-4.09
Iron and steel	-1.48	-4.36	-7.07
Coal mining	-2.64	-7.00	-10.46

Source: Infometrics (2001)

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In the work by ABARE, it was assumed that New Zealand applied a carbon tax of $NZ15 per tonne of CO_2; the international price of carbon (determined by the model) was about $NZ20 per tonne of CO_2. As with the Infometrics work, this work did not include a tax on agricultural emissions of methane or nitrous oxide. The results were similar to those from Infometrics. GDP in 2010 was 0.03 percentage points lower than it otherwise would have been and sectors with a reduction in output of more than 1% were coal, gas, petroleum and coal products, electricity, iron and steel, and non-ferrous metals.

Comparable investigations of changes in agricultural output in response to a carbon tax do not appear to have been undertaken.

The possible constraints (stemming from a diversity of domestic policies in the countries that are New Zealand's competitors) on the initial level and the scope to increase any carbon tax raise issues about its efficiency over time (dynamic efficiency). These issues are particularly important in relation to decisions on long-lived assets such as houses, other buildings, power stations, transmission lines and transport infrastructure.

Power stations typically have an economic life of at least 30 years and often longer; houses and transport infrastructure such as roads, railways, ports and airports typically have an economic life of closer to 100 years. Decisions made about these assets in the short and medium term will have a major influence on New Zealand's greenhouse gas emissions for many decades to come.

As New Zealand's emissions are such a small part of global emissions, the emissions intensity of our assets will not actually make any difference to whether greenhouse gas emissions are still a serious global problem in the long term. However, at any point in time, the emissions intensity of our assets affects the level of domestic emissions and the cost of reducing those emissions by any given amount.

Learning by experience

It is likely that international carbon markets will continue to develop and that it would be desirable for New Zealand firms to learn about these markets by participating in them. None of the four options would provide incentives and opportunities for New Zealand firms to gain valuable experience in these markets. However, by improving the economics of some projects and having them implemented earlier than would otherwise be the case, **Option 1b** (broad-based (world price) tax, targeted recycling) in particular, but also **Options 1a and 2b**, have the potential to enhance learning by experience with technology that is not well-established in New Zealand.

International competitiveness

Overall, as Section 2 of the review has shown, different countries are taking a variety of responses to the challenges of climate change. Firms in many countries do not currently (and are unlikely to) face greenhouse gas taxes on their emissions. This potentially puts New Zealand firms at a disadvantage as a result of any greenhouse gas tax introduced here. However, these international competitiveness issues should not be overstated, as there are many factors that affect competitiveness and the balance of international trade in different goods and services. The overall level and design of taxation is only one of these factors, and the effects of greenhouse gas taxes within this will typically be small.

It is very unlikely that the great majority of New Zealand's agricultural competitors will face a price on their agricultural emissions within the next decade or two. There are proposals

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internationally to develop global agreements for industrial sectors that are large emitters of CO_2 and that would involve both developed and developing countries. Sectors proposed include cement, steel, electricity and pulp and paper. But even if these agreements eventuated and removed the international competitiveness issue for these industries in New Zealand, there are several other industries in New Zealand (apart from agriculture) for which international competitiveness might still be an issue (eg, wood processing, food processing, basic metals, non-metallic industries, paper and paper products, tourism transport, glasshouse crops, fishing, irrigated dairying and irrigated arable crops).

For these reasons, the nature of the post-2012 regimes that emerge internationally, together with the Government's desire to achieve its economic and social objectives, may constrain the longer-term settings and likelihood of reform of any of the four options (all of which are designed to address international competitiveness issues in at least the short term). Whether, or when, such a constraint might bite would depend on the level of the carbon tax, how long it had been in effect and what degree of adjustment had already taken place in these industries.

Another perspective on the effect of any carbon tax is that some New Zealand export industries may be able to use the tax as a point of differentiation in their marketing.

Regulatory certainty

In general, higher levels of regulatory uncertainty are more likely to be damaging to investment (and hence economic growth) than are lower levels of regulatory uncertainty.

With any carbon tax, there would be lobbying activities by firms around international competitiveness issues. If, as is expected, many of the foreign competitors of New Zealand firms will not face equivalent costs of greenhouse gas emissions for many years, this lobbying would be expected to increase as the level of the tax was increased.

Compliance, administration and lobbying costs

In general, it is desirable to minimise the compliance and administration costs associated with any tax. The design of the announced carbon tax has shown that compliance and administration costs for a tax that is imposed early in the supply chain are small. Moving the point of obligation downstream (eg, to provide for an easier transition to emissions trading) is expected to result in a modest increase in compliance and administration costs.

Options 1b (broad-based (world price) tax, targeted recycling) and **2b** (tax on industrial emissions above world's best practice) are expected to involve higher compliance and administrative costs than the other two options.

There are also costs to government and business around lobbying to influence any change in the regime. These costs are likely to be higher if the policy adopted is unpopular, lacks widespread support and/or anticipates further changes in treatment over time (eg, further policy reforms, and/or changes in rates). Good design would also minimise the scope for gaming behaviour by firms to exploit the regime.

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Fiscal impact

The fiscal impact includes the net revenue raised by the different options, which could, in theory, be used to reduce the costs of other taxes so that revenue overall is raised at a lower cost. In this respect, there are benefits from not returning a significant element of the tax collected as rebates. The announced carbon tax is expected to give $360 million per year net revenue, **Option 1a** (low-level, broad-based tax) is expected to give about $225 million (inc GST) per year in the short term but approximately double that if coverage is extended to agriculture, **Option 1b** (broad-based (world price) tax, targeted recycling) about $600 million (inc GST) if its coverage excludes both agriculture and forestry, **Option 2b** (tax industrial emissions above world's best practice) is expected to provide very little revenue (less than $10 million per year) and **Option 2a** (defer decision on price-based measure), no revenue.

Options 1a and **1b** would contribute significantly to a move to greater reliance in the tax system on taxing "bads", should this be an objective of the Government.

Another factor to consider is the general principles of good tax-policy design, and the way the carbon tax options relate to the wider approach to tax policy. The aim is to raise the required amount of revenue at the lowest cost. In New Zealand, this is achieved with a broad-based tax regime with few exemptions or concessions, and with much the same relatively low tax rates applying across different activities.

Sustainability and flexibility

Impact on achieving economic and social objectives

It will be important to minimise any adverse impact of the carbon taxes on the Government's objectives for economic growth and social cohesion.

In general, the impact on domestic emissions and on domestic economic and social objectives could be managed through the rate of the tax (and the breadth of its coverage). The low-level, broad-based tax (**Option 1a**) is designed to ensure a low impact on these objectives in the short term. However, the flexibility of the tax to achieve a particular outcome for domestic emissions may be constrained by the nature of the international regimes that emerge. As long as there are major foreign competitors who do not face an equivalent cost of greenhouse gas emissions, there is the possibility that the Government would find it difficult to reach a high rate for the tax (say, the world price of carbon) because to do so would create unacceptable international competitiveness issues for some New Zealand firms, and/or have unacceptable adverse affects on economic growth or social cohesion.

The tax on large industrial emissions above world's best practice (**Option 2b**) is designed to have minimal effect on the Government's objectives for economic growth and social cohesion. The major effect of this option and the "defer decision on a price-based measure" (**Option 2a**) on the Government's economic and social objectives is expected to be from deterred or delayed investment.

The issue is different, and the risk greater, for **Option 1b** (broad-based (world price) tax, targeted recycling), which starts with a high rate for the tax. Its impact on economic growth or social cohesion would depend critically on the nature of the targeted assistance measures.

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Need to, and ease of, changing policy settings

Once a primary price-based measure has been implemented, it would be a major undertaking, involving significant legislative change, for the Government to change to another primary price-based measure.

For all four options, it may be desirable in the medium term to change to emissions trading. There is a higher probability with **Option 2a** (defer decision on price-based measure) and **Option 2b** (tax industrial emissions above world's best practice) than with the other two options that they would become unsustainable and require significant change before conditions were favourable for a change to emissions trading.

Transition to emissions trading

Potentially, there are three main issues around the transition from a tax to an emissions trading regime: points of obligation, discontinuities in the price of marginal carbon emissions and the allocation of permits.

There appears to be no reason why entities that were a point of obligation for the tax could not also be the points of obligation for an emissions trading regime. Indeed, if it were judged that a transition to emissions trading was a possibility within, say, the next 10 years, it would be desirable when designing the tax to decide what the best points of obligation for emissions trading would be and then make those entities the points of obligation for the tax. For greenhouse gas emissions from energy, this approach might lead to more points of obligation than is proposed with the announced carbon tax (eg, adding large end users of gas, coal and petroleum products, namely electricity generators and some industrials). **Option 2b** (tax industrial emissions above world's best practice) is not consistent with setting points of obligation for the tax according to likely points of obligation in an emissions trading scheme.

If, at the time of the change to emissions trading, the level of the tax were close to the international price of carbon, the change could be made relatively simply by replacing the obligation to pay the tax with the obligation to surrender an emission permit. However, if the level of the tax were significantly below the price in the international market, it would raise other issues, because moving to an emissions trading regime would mean that the price of greenhouse gas emissions in New Zealand would move towards the international price. Options to address this would include increasing the level of the tax in the run up to the change so that it was close to the international price at the time of the change, or giving free permits to at-risk firms.

Feasibility

Further work would need to be done on how best to apply any greenhouse gas tax in the near future to agricultural emissions of nitrous oxide. Application of the tax to agricultural emissions of methane, and an extension of any tax to include forestry, would not be practical in the near future.

If a transition to a lower carbon economy in the longer term is likely, it is possible that the transition can be achieved at lower cost if it is started earlier (say, 2007 rather than 2012) and is undertaken more gradually. In this case, the benefits of introducing some carbon tax quickly, rather than maintaining a "holding pattern" for any length of time, may be significant. On the other hand, if a transition to a lower carbon economy in the longer term

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is unlikely, or if the costs of delay by New Zealand are small, there may be benefits (or only small costs) from maintaining a holding pattern for a number of years.

One source of significant costs may be long-lived, emission-intensive investments on which decisions to proceed are made while any "holding pattern" tax is in place and there is no guidance for decision-makers about the likely future value of carbon emissions in New Zealand. The emissions associated with such investments are likely to contribute to New Zealand's emissions for many decades and will constrain the extent to which (or the cost at which) New Zealand would be able to reduce its emissions in the medium and longer term.

Conclusion

A credible, consistent price signal is expected to result in significant reductions in domestic emissions in the longer term, say 2020 and beyond, principally through the implementation of new ways of reducing the emissions intensity of production and consumption. Such a tax would have negligible effect on domestic emissions in the short term and only a modest effect in the medium term. Any quantitative estimate of the extent of emissions reductions over the long term would depend critically on the assumptions made about emission-reducing technological development and up-take. Such assumptions would require further work before they could be made with any confidence.

The assessment of the different options is set out in the rest of this section. Table 14 summarises the results of this assessment for the longer term.

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Table 14 – Summary Assessment of Carbon Tax Options (longer term effects)

Schematic Comparison of Carbon Tax Models against Assessment Criteria

KEY

✓ Positive impact on emission reduction goal, or growth, or sustainability
X Negative or negligible impact
? Unknown impact

	Effect on domestic emissions in CP1	Effect on domestic emissions beyond CP1	Impacts on medium term economic growth	Sustainability, flexibility and feasibility
Announced carbon tax	**✓ 13 Mt reduction**	**? Depends on whether policy survives "overheads" of negotiating NGAs**	**X Negligible**	**X Large overheads of NGAs means sustainability questionable**
Option 1a: low-level broad-based tax, rising over time	**X Negligible in CP1**	**✓✓✓ (With agriculture in.) ✓✓ (With agriculture out.) Potentially substantial to 2020 (*Depends on the level to which the tax can be raised)***	**?**	**✓✓ Provided community buy-in**
Option 1b: broad-based tax at world price, targeted recycling	**✓✓**	**? Depends on the nature of the targeted assistance**	**?**	**? This option would face major sustainability barriers – fiscal pressures**
Option 2a: defer decision on primary price based measure	**X**	**X**	**X This option would create substantial regulatory uncertainty.**	**X Unlikely to be sustainable to 2020**
Option 2b: tax on large industrial emitters that do not meet world best practice emissions intensity	**X Negligible emission reductions**	**X**	**X This option would create substantial regulatory uncertainty**	**X Unlikely to be sustainable to 2020**

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Coverage of any carbon tax – agriculture and forestry

Agriculture

About 80% of agricultural emissions of methane and nitrous oxide are either directly emitted by the belching of ruminant animals – cattle, deer and sheep – or come from the excreta of these animals. Different types of ruminant livestock emit different levels of greenhouse gases (ranging on average from about 2.5t CO_2e per year for a dairy cow to 0.3t CO_2e per year for sheep) and within each type, different animals have different emission levels depending on factors such as their age, size, genetics, and feed.

If any carbon tax were simply applied at a standard rate for each type of animal, it would create incentives for farmers to change their stocking levels and the mix of their livestock in order to reduce the tax paid but would not create incentives to investigate, or apply, other methods of reducing emissions (animal breeding, vaccines, feeding regimes, etc).

More sophisticated but low-cost, on-farm measurement and monitoring is needed if a carbon tax is to be applied to emissions from ruminant animals.

Use of nitrogenous fertiliser releases nitrous oxide to the atmosphere: each tonne of nitrogen in nitrogenous fertiliser ends up as 6.8 tonnes of CO_2e in the atmosphere. This suggests that one small first step to including agricultural emissions within the scope of the tax could be to tax these emissions from nitrogenous fertiliser. The point of obligation for the tax could perhaps be the manufacturers and importers of the fertiliser. Nitrate loads in ground water and lakes are a serious problem associated with pastoral farming in several parts of New Zealand. A greenhouse gas tax that reduced the use of nitrogenous fertilisers would also have water-quality benefits.

At farm level, average, annual per animal emissions of methane and nitrous oxide (from excreta) are 2.5t CO_2e for a dairy cow, 1.7t CO_2e for beef cattle, 0.7t CO_2e for deer and 0.3t CO_2e for sheep (Ministry for the Environment 2005b). On this basis, a tax of $5 per tonne of CO_2e would be equivalent to $12.50 a head per year for dairy cows, $8.50 for beef cattle, $3.50 for deer and $1.50 for sheep.

Each tonne of nitrogen applied in the form of fertilisers produces, on average, about 6.8 tonnes of CO_2-equivalent nitrous oxide emissions. At a cost of $5 per tonne of CO_2e, this would increase the average price of urea fertiliser (which is the main fertiliser used in the dairy sector) by about 3%. The proportional price increase would be less for other fertilisers such as ammonia sulphate or diammonium phosphate.

Sin *et al* (2005) have estimated total agricultural emissions per hectare of methane and nitrous oxide for dairy farming and for sheep/beef farming: 7.6 tonnes per hectare per year and 3 tonnes per hectare per year respectively. For a tax of $5 per tonne of CO_2e, the increased costs would be $38 per hectare per year and $15 per hectare per year respectively.

These issues are discussed in more detail in Section 4.7 on agriculture.

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Forestry

Forestry has an important role in our climate change policies, as planting forests absorbs carbon, while felling forests releases carbon. In theory, a carbon tax that included tax rebates to forest owners while the forest is growing and carbon liabilities on the felling of forests could be more efficient than a carbon tax that excluded forestry.

However, if tax rebates were given to forest owners who had already planted their forests, they would be rewarded for decisions made some time ago. In these cases, the payment would simply be a deadweight expenditure. In addition, such a tax potentially introduces a liability on the deforestation of non-Kyoto forests, which raises distributional and equity issues. A simple carbon tax would not create incentives to investigate, or apply, other methods of reducing emissions within the forestry process (eg, the types of trees developed and planted, growing regimes, etc). Finally, there are fiscal risks to the Crown, as forest owners may not be in a position to pay the large carbon tax liabilities on felling. These expected liabilities may also distort the behaviour of forest owners.

Overall, it is unclear that the exclusion of forestry would reduce the impact or economic efficiency of any greenhouse gas tax. It is likely that a more sophisticated policy response will be needed to secure real climate change benefits from the forestry sector.

Option 1a: A broad-based tax on greenhouse gas emissions that starts at a low level and is gradually increased over time

Specification

The tax would apply to CO_2 and CH_4 from fossil energy sources and process emissions from the industrial sector, and ideally, eventually to CH_4 and N_2O emissions from the agriculture sector and to CH_4 from the waste sector as well.

It would be introduced at a level at which the effect on New Zealand's objectives for economic growth and social cohesion was minimal, possibly around $5 per tonne of CO_2e. It would be increased over time, say at the rate of $2 every two years, to a level judged to be appropriate to achieve whatever medium- and long-term emissions reductions New Zealand commits to in the future or to the level of the relevant international price of carbon. The level of the tax would never exceed the international price of carbon. Using this example, a tax of $5 per tonne of CO_2e introduced in 2007 would increase to $11 per tonne in 2013 and $19 per tonne in 2021 (provided the relevant international price in 2021 is greater than $NZ19 per tonne).

For emissions from the use of fossil fuels, the points of obligation for the tax could be the same as those for the announced carbon tax (generally, as early in the supply chain as possible). Alternatively, the points of obligation could be fixed by considering what the best points of obligation for an emissions trading regime would be and making the points of obligation for the tax the same as the optimal points of obligation for emissions trading.

If a low-level, broad-based tax were largely removed from the political arena (eg, if sufficient cross-party political support could be secured for it), the Government would be able to use the tax to indicate a forward price path for carbon in the New Zealand economy for perhaps up to 10 years ahead. If the Government's adherence to such a price path was considered credible, it would provide considerable stability, consistency and certainty for those making decisions about investment in New Zealand. For example,

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the Government could regularly specify (say, every five years) what the level of the tax would be for each year for some future period (say, 10 years). The future increases could be specified in legislation. This would assist the formation of stable and consistent expectations about the future price of greenhouse gases in the New Zealand economy.

While there would be advantages if increases in a low-level, broad-based tax could be credibly signalled in advance, the assessment of this option does not assume that that would necessarily be possible in practice.

Effect on domestic emissions

A credible, consistent and gradually increasing price signal is expected to contribute to significant reductions in domestic emissions in the longer term, say 2020 and beyond, principally through the development and uptake of emission-reducing technology. The tax is expected to have negligible effect on domestic emissions in the short term and probably only a modest effect in the medium term.

At $5 per tonne, this tax would increase energy users' costs by about $200 million per year (and pastoral farming emitters' costs by about the same amount when/if its scope was extended to them). The full effects of this measure will be driven primarily by the expected profile and coverage of the tax over time, when/whether the rate reached the world price of carbon, and the credibility of this profile and coverage.

Economic impact

Coverage

A low-level, broad-based carbon tax is expected to be economically efficient (in the sense that emitters would have an equal incentive to find and apply the lowest-cost methods for reducing their emissions), especially if the intention to apply the tax to agricultural emissions is credible and eventually becomes reality. The number of emitters facing the incentive would be greater than with the announced carbon tax, the "defer a decision on price-based measures" option or the "industrial emissions above world's best practice" option, but similar to the broad-based, targeted recycling option.

Initial direct price impact

At the level of businesses and households, a tax of $5 per tonne of CO_2e would lead to price increases (including GST) of about $7 a tonne for sub-bituminous coal, about 20c a GJ for reticulated gas, and about 1 cent a litre for diesel and petrol. The increase in electricity prices is not straightforward to estimate but, based on an extrapolation of modelling of the electricity market done for a $15 per tonne tax, would be likely to be below 0.2 cents a kWh.

Longer-term economic impact

The longer-term impacts depend on the anticipated path of the level of the tax and the extent to which it is perceived to be credible. If the tax can be increased over time towards the world price of carbon and there is widespread support for it and these increases in its level, it is likely to have a growing impact on investment decisions over time. Modelling (Infometrics 2001) suggests that the longer-term impact on GDP of carbon taxes in the $3 to $13 range would be small (this work did not include a tax on agricultural emissions).

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Learning by experience

It is likely that international carbon markets will continue to develop and that it would be desirable for New Zealand firms to learn about these markets by participating in them. This tax would not provide incentives and opportunities for New Zealand firms to gain experience in these markets. It would, however, improve the economics of some emission-reducing projects and may provide some opportunities for learning by doing with respect to technologies that are not well-established in New Zealand.

International competitiveness

A tax of $5 per tonne of CO_2e would pose a serious risk to the international competitiveness of very few, if any, New Zealand businesses. The low-level, broad-based tax option allows the Government to manage the risk posed by the tax to the international competitiveness of New Zealand businesses by managing the level of the tax and its rate of increase.

Regulatory certainty

To the extent that the long-term profile for the level of the tax is credible, a low-level, broad-based tax would provide more certainty that all greenhouse gas emissions in New Zealand are likely to be of continuing concern to the Government than would the "defer a decision on price-based measures" option, the "tax on industrial emissions above world's best practice" option or the announced carbon tax/NGA policy. It would provide much the same level of certainty on this as the broad-based tax, targeted recycling option.

To the extent that it is credible, this option provides more certainty about how firms within the same industry will be treated in the short term, and are likely to be treated in the longer term, than does the announced carbon tax/NGA policy or the three other modified tax options considered by the review.

To the extent it is credible, this option also provides more certainty about both the form and price level of the primary price-based policy instrument that is likely to be used over the medium term than does the announced carbon tax/NGA policy or the three other modified tax options considered by the review.

However, if the Government seeks to manage the risk posed by the tax to the international competitiveness of New Zealand businesses by managing the level of the tax and its rate of increase (as above), then this certainty will be reduced.

Compliance, administration and lobbying costs

The design of the announced carbon tax has shown that compliance and administration costs for a tax that is imposed early in the supply chain are small. Moving the point of obligation downstream (eg, to provide for an easier transition to emissions trading) is expected to result in a modest increase in compliance and administration costs.

A low-level, broad-based tax provides little opportunity for gaming behaviour by firms.

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Fiscal impact

Based on the draft New Zealand fourth national communication under the UNFCCC projection of gross emissions of 81Mt in 2010 and a tax of $5 per tonne, annual gross revenue would be about $225 million (inc GST) if applied to all emissions other than agricultural emissions and $450 million (inc GST) if also applied to agricultural emissions. The former is about 60 percent of the net revenue from the announced carbon tax.

As the effect on domestic emissions during CP1 is expected to be broadly similar to the effect of the announced carbon tax, the low-level, broad-based tax option is not expected to significantly change the fiscal cost of meeting our CP1 obligations under the Kyoto Protocol.

This tax is compatible with good tax-policy design, as it is applied widely at a common rate, with few exclusions.

Sustainability and flexibility

Impact on achieving economic and social objectives

A tax that started at a low level and gradually increased over time would minimise any adverse impact on the Government's objectives for economic growth and social cohesion, especially if the changes in the rate of the tax had been signalled well in advance.

Need to change, and ease of changing, policy settings

A low-level, broad-based tax would minimise the need for significant policy change, as there would be few circumstances in which new information (eg, about post-2012 international regimes or the cost of mitigating emissions in New Zealand or elsewhere) would make it desirable to replace the tax with some other policy instrument.

One circumstance in which a change from the tax might be considered is if New Zealand was in the position of having binding emission targets for some period beyond CP1 and there was a well-functioning international carbon market. This would raise the question of whether the tax should be replaced by an emissions trading regime. Such a change would involve significant legislative change and is discussed further below.

As long as there are major foreign competitors who do not face an equivalent cost of greenhouse gas emissions, there is the possibility the Government would not persist with a gradual increase in the tax because to do so would create unacceptable international competitiveness issues for some New Zealand firms and/or have unacceptable adverse affects on economic growth.

Transition to emissions trading

If the point of obligation remains early in the supply chain, there would be some costs in moving this point of obligation downstream to fit with any emissions trading regime. To the extent this broad-based greenhouse tax is close to the world price of carbon, the adjustment costs are likely to be small. To the extent this broad-based greenhouse gas tax is substantially below the world price of carbon – which is likely at least in its initial years of operation – the adjustment costs involved in the transition to emissions trading will be higher.

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Feasibility

Applying the tax to emissions from energy and the industrial sector would not present any problems that have not been addressed in the course of the work on implementing the announced carbon tax.

Further work would need to be done on how best to apply the tax in the near future to agricultural emissions of nitrous oxide. Application of the tax to agricultural emissions of methane in a way that incentivised efficiency improvements (as well as stocking and land-use changes) would not be practical in the near future.

Conclusion

A main strength of this option is that, by starting at a low rate, it may be less politically contentious and hence more credible as a long-term policy setting. This option has a broad coverage with few exclusions, which is likely to be more efficient (and effective) than the alternatives.

Assuming this option is widely accepted, there is a good chance that change to another primary price-based measure would not be required for at least 10 years, irrespective of what post-2012 regimes emerge and what New Zealand decides to do about domestic emissions. It is possible that the tax could be increased gradually over time towards the rate that would give the appropriate level of reductions in domestic emissions while minimising the unacceptable impacts on domestic economic and social objectives (and international competitiveness concerns). However, increasing the tax may still be difficult even if the tax itself has broad acceptance, and there is likely to be pressure to hold the tax at a low level.

If New Zealand has binding emission targets for some period beyond CP1 and there is a well-functioning international carbon market, a transition to emissions trading may be desirable and would be feasible provided the international price was not so high that it was incompatible with achieving New Zealand's economic and social objectives. Such a transition would require legislative changes. The adjustment cost of the change would be reduced if the tax had been designed with a transition to emissions trading in mind, though this is likely to increase the compliance and administrative costs of this option.

If it is credible, a low-level, broad-based tax would provide greater regulatory certainty than any of the other options considered. If sufficient cross-party political support were secured for this option, it would enable the Government to provide even greater stability and certainty for investors by signalling a credible forward price path for carbon in the New Zealand economy. However, if this broad support were not available, then many of this option's advantages disappear, and this option would face many of the same costs as the other options.

In addition, this option has two particular risks associated with it.

One is the risk that because the tax would have only a minimal effect on behaviour and investment decisions in the short term, it would be seen as pointless and silly. This risk can be managed by clearly communicating the fact that the important things about the tax are that, firstly, it signals to all parts of the economy that emissions of greenhouse gases are no longer free and it contributes to the process of creating changed expectations about this; and secondly, it best positions New Zealand to respond to whatever emerges over the next decade.

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The second risk is that any assertion by the Government that the tax will be gradually increased over time is not seen as credible. This would reduce its value as a signal to decision-makers about the costs of greenhouse gas emissions in the long term and undermine any attempt to provide greater certainty for investment by establishing widely-held, consistent expectations about the forward price path for greenhouse gas emissions in the New Zealand economy.

Option 1b: Broad-based tax (world price), targeted recycling

Specification

The elements of this option are:

- New Zealand should move quickly to applying a "world price" carbon tax across as much of the economy as possible (excluding agriculture and forestry). In effect, this would mean a carbon tax of between $10 per tonne and $25 per tonne but no NGAs

- the revenue from the carbon tax would be recycled into "helping" firms and individuals adjust to the tax. This might be a combination of targeted government assistance for energy-efficient technology and structural-adjustment assistance.

The option is effectively an adaptation of the announced carbon tax. The features that differ are the removal of NGAs and their replacement with specific proposals around revenue recycling to provide targeted assistance. The success of this adaptation depends critically on whether the targeted assistance can achieve a superior emissions outcome to the NGAs.

To the extent that the targeted assistance simply offsets the price signals from the carbon tax – to mitigate the effects on international competitiveness – then it will have a similar effect to the announced NGAs.

Effect on domestic emissions

The effect of this option on domestic emissions is expected to depend on the effect of the targeted assistance. Taxing carbon at the world price should, of itself, have a larger impact on emissions than the other options (or the announced carbon tax). If the targeted assistance supports structural change and the transition to lower-emissions technologies, this could amplify the overall impact on emissions while still limiting the reductions that might otherwise occur in production in New Zealand. This structural adjustment would see firms moving ahead of current world's best practice to adopt and develop energy-efficient technologies in their activities where they can, and encourage them to shift resources out of emissions-intensive activities where improvements in efficiency are impractical. Potentially, this could improve on the outcome from the announced carbon tax/NGAs. On the other hand, if the targeted assistance simply offsets the effects of the carbon tax to minimise international competitiveness issues, then the effect of this tax option on emissions would be reduced (and expected to be similar to that of the announced carbon tax).

Assumptions about the nature, level and allocation of the targeted assistance would have to be made to pursue this further.

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Economic impact

Coverage

Not having NGAs would widen the coverage and the economic efficiency relative to the announced carbon tax.

Longer-term economic impact

Depending on its design, targeted assistance can provide either an incentive or a disincentive for economically efficient investment decisions over time.

There is a risk that some firms or industries will develop a dependence on the assistance.

It is likely that having a "world price" in the New Zealand economy would have a greater adverse effect on economic growth if there were no NGAs. Specific assumptions about the nature, level and allocation of the targeted assistance, and firms' responses to that, would have to be made to investigate this issue further.

Learning by experience

This option would not provide opportunities for New Zealand businesses to gain experience of carbon markets. However, by improving the economics of some projects and having them implemented earlier than would otherwise be the case, this option would enhance learning by experience.

Regulatory certainty

With respect to the level of the tax, this option would provide a similar level of certainty as the announced carbon tax or the low-level, broad-based tax. The certainty, at least in the short term, would be greater than with the "holding pattern" options.

With respect to the targeted assistance programmes, a key consideration would be the Government's decision about how long the programmes would run for before they were reviewed or discontinued.

International competitiveness

One of the challenges with this option would be to design targeted assistance programmes that satisfactorily addressed risks to the international competitiveness of New Zealand businesses.

Lobbying, compliance and administrative costs

It is likely that there would be considerable lobbying by industries and businesses around the design of the targeted assistance programmes, their duration, their performance and changes to them.

Compliance and administration costs would depend largely on the nature and design of the targeted assistance. Targeted assistance can have significant transaction costs.

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Fiscal impact

The revenue from this option with the tax at $15 per tonne of CO_2e is expected to be about $600 million (inc GST) a year.

The option assumes that the revenue from the tax is the optimal amount to spend on targeted assistance. The validity of this assumption would need to be carefully examined. Ideally, the expenditure would be assessed on its own merits relative to competing priorities for the use of that revenue.

This tax is compatible with good tax-policy design, as it is applied widely at a common rate, with few exclusions.

Sustainability and flexibility

Impact on achieving economic and social objectives

It would be a big challenge to design and implement targeted assistance that supported emissions reduction, satisfactorily addressed international competitiveness issues, and did not create significant inequities and inefficiencies. This would be an area of major risk.

Need to change, and ease of changing, policy settings

One of the factors that would determine whether there was a need to change the policy settings in the short or medium term would be the performance of the targeted assistance programmes. If it became apparent that there was conflict with achieving economic and social objectives, it is likely that the Government would wish to change the policy settings. This is likely to be a major undertaking.

There is also the issue of how long the targeted assistance programmes should run for, and how we would know when they had achieved their objective.

Transition to emissions trading

To make a transition to emissions trading from this option easier, the points of obligation for this tax could be established with such a transition in mind. If the tax had been adjusted over time to track the "world price", price discontinuities at the time of transition would not be a problem.

Feasibility

The design and administration of targeted assistance could be complex, and it may be difficult to avoid creating some perverse incentives. Design of cost-effective targeted assistance requires that there is clarity about objectives, eg, in relation to domestic emissions and structural change in the economy.

It is likely that the process of designing the targeted assistance would reveal issues that the Government would see as large risks.

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Conclusion

The impact on economic growth and efficiency would depend crucially on the objectives and the design of the targeted assistance. Design of the targeted assistance would be complex, especially to minimise adverse effects on economic efficiency, and administration of the assistance could require significant resources.

Regulatory uncertainty would be on a par with the announced carbon tax and higher than with the low-level, broad-based tax.

Option 2a: Defer a decision on price-based measures

Specification

Do not proceed with the announced carbon tax/NGA policy; give a commitment that there will be no decision on a primary price-based measure for at least five years (ie, until 2011); defer implementation of any primary price-based measure until at least 2013.

Effect on domestic emissions

In the short term, the effect on domestic emissions is expected to be less than under the announced carbon tax or any of the modified carbon taxes considered in the review. In the longer term, the effect would depend on the policy settings eventually adopted by the Government.

Economic impact

Coverage

This option would apply to all emissions and so would not create distortions in production and consumption decisions (other than the distortion of greenhouse gases continuing to be costless).

On the one hand, the absence of a price on emissions that are acknowledged to have economic costs would be economically inefficient in both the short and the long term. On the other hand, because it would provide the same (zero) price signal to all firms, it would not distort within or between sectors of the economy.

Initial direct price impact

There would be no price increases due to a carbon tax through to 2012. Direct price impacts beyond 2012 would depend on the policy settings eventually adopted by the Government.

Longer-term economic impact

Under this policy, there would be a tendency to defer investment decisions until the policy for the future was clearer. If this occurred on a large enough scale, or in critical areas such as electricity generation, it could materially reduce economic growth in the short or medium term. Long-term impacts would depend largely on the climate change mitigation policies eventually adopted by the Government.

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In comparison with the announced carbon tax or any of the modified carbon taxes, this option would provide less information about future prices of greenhouse gases in New Zealand.

Learning by experience

This option would not provide opportunities or incentives for New Zealand firms to learn by experience in international carbon markets or from the earlier implementation of emissions-reducing projects involving technology that is not well-established in New Zealand.

International competitiveness

No international competitiveness issues in the short term. The extent of international competitiveness issues beyond 2012 would depend on the policy settings eventually adopted by the Government.

Regulatory certainty

Regulatory uncertainty during the short term would be greater than under the announced carbon tax or any of the modified carbon taxes. This would be expected to deter some investment and defer other investment. Regulatory uncertainty in the longer term would depend on the policy settings eventually adopted by the Government.

Compliance, administration and lobbying costs

There would be none of these costs in the short term. The costs beyond 2012 would depend on the policy settings eventually adopted by the Government.

Fiscal impact

This option would not raise net tax revenue before 2012.

As the effect on domestic emissions during CP1 would be less than the effect of the announced carbon tax, deferring a decision on a primary price-based measure would increase the fiscal cost of meeting our CP1 obligations under the Kyoto Protocol by a modest amount.

The impact beyond 2012 would depend on the policy settings eventually adopted by the Government.

As there is no carbon tax, this option has no effect on tax design.

Sustainability and flexibility

Impact on achieving economic and social objectives

In the short term, it is likely that some investment will be deterred or delayed; in the longer term, it depends on the policies adopted by the Government.

Need to change, and ease of changing, policy settings

This option would postpone the major effort required to implement a primary price-based measure.

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Transition to emissions trading

If a primary price-based measure were to be implemented by the Government post-2012, it is possible that it might be an emissions trading scheme.

Feasibility

The option is feasible.

Conclusion

One main effect of this option would be to increase uncertainty for business and research investment about the pricing of greenhouse gases in New Zealand for at least the next five years. It is likely that wherever possible, eg, in research funding or possibly electricity generation, decisions will be deferred. If it is considered imprudent to signal now whether it is likely that greenhouse gas emissions in New Zealand will be priced in the future, this is an advantage. Otherwise, it is a disadvantage.

If the Government does not wish to provide any signal now about the likelihood of greenhouse gases being priced in the future in New Zealand, it is an option that is uncomplicated and needs few resources to implement.

A strategy for our international engagement would need to be developed should the government proceed with this option.

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Option 2b: A tax on large industrial emitters of CO_2 where their emissions intensity is above world's best practice

Specification

The tax would apply only to large industrial final emitters of CO_2, possibly excluding power stations, gas suppliers and the oil refinery.

"Large" would be defined as firms emitting more than 1% (or perhaps 0.5%) of New Zealand's emissions of CO_2. Large industrial final emitters that did not meet world's-best-practice emission-intensity levels would pay the tax on emissions above a straight line from where they were in 2004 to world's best practice in 2012 for a period starting in mid-2007. Emitters who met world's-best-practice emission-intensity levels would not pay any tax.

It would be implemented at a level that created substantial incentives for large final industrial emitters to meet world's-best-practice emission-intensity levels, say $15 per tonne of CO_2e or the world price of carbon.

To the extent that fossil fuel power stations, gas suppliers and the oil refinery were close to world's best practice, they would pay little if any tax and the price increases passed through to electricity, gas and petrol/diesel users would be small – too small to significantly increase the risk to firms' international competitiveness. If, however, they were not close to world's best practice, the issue of international competitiveness might be relevant. This would potentially be a reason for excluding them from the coverage of the tax.

One percent of New Zealand's emissions of CO_2 is about 0.35Mt per year; this is the quantity of CO_2 that is produced by burning 180,000 tonnes of coal or 6.8 million GJ of gas. As a point of reference, Genesis Energy has produced between 3.5 and 5 million tonnes of CO_2 a year for the last four June years (principally from the Huntly power station).

If the threshold were set at 1% of New Zealand's total CO_2 emissions, then 12 firms would be covered. Extending the threshold to 0.5% of total emissions would extend the coverage of the tax to an additional two or three firms. There are four companies that emit large amounts of CO_2 when they generate electricity, supply natural gas or refine crude oil that could potentially be excluded.

From our experience with NGAs, it is expected that most large industrial final emitters will be close to world's best practice in emissions intensity (within 7%). This suggests that if the threshold for liability were set at 1% and the four gas, electricity and refining firms were excluded, the quantity of emissions paying the tax would be less than 0.43Mt a year.

The tax would be reviewed (with the expectation that it would be replaced by more appropriate policy settings) once there was sufficient clarity about post-2012 international regimes, their implications for New Zealand and the cost of emission reduction in New Zealand.

Effect on domestic emissions

In the short term, this option is expected to result in much the same level of emissions as the announced carbon tax and the low-level, broad-based tax. This level of emissions would probably be below the level associated with the "defer a decision on a price-based measure" option.

In the longer term, this option and the "defer a decision on a price-based measure" option are likely to give less reductions in domestic emissions than the other options, because of the five-year or longer delay in giving clear signals to all business and investment research managers.

Economic impact

Coverage

Coverage would be limited and hence emissions reductions would not be economically efficient. Excluding electricity generation, gas supply and oil refining from the scope of the tax simplifies it considerably, but means an even more limited coverage.

Initial direct price impact

While this option remained in effect, there would be cost increases for very few firms and, where there were cost increases, they would be relatively small. Initial direct price increases when this option is replaced are unknown.

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Longer-term economic impact

Under this policy, there would be a tendency to defer investment decisions until the policy for the future was clearer. If this occurred on a large enough scale outside of these large industrial final emitters, or in critical areas such as electricity generation if these were excluded from the scope of the tax, it could materially reduce economic growth in the short or medium term. Long-term impacts would depend largely on the climate change mitigation policies eventually adopted by the Government.

In comparison with the current carbon tax, the low-level, broad-based tax and the broad-based (world price), targeted recycling tax, less information about future prices of greenhouse gases in New Zealand would be provided.

Learning by experience

In the short term, this option would not provide significant opportunities or incentives for firms to learn by participating in international carbon markets or from the earlier implementation of projects involving technologies that are not established in New Zealand.

International competitiveness

There would be few international competitiveness issues in the short term. The extent of international competitiveness issues in the longer term would depend on the climate change mitigation policies eventually adopted by the Government.

Regulatory certainty

Regulatory uncertainty during the short term would be greater than with the broad-based tax options; this would be expected to deter some investment and defer other investment.

Regulatory uncertainty in the longer term would depend largely on the climate change mitigation policies eventually adopted by the Government.

Compliance administration and lobbying costs

In the short term, there would be compliance and administrative costs at a similar level per firm as for NGAs, but for fewer firms. The costs in the longer term would depend largely on the climate change mitigation policies eventually adopted by the Government.

There would be little opportunity for gaming by firms. Transaction costs are expected to be significant at the level of the firm, but would apply to only a few firms.

Fiscal impact

It is expected that the revenue from the option would be small, because most of the firms that would potentially be liable to pay it will be at, or close to, world's best practice in emissions intensity and because there would be no tax on CO_2 emissions from transport (or, potentially, electricity generation, gas and refining).

If the threshold for liability is set at 1% and if companies that emit large amounts of CO_2 when they generate electricity, supply natural gas or refine crude oil are excluded from coverage of the tax, it is estimated that the tax revenue will be less than $7 million a year.

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A narrow, specific tax regime for a selected group of firms or industries is inconsistent with the general approach to tax policy, but may be justifiable in these circumstances.

Sustainability and flexibility

Impact on achieving economic and social objectives

A tax imposed on a small number of high-emissions firms should minimise any adverse impact on the Government's objectives for economic growth and social cohesion. If electricity generation, gas and refining are included, this tax may have a wider impact on businesses and consumers (depending on its level and whether/how it is passed on).

If this tax is regarded as a temporary measure, it is likely that some investment outside the firms subject to the tax will be deterred or delayed.

Need to change, and ease of changing, policy settings

There would not be a lot of work involved in changing the announced tax/NGA policy to this option.

Given that this option is proposed as a "holding pattern" option, it leaves open at least two possibilities for future longer-term policy settings:

- a change to an economically efficient, primary price-based measure (either a tax or emissions trading) that dispenses with NGAs
- no economically efficient, primary price-based measure (either continuation of the tax on large emitters above world's best practice or no primary price-based measure).

The first of these would imply that the Government would undertake two major initiatives (both involving substantial legislation) on climate change price-based measures policy settings, possibly within as short a time as five years.

Transition to emissions trading

This option would not provide a good platform for a transition to emissions trading.

Feasibility

Such a tax is feasible. It would be a simplified version (eg, no NGA rebates) of the announced carbon tax/NGAs, for which most of the implementation issues have now been resolved. It would apply to less firms than those likely to be eligible for an NGA under the current carbon tax/NGA policy.

Conclusion

With a minimum of changes from the current carbon tax/NGA option, this option removes the tax from areas that are seen by some people as contentious – transport (where it will have very little effect) and energy (except for the direct use of fossil fuels by large industrial emitters) – and focuses it on emissions from large industrials that exceed world's-best-practice emission intensity. Excluding electricity generation (and gas and refining) from the scope of the tax simplifies it considerably, but would be an important source of economic inefficiency.

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This option reduces the proportion of New Zealand's total emissions that are influenced . This is desirable if the Government's objective for the short term is to limit the areas where it seeks to influence decisions to large industrial emitters of CO_2.

One important effect of this option would be to increase uncertainty for business and research investment about the pricing of greenhouse gases in New Zealand, for at least the next five years. It is likely that decisions will be deferred where possible; eg, in research funding or, possibly, electricity generation. If it is considered imprudent to signal now whether it is likely that greenhouse gas emissions in New Zealand will be priced in the future, this is an advantage. Otherwise, it is a disadvantage.

If the Government does not wish to provide any signal now about the likelihood of greenhouse gases being priced in the future in New Zealand, it is an option that is much more complicated than the "defer a decision on a price-based measure" option.

4.2.4 Alternatives – a New Zealand emissions trading scheme

Introduction

One price-based measure that is worthy of serious consideration for New Zealand is to introduce an emissions trading scheme.

The key advantage of an emissions trading scheme is that, in theory, it allows New Zealand to meet its Kyoto (and beyond) targets in a way that minimises the costs to the economy and to society as a whole. An emissions trading scheme would provide clear incentives for reductions in emissions to occur where the cost of that emission reduction is lowest.

There is a range of difficulties associated with emissions trading schemes and these difficulties should not be under-estimated. This section examines the theory behind such schemes, analyses generic and industry-specific issues related to the possible introduction of a New Zealand emissions trading scheme (NZ ETS), and draws conclusions on an appropriate way forward.

Potential benefits of an emissions trading scheme

Under an emissions trading scheme, firms where emissions reductions are relatively easy and cheap to achieve would have a strong incentive to achieve these reductions (and reap the benefits of the sale of any associated emission permits). Firms for which emissions reductions are more costly to achieve would be likely to purchase emission permits through the emissions trading scheme. Such a firm would have strong incentives to invest in technology or otherwise restructure their operations to reduce their emissions on an ongoing basis. Therefore, emissions reductions would be likely to occur where it is cheapest to do so. An emissions trading scheme is particularly valuable when firms face quite different costs of reducing emissions.

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In a discussion paper on emissions trading, the Australian Greenhouse Office (Australian Greenhouse Office, 1999a) states that an emissions trading scheme is often seen as an attractive means of addressing environmental concerns because it:

- is not prescriptive about how emissions reductions are achieved, or who achieves them, thereby allowing emitters maximum flexibility to allocate available permits to their most valuable uses
- provides greater certainty that targets will be achieved, because the number of permits on issue can be controlled
- introduces appropriate price incentives for developing better abatement and monitoring technologies.

Differences between an emissions trading scheme and a taxation-based price measure

The key difference between an emissions trading scheme and a tax-based policy is that a tax policy sets the price of emissions (ie, the tax rate). Within a tax-based policy, therefore, there is no certainty about the volume of emissions to be undertaken. In contrast, under an emissions trading scheme there is the potential to limit the volume of emissions. However, such a limit may not be so easy to achieve in a New Zealand context.

There are other important differences between a taxation system and an emissions trading scheme. One difference is that the price of an emissions trading scheme is likely to change frequently, while changes in tax rates tend to be relatively infrequent. Changes in the price of an emissions trading scheme are perfectly acceptable and reflect a variety of factors such as the availability of technologies to reduce emissions, the demand (or lack of) from firms to increase outputs associated with the production of emissions, the stringency of the cap, and, potentially, the price of emissions on the world market.

Furthermore, although it is possible to agree NGAs with emitting firms, the ability to grandparent emission permits to firms potentially allows more subtlety in policy design than tax exemptions allow. Having said this, an emissions trading scheme is a far more complicated policy than a tax-based policy, so set-up costs, timeframes and difficulties are greater.

What would an emissions trading scheme look like?

There is a variety of options and variants for a domestic emissions trading scheme. A model cap-and-trade scheme is outlined below in a simplified form. It is important to note that the variant of an emissions trading scheme outlined in Box 1 should be viewed as being only indicative of the concept.

The Annex 4 briefly outlines the operations of the European Union Emissions Trading Scheme (EU ETS). This is the most publicised emissions trading scheme related to the Kyoto Protocol.[76]

[76] There are many examples of cap-and-trade schemes. In order to reduce emissions that were causing acid rain, an allowance trading scheme to control sulphur dioxide (SO_2) emissions, called the US Acid Rain Programme, was set up in the United States in the 1990s. Closer to home, a cap-and-trade scheme is being introduced by Environment Waikato to control the amount of nitrogen entering Lake Taupo.

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Box 1: High-level Overview of how an Emission Trading Scheme May Work	
Step 1	The Government sets a number of[77] parameters around the scheme: • what industries are covered • what gases are covered • whether to set an overall limit on the number of permits and, if so, what that limit is. Following these decisions, legislation is passed requiring relevant emissions to be covered by an emission permit.
Step 2	The Government allocates emissions permits to firms and organisations (a permit being the right to emit one tonne of CO_2e). The permits can be sold or auctioned to firms, or allocated gratis, or a combination of the two. If revenue is gained from any sales of the emission permits, this is recycled through the economy.
Step 3	The Government keeps a register of permits.
Step 4	Emissions permits will be tradable domestically (and possibly internationally). Trades are maintained in the register.
Step 5	At regular intervals, firms must report on their emissions. This reporting must be accurate and measurable.
Step 6	Following the reporting outlined in step 5, firms or organisations that have emitted CO_2e (or have undertaken activities that will result in emissions)[78] must surrender permits equivalent to that CO_2e to the Government. If the firm does not have sufficient permits, it must pay an appropriate penalty to the Government.[79]
Step 7	At the end of CP1, our emissions across the period will be measured and compared with our emissions permits. The question is not whether we have achieved our emissions target as a country, but whether all of our emissions are covered by emissions permits (if we exceed our emissions target, some of our emissions will need to be covered by international permits). The scenarios are: • if all our emissions are covered, nothing further needs to happen • if some New Zealand individuals or firms hold permits that do not cover emissions, this is not a problem in itself, just a lost opportunity for them (they could have sold them on the international market) • if not all of our emissions are covered, the Government is required to purchase units on the international market to cover them. The Government would pay for this with the penalty money paid by those who did not cover their emissions.

[77] Even though Australia has not ratified the Kyoto Protocol, there is interest at Australian state level in setting up a National Emissions Trading Scheme. This is currently at a background paper stage. If set up, it is proposed to be a cap-and-trade scheme operating on the stationery energy sector (this sector is rapidly growing and contributes approximately 50% of Australia's total greenhouse gas emissions). It would cover all six greenhouse gases under the Kyoto Protocol. (Cabinet Office, New South Wales Government).

[78] Issues relating to the point of obligation are discussed later.

[79] Effectively, that penalty forms an upper limit on prices within the ETS.

The key feature of such a scheme is that, effectively, decision-making about whether to emit CO_2e, and how much CO_2e is emitted, is devolved to CO_2e-emitting firms and organisations. The decision for firms therefore relates to how much it costs them to reduce their emissions relative to the permit price prevailing in the market discussed in step 4 (and the penalty price for non-compliance outlined in step 6).

Baseline and credit schemes have many similar features to cap-and-trade schemes. They operate by allocating an emissions baseline to firms and then allowing trades to occur between firms if baseline targets are over- or under-achieved. The credits are created after the date at which an emission permit must be retired, so the timing of the operations in the cap-and-trade scheme and in a baseline and credit scheme is different.

As a general rule, cap-and-trade schemes are preferred over baseline and credit schemes. Major reasons for this are:

- cap-and-trade schemes allow a greater depth in the market, whereas baseline and credit schemes only limit tradable credits to those below the defined baseline
- cap-and-trade schemes allow various options of allocation of units (eg, grandparenting or auctioning) where a baseline and credit approach effectively grandparents firms' initial allocations of units.

Furthermore, cap-and-trade schemes are the norm internationally in climate change policy. Relating an NZ ETS with international trading schemes would be easier if the NZ ETS were to be a cap-and-trade scheme as opposed to a baseline and credit scheme.

Could we have a solely domestic emissions trading scheme?

A questions that arises, when considering whether to develop an emissions trading scheme, is whether a NZ ETS could operate without links to an international market. This section argues that this is not sensible and, therefore, does not recommend such a measure. In designing a NZ ETS, an absolutely critical decision is whether there should be a limit on the number of permits within it and, if so, what that limit should be. Having a limit would determine the amount of emissions that New Zealand would permit in the relevant time period. Setting such a limit, however, is likely to be highly problematic.

If the limit were set too low, the price within the NZ ETS would be high (reflecting the difficulty that many New Zealand firms and emitters have in reducing their emissions with existing technology). This might well have a significant, and very unhealthy, effect on those firms – in particular, it might lead to reduced production within these firms.

Alternatively, if the limit on the number of permits to be traded within a NZ ETS were to be too high, there would be few buyers and many sellers in the market. Incentives to reduce carbon emissions would be weak, as the price of purchasing emissions permits would be low (or zero). If this were the case, the goal of an emissions trading scheme of being a policy tool to assist in reducing emissions would not be met.

The current projected balance of units for New Zealand in CP1 is that we will have a deficit of 36.2Mt CO_2e. As part of the modelling around our net emissions position, variability around the mean was estimated (95% confidence intervals). In a pessimistic scenario, our net emissions position in CP1 would be a deficit of 62.6Mt CO_2e, while in an optimistic scenario, it would be a deficit of 11.3Mt CO_2e. When added to New Zealand's

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assigned amount units of 307.6Mt CO_2e for CP1, our total emissions (less sinks) is estimated to fall within the range of 318.9Mt CO_2e to 370.2Mt CO_2e.

The variability in these estimates is too high to predict with any confidence the appropriate limit for the number of permits that should be allowed within a NZ ETS. It is therefore recommended that, if there is to be a NZ ETS, there is no limit on the number of permits. Effectively, this implies that it **would not be appropriate to set up a NZ ETS with no external links**.

One option for New Zealand would be to develop an emissions trading scheme in some sectors of the economy and then seek to expand the coverage to cover all sectors. The energy and transport sectors would be best suited in this regard. Even if an emissions trading scheme were developed covering only the energy and transport sectors, the variability in the net emissions estimates is too high to allow contemplation of a NZ ETS covering only those sectors that is not linked internationally.

This effectively recognises that it is not sensible to explicitly limit the amount of emissions from New Zealand. It does not, however, rule out that New Zealand should pursue domestic policies that will reduce our emissions. (If there were a climate change objective of limiting New Zealand's net emissions to some agreed amount, a NZ ETS with no (or limited) links to an international market might well be an appropriate policy tool.)

The EU ETS allows only a relatively small proportion of units to enter the system through a linking directive. This essentially ensures that much of the European Union Kyoto target is attained with emissions reductions within Europe. It also means that there is still a limit on the number of emissions permitted within the EU ETS. Such an approach would not reduce the difficulty associated with accurately estimating the size of the carbon market so is not a sensible option for New Zealand.

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International linkages for a NZ ETS

The only possible way for New Zealand not to have a pre-determined limit on the amount of emissions allowed within New Zealand through an emissions trading scheme is for players in a NZ ETS to have unlimited access to an international emissions market. Under such a scenario, there would be no limit on the number of emission permits that could be traded internationally.

If there were full links with an international market, it is likely that the trading price of permits in a NZ ETS would match the international price[80] in the market New Zealand is trading in. A key difference between such a scenario and a carbon tax would be that the price would adjust regularly, while price adjustments in a tax are irregular.

At present, it is arguable whether there is a sufficiently strong international market in place. A key feature of such a market is that there would be relatively low transaction costs associated with the buying and selling of units for New Zealand firms, and that New Zealand firms could **access low-priced emission reduction units** from overseas.[81]

[80] An international price is an interesting concept. Currently, there are several prices for carbon that apply internationally, depending on what market one is trading on and what "product" one is buying.

[81] Further work could explore the criteria for determining whether, in fact, a sufficient international market has developed.

It is not necessary to have an international market that covers all countries, or all countries that have ratified the Protocol. Arguably, the conditions outlined above are met through the current world market for JI and CDM. This market is developing rapidly and may well mature into enough of an international market to allow the development of a NZ ETS.

One strategy that New Zealand could pursue is to attempt to join the EU ETS. This is not recommended at this point (although the possibility of a future linking with the EU ETS should not be ruled out). If New Zealand were admitted to the EU ETS, it would effectively mean that New Zealand would take both the policy and the price from the EU ETS (our emissions are very small in the context of the European Union so the New Zealand contribution would be swamped).[82] The effect of this is that New Zealand firms would, if they wished to purchase emission permits, pay approximately €20 per tonne of CO_2 (assuming the EU ETS price does not change significantly over time). This is a significantly higher price than the price that New Zealand would pay for emissions-reduction units if it purchased them under the Kyoto flexibility mechanisms (again assuming current prices).[83]

A further issue that would need addressing if a NZ ETS were linked to an international market is the quality of the units firms would be permitted to purchase. For example, firms may buy "hot air" from an international market to meet their emission permit responsibilities. If New Zealand as a whole was not prepared to meet our Kyoto obligation through "hot air" credits, clear rules would need to be set about the types of international units that would be permitted to be traded within a NZ ETS.

A hybrid scheme?

This section argues that it is not desirable to develop a NZ ETS at this stage. It does, however, suggest that the development and operation of a NZ ETS is desirable in the longer run if international climate change policy settings continue to be related to quantitative goals. This raises the issue of whether there are intermediate steps that could usefully be employed in the short term.

Sin and Kerr recommended that a hybrid tax/permit scheme could be a good policy option to develop in the short term. Under the Sin and Kerr model (variants on the theme exist), the coverage would be the same as the existing carbon tax design (ie, it would avoid the forestry and agriculture sectors). It would operate as a permit scheme with a trigger price at which firms could buy unlimited numbers of permits from the Government. If the trigger price is reached, the system effectively operates as a tax. When the price is less than the trigger price, it operates as a permit scheme.

Such a system would not add great value over and above a carbon tax in the short term.[84] It would, however, be invaluable as an intermediate step for New Zealand to take if a decision were made to pursue the option of an emissions trading scheme in the future. There would be a marginal cost and effort associated with developing a hybrid scheme as opposed to a carbon tax, but this cost is not considered to be overwhelming.

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[82] The European Union may also have a view on what level of our Kyoto target that should be met within New Zealand.

[83] The scope of the EU ETS in terms of types of industry is quite limited and would exclude the bulk of sources of New Zealand's greenhouse gases.

[84] There would be related benefits. For example, New Zealand would gain valuable experience and lessons in operating permit schemes.

As with all policy options in this area, there would be design issues to overcome. One particular issue would be ensuring that there was not the ability to arbitrage permits[85] if the international price for permits were higher than that in a hybrid scheme. Furthermore, a hybrid scheme might be ineffective if the trigger price were set relatively low, as it would effectively operate as a tax at all times. Therefore, it might prove difficult to implement if the carbon tax were levied at a relatively low rate.

Issues to consider when developing an emissions trading scheme

There is a variety of issues to consider and policy decisions to make if New Zealand develops an emissions trading scheme. This section outlines some of the implicit trade-offs and issues; it does not attempt to reach a conclusion on all these matters.

Allocation of permits

The initial allocation of permits is a key issue associated with setting up an emissions trading scheme.

Options in this area relate to grandparenting the permits (allocating them gratis), or selling the permits through some process (eg, an auction or a fixed-price sale), or a combination of the two.

There are strong efficiency and equity arguments involved.[86] Typically, efficiency is more likely to be maximised with the sale of permits as the value of the permits will move quickly to their most valued use and the cost of determining the initial allocation is likely to be lower. If the permits are sold, issues of revenue recycling also apply (ie, using revenue gained from the sale of the permits elsewhere in the economy). Each emission permit has a property right associated with it (ie, the ability to emit a unit of CO_2e), so there are large wealth transfers involved. On the other hand, equity goals can be advanced through the use of grandparenting emission permits. There is a wealth of literature on the topic; see, eg, Crampton and Kerr (1998), Sin and Kerr (2005), the OECD Environment Directorate and International Energy Agency (2004), the Australian Greenhouse Office (1999b) and the New Zealand Climate Change Programme (2001).

One issue that arises from a decision to grandparent relates to timing. In particular, if a decision were made to grandparent (some or all) permits to those existing in an industry, what date should the grandparenting relate to – eg, to 1990 levels? 2005 levels? 2008 levels? This decision relates to determining the most equitable and effective baseline to use going forward – what baseline can be measured? From what point is it "fair" to base a charge?

Decisions on the allocation of permits also influence the acceptability of an emissions trading scheme from the public's viewpoint. As a general rule, the more permits are grandparented, the more acceptable an emissions trading scheme will be. Partially for this reason, in the EU ETS, the bulk of permits were grandparented while some were sold.

Determining the appropriate points of obligation

[85] If permits in a hybrid scheme were tradeable internationally and the international price were higher than the permit price, care must be taken to ensure that it is not possible to buy permits from the government and then sell them at a higher price to international bidders.

[86] The setting up of the Individual Transferable Quota system for New Zealand fisheries was an example of a tradable permit scheme that involved a grandparented allocation of the relevant permits.

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Determining the point of obligation involves determining the businesses and organisations that have the legal obligation to hold emission permits. This need not necessarily be the final emitter of carbon (eg, oil companies may be required to hold permits).

For an emissions trading scheme to be effective, it is important that any price increase can pass through to final consumers of the product (eg, so that the motorist is faced with the cost of the emission permit at the pump). This is known as internalising the cost. The end consumer, in this case the motorist, would face the cost of the permit and would be able to factor that into their travel decisions (eg, whether to travel, what mode of transport to use, what types of vehicles to buy). Furthermore, second-order effects would also be relevant; the price of emissions permits would also be reflected in high fuel-intensity products.

Determining which sectors and gases are included

It is not necessary to have all sectors and greenhouse gases included within any emissions trading scheme. As a general rule and depending on the scope for mitigation, a larger market (both in terms of the number of sectors included and the number of greenhouse gases included) is more likely to operate effectively and achieve climate change goals than a smaller market. Even if all of New Zealand's major greenhouse gases[87], and all sectors of our economy were included in a NZ ETS, it still would be a small market by international standards.

Leakage issues

A firm having to purchase permits to maintain or increase production levels would have the option of relocating offshore. This concern applies equally to carbon taxes and emission permit schemes, and is difficult to overcome. These arguments apply across many sectors of the economy, to some extent. See the discussion on NGAs for more detail.

Leakage concerns can be addressed by grandparenting initial allocations to major firms that are in direct competition with firms in overseas countries that are not signed up to Kyoto. This would cover emissions from those firms themselves but not any emissions from inputs to their processes (eg, emission permits contained within any upstream effects). Under such a scenario, firms would also face the costs in terms of the emissions trading scheme associated with expansions in production.

Public and political buy-in

An emissions trading scheme is a complicated policy instrument. It involves the assigning and trading of property rights and the development of an effective market for trading those rights. It is not quick or simple to implement and will operate only if there is a high level of buy-in that it is fair and necessary.

To be successful and lasting, an emissions trading scheme requires a high level of both political and public buy-in to the problem of climate change and the domestic policy chosen (the ETS). Simpler policy mechanisms such as regulatory options, or the imposition of a carbon tax, may be more appropriate in an environment of public and political uncertainty.[88]

[87] Carbon dioxide, methane and nitrous oxide.
[88] To make use of the costs of setting up an ETS, an ETS would ideally be able to be used in more than one Kyoto period.

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Data collection and administrative issues

Effective data collection and administration are critical to sound operation of an emissions trading scheme. Issues, listed in no particular order, include:

- being able to accurately measure emissions performance and to tie individual firms' obligations to New Zealand's overall obligation – an accountability issue. These measurements must be able to be done within acceptable cost ranges

- ensuring that emission permits are easily tradable with no excessive transaction costs (this may be an issue where small volumes of units are either available for sale or required to be purchased).

The first point applies to both a carbon tax and an emissions trading scheme.

The second point is, however, unique to an emissions trading scheme. Anecdotal evidence suggests that the packages of emission reduction units allocated to firms under the PRE initiative were sometimes too small to easily enable sale of those units to potential purchasers. Similarly, firms may need to purchase or sell small numbers of emissions permits to balance their emissions permits with their emissions. For an emissions trading scheme to be effective, a cost-effective way of doing this is highly desirable.[89]

Particular industry-related issues

Outlined below is a very brief overview of how a NZ ETS would affect different sectors of the economy.

Agriculture

Agriculture accounts for approximately half of New Zealand's net GHG emissions. Ideally, therefore, agriculture would be included in any emissions trading scheme in a New Zealand context.

There are issues to consider relating to:

- the point of obligation (and whether there is a way of ensuring that the appropriate signals are sent to the decision-makers – the farmers)

- measurement

- the grandparenting of obligations.

Point-of-obligation arguments relate to the extent to which the appropriate signals can be sent to the decision-makers (ie, farmers). For an emissions trading scheme to be as effective as possible in an agricultural context, it would take into account on-farm decisions that result in carbon emissions, such as on-farm feeding patterns. The transaction costs associated with measuring this would be prohibitive, however. (For some farm inputs, such as fuel or fertiliser, it may be possible to require firms upstream to hold emission permits; the price could then flow through into on-farm decisions). These

[89] From this viewpoint, a firm may prefer a tax as opposed to an ETS, as a tax would simply require the payment of the appropriate funds, whereas an ETS would require firms to purchase units and then pass them on to the Government.

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measurement issues are considered to be very serious in the context of agricultural emissions.

Industry bodies could be required to hold emission permits relating to livestock numbers. The incentives created by such a scheme may not be entirely productive, as such a measure would create incentives to reduce livestock numbers. Related to this, the agriculture industry might move to fewer but larger animals (with higher GHG emissions per animal) if emission permits were related to the number of animals.

If our agricultural research efforts are successful in identifying technologies that can cost-effectively reduce agricultural emissions, it is important that these are put into practice. If the point of obligation of a NZ ETS were at an industry-body level rather than a farmer level, the means of adoption of new technologies would need to be examined closely. This again relates to measurement issues (eg, could the use of new technologies at a farm level be accurately measured?), and also to point-of-obligation issues.

If there were a decision to grandparent emission permits, say to 2005 levels, then (only) any marginal changes in farming operations would be liable under the emissions trading scheme.[90] Therefore, farmers that decreased their carbon emissions from 2005 levels would have an asset they could sell, while farmers that increased their emissions would face the cost of purchasing the required number of permits. As noted above in the discussion relating to the point of obligation, measuring relatively small changes in agricultural emissions may well be problematic.

Having said this, for significant changes to land-use operations such as conversions from one land use to another (eg, sheep to dairying, forestry to dairying, cropping to livestock production), there is a strong case for the decision-maker to face (at least some of) the related carbon emissions costs. In these situations, the decision to change land use presents the nation as a whole with a reasonably significant carbon saving or cost (depending on the land-use change in question). An emissions trading scheme applied to agriculture would enable such a cost to be faced by farmers, so long as it could be implemented effectively. If an emissions trading scheme were not developed, alternative measures to make decision-makers face some of the carbon-related implications of significant land-use changes could be investigated. This is discussed further below.

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Forestry

There are particular challenges and opportunities for an emissions trading scheme as it relates to forestry.

Consistency with Kyoto rules

The Kyoto Protocol contains slightly anomalous rules relating to the difference between forests planted post-1 January 1990 (Kyoto forests) and forests planted pre-1990 (non-Kyoto forests). For more detail on these, see Section 4.6. This distinction is, to some extent, artificial and may not exist in future commitment periods, making the development of policy in this area particularly problematic.

[90] Farmers may argue that such a measure would be equitable, as a decision not to grandparent would penalise them for past decisions. Although there is an equity element implicit in this, the issue is no different from grandparenting obligations to other sectors of the economy. Partial grandparenting (ie, grandparenting 50% of permits) is possible.

These rules mean that New Zealand faces the liability associated with the deforestation (felling and not replanting) of non-Kyoto forests but does not face any liability associated with harvesting (felling and replanting) non-Kyoto forests. In contrast, New Zealand faces a liability associated with both the deforestation and harvesting of Kyoto forests.[91] If a non-Kyoto forest is deforested prior to 2008, however, New Zealand does not face any liability associated with the deforestation (although New Zealand is liable for any resulting emissions from agriculture on that land).

Given this difference in rules, and that it is not clear that these rules will extend beyond CP1, New Zealand must determine to what extent this distinction should exist in domestic policy settings. This issue is not necessarily insurmountable, but does require careful thought. One particular behaviour that is worth attempting to avoid is land-swapping, where a non-Kyoto forest is deforested prior to 2008 and a Kyoto forest is created of a similar size. If emission permits were devolved strictly on the basis of Kyoto rules, there would be an incentive for firms to land-swap in this way, even though, from an aggregate carbon viewpoint, land-swapping is more analogous to the harvesting of a non-Kyoto forest.

Dealing with inter-temporal issues – Kyoto forests

An obvious feature of forestry is that it is a long-term investment, with the average rotation of a *Pinus radiata* forest of between 25 and 30 years. In a simplistic sense, carbon is sequestered from the atmosphere in the period of growth of the trees and released to the atmosphere when the trees are felled.[92] (If the Kyoto forest is replanted, there is an increase in the stock of carbon in the forest, as sequestration associated with growth from the second rotation covers the loss of carbon from decaying material).

One feature of the long timeframe of forestry investments is that a forestry investment spans several Kyoto commitment periods. If there were an emissions trading scheme in place that included forestry, effectively, the Government would be allocating units to forest growers for the credits associated with carbon sequestration over time. On the harvesting or deforestation of the forest (or loss of the forest through wind or fire damage), the forestry company would be faced with a large liability for the loss of sequestered carbon.

This would involve quite a financial exposure for forestry companies; effectively, forestry owners would be exposed to changes in the price of carbon over time.[93] There would also be an exposure for the taxpayer; if forestry companies did not repay any liability of credits to the Crown on deforestation or harvesting of a Kyoto forest, the taxpayer would pay that liability. Given this, if the Government were to include Kyoto forests in an emissions trading scheme, it would require an appropriate form of bond or insurance from the forest industry (this issue would need to be overcome but may not be particularly problematic; options are available in this area).

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[91] The liability faced by New Zealand on the harvesting of Kyoto forests is limited to the amount of carbon claimed previously from that forest.

[92] There is debate around levels of residual soil carbon and also around how to account under the Kyoto rules for carbon that is retained in harvested wood products (ie, not all of the carbon sequestered is immediately released into the atmosphere when a tree is felled).

[93] It is estimated that if the international price of carbon were to increase at a compounding rate of 6% per year, a devolution of credits (as an ETS including forestry would imply) to the forestry industry would have a strong negative effect on the rates of return for forestry investments.

The converse of this is that, under current policy settings, the Government is exposed to changes in the price of carbon (with associated upside and downside risk). From a theoretical viewpoint, it would be appropriate for this risk to be devolved to the forestry industry, as this is a cost associated with the industry. For this to occur, the various issues associated with forestry vis-à-vis an emissions trading scheme must be overcome.

Decisions around grandparenting for Kyoto forests are similar to those for agriculture. In the agricultural scenario, an equity issue has been raised around grandparenting emission permits when the land-use decision was taken some time ago. In a forestry context, this translates to an issue of whether it is equitable for a forest owner to gain benefit (at the expense of the taxpayer) from a decision to plant a forest 15 years ago. This has links to arguments around compensation for non-Kyoto forests (see below). To continue the agricultural parallel, if farmers were grandparented emission permits to account for current (or 2008 emissions) then, in a similar vein, only new Kyoto forests would attract an emission permit for any sequestered carbon.

Equity issues relating to non-Kyoto forests

The previous discussion dealt with issues to do with Kyoto forests. A different set of issues is associated with the possibility of an emissions trading scheme including non-Kyoto forests.

Companies have invested in forestry for many years in New Zealand. Inclusion of these forests in a NZ ETS potentially introduces a liability on the deforestation of non-Kyoto forests. This would reduce the option (and financial) value of some land currently planted in forestry.

This raises distributional and equity issues and a strong case for compensation can be made. If compensation were to be payable, a major issue to be considered is how it would be distributed among non-Kyoto forest owners. The development of an adequate and equitable compensation regime is not necessarily simple. For an emissions trading scheme to be effective in relation to non-Kyoto forests, one would want the liability for deforestation to be included in the price faced by the land owner (ie, any compensation payable is paid irrespective of actual decisions on deforestation).

Issues in this area are difficult. If no equitable and reasonable solution could be found, one option available to the Government would be to include only Kyoto forests in a NZ ETS. While this would not be ideal from the viewpoint of land owners facing the correct price signals around land-use decisions, it may prove to be a practical way forward. Such a policy would have large implications for the taxpayer (who would bear the liabilities for the deforestation of non-Kyoto forests).

Other forestry-related issues

There are a range of other issues associated with the possible inclusion of forestry in a NZ ETS. These include:

- who to devolve the credits and liabilities to – the land owner or the forest owner?
- how to monitor carbon sequestration efficiently

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- if an emissions trading scheme were to include Kyoto forests, what date would be used to determine which forests were covered? When Kyoto was signed? When Kyoto, or the ETS, came into effect?

- how to avoid opportunistic and (possibly) distortional behaviour while an emissions trading scheme is being considered/set up

- how to deal with existing contracts to deforest, assuming non-Kyoto forests are included

- how best to deal with any associated fiscal issues

- to what extent any devolution of credits into an emissions trading scheme could, or should, be compulsory (for Kyoto forests). Or should it operate on an opt-in basis only, given that the forest owner will need to repay any emission permits previously gained if there is harvesting, deforestation, or any other loss of carbon from the forest?

These issues are not discussed further in this paper. They would, however, need to be resolved if any future NZ ETS included forestry. It is important to note that work has been done on all of these issues and potential ways forward can be identified.

Under current policies, the Government/taxpayer receives any of the Kyoto benefits and pays all of the liabilities associated with changes in land use. It would be preferable from a land-use perspective if these prices were factored into land holders' decision-making frameworks, as these are real costs that directly flow from land holders' decisions. If it could be developed, a NZ ETS is an ideal way of incorporating these prices into land-use decisions.

Energy

The carbon tax, due for introduction in 2007, is intended to include the energy sector. Within the design of the carbon tax, many of the issues implicit in the design of an emissions trading scheme have been worked through. It would appear sensible for the point of obligation to be the same as that proposed in the carbon tax design; ie, producers and importers of fossil fuels and firms that carry out certain industrial activities that produce greenhouse gas emissions would be responsible for holding sufficient emissions permits to cover their activities.

If one wanted to allow for emissions resulting from inputs into major emitting firms (that potentially may relocate offshore), some form of an agreement with that firm would be required. As noted in the section on NGAs, these agreements are problematic.

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Transport

The situation with transport is not dissimilar to the situation with energy with regards to a NZ ETS. In particular, using the model of the carbon tax, fuel importers would be responsible for holding sufficient emissions permits to cover their activities. Any costs associated with the purchasing of permits could be passed through to end consumers.

One slight difference between a tax and an emissions trading scheme with regards to transport (and energy) is that it is important that the transaction costs for purchasing or selling relatively small numbers of units are relatively small. If they are not, companies may have a justified preference for a tax, other things being equal.

Summary of issues associated with an emissions trading scheme

The table below summarises major issues associated with a NZ ETS from an industry-by-industry viewpoint.

Table 15 - Summary of Issues, Industry by Industry

Issue	Possible Solution
Transport	
Firms would need to purchase or sell small numbers of emission permits	An effective market with low transaction costs is essential
Agriculture	
Existing farmers may argue that it is inequitable to force them to purchase permits, given they have been in agriculture for a significant period and mitigation options are few	Possible to grandparent (some or all) permits to existing farmers. This could effectively price carbon into differences in behaviour at the margin
Measuring emissions at farm level is difficult to do cost-effectively	Hard to overcome in the short term. Could move to a different point of obligation but may lead to perverse incentives
Leakage issues apply	Very difficult to overcome. To some extent marginal, however

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Issue	Possible Solution
Forestry	
Would place large liability on non-Kyoto forest owners. Could be viewed as highly inequitable	Hard to overcome without some form of grandparenting (or the Government retaining the liability)
Equity issues arise if permits are granted to existing Kyoto forest owners - ie, benefiting people for past-decisions (the flip-side of the previous issue)	The Government does not grant permits for existing Kyoto forests. Permits are granted only for new forests
Problem where permits allocated for sequestration are required to be repaid on harvest – leaving large liability for forest owner	Require some form of bond or insurance from the forest industry. There would still be exposure to changes in the price of carbon
Energy	
Firms would need to purchase or sell small numbers of emission permits	An effective market with low transaction costs is essential
Leakage issues apply to large energy users where their production is internationally mobile	Could grandparent initial allocation. This would cover emissions from the production of the firm itself but would not provide any relief from ETS costs embedded in energy Relief from the cost of an ETS that is implicit in inputs (to firms) such as electricity could be overcome only by some type of NGA. As noted, these are problematic

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Summary

An emissions trading scheme is potentially a very powerful policy instrument. An emissions trading scheme could lead to innovative ways of meeting climate change objectives that would otherwise be very difficult, if not impossible, to achieve. Incentives created under an emissions trading scheme can influence behaviour across all relevant areas of the economy. An emissions trading scheme also has the potential to reduce emissions in a least-cost way. As such, there are strong reasons for New Zealand to pursue the development of an emissions trading scheme.

There are significant implicit complexities, however, and these should not be under-estimated. In particular, for an emissions trading scheme to be effective, there are a number of administrative and transactional issues to overcome. These include:

- being able to accurately measure emissions performance and tie individual firms' obligations to New Zealand's overall obligation
- ensuring that scheme participants are accountable for their emissions
- ensuring that emission permits are easily tradable, with no excessive transaction costs.

For an emissions trading scheme to be effective, there would need to be an acceptance that it is here to stay, at least for CP1 but preferably longer. Given this, consistency of policy settings is important, as is a high-level of buy-in, both politically and within the economy. The difficulty of design (and time required for the design) of an emissions trading scheme implies that, ideally, an emissions trading scheme would be used for more than one commitment period.

It would be preferable to include as many New Zealand emitters and major greenhouse gases in a NZ ETS as possible. This would help to ensure that a NZ ETS operates effectively as a market and would provide an incentive for as many players as possible to reduce their emissions where it is cost-effective to do so. Leakage may be a problem, especially if the emissions trading scheme results in a high price for carbon within New Zealand. In the first place, however, it may be preferable to include only some sectors of the economy. There are difficulties associated with including agriculture and forestry. It would be more practical to add these sectors to an existing emissions trading scheme rather than develop a new emissions trading scheme including agriculture and/or forestry.

This said, much of New Zealand's emission is land-use related, and a NZ ETS would be most effective if it included all types of land-use decisions that have significant climate change implications, such as afforestation and deforestation rates, changes in stock numbers (especially cattle), fertiliser application and use of technology. Forms of grandparenting could potentially be employed to resolve equity issues, although further work is required to ensure that major inequities would not remain. From an agricultural viewpoint, measurement issues are important. Although these issues relating to forestry and agriculture apply to all price-based measures, they are especially important from an emissions trading scheme viewpoint.

At this point, it is arguable whether there is an effective international carbon market for a NZ ETS to link into. Such a market may emerge relatively shortly. A market of this nature is necessary to avoid the highly problematic exercise of setting a limit on total New Zealand emissions. An international emissions market would, ideally, allow New Zealand firms to access low-cost emission permits from overseas at low transaction cost.

Going forward

Although an emissions trading scheme offers significant opportunities for New Zealand, there are a number of issues that need to be overcome before an effective one can be set up. In particular, there is (arguably) not an effective international market for New Zealand to trade within, there is probably not the required level of public and political buy-in to the need for a NZ ETS at this stage, and there is not sufficient stability in international policy settings to warrant the significant effort involved in setting one up.

It is not recommended that New Zealand attempt to develop an emissions trading scheme for CP1. Depending on the nature of any successor to the Kyoto Protocol, New Zealand should seriously consider developing a NZ ETS.[94] It is important that any domestic policies developed in the short term are designed to enable a transition to an emissions trading scheme as effectively as possible.

[94] The Kyoto Protocol is essentially a quantitative agreement where total emissions from Annex I countries that have ratified the Protocol is fixed. An ETS is an ideal policy instrument to assist in achieving quantitative goals. If, however, any agreement following the Kyoto Protocol does not include such a quantitative goal, an ETS may not be appropriate.

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If New Zealand were to make a strategic decision to develop an emissions trading scheme in the future, a logical starting point might well be to develop the energy and transport elements of a carbon tax as some form of hybrid model (this could probably be done at relatively low cost). This may prove difficult if a carbon tax were to be levied at a relatively low rate, but would provide valuable experience in developing and operating emissions trading schemes and would significantly ease any future transition to a NZ ETS.

4.2.5 PRE – assessment and future role

Background

The PRE initiative was established in late 2003 as part of a suite of policies to assist New Zealand in meeting its climate change objectives.

Under PRE, the Crown grants a promise of Kyoto-emission units in exchange for firms delivering verified emissions reductions during CP1 from projects that would otherwise not have been financially viable (ie, the project would not occur without the granting of the units). Firms can trade those units internationally.

To date, there have been two PRE rounds (PRE1 and PRE2) plus the awarding of units to two "early" projects. In total, 10.88 million emission units have been allocated under PRE to date.

To assist the Climate Change Policy Review, the Allen Consulting Group has reviewed the performance of the PRE programme.[95]

This section draws heavily on the Allen Consulting review. It outlines the objectives of PRE, provides an overview of the PRE programme guidelines, summarises the Allen Consulting Group's key findings and provides some guidance on going forward with PRE.

PRE objectives

The key objective of PRE is to reduce New Zealand's emission profile in the 2008 to 2012 period. Enhancing New Zealand's energy security was also identified as a desirable outcome of the first assessment round.

Ancillary benefits are also associated with PRE. These include:

- "learning by doing" in respect of firms participating in carbon markets
- "learning by doing" in relation to technologies that are immature in the New Zealand context.

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[95] The vast majority of units awarded under the PRE programme were awarded to electricity projects. Given this, the Allen Consulting Group review focused on electricity projects only.

An overview of PRE programme guidelines

The key features of the guidelines for PRE are as follows:

- the project must take place in New Zealand
- it must result in a reduction in greenhouse gas emissions over CP1
- it must be additional to business-as-usual (this key point is discussed later)
- there must be a contestable process for the selection of successful projects.

The following have been drawn from the Ministry for the Environment's website and describes the PRE selection and eligibility criteria in more detail. (The reference to the 6 million units at the end of the selection criteria is a reference to the second-project round.)

Eligibility criteria

To be eligible for Projects to Reduce Emissions tender rounds, projects need to:

- Take place in New Zealand.
- Result in a reduction over the first commitment period of the Kyoto Protocol (2008 - 2012) in the total greenhouse gas emissions that will be reported by New Zealand in the National Greenhouse Gas Inventory to the United Nations Framework Convention on Climate Change, and consequently have a direct impact on reducing the Crown's liability for emissions in the first commitment period. Greenhouse gases are those listed in the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).
- Provide a minimum reduction in emissions of 10,000 tonnes of CO_2-equivalent in the first commitment period of the Kyoto Protocol (2008 - 2012).
- Be additional to "business-as-usual".
- Result in measurable emissions reductions that would not occur without the project receiving the Projects' incentive. Project proposals will undergo:
    - an investment assessment to confirm that they are additional to "business-as-usual"
    - an environmental assessment to determine the level of emission reduction beyond "business-as-usual".
- The number of Kyoto Protocol emission units requested by the tenderer must be less than or equal to the tonnes of CO_2-equivalent emissions expected to be reduced by the project during the first commitment period of the Kyoto Protocol (2008 - 2012).

Further considerations:

- Each project proposal must be for a single definable project (although parties can submit more than one proposal).
- Firms in the process of negotiating an NGA with the Government may participate in Projects with respect to activities that are not within the scope of their NGA application or deemed by the Government to be ineligible for inclusion within the scope of an NGA. Firms with an NGA in place can participate provided that the Projects incentive is not being used to help meet an agreed NGA target.
- Forest sink activities and projects involving sequestration by land-use change and management activities are not eligible for the Projects tender.

Once a project has been confirmed as being eligible to participate, it will be subjected to a risk assessment to identify the risk of it failing to deliver the expected reduction in emissions. This includes assessing any risks associated with the project owner, the project technology, the project resources, and the project economics.

Selection criteria

In the second tender round, eligible projects were ranked and selected on the following basis:

- The ratio of the number of emission units requested by the tenderer divided by the tonnes of CO_2-equivalent emissions expected to be reduced by the project during the first commitment period of the Kyoto Protocol (2008 -2012).
- Risk assessment of the project.

Subject to the assessed risk of a project, projects offering the most reduction in emissions in exchange for the least number of emission units requested were ranked highest.

Projects were selected in order of their ranking until the 6 million emission units available in the second tender round had been allocated.

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Review of the performance of PRE

The key findings of the review of the performance of PRE are as follows:

- identifying the projects at the margin (ie, achieving maximum cost-effectiveness) will always be difficult and requires considerable judgement
- it is likely that PRE is among “best practice” in terms of incorporating mechanisms designed to minimise units being awarded to projects that would have gone ahead anyway
- **[withheld under OIA s9(2)(b)(ii)]**
- choices over increments to New Zealand’s electricity supply are increasingly between competing renewable technologies.

The overall effect of these findings is that, in the view of Allen Consulting, it is likely that emissions reductions associated with PRE have been "achieved at a cost (on average) greater than the Kyoto price".[96]

Each of the itemised findings is discussed below.

1. The difficulty of assessing projects at the margin

The review notes that the challenges faced in the design and application of PRE are significant. These challenges include:

- needing to estimate the amount of emissions avoided as a result of the project
- needing to estimate emissions avoided at a future time (ie, 2008 to 2012)
- ensuring that a disproportionate share of benefits is not captured by those who are most able to misrepresent their true circumstances and "play the system"
- assessing that the abatement projects involved are indeed in need of Government support if they are to proceed
- determining the minimum amount of support necessary to enable the project to proceed.

2. PRE being among best practice

The review noted that PRE is among best practice in terms of incorporating mechanisms to avoid the PRE support flowing to projects that would have gone ahead anyway.

In terms of this best practice, the Allen Consulting review identifies three key features:

- **a competitive tendering process** provides incentives for project proponents to reveal the lowest number of Kyoto units they would be prepared to accept in order to move ahead with their investment
- **a project analysis**, comprising a financial analysis, is carried out on each project proposal. This assesses the financial assumptions and costings associated with each proposal to determine whether the project is, in fact, additional
- **a formal declaration** is sought from proponents confirming that projects would not be carried out "… but for the award of a contract for emission units".

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96 There are other benefits associated with the PRE programme. Anecdotal evidence suggests that the PRE initiative has materially assisted in the development and take-up of technologies associated with renewable energy sources in the New Zealand context. Furthermore, the PRE initiative has helped New Zealand gain experience in trading emissions units.

[withheld under OIA s9(2)(b)(ii)]

The Allen Consulting review suggests that there was also likely to be some speculative project component in the projects claimed by PRE. This relates to investors who may not proceed with their projects, as agreed. In this eventuality, Kyoto allowances promised under PRE revert to the Crown at their full value, so there is no loss to the Crown (other than transaction costs).

4. Choices over increments to New Zealand's electricity supply are increasingly between competing renewable technologies

Partially as a result of:

- the decisions about the introduction of the carbon tax
- the increasing cost-effectiveness of renewable electricity technologies
- the increases in the cost of fossil fuels for electricity generation,

an increasing proportion of New Zealand's increases in electricity generation has come, and is likely to continue to come, from renewable energy sources. This means that it is increasingly likely that, at this time, new renewable electricity projects (irrespective of whether they are business-as-usual, or additional to business-as-usual) will have only a small effect on electricity generation emissions during CP1.

For this reason, the emission-reducing potential of PRE-supported projects may be less than the assessment implicit in PRE. This finding, in addition to the point about additionality discussed in finding 3, may adversely affect the cost-effectiveness of the PRE programme.

Going forward

In light of the findings that:

- a high proportion of units allocated under PRE went to electricity projects
- the bulk of New Zealand's additional electricity capacity (apart from one new combined-cycle gas turbine station) is likely to come from renewable sources in the immediate future
- there is doubt about whether the expected CP1 emissions reductions resulting from PRE exceed the emission units allocated under PRE,

the review recommends that the Government not continue with PRE in its present form.[97]

An issue therefore arises about the nature of any PRE programme going forward. Relevant questions include:

[97] Although this analysis raises questions about the value of PRE, it is proposed that existing PRE contracts be allowed to continue.

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- is the PRE model worth continuing with?
- if so, what should the scope of any future PRE include? (any non-electricity project? any non-energy project?)
- how can any future PRE programme fit with other policies such as the carbon tax, or policies arising from the Climate Change Policy Review, in order to avoid "double-incentives"?
- can the PRE additionality (and related) tests be strengthened to avoid business-as-usual projects being successful in any future PRE rounds?
- should units (of uncertain value) be allocated to successful firms or is a cash payment more suitable?

The Government's decision on carbon tax

An important factor in addressing the first three of these issues will be the Government's decision on the carbon tax. If the Government decides to change current policy on the carbon tax (linked to the international price of carbon, capped at $25 per tonne of CO_2e, starting on 1 April 2007 at $15 per tonne), firms' expectations of future prices (in particular for fossil fuels and electricity), and their assessment of the financial viability of different electricity generation projects and projects that would reduce emissions, are also likely to change. The assessment that the bulk of New Zealand's additional electricity capacity (apart from the one CCGT) is likely to come from renewable sources in the immediate future[98] may change too, although current modelling suggests that this is unlikely.

Conclusion

Consideration of whether PRE should continue and, if so, in what form should be delayed until the Government has confirmed either current policy or some alternative policy on the carbon tax.

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[98] Based on modelling by the Ministry of Economic Development.

4.3 Non-price and supplementary price measures

Summary
This section:

- provides an overview of the role of non-price and supplementary price measures in achieving mitigation outcomes
- summarises current work and assesses additional options for cross-sectoral non-price and supplementary price measures in the following areas:
  - public awareness and communication/information
  - climate change research and development of new technologies
  - incentives for technology uptake
  - business opportunities
  - the role of local government
  - treatment of synthetic gases (HFCs, PFCs and SF_6)
  - government leadership.

It concludes that:

- non-price or supplementary price-based measures can usefully complement a carbon tax or emissions trading
- public awareness programmes about climate change and information to influence behaviour provide a critical underpinning to climate change policy, and measures to date have been successful in raising awareness of the issues
- the limited scope of the carbon tax under current policy settings is suboptimal for incentivising research, technology development and uptake
- whatever the future policy settings for climate change, a single instrument of support for research and development is unlikely to be effective across the wide range of potential options
- clear strategic policy objectives and directions could usefully inform the prioritisation of research and technology investments related to climate change
- technology uptake is likely to be affected by the extent to which new technologies need to be adapted to local conditions or require particular infrastructure or platform technologies
- there is only a slowly emerging sense of business opportunities arising from a carbon market, and ongoing provision of information will be necessary to help develop market-based opportunities
- local government is providing an important mechanism to enhance awareness and provide leadership to reduce emissions at local level; existing regulatory measures for waste emissions appear to have been very successful
- the Ministry for the Environment is considering additional regulatory and/or voluntary measures regarding hydrofluorocarbon emissions
- government leadership can provide opportunities for awareness raising.

4.3.1 The role of non-price measures

Complementary measures

As noted in Section 4.2, a price-based measure that applies across substantial parts of the economy generally has advantages over policies based on the imposition of controls. However, non-price-based measures or supplementary price-based measures can be useful complements to a primary price-based measure so that the overall outcome of the total package better achieves the Government's set of objectives.

Circumstances in which additional measures can make the primary price-based measure work better are where:

- context is needed for the primary price-based measure
- personal engagement with the issue is difficult
- there is no market to give effect to the primary price-based measure
- there is market failure
- there are sufficient non-climate change benefits from the non-price-based or supplementary price-based measure that the measure is worth doing for other reasons.

Setting the context for climate change policy

Government action on climate change is sustainable only if a sufficient number of the voting public supports the Government's actions. For this reason, providing information about climate change and its risks and benefits is an important role for the Government in setting the context for any primary price-based measure.

Engagement with climate change

People's motivation to take action is determined in part by the extent to which they believe that climate change is a threat or opportunity to them or other people who are close, and the extent to which they believe that their action will make a difference. This is particularly relevant when the cost of emissions is small relative to other expenditures; eg, purchases such as household appliances, motor vehicles or fuel.

These issues are particularly relevant to climate change because of its long-term, complex and global, rather than local, nature. Information and education measures to help people relate to climate change at a personal level can therefore complement a primary price-based measure.

Absence of markets

If a primary price-based measure does not apply to all sectors, then applying non-price-based measures or supplementary price-based measures in those sectors may be better than doing nothing. For example, if agricultural greenhouse gas emissions are excluded from the primary price-based measure, application of particular non-price-based measures or supplementary price-based measures in the sector may be worth considering.

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Market failure

Market failures occur because of a shortcoming in the operation of the market that cannot be corrected by price signals alone. Typically, these involve asymmetry of information or cases where there is a substantial "co-benefit" that is not taken into account because of failure to price an associated negative outcome (a negative externality) or positive outcome (a positive externality) (Pearce, 2000). With respect to the mitigation of greenhouse gas emissions, the consequences of market failures are most often choices of production or consumption mixes, or choices of technologies, that fail to reduce emissions by as much as other choices (that appear economic from a cost-benefit perspective) would.

It is important to draw a distinction between genuine market failures and other market outcomes that do not accord with what appears to be economic (Jacoby, 1998). Genuine market failures occur when the market is not operating in a way that optimises economic welfare (eg, because of lack of information, unpriced costs or benefits, or regulatory constraints). However, it is not a market failure where the discrepancy between the choices actually made by businesses and households and what appears to be economic from a cost-benefit perspective is because the businesses or households have better information (eg, about the costs or risks associated with adopting a particular technology). In such cases, the market is giving an outcome that does optimise economic welfare. A genuine market failure can be corrected by measures that reduce emissions and increase economic welfare.

Table 16 – Some Examples of Market Failure and Possible Responses

Market failure	Responses
Information on the fuel efficiency of vehicles is not readily available to purchasers	Mandatory fuel-efficiency labelling
The party with the incentive (say, a tenant who is paying the heating bills) cannot capture enough of the benefits to persuade them to take action (say, having insulation installed)	Put appropriate insulation or energy-consumption performance standards in the Building Code
The structure of the wholesale electricity market makes it very difficult for demand-side management to compete with new generation	Options are being considered by the Electricity Commission
The relative energy efficiency of different equipment or appliances is not taken into account in purchase decisions because to each purchaser it is not worth their while, but taken together, the emissions implications of the individual decisions are large	Mandate minimum energy-performance standards
"Learning by doing" benefits from early application and economies of scale of new technology are not taken into account in private decisions about whether and when to adopt the technology	Measures, such as PRE, that reward early adoption

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Market failure	Responses
Significant benefits of research and development cannot be captured by those funding the research	Public funding for research
Technological "lock in" or path dependency	Financial incentives or public funding of infrastructure, to reduce the private cost of adopting the alternative technology
A bias in people's estimates about the future (say, the price of carbon in the future or the costs of climate change in the future)	Energy-performance standards for long-lived assets such as houses

Leaving decisions to the market in the case of greenhouse gas emissions requires careful consideration; in particular, consideration of the market's ability to respond to uncertainty (about costs and timing of climate change, about the nature and rate of development of low-carbon technologies, and about the cost of abatement at different rates in the future). The magnitude of the effects of climate change and the long time scales involved also add to the uncertainty.

Co-benefits

As an example of a measure with significant co-benefits, it may be worth introducing congestion pricing on some New Zealand roads, even without taking into account the benefits of reduced greenhouse gas emissions. Or it may be worthwhile taking actions to conserve biodiversity, or to conserve soil, even without taking into account the benefits of sequestering additional carbon.

Necessary but not sufficient conditions

The existence of any of the circumstances discussed above is not a justification for applying non-price-based measures or supplementary price-based measures; rather, it is justification for considering whether adding particular measures to the primary price-based measure in the total policy package is likely to give a superior outcome.

Specific measures that would complement a carbon tax or emissions trading are considered in the sections of the review that consider each of the main sectors.

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4.3.2 Public awareness about climate change

From 2003, social marketing has been integrated as part of the overall climate change policy package as a means of addressing specific market failures that cannot be effectively addressed through price-based measures.

In New Zealand, social marketing campaigns have been employed in a number of sectors where price-based measures alone would not create the kind of behaviour change required. As such, attitudinal changes have been achieved through successful social marketing campaigns to prevent drink-driving, encouraging behavioural changes around saving for retirement and getting more exercise (*Sorted* and *Push Play* campaigns).

At its core, a social marketing campaign is designed to influence social behaviours by engaging the public and key stakeholders at an emotional and practical level. It also works to support price-based measures by recognising that it is very hard to achieve the strategic aims of any policy package without the public and business community's support and participation. In terms of climate change, this means:

- awareness and acceptance among individuals and the business community that climate change is an issue
- awareness and acceptance that individuals and company behaviour have a part to play in addressing the issue
- awareness and acceptance of policy solutions that the Government is putting forward
- active participation by individuals and companies in the required behaviour changes.

Various evaluations of social marketing activities have shown that this information is not as effectively communicated by solely promoting individual policies. Social marketing campaigns employ tools and techniques that promote a behaviour change across a range of information mediums and tend to have a longer-term perspective.

The Government's three-phase social marketing programme, called the 4 Million Careful Owners campaign, was launched in 2003.

The campaign was designed to improve New Zealanders' understanding of the issues relating to climate change and to bring about changes in behaviours that would help reduce greenhouse gas emissions. The Government has an important role in providing information about climate change and about the risks and benefits associated with it, particularly in setting the context for price-based measures.

The decision to launch this campaign was based on extensive research, undertaken by the Ministry for the Environment, 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 emissions and, therefore, the effects of climate change.

The approach was intended to be a whole-of-government one, led by the Ministry for the Environment, with involvement in programme development and implementation from the EECA, MAF and MOT.

The central challenge of the entire campaign 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 was designed in three phases. The first phase was launched in December 2003 and focused on raising public awareness. Phase Two (November 2004 to February 2005) of the programme built on these messages and moved to making a difference through behaviour change. Phase Three, which is expected to begin at the end of 2005, will further the objectives of the first two phases.

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The campaign brought together a range of marketing, public relations and stakeholder relations elements that have been proven both in New Zealand and overseas to be effective in building engagement and changing behaviour. Specifically, these elements were designed to prompt debate and move New Zealanders through the awareness stage and into action mode and included a website, media campaign and education activities.

The 4 Million Careful Owners site is aimed at the general public and the education market and provides useful tips on how to reduce emissions from transport, energy 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 with other Kiwis.

In addition, a climate change education unit has been developed for teachers and distributed to nearly 3,000 primary and intermediate schools around the country. This is supported by a new section for school students on the website, including an online activity called Play it Cool. The booklet has been highly successful, with many requests for more copies.

Other elements of the campaign included nationwide advertising via various media channels and the distribution of positive media stories around the country.

Stakeholder communications and cooperation have also been employed in the 4 Million Careful Owners campaign. Key stakeholders, such as industry groups, non-governmental organisations and professional umbrella groups, have been engaged 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, which includes senior representatives from a broad range of sectors such as farming, transport, regional and district councils, dairying, large corporate service organisations and business, has been convened to act as a sounding board to provide input and feedback on climate change communication initiatives for the campaign, and has been essential for establishing what was practical and possible to voluntarily reduce emissions in the respective sectors.

The group's members have stated that the bi-monthly meetings are useful and have prompted them to place climate change higher on their agendas than it was previously. 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.

It is extremely difficult to quantify whether a social marketing campaign, such as the 4 Million Careful Owners campaign, is directly responsible for a change in public attitudes. Following the second phase of the 4 Million Careful Owners campaign, a survey showed that the number of New Zealanders who considered that climate change was a serious problem increased from 66% to 73%. Also, the number of people who attributed climate change to human-caused emissions (rather than natural climate variations) increased from 63% to 71% over the same period.

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4.3.3 Motivation and information about behaviour changes that lead to reduced greenhouse gas emissions

Achieving the strategic aims of any future climate change policy package requires the support and participation of all New Zealanders. Similar international campaigns, such as in Canada and Europe, have shown the response to price-based measures is far more effective if individuals are better informed about the risks of climate change and are personally engaged in its relevance to them. Achieving this requires overcoming the multiple barriers and benefits around an individual's sustainable behaviour towards the environment. People's motivation will be increased if their own barriers are reduced through good information and engagement.

In terms of the 4 Million Careful Owners campaign, UMR research carried out at the end of the first phase clearly showed it was successful against its objectives of:

- creating awareness
- engaging New Zealanders
- preparing the ground for a long-term campaign aimed at behavioural change.

In a January 2005 survey, following the second phase of the 4 Million Careful Owners campaign, nearly six out of ten New Zealanders (56%) said they had thought about taking, or had taken, actions to help reduce the effects of climate change. While not directly comparable, in January 2004, of those who had seen the 4 Million Careful Owners advertising (20%), 21% of these were prepared to take actions to reduce the effects of climate change.

Work to date targeting businesses, transport, energy providers and local government to support the climate change policy package has been ad hoc and not always as effective as it could be.

Integrated communications and media plans have been run sporadically around particular issues, such as the carbon tax. However, there has been little promotion of good-news stories or support or cooperation around the many other stakeholder activities that are occurring both at a central government level and within stakeholder communities themselves.

The third phase of the 4 Million Careful Owners campaign should work to address some of these issues. It is due to begin in the final quarter of 2005 and run through to the first quarter of 2006.

As well as converting gains and addressing the public, future phases of the 4 Million Careful Owners campaign also need to address a wider range of stakeholders, including small and medium enterprises and energy-intensive businesses. The latter include businesses involved in wood processing, arable crops, irrigated crops, metallic industries, non-metallic industries, glasshouse crops, pulp and paper, tourism and meat processing, which were not directly addressed in earlier phases.

It is recommended that future phases of the 4 Million Careful Owners campaign should also be broad-based and extensive, using advertising, public relations and stakeholder relations activities to help business, land users, transport, energy providers, central and local government and the general public to take voluntary actions now.

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4.3.4 Research and development

Summary

The area of climate change research and development is very broad, ranging from basic research of climate processes and systems through to applied mitigation and adaptation research and technology development. Across these research types, choices are made about what problems and issues to emphasise, spanning fundamental understanding and monitoring, mitigation (reducing emissions) and adaptation (adapting to the effects of climate change on the environment, economy and society). Choices are also made regarding which "sector" to focus research on (eg transport, agriculture etc), the type of technology approach, and the relative roles of the public and private sector. Climate change policies and strategies can influence these choices.

Accurately stocktaking current investment in climate change research is difficult. Relevant research and activities are spread across several of the Foundation for Research Science Technology's (FRST) investment portfolios, as well as generic industry-support programmes and private-sector undertakings.

The Government currently provides around $30 million per annum for direct climate change research, largely through FRST. A relatively small proportion of this is explicitly directed to mitigation research.

The broader climate change policy settings are also relevant when considering the private incentives for research and development and technology uptake. Current policy settings include the proposed carbon tax, EECA's energy audits and energy-efficiency information programmes, minimum energy-performance standards and labelling, and energy-efficiency demonstration projects.

Price-based measures work to change relative prices and hence altering the relative returns to research and development. Their advantage over command-and-control measures is that they are technology neutral (they do not rely on the Government "picking winners") and allow firms flexibility in their response, of which undertaking research and development is just one option.

From the perspective of motivating mitigation research and development, some literature suggests that an appropriate price-based measure would be:

- broad-based (economy-wide)
- phased in gradually
- implemented in a predictable and continuous manner.

The carbon tax as currently designed (with its exemptions for agriculture and for significant parts of major energy users, and its current limitation to 2012) is not optimal from a research and development perspective. Furthermore, without a credible threat of future price-based measures, farmers in particular have little incentive to take up mitigation technology that is not cost-effective in its own right.

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However, there are a number of impediments to this optimal design from a research and development perspective. In the absence of a reliable long-term international carbon market, establishing a long-term domestic path with an increasing tax rate is difficult. A fully fledged carbon market involving all major emitting countries and to which New Zealand would have full access is unlikely in the foreseeable future. The coverage of any price-based measure is also problematic, not least because of the measurement difficulties associated with agricultural non-carbon dioxide emissions.

Alternatives to a price-based measure include Government funding and/or provision of research, regulation (mandatory performance standards) and industry support schemes. Effective linkages with industry (eg, via appropriately targeted demonstration projects) and with domestic and international research programmes are important. The Government's new pilot projects aimed at energy-intensive businesses focus on technologies that have already achieved widespread diffusion and uptake, and in this respect, seem poorly targeted. International collaboration appears to be well funded and supported. There may be scope for investigating further the way domestic linkages and clusters are supported.

Whatever the future policy settings for climate change, a single instrument of support for research and development is unlikely to be effective across the wide range of potential options. It is therefore important to assess the effectiveness of the current prioritisation process in determining and reflecting climate change research priorities that are unique to New Zealand.

The current science priority-setting mechanism is in a state of change, with greater emphasis being placed on responsibilities and how priorities are set. There is a process of developing road maps for a number of the current FRST portfolios.

Any fundamental change in the direction and scope of overall climate change policy arising from this review is likely to impact on the suitability of current climate change research priorities. Furthermore, the resulting incentive effects on firms and individuals will influence the appropriateness and effectiveness of any Government investment in research and development.

A key judgment is whether, subject to changes in the broader policy landscape, there is a need for a more formal and structured approach for feeding into the science priority-setting exercise. Such an option would not attempt to duplicate existing mechanisms for priority-setting, but would seek to provide a clear information base and research direction to inform these existing mechanisms. A product that would usefully influence decision-making would do the following:

- set out the climate change **policy objectives** – domestic emissions reduction? In specific areas/sectors? Over what timeframe? This could include specific (quantified) targets

- set out the **relative priority** of climate change with respect to other Government goals against which trade-offs are made – are we concerned about climate change, and what is the level of this concern?

- establish **how research and development fits** into the broader climate change policy settings, and any sector-specific goals and mechanisms

- go beyond providing a description of issues and set out a **clear direction** – establishing what's important (or critical) and what's not (or of lesser importance)

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- be responsive over time, as issues, opportunities and new information emerge and relative priorities alter

- provide scope for long-term partnerships with industry.

In order to achieve widespread diffusion and adoption, and cost-effective mitigation more broadly, technology options must be cost-effective in their own right. Expecting firms to weight mitigation characteristics over and above other factors such as price would require a change in objectives from profit maximisation to climate change mitigation – this is neither likely nor desirable.

Furthermore, technologies adopted from overseas may require adaptation (eg, to our particular climatic conditions) or suitable infrastructure or platform technologies in order to achieve widespread adoption in New Zealand (such as upgrading of the electricity grid). Such requirements will impact on the desirability and cost-effectiveness of adoption of particular technologies, and on the speed of adoption. These considerations should also be factored into research and development investment decision-making, so that the total costs and benefits of particular technology choices are taken into account.

There is some concern regarding attracting and retaining an appropriate pool of skilled researchers. Taking a long-term, strategic view of research priorities could assist in this respect. FRST has recently moved to trial outcomes-based investment over a period of 12 years in the environment area, which should assist with funding certainty and hence staff retention. The Ministry of Research, Science and Technology (MoRST) is also aware of the issue of funding volatility, and is currently developing a strategy to support an attractive research and development environment for skills and talent.

Current investment mechanisms and industry-support schemes

Growth and Innovation Framework

The Growth and Innovation Framework is the key framework within which the Government seeks to deliver its economic objective of returning New Zealand's *per capita* income to the top half of the OECD rankings. It sets a role for Government as proactively supporting growth and working with targeted sectors to achieve that growth. The framework relies on building more effective innovation in targeted areas, one of which is biotechnology.

Sustainable Development Programme of Action

The Sustainable Development Programme of Action is another important Government framework with respect to research and development. The Government has agreed that sustainable development principles should underpin its decision-making. This requires the Government to take account of the long-term economic, social, environmental and cultural consequences of its decisions.

Institutional arrangements

The Government's investment in research, science and technology is managed by MoRST, through Vote Research Science and Technology. Funding is contracted by three purchase agents: FRST, the Health Research Council and the Royal Society of New Zealand (through the Marsden Fund).

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FRST is a Crown entity responsible for administering around $400 million per annum of Government funding. FRST invests its funding through a number of funds and schemes, including five "public good"-related science and technology output classes. The environmental output class is a funding stream of key relevance to climate change research. Other research portfolios support more generic, economically-focused outcomes, which may (indirectly) deliver mitigation benefits.

Some climate change research is also funded by other government departments, as well as local government and the private sector.

National Science Strategy Committee for Climate Change

The National Science Strategy Committee for Climate Change was established in 1991 and charged with developing a comprehensive climate change research strategy that would identify climate change research priorities and gaps and evaluate overall funding needs. It was to advise funding agencies on the priority and integration of research proposals and develop a portfolio of research to meet the objectives of the National Science Strategy.

The committee was disestablished in 2003. Factors leading to this decision included its focus on developing a broad portfolio of climate change research, and associated difficulty in providing advice on funding priorities, in particular on trade-offs between broad areas of research within a limited budget. The committee's influence was also regarded as diminished following New Zealand's ratification of the Kyoto Protocol, as Government departments were seen to have increasingly clear visions of their climate change work programmes and hence unlikely to be influenced by research recommendations from an independent committee.

Prior to its demise, the National Science Strategy produced the 2002 Climate Change Research Strategy. Cabinet has noted that it remains important for the Government to receive strategic advice on climate change research needs, directions and priorities. It was noted that the Convenor, Ministerial Group on Climate Change would subsequently assess every three years whether an independent review of New Zealand climate change research is required. An assessment is due in 2006.

The Pastoral Greenhouse Gas Research Consortium

The Pastoral Greenhouse Gas Research Consortium (PGGRC) is a funding partnership between the Government and the agricultural industry that was launched in 2002. The industry partners represent the dairy, sheep, beef cattle and deer sectors, as well as fertiliser manufacturers.[99]

A memorandum of understanding between the Crown and the agricultural industry was signed in 2003. This memorandum recognises that "there are currently no proven, practical and cost-effective farm practices and technologies to reduce agricultural emission, whether by improving production efficiency for ruminant animals or otherwise".[100] It sets out the Crown's decision to not levy the sector for the purposes of raising research funding emissions, provided that the sector voluntarily contributes to

[99] Consortium members are: AgResearch Ltd, Dairy Insight, DEEResearch, Fonterra, Meat and Wool New Zealand, Wrightson Ltd (now PGG Wrightson) and the Fertiliser Manufacturers' Research Association. MAF and NIWA currently are associate members of PGGRC.

[100] Memorandum of understanding between the Crown and the agricultural industry. <http://www.pggrc.co.nz/pggrc.asp?type=mou>

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research into ways to reduce greenhouse gas emissions from agricultural activities. This arrangement represents the Government's decision to bear the cost of the agricultural sector's non-carbon dioxide emissions (as opposed to devolving the liability to emitters).

The strategic goals of the consortium are to:

- identify, establish and develop on-farm technologies to improve production efficiency for ruminants
- identify, establish and develop on-farm technologies for sheep, dairying, beef cattle and deer that 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 PGGRC manages the jointly-provided funding, of which the Government's contribution comes through FRST.[101] This contribution is matched dollar for dollar by the industry. The participating industry groups also fund their own research programmes, some of which represent important underpinning data and field-trial opportunities.

Industry-funded Research and Development in the Agriculture Sector

New Zealand's agricultural sector comprises a large number of small producers, making it often infeasible for individual producers to fund or undertake significant research and development. Under the Commodities Levies Act, industry organisations can impose levies on their members. Dairy Insight's levy on dairy farmers who supply milk solids to dairy companies is an example of this. Their levy revenue is spent on industry-good activities, including farm-focused research and information transfer, product safety, promotion and education and environmental research.

There are also a number of industry research programmes funded through voluntary levies. Fert Research, for example, is an industry-funded association, with its two member companies together responsible for manufacturing, distributing and marketing around 90% of fertiliser sold in New Zealand. Aiming to maximise the benefits of sustainable fertiliser use, it commissions research where it perceives there is a need in the industry. It focuses on research that generates major changes in nutrient management practices; significant innovation in systems and tools for nutrient management; and direct benefits to farmers (whether financial, environmental or technological).

Other industries have weaker and less well-structured umbrella groups, with lesser capacity to raise research funding from their suppliers and members.

Sources: <http://www.dairyinsight.co.nz/main.cfm?id=5>; <http://www.fertresearch.co.nz>

[101] The Government's contribution is currently $1.820 million per annum.

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Vote Research, Science and Technology

Total operating funding allocated to Vote Research, Science and Technology for the 2005/06 year is almost $600 million.[102] Of this, $86.4 million (13.6% of the Vote) is allocated to the Environmental output class. The purpose of this research is to "increase understanding of the environment and factors that affect it". Funding for "Global Biophysical Environment" research outputs sits within the Environmental output class and comprises $22.8 million for 2005/06. Also within this output class is funding for "Sustainable Production" research, which amounts to $27.1 million for 2005/06.

This latter funding stream focuses on research to enhance the environmental sustainability of New Zealand's primary sector industries. More broadly, other FRST portfolios (enhancing sustainable growth, optimising use of physical resources and resilient infrastructure use) support more economically oriented outcomes, which can include climate change benefits. In this respect, climate change mitigation is effectively "mainstreamed" into broader, growth-focused research and development programmes.

Priority setting

A key challenge for FRST has been clarifying the "strategic basis" for detailed funding decisions at the operating level. While FRST aims to align the funds it invests in RS&T with Government objectives, there have been some difficulties. FRST has been heavily reliant on the consultation process to develop the target outcomes and themes within this framework. This has involved targeted consultation with Government agencies and research organisations, as well as other relevant stakeholders.

In May 2005, FRST revised its investment framework to better operationalise and align with high-level Government objectives. This comprised a mixture of bottom-up and top-down analysis. MoRST is now developing a "road map" to give FRST greater policy direction.

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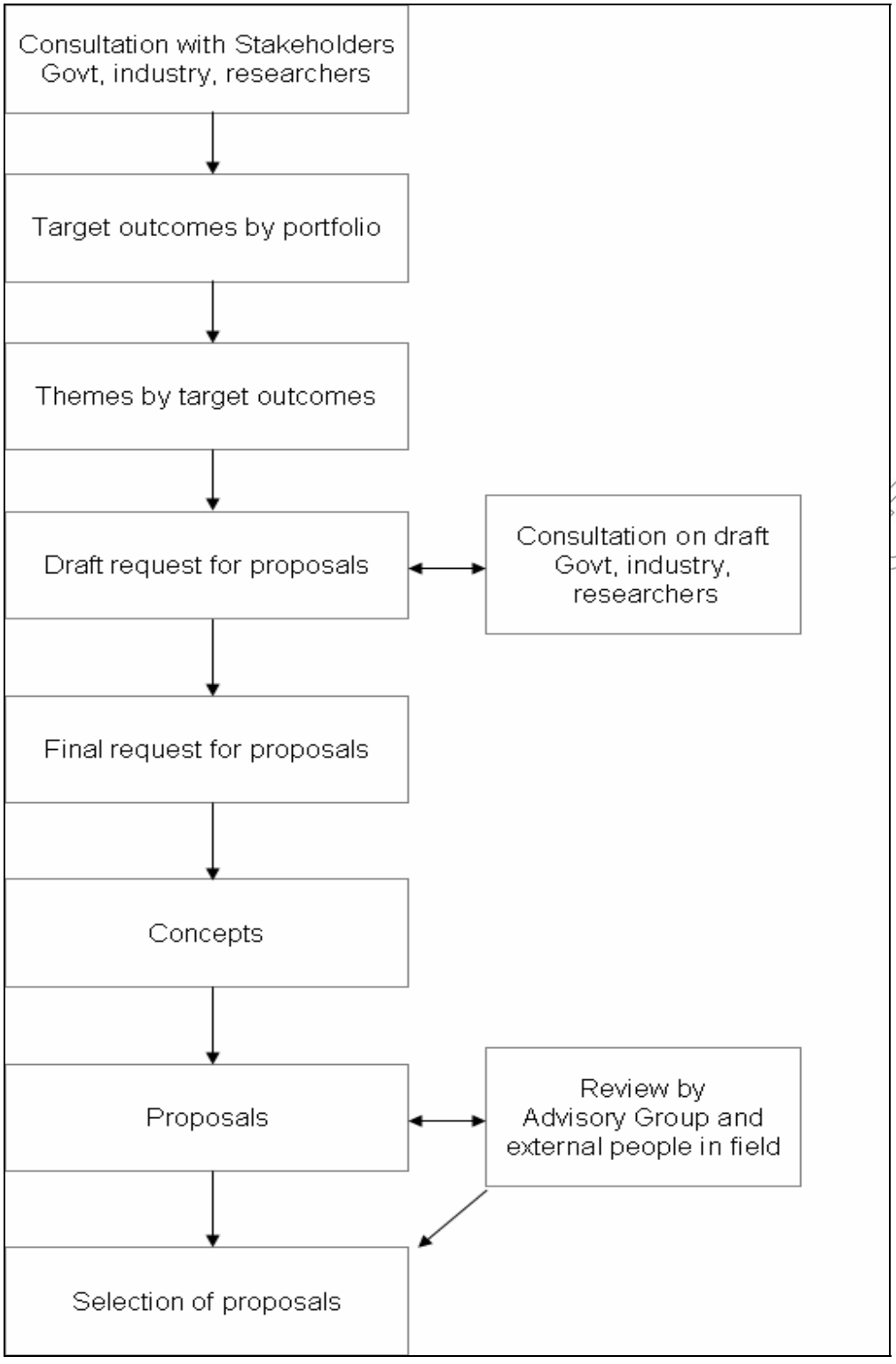
102 Budget figures exclude GST.

Figure 37 – FRST's Priority-Setting Process



Source: FRST, 2005 Pers. comm.

New Zealand last reviewed and updated its national climate change research strategy in 2002 (National Science Strategy Committee for Climate Change 2002). It appears that this strategy has not been widely adopted and utilised for the purposes of prioritising Government research funding contributions.

There are a number of other, environmentally-related strategies that can be used to inform the Government's funding prioritisation processes. These include the Sustainable Development Programme of Action (which has sustainable energy as a particular focus area), the National Energy Efficiency and Conservation Strategy, the New Zealand Biodiversity Strategy, the Water Programme of Action and Oceans Policy (currently under development).

In October 2004, the Government released a paper: *Sustainable Energy: Creating a Sustainable Energy System* as a basis for engagement with key stakeholder groups. The subsequent report back noted that stakeholders expressed a general desire for the government to articulate a clearer strategy for achieving sustainable energy objectives. Cabinet has directed officials to report back by 30 November 2005 on what steps, if any, should be taken to strengthen the contribution of research, science and technology policy to sustainable energy, including in the areas of research and development, technology testing and international technology collaboration (CBC Min (05) 8/9 refers).

Since 1998, overall funding for MoRST's Environmental Research output class has remained static. Funding increases have been targeted in particular areas, one of which is climate change (the others being GM and possums). As a result, climate change research accounted for 18.5% of this funding stream over 2002/03.

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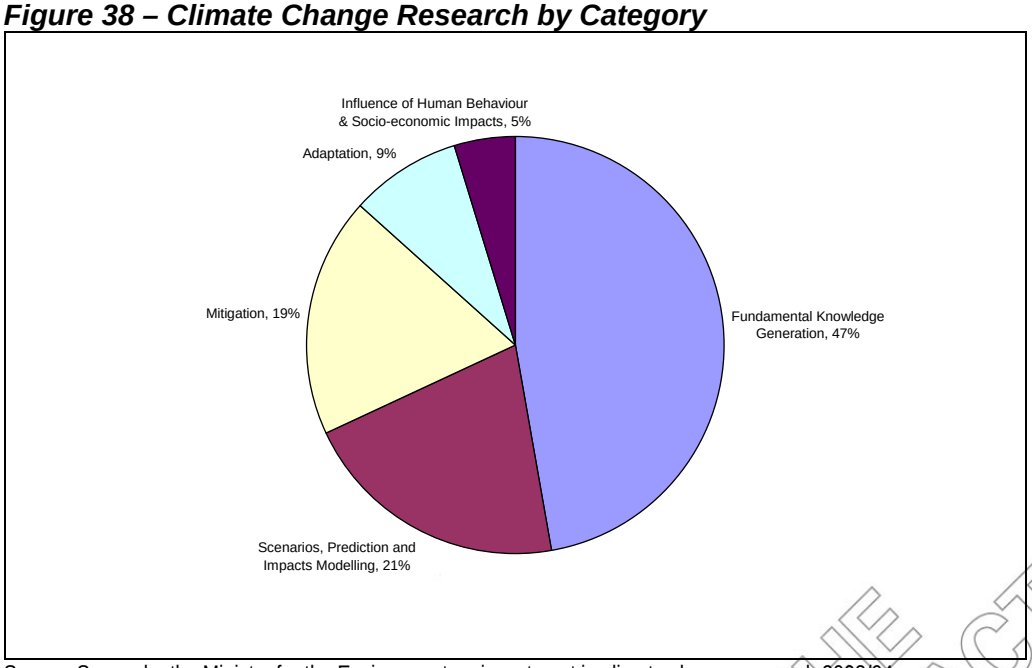
Current New Zealand climate change mitigation research and development

Climate change research and development falls into a number of key categories (the boundaries to which are far from concrete). Broadly speaking, they are: basic research, which contributes to the international understanding of climate change; basic and applied research that looks at translating this information into the impacts of climate change on New Zealand (both directly in climate as well as consequential impacts); and research into technology that can contribute to mitigation. The last type of research is aimed more directly at the issue of how New Zealand can reduce its domestic emissions.

Research in other areas, for example into farm management practices, can indirectly provide emissions-mitigation benefits. A stocktake of projects directly focused on climate change is therefore likely to understate the extent of research that may contribute to climate change objectives.

A survey of climate change-relevant research by the Ministry for the Environment found that almost $33 million of projects were under way in 2003/04. Around 19% of this was directed towards mitigation research (Figure 38). Two-thirds of this funding was administered by FRST, with the rest from central government departments, the Marsden Fund, local government and the private sector.

Figure 38 – Climate Change Research by Category

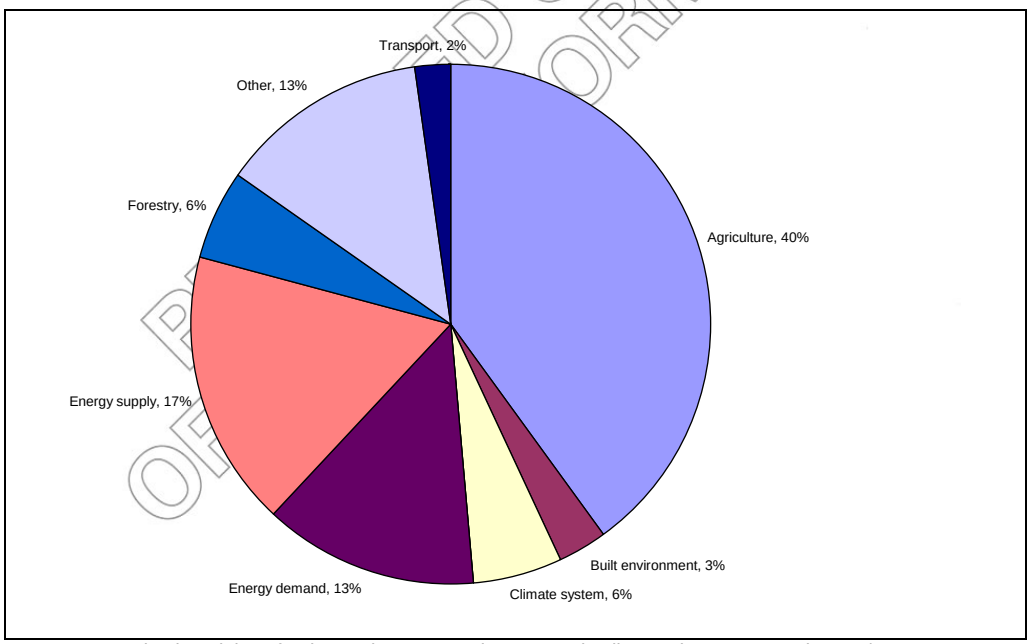


Source: Survey by the Ministry for the Environment on investment in climate change research 2003/04

Of the approximately $6 million worth of targeted mitigation research, around 40% of this was being undertaken in the agricultural sector, followed by 30% in energy (supply and demand). Just 2% of this research was focused on transport emissions mitigation (see Figure 39).

Figure 39 – Mitigation Research by Sector

Proportion of Total Value of Projects Under Way in 2003/04



Source: Survey by the Ministry for the Environment on investment in climate change research 2003/04

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It should be noted that the categorisation of projects is somewhat subjective, and categories are not mutually exclusive. For instance, some research classified as "fundamental knowledge generation" will also contribute to mitigation outcomes. There will, therefore, be a degree of fuzziness around these boundaries, and proportions shown are indicative only. But what this does serve to illustrate is the wide diversity of end uses of climate change research, and hence the diversity of the research itself.

Time series analysis is difficult, but examination by FRST in 2000 suggested that, at least over the 1999 to 2000 period, FRST funding increases in this area were directed towards "effects" and "responses", with funding for the "processes" category declining.[103] This is the first time that such a reprioritisation within the Vote has been initiated outside normal investment cycles, and reflects strong signals from Government and the Minister of Research, Science and Technology that mitigation research is important. This analysis also suggested that while funding through the private sector increased markedly, funding from universities declined. If this constitutes a trend, this latter point has implications for the future supply of researchers in this area as discussed further below (FRST 2000).

Mitigation research and development: priorities for New Zealand

There are a number of factors to be taken into consideration when assessing the research and development priorities for climate change mitigation:

- critical emissions areas – both in terms of level (proportion of total emissions) and growth
- potential areas of pay-off
- possible value of pay-offs, including co-benefits and spin-offs
- costs of investment
- likelihood of success (probability of pay-off)
- timeframe for pay-off
- the degree of uncertainty around these factors
- for each possibility, the extent to which New Zealand could be a world leader or a technology/innovation taker (fast follower)
- the uniqueness of New Zealand's requirements with respect to applying overseas innovations (eg, the significance of New Zealand's unique biological and climatic systems to adopting or adapting overseas agricultural technologies)
- the extent of potential co-benefits (including assisting adaptation to the impacts of climate change) or perverse impacts (such as resulting increases in other greenhouse gases, or emissions elsewhere).

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[103] Effects = improved understanding of physical, biological and social systems to changes in climate. Responses = establishing a scientific basis for adaptating to climate change, sustainable practices to manage human impacts on the climate system, and mitigation responses. Processes = understanding variability and likely future change in New Zealand's atmosphere and climate system.

Assessment of these factors can then be matched against the current level and mix of research and development investment.

As described in Section 3.1, emissions from agriculture comprise around half of our total emissions. Also of critical importance are transport CO_2 emissions, which comprise around 18% of our total gross emissions and are rapidly growing.

The split of mitigation research as shown in Figure 39 suggests the funding allocated to agriculture (around 40%) is broadly in proportion with this sector's contribution to total emissions. However, the relatively small proportion dedicated to mitigating transport emissions seems, at first glance, surprisingly small.

This may be explained in part by New Zealand's position as a technology taker in the transport sector. Being totally reliant on imported technology, our scope for mitigation innovations is largely dependent on our decisions regarding source markets (currently dominated by Japan). There may be scope for research into optimal infrastructure and urban design, as well as behavioural change (such as increased uptake of public transport and alternatives to road transport, such as walking and cycling).

In agriculture, on the other hand, New Zealand has considerable incentives to generate innovations, and hence undertake domestic research and development. Our primary-industry background provides us with a comparative advantage in research to improve productivity in this area. Because of our unique interest in and focus on agricultural emissions, there is less scope for being a technology follower in this area (as other countries do not have similarly strong incentives to undertake such research). There is therefore a strong element of necessity being the "mother of invention".

In terms of energy supply, New Zealand is well placed as a fast follower with respect to new renewable generation, in particular wind generation. Other countries, such as Denmark, have considerable experience in developing wind turbines, and the technology is now well developed (although there may still be a need to adapt overseas technologies to local conditions). The scope and potential application issues around small-scale distributed electricity and heat generation, geological carbon capture and storage, and the use of biomass as solid and liquid fuel in New Zealand's potential future energy mix, could also warrant further investigation. MoRST, along with MED, is developing a "road map" for future energy research directions. This will have a particular focus on renewables, trialling technology, oil and gas research, and coordination.

With respect to energy demand, New Zealand is largely a technology taker in terms of plant, equipment, appliances and so on, which are sourced largely from overseas. The potential for domestic research and development in this area is therefore largely in investigating options to address barriers to optimal investment in energy-efficient technologies and changes to behavioural practices.

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Another consideration is the mix of basic versus applied research. As shown in Figure 38, basic research (fundamental knowledge generation) comprises by far the largest proportion of climate change research. Targeted mitigation research[104] accounts for around 19% of total climate change research. Splitting the data another way shows that around 23% of funding is directed towards projects that have some aspect of international collaboration, and around 11% into projects expected to contribute to "economic opportunities".[105]

It is noteworthy that research into human behavioural responses accounts for a very small proportion of total climate change research investment. This may, in part, reflect the small base of social scientists working in this area in New Zealand (and hence submitting research tenders). To the extent that there may be unique characteristics of the New Zealand socio-economic landscape, the adequacy of effort in this area could warrant further investigation.

The diversity of end uses noted above suggests that one type of programme alone is unlikely to effectively achieve the range of outcomes sought. It also points to the desirability of linking investment criteria to strategic climate change priorities, in order to achieve the most effective mix of programmes.

United States Climate Change Technology Programme – Portfolio Planning and Investment Criteria

The United States Climate Change Technology Programme (CCTP) has a set of four criteria for planning its investment portfolio:

- **maximising return on investment** – priority is given to research investments that offer the greatest likelihood of success, in terms of climate change benefits per dollar invested. This criterion includes consideration of development and deployment risks. High-risk projects offering potentially low emissions reductions are excluded from the portfolio
- **acknowledging the proper and distinct roles for the public and private sectors** – this criterion recognises that some research and development is best undertaken by the private sector, some through public-private partnerships and some by the Government. In the case of the last, it is nonetheless acknowledged that technology development and adoption require close cooperation and engagement with the private sector
- **focusing on technology with large-scale potential** – emphasis is given to technology potentials that offer large mitigation contributions, global-scale adoption opportunities and a clear path to commercialisation
- **sequencing research and development investments in a logical, developmental order** – this criterion recognises that technology options should not necessarily all be supported simultaneously. Logical sequencing of research and development investments takes into account the expected times when different technologies need to be made available and cost-effective, the need for early resolution of critical uncertainties and the need to demonstrate early success or feasibility of technologies upon which other advancements may be based.

[104] Research aimed at stimulating and guiding the identification, development and implementation of mitigation response strategies.

[105] Promotion of the innovation and business opportunities with potential economic benefits to businesses and consumers, and technology transfer.

These criteria are all applicable to the New Zealand context, and offer opportunities for maximising the value for money from our climate change research programmes. An important message from the United States programme is that strengthening research and development does not necessarily imply spending more money – it also includes spending more wisely.

Note: These criteria relate to the US' climate change-specific basic science. Other or generic research programmes may have different investment criteria. Source: CCTP, 2005

Effectiveness of price-based measures in stimulating New Zealand climate change mitigation research and development

In order to reap widespread benefits from mitigation research and development, there needs to be:

- successful innovation/development results (pay-offs)
- commercialisation or other market incorporation mechanisms (eg, incorporation into planning processes)
- widespread diffusion and uptake of the resulting technology/process.

This section focuses on the role of policy measures in stimulating the first two actions. Technological uptake is discussed in more detail in Section 4.3.5.

Research and development represents just one way of achieving behavioural mitigation responses. Each emitter faces a range of potential mitigation options, including capital investment (in more efficient technologies) and process improvements. At the extreme, they can reduce or move out of production altogether. Optimal decision-making behaviour will involve emitters investing in the most cost-effective mitigation responses.

Rationale for government intervention

There are a number of reasons why the market may "underinvest" in mitigation research and development. These include the facts that:

- where environmental externalities are not "priced in" to decision-making, investment in mitigation research and development will be lower than what is environmentally optimal since the "true" benefits of research and development are not being reflected in market prices
- the benefits of mitigation accrue beyond the individual investor, to society more broadly. Because the social benefits of mitigation exceed the private benefits, and because the decision to mitigate is taken by the individual investor, we may expect a suboptimal level of mitigation investment, including in research and development
- research and development is a high-risk investment, with much accompanying uncertainty. There can also be a long lead time before the benefits of research can be captured by investors. Individual firms may be unwilling or unable to bear all of this risk, or may not be fully aware of the future risks that research and development could ameliorate, and may therefore opt for less environmentally effective but more certain outcomes via, eg, capital investment. This is likely to be especially true for the New Zealand economy, which comprises a high proportion of small- to medium-sized firms.

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Government may respond to these barriers by:

- pricing in environmental effects through market-based measures such as taxes or permits
- imposing regulation and standards to achieve environmental objectives. This would stimulate research and development insofar as manufacturers and producers are compelled to produce products to a certain technological standard
- co-funding research or underpinning research capacity to assist with risk-bearing
- other forms of industry support, aimed at redressing information or capability problems.

More broadly, the Government can help stimulate generic research and development by providing a stable macroeconomic environment and robust regulatory settings.

Price-based measures

Price-based measures include taxes, grants and permits (trading schemes). What price-based measures do is alter the rates of return for research and development. For instance, a tax on CO_2 emissions would increase the value of successful research into CO_2 mitigation measures, both in absolute terms and relative to other research options. Similarly, grants can lower the costs associated with research and development.

The key price-based measure of relevance to New Zealand's climate change research and development is the planned carbon tax.

The received wisdom in the economics community has traditionally assumed that price-based tools provide greater incentives for research and development than "command and control" tools such as emissions-standards regulation. The rationale for this is that price-based measures (as opposed to regulation) change the incentives to mitigate by pricing in the environmental externality, but retain flexibility for emitters in how they implement this abatement. This maintains the ability of emitters to undertake the most cost-effective mitigation responses. However, the empirical evidence to support this assumption is mixed, and assessing relative efficacy of the various policy tools in stimulating research and development is more complex than this hypothesis would suggest.

Most literature in this area tends to focus on comparing and assessing the various types of policy tools available. There is less emphasis on the optimal design of price-based measures from a research and development perspective. Research from the US suggests that, for price-based measures to be optimal with respect to stimulating mitigation research and development, they should be broad-based (to stimulate the most immediate response from mature technologies), and phased in gradually (to give emitters time to adjust to new costs, and gradually stimulate the uptake of emerging technologies and investment in the development of new ones).

Key for researchers and firms is the predictability and continuity of price signals such as taxes (NRTEE, 2005). This allows for price signals affecting the rates of return to mitigation research and development (in a net present value sense) to be factored into decision-making, and for research and development programmes to be planned accordingly. More generally, a clear, robust regulatory context is desirable in promoting an optimal level and balance of research and development. New Zealand's planned carbon tax is designed to approximate the international price of carbon, with an introductory rate of $15 per tonne of CO_2e. It is not broad-based, as it excludes methane

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and nitrous oxide emissions from the agricultural sector, and involves significant exemptions to major emitters.

Theoretical research suggests that taxes are likely to encourage more innovation than a permits-based system. A permits system could limit the amount of research undertaken, because as successful innovation causes abatement costs to fall, permit prices will also drop (hence reducing the value of potential gains from further research). The differential between the two systems depends on potential for the innovator to recoup gains (ie, the ability to obtain rents from adopting firms) (Fischer, 2003).

Government Response – What are Other Countries Doing?

United States

The United States has not ratified the Kyoto Protocol. However, it has a substantial climate change research and development programme aimed at encouraging innovation, scientific and technological breakthroughs and global participation. In addition, its Energy Policy Act provides a number of incentives for renewable energies and energy-efficiency technologies.

The focus of its research and development programme is on reducing emissions while sustaining economic growth, the rationale being that growth and the capital that growth creates is necessary to finance investments in mitigation technologies. The United States approach to mitigation is therefore science- and technology-based, relying on cleaner, more efficient technologies to enable economically sustainable emissions reductions. The federal government allocated nearly $US3 billion to climate change-related research and development over 2005 (to put this in context, the total budget for basic and applied research was $US56 billion, and for development was $US71 billion).

Particular foci include:

- improving energy efficiency
- low-emission energy-supply technologies (including nuclear and hydrogen)
- CO_2 capture and storage
- carbon sequestration (biological, terrestrial and geological).

Key initiatives include:

- strengthening research at university and national laboratories
- enhancing partnerships in applied research
- improved technology for measuring and monitoring emissions
- ensuring a viable technology workforce through education and training
- funding demonstration projects of cutting-edge technologies.

Australia

The Australian Government has identified climate change and technological responses as a key national research priority. The Australian Climate Change Science Programme aims to improve understanding of the causes, nature, timing and consequences of climate change in Australia. This is funded by $AU30.7 million over four years from Government, with additional equal contributions from the

Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology.

A key focus of research investment is renewable and low-emissions energy generation. Projects include CSIRO's work on zero-emissions coal technology (via gasification and geosequestration of greenhouse gas by-products), natural gas-powered distributed energy systems, and the use of hydrogen. Under the Mandatory Renewable Energy Target, the Government has allocated over $AU300 million to projects encouraging the deployment of existing renewable energy technologies and commercialisation of new technologies. Many of the 50 new technologies projects are already exhibiting market potential – eg, the commercialisation of dish and trough solar concentrators and the development of innovative photovoltaic cells. The Strategic Research and Development Investment Plan focuses on developing technical solutions specifically to address climate change in agriculture and natural resource management The Government's contribution is $AU9.4 million over four years, with additional co-funding expected from industry and research organisations. Priority investment areas within this plan are livestock, agricultural soils, savannas, planted forests, natural resource management and farming systems.

Canada

Canada's climate change strategy aims to achieve long-term domestic emissions reductions, while maintaining a competitive and growing economy. Their strategy focuses largely on voluntary mitigation responses, with the exception of their domestic emissions-trading system for large final emitters (LFE). Encouraging innovation and developing environmental technology is a key aspect of the Canadian Government's approach to long-term mitigation. Specific measures include:

- a $CA200 million package (out of a total for research and development of around $CA1 billion) announced in the 2005 Budget to develop and implement a Sustainable Energy Science and Technology Strategy. This reflects the aim of establishing Canada as a global leader in the field of environmental technologies, promoting the export of low-emissions technologies
- changes to taxation policy to increase investment in energy-efficient capital and renewable energy generation capacity
- the establishment of a Greenhouse Gas Technology Investment Fund to support the development and deployment of domestic mitigation technologies. Such investments can be counted by LFE firms towards compliance with their mandatory abatement targets
- a voluntary agreement with the automobile industry to, among other things, develop and apply high-fuel-efficiency technologies.

Work on establishing priorities for the Sustainable Energy Science and Technology Strategy is currently under way. Key objectives already identified include leveraging off the private sector, universities, and provinces, and developing a set of research goals for energy efficiency and renewable energy.

Sources: CCTP, 2005; NRTEE, 2005; Government of Canada, 2005; Australian Climate Change Science Programme; Australian Greenhouse Office, 2004

Appropriateness of other current measures

The Government has a range of non-market measures in place that could impact, either directly or indirectly, on research and development investment. Direct industry support is targeted in specific industries deemed to represent high growth potential. Public funding for mitigation research and development is not explicitly targeted. It is difficult to provide a detailed evaluation of the returns to individual investments, or the investment alternatives.

The Government has a programme for regulating Mandatory Energy Performance Standards for energy-using appliances and equipment. A number are already in place, and further standards will be progressively introduced. By targeting selected products, this measure effectively changes the relative incentives for energy-efficiency research and development. There may be proportionally large gains to be made if energy-efficiency measures are incorporated at the design stage (ECNZ, 1994). Mandatory standards are attractive from a fiscal point of view, as they involve relatively low fiscal expenditure.

Assessment

It is difficult to robustly assess the appropriateness of current policy settings in inducing mitigation research and development. There can be a long lead time between research investment and mitigation pay-offs. For example, agricultural technologies (such as animal remedies) must be laboratory trialled, manufactured and registered before they can be marketed. Diffusion, adoption and subsequent emissions mitigation will further add to the lead times.

It is also difficult to attribute policy measures, such as funding, directly to mitigation outcomes. This is partly because climate change benefits may not be the primary objective of research (it represents an indirect benefit), so it is difficult to isolate the relevant research and development in the first place. And secondly, it is difficult to decompose the impact of the policy measure on the outcome of the research (ie, how much was attributable to other factors).

The evidence we do have suggests that environmental research programmes are producing some tangible results. For instance, environmental research reported the highest number of new or improved products, processes or services per dollar invested out of FRST's research investments (three services per $1 million of funding) in 2002 (FRST, 2002). New Zealand performs well in world terms in publications, and we are above average for citations in the agricultural, veterinary and environmental fields (New Zealand Government, MoRST, 2005).

As previously stated, the carbon tax as currently designed is sub-optimal from the perspective of incentivising mitigation research and development. Ideally, a price-based measure would be broad-based and implemented in a planned and predictable manner. This would provide long-term incentives to undertake research and development, while retaining flexibility for emitters to respond in the most cost-effective manner (which may or may not involve research).

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However, there are a number of impediments to this optimal design (from a research and development perspective) of a price measure. In the absence of an international carbon market, establishing a long-term path for increasing the tax rate is difficult. A fully fledged carbon market involving all major emitting countries and to which New Zealand would have full access is unlikely in the foreseeable future. The coverage of any price-based measure is also problematic, not least because of the measurement difficulties associated with agricultural non-carbon dioxide emissions.

Alternatives to a price-based measure include direct Government funding support and/or provision of research, regulation (mandatory performance standards) and industry-support schemes.

Despite a steady rise in total research and development expenditure since 1994, overall research and development activity in New Zealand is relatively low compared with other countries – around half that of OECD countries as a percentage of GDP. However, Government expenditure specifically on climate change research and development has increased in recent years, which reflects the growing policy importance of this area. In 2002, FRST invested new funding ($1 million) into a programme on tools for agricultural non-CO_2 emissions monitoring and verification, which was complemented by a research consortium on ruminant methane and agricultural nitrous oxide reduction. Other funding ($1 million over three years) was redirected into research on energy efficiency and transport emissions. Other climate change-related programmes have been strengthened or initiated.

There looks to be further scope for the Government to formally provide research funders (in particular FRST) with greater clarity regarding the strategic priorities for climate change research. A 2001 review of FRST's Global Environmental Processes and Change Strategic Portfolio Outline suggested that there is a need for better links between disciplines (particularly between social and biophysical scientists) and between policy makers and the science community.[106]

The balance between basic and applied research could also warrant further consideration, as well as the allocation of mitigation funds across sectors and technologies. No single technology option is going to provide us with the "silver bullet" to emissions abatement, and every research undertaking involves a degree of risk, so a diverse portfolio of programmes will enable this risk to be spread across technologies and innovations. This risk hedging should give explicit consideration to the balance between "breakthrough" and advanced technologies, infrastructure and equipment (the technology "platform") and transition and deployment.

Funding prioritisation for basic research, with long-term pay-offs, should take a long-term perspective (five to fifteen years and beyond). This would provide some funding certainty for providers. It would also assist in attracting and retaining high-quality research staff, and could reduce the compliance costs of frequently re-negotiating contracts. It could improve matching of policy priorities with research tendered and commissioned; ie, match the top-down and bottom-up approaches.

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[106] See <http://www.frst.govt.nz/About/downloads/spo/global.pdf> and <http://www.frst.govt.nz/Research/downloads/oceans/Analysis.doc>

FRST has recently moved to trial outcome-based investment over a period of 12 years in the environment area, which is appropriate for basic research. The governance arrangements for this process include review periods, allowing flexibility for new investment signals to be incorporated and, hence, emerging opportunities to be addressed.

The number of personnel working in research and development in New Zealand appears to be around the average for OECD countries. There may nevertheless be a question of "critical mass" in terms of total numbers (as opposed to proportions) of researchers in the country. In addition, MoRST is aware that researchers have expressed concern about funding volatility and is therefore actively developing a strategy to support an attractive research and development environment for skills and talent.

FRST (2000) suggests that, while there does not appear to be any immediate threat to core capability, a lack of climate change research activity in universities and the retirement of the current cohort of researchers by the end of the decade could stretch research capacity in the longer term.

4.3.5 Technology uptake

Current policy

New Zealand is a small, geographically isolated country. Our capacity to absorb internationally generated technological advancements therefore depends on our ability to readily access and take up these measures. This will depend partly on the international networks maintained by our science and business communities (and our domestic knowledge-transfer systems) and the ability of our domestic firms to understand and incorporate new knowledge. The latter relies partly on developing, attracting and retaining staff with the requisite skills to support and adapt to new technologies.

This suggests that some prerequisites for optimal technology uptake are:

- developing and maintaining an appropriately skilled pool of researchers and workers in New Zealand
- forging links to and collaboration with international research programmes
- having effective linkages between researchers and industry
- having effective international industry-industry linkages
- a well-developed infrastructure, including clusters of firms and related industries.

Some potential barriers to technology uptake include:

- a lack of access to capital (due to high up-front costs)
- a lack of awareness of or capability (understanding) to take up measures
- pricing problems – when the social/environmental benefits of technological uptake exceed the private benefits.

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Industry support

The Government provides a generic suite of schemes aimed at promoting the development and adoption of technologies by businesses. TechNZ is a business unit of FRST that provides support for technological developments in firms. Over the five years from 1995/96 to 1999/2000, 18% of TechNZ funding was provided to firms in the agriculture sector. A further 8% of funding went to basic manufacturing firms, which includes companies involved with energy production, distribution and products (Infometrics, 2001).

New Zealand Trade and Enterprise (NZTE) is the Government's national economic development agency. It focuses on industries and sectors that have been identified as having high growth potential, providing business training, advice and funding. One of NZTE's target industries is biotechnology and agritech. The biotechnology industry has been identified in the Government's Growth and Innovation Framework as being a key contributor to future economic growth and competitiveness.

Information provision and financial assistance

EECA provides financial assistance to large energy-using firms for energy audits, to help them identify areas where they can improve their energy efficiency. They also provide energy-efficiency information and support to firms. These initiatives seek to address information problems regarding the availability and efficacy of energy-efficiency measures.

The Government has recently announced a programme aimed at helping energy-intensive businesses adjust to the planned carbon tax. This programme includes:

- 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 an energy-conservation culture
- education for company managers and staff on the carbon tax and energy efficiency.

The demonstration projects will target technologies that are capable of delivering significant energy savings and are already in widespread use. Target industries include:

- wood processing
- food processing
- basic metals
- non-metallic products (eg, plastics and ceramics)
- paper and paper products
- tourism transport
- glasshouse crops
- fishing (fleet operation)
- irrigated dairying
- irrigated arable crops.

Regulation

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As discussed above, the Government has in place a programme of energy-performance standards. A mandatory energy-performance labelling scheme is also under way.

Effectiveness of price-based measures at driving technology uptake

As discussed, price-based measures offer fiscally low-cost tools to effect behaviour change. Non-price measures can also assist in growing capability (such as intellectual, practical human resources and infrastructure), allowing people to respond more quickly and effectively to price signals.

Because price-based measures offer firms flexibility in how they respond to changes in relative prices, the outcomes (both from an emissions-mitigation perspective and in terms of uptake of specific technologies) are uncertain. For instance, firms may choose to adapt to a carbon tax by investing in more energy-efficient plant and equipment, or may change the mix or level of their outputs (to name just a couple of options). In this respect, they are "technology neutral", as they do not attempt to "pick winners", but let the market decide how to adjust.

Directed Government funding, on the other hand, tends to favour certain technologies. This can, in turn, dampen investment in innovation and favour technology-based solutions as opposed to systems innovations or other responses. Investment support (such as tax breaks and low-cost loans) can reduce the barriers to technology uptake but risks providing windfall gains to firms that would have undertaken the investment anyway.

The selection of instrument can greatly affect both the level of response and the distribution of impacts. For example, economy-wide price measures are generally regarded as more efficient than sector-specific measures, as they ensure that all emitters face an equal price and allow the marginal cost of abatement to converge across sectors. The cost of price-based measures is generally lower when the price signals are anticipated, gradual, continuous and well-designed. Broad-based price measures are likely to stimulate the most immediate response from mature technologies. However, when applied in a predictable and continuous fashion, they can also assist with the uptake of emerging technologies and investment in the development of new ones (NRTEE, 2005).

Price-based measures often require other policy measures to be implemented in tandem to ensure maximum effectiveness. For instance, a carbon tax that encourages the development of new wind generation will require access to a transmission grid of a suitable scale and technology standards to ensure full deployment of the resource.

Appropriateness of other current measures for driving technology uptake

Energy-efficiency programmes

International research has shown energy audits to be relatively cost-effective mechanisms. Energy-efficiency product standards are also low cost from a fiscal perspective (as they shift costs onto producers, and hence to consumers). They are complemented by labelling, as standards eliminate the worst-performing models from the market and labelling encourages the best. Both measures work best if supported by an information campaign.

One drawback of minimum performance standards is that they provide little incentive for firms to exceed the requirements. This is particularly so if the standards are technology-prescriptive.

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New Zealand's current mix of energy-efficiency programmes spans the range of intervention types, with the exception of an overarching public education programme.

Collaboration

Collaboration reduces duplication of efforts and facilitates information exchange. It is important that New Zealand maintains strong international linkages and collaboration so that we are well placed to quickly take up new technologies and learn from international experience.

Around 17% of climate change research funding is currently contributing to international collaboration. More broadly, FRST's environmental research funding produces a very high number of peer-reviewed items and national and international collaborations compared with other research streams. Environmental funding also demonstrates a high number of relationships with users per dollar invested (FRST, 2002).

System platforms and infrastructure

Another consideration is the role of and support for "platform" technologies in the development of other mitigation technologies. For example, a modernised electricity grid can enable (and may be a necessary precondition for) the deployment of more advanced end-use and distributed energy technologies. The widespread uptake of wind energy, for instance, has particular technical requirements of the transmissions and distribution networks. In respect of this, the levy-funded Electricity Commission is undertaking two projects: a Tactical Project and a Strategic Wind Generation Investigation Project to identify and propose solutions to issues surrounding the integration of large-scale wind generation into the national electricity grid.[107]

Related to this is the issue of industry capability. This is a "chicken and egg" issue – an industry will not develop without the demand for its products and services, but demand cannot grow without the industry's ability to deliver.

Demonstration projects

The United States CCTP highlights the importance of demonstrations of cutting-edge climate change mitigation technologies. These projects can help a technology to progress from the research phase, where performance in an operating environment and at a larger scale is still uncertain. Demonstration projects can help reduce investment uncertainty by revealing the parameters affecting a technology's cost and operational performance, and identify areas requiring further improvement or cost reduction.

The New Zealand energy-intensive businesses programme focuses on technologies that have already achieved widespread diffusion and uptake. This suggests that it is unlikely to significantly assist in delivering the types of benefits envisaged by the United States scheme.

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107 See <http://www.electricitycommission.govt.nz/opdev/comqual/windgen/index.html/>

Demonstration farms, on the other hand, lend themselves well to an industry characterised by a large number of small, dispersed players. Industry-provided demonstration farms, such as Meat and Wool's Monitor Farm Programme, have proven highly successful and well-supported by the farming community.[108] However, in the absence of a strong price signal (such as a tax on agricultural methane emissions) climate change is unlikely to be a primary concern for individual farmers – the focus tends to be on maximising efficiency and hence profitability. Emissions-mitigation technologies therefore need to be cost-effective (and hence contribute more broadly to economically sustainable farming practices) in their own right.

This latter point suggests that focusing on mitigation benefits alone (eg, by incorporating specific recognition of mitigation benefits into TechNZ's or NZTE's funding investment criteria) would not be appropriate. To the extent that mitigation technologies are economically viable, their benefits are effectively already mainstreamed into broader Government-funded industry support and technology development programmes.

Requiring firms to rank mitigation benefits above other investment considerations is also unlikely to be efficient. For a firm to select capital that is less emissions intensive, even if it is not optimal with respect to the efficiency of other factors of production, would imply a deliberate change in the focus of the business away from maximising profit to maximising climate change mitigation.

Assessment

The difficulties with implementing an optimally designed price-based measure are discussed above. In the absence of an economy-wide price signal, both research and development and technology uptake will be assessed on the private productivity benefits. Environmental benefits may be derived indirectly but, without the price signal, negative environmental effects may not be explicitly taken into account in firms' decision-making. Regulation can assist in this respect but, as noted above, this approach risks "picking winners" in terms of technologies, and even stifling innovation.

Timeframes are important when considering technology uptake. Infrastructure, plant and equipment typically have long lifespans; hence, noticeable improvements in the total capital stock (and hence in gross emissions) can take decades to eventuate. Capital upgrades represent critical decision points at which new technologies can be incorporated. They also lock in the emissions intensity of the capital over its lifetime, hence affecting the emissions intensity of production for decades to come. The commercialisation of energy-efficient technologies in particular therefore needs to be integrated into these decision points.

At the other end of the spectrum are smaller technologies with shorter life spans, which, nevertheless, may stand to deliver large gains. The balance of technologies in terms of scale is therefore another factor to take into account.

Linkages with industry, both domestically and internationally – eg, through public-private partnerships and demonstration projects – would seem critical to the effective and timely deployment of technologies.

While the proportion of New Zealand climate change research funding that makes a contribution to international collaborations looks reasonably significant, the proportion

108 See, for example, <http://www.meatnz.co.nz/main.cfm?id=40>

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contributing to “economic opportunities” is substantially smaller, at 11%. Firms can apply for the more generic funding administered by TechNZ. However, there looks to be scope for further investigating the way domestic industry linkages and clusters are supported.

Assessment of policies to encourage technology uptake requires robust data, both on the rates of uptake and on the effectiveness of these technologies. And for an emissions abatement technology to be worthwhile from a Kyoto point of view, its benefits must be able to be counted in our national inventory. This aspect should therefore be taken into account both when a technology is being developed and when improvements to reporting and inventory data and systems are being considered.

The previous section suggested that determining long-term strategic climate change research priorities would assist in prioritising planning and funding. It could also assist with the structured development of supporting infrastructure. That is, if technology commercialisation and deployment could be monitored and planned for in a strategic way (notwithstanding the inevitable uncertainties involved), the requisite platforms and infrastructures could be progressively rolled out accordingly.

To inform the development of such priority setting, it would be useful to first conduct a bottom-up analysis to identify and assess the range of foreseeable (likely and possible) technology options. This potentials analysis would most usefully be based in an engineering-economic framework, identifying options that are likely to be both technically viable **and** cost-effective. It would need to give consideration to mature, emerging and long-term technology options. Projected costs and benefits would need to make some assumptions (or range of assumptions) regarding the likely uptake of each option. Using the criteria suggested for mitigation research and development priorities for New Zealand (see Section 4.3.4), a bottom-up potentials analysis would provide a quantitative guide to establishing a strategic framework for long-term climate change mitigation research and development and technology incentivisation policies.

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4.3.6 Business opportunities

Promoting the carbon market in New Zealand

The carbon market (based on potential domestic measures and the international market) provides the opportunity for New Zealand to explore services and technologies associated with reductions of greenhouse gas emissions. Some of these services could relate directly to the carbon market; some may not. Policy on climate-friendly business and technologies can typically include the following types of initiatives:

- innovation: the development or implementation of new technologies
- export or deployment of existing technologies: the carbon market can help promote “off the shelf” technologies (existing technologies) to reduce greenhouse gases either domestically or internationally
- liaison: providing links between domestic business and opportunities available overseas
- outreach: bringing a range of different sectors less familiar with the carbon market up to speed on potential climate change opportunities.

While innovation is normally viewed as one of the key foundations of climate change policy, the carbon market offers opportunities for existing technologies. Technologies that offer more cost-effective greenhouse gas reductions and that are already commercialised have more immediate potential than technologies that are still at the research and development stage.

A primary goal of a Government-led business opportunities programme could be to facilitate industry's access to domestic and overseas markets. This requires coordination across government to allow Government to play a unique role in promoting business understanding of how the carbon market operates.

Current business opportunities policy in New Zealand

Some of the elements of relevant policy outlined above are relevant to the mandates of a number of different departments. Departments and agencies such as MoRST, FRST and NZTE all play a part in implementing these types of initiatives. The Ministry for the Environment has a unique role in terms of coordinating the efforts of different departments.

The Ministry for the Environment has completed the following types of initiatives:

- outreach on the CDM (both domestic and international)
- general outreach on domestic greenhouse gas reduction opportunities
- the establishment of the energy-intensive businesses programme. This programme (designed for firms that are not eligible for NGAs) provides companies with funding to undertake demonstration projects
- general Internet research on international opportunities available under the Kyoto mechanisms
- seeking funding from NZAID to obtain market information for reduction opportunities in the Pacific
- establishing relations with other key departments such as New Zealand Trade and Enterprise.

A recent study found that a service sector focusing on climate change and renewables and energy efficiency has, in fact, emerged in recent years. Collectively, there are several entities, organisations, groups and companies focusing on climate change issues and it is not unreasonable to link them and refer to them as a "climate change industry" or group. However, recent surveys by the Ministry for the Environment indicate that a number of stakeholders are not familiar with potential opportunities.

Experience within the waste sector suggests that more domestic outreach needs to be completed to determine what New Zealand has to offer. Approaching outreach efforts from a sectoral basis has allowed the Ministry for the Environment to determine that there are a number of potential players that could be involved but were not engaged when the focus was primarily on climate change alone.

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The effectiveness of existing business opportunities policy

The carbon market plays a unique role in terms of engaging potential environmental services and technology suppliers.

However, any future policy on business opportunities (or enhancement of the existing approach) must consider how opportunities will be affected by a number of cross-cutting issues. These include changes to existing domestic policy, the appetite for climate change investment in New Zealand, and the advancement of the international market. Once New Zealand's involvement in either a domestic or international market can be established, more concrete measures could be investigated in terms of industry engagement. This could involve obtaining supportive funds for developing reduction projects, for example.

Business opportunities could also be enhanced if New Zealand decides to purchase on the international market. Depending on the design of a potential purchasing programme, it could leverage opportunities for an increasing number of New Zealand stakeholders.

The Ministry for the Environment can play a role in providing information in this area. Investigation of further data requirements needed to enhance understanding may be worth considering. Those attending the climate change/waste seminars held in July 2005 pointed to the lack of data for allowable reductions in New Zealand.

Challenges to effective business opportunities policy

The key issues cited as barriers to New Zealand businesses fully accessing existing business opportunities are:

- size – many New Zealand businesses are too small to secure climate change business opportunities
- cost of investigation, research and technology development, and market development
- lack of awareness of emerging business opportunities
- lack of certainty about long-term price signals and performance expectations with regard to greenhouse gas emissions.

The government programmes outlined above are all aimed at addressing these barriers through facilitating access to information and enhanced domestic and international networking. The key distinguishing features for climate change business opportunities are the relatively rapid development of the international market for such products and services, the presence of fixed emission targets that New Zealand has to meet at least cost, and where business opportunities can partially offset the overall cost of emissions reductions. Other barriers and issues related to business opportunities, such as high initial investment costs and relatively small size of individual enterprises, are not unique to climate change and are therefore not considered explicitly in this review.

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Assessment

Business opportunities and development of new products and services face many challenges, many of which are not unique to climate change. A challenge that appears most relevant to climate change business opportunities appears to relate to public awareness. To date, the focus in New Zealand has been more on the relationship between greenhouse gas-reduction efforts and impacts on climate change per se (4 Million Careful Owners), not on the ability of the carbon market to generate profit. For a great number of New Zealand stakeholders, climate change is largely seen as a liability, not an opportunity. There may be some unexplored opportunities for New Zealand firms in the marketing of climate-friendly products and services.

The current Government programmes are aimed at addressing this particular challenge. Of particular importance are the following areas:

- creating a one-stop shop for business opportunities information on climate change and energy products and services, and providing links to domestic initiatives and government funding and support schemes as well as international programmes and reports such as those provided by the IEA, OECD and World Business Council for Sustainable Development

- further information on, and promotion of, the Kyoto flexible mechanisms to provide additional business incentives for international opportunities

- raising awareness of energy-efficiency options with business and the general public as compared with energy-conservation measures, to support the case for using technologies that can maintain or improve existing levels of service and comfort while reducing energy consumption and greenhouse gas emissions

- quantifying the economic benefits from greenhouse gas-cutting measures, and the barriers to making such reductions even where they appear cost-effective. There is currently insufficient information on this. This area may warrant further investigation to determine the potential for New Zealand to benefit. A price signal would also help in this regard.

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4.3.7 Local government programme and waste sector

The current climate change policy package recognises that local authorities have a significant role in New Zealand's national climate change response. City, district and regional councils are locally and regionally significant energy users and have regulatory and planning powers, ownership of local infrastructure, and broad environmental guardianship under the terms of the Resouce Management Act and the Local Government Act.

In particular, local bodies undertake urban planning, regulate activities that have an environmental impact, provide roading and passenger transport services, manage waste, administer building regulations, facilitate economic development and manage natural hazards - all of which are relevant to climate change responses at the local level.

Local government also plays a wider community governance role, including in the area of the environment. In this respect, many regional councils and territorial authorities also undertake public awareness activities that can influence the community.

Local government programme – Communities for Climate Protection™

The key element in the local government sector work programme is the roll-out of the *Communities for Climate Protection™ New Zealand* (CCP) programme to councils across the country. This programme provides a strategic framework via which councils can act to reduce their greenhouse gas emissions and influence emissions reduction in their communities. Because it is a global programme, councils participating in it benefit from international best practice and experience.

The main rationale for the programme is to provide strong links between the national benefits of greenhouse gas mitigation and the local co-benefits these provide. It is considered an important tool in raising local awareness and influencing infrastructural planning and urban development. It is therefore expected to help avoid lock in to emissions-intensive technologies and structures at the local level. To date, 17 councils representing 50% of New Zealand's population have joined the programme and have progressed to various stages consisting of undertaking an emissions inventory, identifying mitigation options and costs, setting goals and monitoring progress towards these goals.

Offshore experience tells us that the CCP programme is an effective driver of emissions-reduction activities. Firstly, it provides a low-cost and accessible way for the council to start taking action. In Australia, for example, for every dollar spent by the federal government in rolling out the CCP programme, around $4.5 additional dollars for emissions-reduction activities are leveraged from councils and State Government. This is an excellent rate of return from a central government fiscal perspective.

Once a council is in the programme, the co-benefits of taking action (ie, lower fuel and electricity costs, cleaner management of the waste stream, enhanced urban and transport planning) usally ensure that momentum for action is maintained.

Emissions reduction in the waste sector

Local government is also the main owner and operator of waste operations though landfills and waste water treatment. Greenhouse gas emissions from the waste sector have been decreasing (in absolute terms as well as the sector's relative share of total greenhouse gas emissions) in recent years despite increases in the volume of waste produced. This trend is expected to continue into the future (see Table 17). The main greenhouse gas emitted is methane from solid waste disposal. Waste water treatment also contributes small emissions of methane and nitrous oxide.

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Table 17 - Total Historical and Projected Emissions from the Waste Sector

Waste sector emissions 1990 to 2020 (kt CO_2e)					
	Methane (solid waste)	**Methane (waste water)**	**Nitrous Oxide (waste water)**	**Sector Total**	**Sector % of Total Gross Emissions**
1990	1905	157	146	2207	3.4%
2003	1688	166	163	2017	2.6%
2010	1208	175	164	1547	1.9%
2020	1098	180	167	1445	Not modelled

Source: Based on New Zealand, Ministry for the Environment (2005) and Waste Management (2005)

Greenhouse gas emissions from waste-water treatment are projected to increase slightly over the next two decades, owing to population increases and expanded meat processing, assuming constant treatment methodologies. The increase on 1990 in absolute amounts (CO_2e) is 0.036Mt by 2010, and 0.044Mt by 2020.

In 2003, disposal of solid waste in landfills contributed 1.7Mt CO_2e, or 84% of the total waste sector emissions, a decrease of 11% from 1990 to 2003. Methane emissions from solid waste landfills are expected to fall significantly further below 1990 levels by 2010 and continue to decline towards 2020.

Contributing factors for the emissions reductions from solid waste are likely to be:

- increases in the use of methane-recovery systems at larger landfills based on the recently introduced national environmental standard that requires landfills for over 1 million tonnes of refuse to collect greenhouse gas emissions
- ongoing closure of smaller landfills and the general trend towards larger landfills that attempt to meet internationally defined best practice in terms of environmental effects
- probable effects from the National Waste Minimisation and Management Strategy, including increased separation and divergence of green waste from landfills
- improvements in landfill management, based on recently introduced (but non-mandatory) landfill guidelines.

Options for additional abatement in the waste sector

It is expected that the national trend of closure of small old landfills and development of high-quality, large-volume landfills will continue. Options for additional abatement from landfills appear limited beyond the implementation of the New Zealand Waste Strategy and the National Environmental Standard.

Emissions and costs related to the transport of waste beyond regional recycling schemes place natural constraints on the cost-effectiveness of additional measures. Enhanced measures for the separation of green waste may provide limited additional opportunities in some regions, but it is expected that these opportunities will largely be taken up where cost-effective due to their environmental co-benefits of reducing waste volumes.

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Additional reductions beyond those already expected under the New Zealand Waste Strategy are unlikely to be cost-effective for smaller landfills compared with the international price of carbon during CP1.

The increase in emissions from waste-water treatment is projected to be about 0.18Mt CO_2e over CP1. The review could not identify any cost-effective options for additional abatement for waste-water treatment due to the small total amount of greenhouse gases emitted and the large number of small disposal sites.

Assessment of additional abatement opportunities by local government

The CCP is relatively new (only 14 months old) and has had a rapid and successful take-up by councils representing 50% of New Zealand's population.

Given this, there are currently no independent data on cost-effectiveness of mitigation actions under this programme. Initial estimates suggest that CCP will provide emissions reductions on business-as-usual in the order of 0.3Mt over CP1.

While the gains are not huge, they are important in terms of the awareness raising at local level and the long-term behaviour shift the programme can achieve. This includes decisions about major infrastructure investment and consents and development of urban forms that can limit or enhance future mitigation opportunities. The programme therefore also acts as a complement to regulatory decisions at the national level (such as the amendment of the RMA to give special regard to the national benefits of energy efficiency and renewable energy), and to generic economy-wide price measures such as the carbon charge.

Additional abatement measures under the CCP programme could be achieved through additional funding. However, there is insufficient information for New Zealand on the cost-effectiveness of providing additional funding in terms of dollars per tonne of CO_2e avoided. Most relevant actions would also have to be considered under a broad umbrella of co-benefits and synergies to get a complete picture of their cost-effectiveness.

The Crown holds the liability for emissions from the waste sector. The projected emissions reduction of 3.3Mt CO_2e over CP1 implies a net financial gain to the Crown of over $28 million through reduced liabilities.

The review did not identify any additional cost-effective abatement measures for the waste sector beyond the implementation of the New Zealand Waste Strategy and National Environmental Standard for large landfills.

Any additional emissions reduction associated with recycling schemes, fees for the disposal of waste to landfills, regulation of landfill environmental impacts, and waste-water treatment schemes are likely to be more effectively driven by regional environmental co-benefits than by their direct additional avoidance of greenhouse gas emissions.

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4.3.8 Synthetic gases

Overview

Synthetic greenhouse gases that are covered under the Kyoto Protocol include:

- sulphur hexafluoride (SF_6), used in New Zealand as an insulator for high-voltage electrical equipment
- perfluorocarbons (PFCs), emitted from aluminium smelters but also found in some refrigerant gases
- hydrofluorocarbons (HFCs), which now replace ozone-depleting substances (ODSs) in many applications in refrigeration and air-conditioning, and are also used in industrial processes such as the manufacture of foams.

Synthetic greenhouse gases have extremely high global-warming potential. For example, SF_6 has 23,900 times the global warming potential of CO_2 and HFC-134a, a commonly used fluorocarbon refrigerant, 1,300 times.

According to the latest greenhouse gas inventory, since 1990:

- SF_6 emissions have increased slightly from 12.33kt CO_2e per annum to 12.38kt CO_2e per annum due to increased changes in the use of electrical switchgear
- emissions of PFCs have decreased 83.5% from 515.6kt CO_2e to 84.9kt CO_2e due to improvements in the aluminium-smelting process
- HFC emissions have increased from 0 to 404kt CO_2e because of the use of HFCs as a substitute for the chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) that are being phased out under the Montreal Protocol.

Together, these synthetic greenhouse gases contributed 501kt CO_2e, or 0.67% of New Zealand's total emissions, in the year 2003. These emissions are slightly lower than emissions of 528kt CO_2e in 1990, with a large shift in total emissions from PFCs towards HFCs. Total emissions are expected to inrease into the future due to the increased use of HFCs and limited scope for further reductions in SF_6 and PFCs.

Inventory estimates of emissions are based on estimates of quantities imported, to which a standard IPCC methodology is applied to derive an average emissions estimate. Actual emissions could be different, but the small quantity of gases emitted generally does not make it effective to move to a more complex monitoring and reporting system.

Under the current policy package, the Government carries the liability for emissions of HFCs, PFCs and SF_6 and relies on voluntary measures by industry to control emissions.

Issues and options for SF_6 and PFCs

We do not have recent import statistics or projections for 2010 or 2020 for SF_6 or PFCs. However, we are confident that the long-term trend in emissions is downward, towards insignificant quantities. PFCs are being phased out of refrigerants worldwide and New Zealand, as a signatory to the Montreal Protocol, benefits from this. In future, the only significant on-going source of PFCs in New Zealand is likely to be the Comalco aluminium

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smelter, and the Comalco operation is expected to be covered by an NGA that will achieve process improvements.

For SF_6, which is used in electrical transformers, the Government has a memorandum of understanding with the major users. This agreement requires users to report their data for the national greenhouse gas inventory and to adopt best practices to ensure leakage of SF_6 is limited. In return, the Government has agreed that the industry will not face an emissions charge on SF_6 during CP1. Unless the emissions trends change significantly, we expect similar arrangements to be most effective into the future beyond 2012.

Issues and options for HFCs

HFC imports, of fluorocarbon refrigerants in particular, are estimated to have increased significantly since 1990, albeit from a zero base. HFC emission trends are therefore of potential long-term concern, but no robust estimates of expected emissions in 2010 or 2020 currently exist. Factors for the observed increase and expected qualitative future trend are:

- a rapid rise in the import of manufactured items containing HFCs such as domestic heat pumps and air conditioning units in new and used cars. Each of these units contains 1kg to 2kg of HFC, which will be lost to the atmosphere if the unit is not properly maintained or the gas is not properly disposed of at the end of the unit's life

- arrangements to collect and destroy unwanted refrigerants are under strain. The Ozone Protection Company – the trust that collects and destroys ozone-depleting refrigerants – was very successful initially, when there were only around six companies importing the gases and those companies paid a levy under a voluntary arrangement. As the refrigeration industry, as a consequence of the Montreal Protocol, has moved from ozone-depleting refrigerants to fluorocarbon refrigerants and/or mixtures of the two, the number of refrigerant importers has mushroomed. A free-rider problem has emerged, as new importers do not pay the levy, while the trust feels compelled to accept any refrigerant it is offered. As a result, the trust's net financial position is steadily worsening and the original environmentally responsible companies are placed at a competitive disadvantage.

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Longer-term options towards 2020

Looking to the 2020 timeframe, even under best management, we should expect a small residual level of SF_6 and PFC emissions from industrial processes. In Europe, fluorocarbon refrigerants are already being phased out in favour of "natural" refrigerants such as ammonia and butane. These gases are not risk-free (butane can explode and ammonia is toxic), but their use is becoming a mature technology (IPCC, 2005a). It is expected that New Zealand will relatively rapidly adopt international best practice regarding the management and residual emissions of those gases.

Regarding emissions of HFCs, it is expected that the successful implementation of the regulation and stewardship scheme for fluorocarbon refrigerants will achieve the most cost-effective abatement option towards 2020. We have not estimated residual emissions of HFCs for 2020 in terms of kt CO_2e because it is not a significant source and current emissions-reporting methodologies, and policies to manage these emissions, appear to be the most cost-effective, given the small absolute size of emissions from this sector. If HFC imports continue to rise significantly, we may need to consider the development of "Tier 3" methodologies for use in the preparation of our inventory to obtain a better understanding of the sources of emissions, and to investigate to what extent imports result in direct emissions or increase the banks of HFCs in appliances.

Assessment

The only sub-sector in synthetic gases with rising emissions is fluorocarbon refrigerants (HFCs). The Ministry for the Environment is currently developing a proposal for regulating the emission of these gases, where one option is the use of the Hazardous Substances and New Organisms Act. This regulatory approach would be coupled with a product stewardship scheme to manage end-of-life recycling from some selected appliances.

Emissions of SF_6 are managed under a memorandum of understanding with relevant industry, and it is expected that PFC emissions from aluminium smelting will be included in an NGA.

These measures, if approved and implemented as intended, are assumed to deliver all available cost-effective abatement options for this sector, and it is proposed that no changes to the current liabilities or policies are made beyond those already planned and outlined in this review.

4.3.9 The role of Government leadership

Government leadership on environmental issues is synonymous with the basic principles of environmental stewardship. In other words, true leadership on sound environmental behaviour needs to be demonstrated by an agency that is deemed to have some kind of authority. For the public sector, this has implications in terms of encouraging the public to engage in environmentally responsible behaviour.

Leadership in environmental behaviour can manifest itself in numerous ways. Apart from providing exemplary behaviour, many governments have developed communications tools that give interested stakeholders the necessary information to undertake their own stewardship programmes. In some cases, governments may even provide financial support for the establishment of such programmes. With respect to climate change, projects have been undertaken that encourage energy efficiency in government buildings, or that promote the use of low-emission vehicles in government fleets.

Initiatives are normally implemented in the following three ways:

- demonstrating new technologies and their potential for replication
- concluding voluntary accords that reduce greenhouse gases
- promoting the use of "clean green" products.

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Current Government leadership

The current policies in this area are undertaken by a number of different agencies and are in some cases indirectly related to climate change (eg, a primary aim being to improve energy efficiency).

Programmes at the Ministry for the Environment

The Ministry currently administers the Govt^{3} programme. The "3" in the word "Govt^{3}" refers to the "three pillars of sustainability": environmental, social, and economic. The programme's primary goal is to improve the sustainability of Government operations, but some of the actions taken are expected to have co-benefits in greenhouse gas mitigation.

Govt^{3} is led by the Ministry, in partnership with the EECA, and is based on the principles outlined in the Sustainable Development Programme of Action, the NEECS, the Climate Change Programme and the New Zealand Waste Strategy. While the primary focus of Govt^{3} is on central government, all government agencies are encouraged to take part.

The initiatives focus on progress in four key topic areas:

- waste minimisation
- energy efficiency in vehicles
- energy efficiency in buildings
- green procurement - office consumables and equipment.
- Within each of these areas, there are key themes:
- maximising efficient use of energy and materials
- minimising waste sent to landfill and noxious emissions
- buying products that are better for the environment
- minimising packaging
- reporting progress.

The Govt^{3} approach is to pilot these initiatives, usually within the Ministry for the Environment, before promoting them with other agencies. All the relevant resources and tools are made freely available on the Ministry's website. Linkages have already been established with local government. As of 1 August 2005, 40 agencies had signed up to Govt^{3} membership through a formal written commitment from chief executives. The programme will be extended into the wider public sector to include local councils and the heath and tertiary education sectors.

Sustainable Procurement

The Sustainable Procurement programme promotes sustainability as a key part of all public-sector purchasing decisions. A central notion is the principle of value for money over whole of life, rather than simply buying the cheapest available product. By taking account of cost savings from use of energy-efficient products and technologies, agencies' procurement can also contribute to achieving the NEECS target of a 15% improvement in energy efficiency over five years in central government. This will also help to reduce greenhouse gases.

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Programmes at other Ministries

The EECA has implemented a number of programmes aimed purely at energy efficiency in businesses and private homes. While still in its formative stages, EECA will be looking to fund demonstration projects with energy-intensive businesses. These demonstration projects will serve as examples of applied technologies that reduce greenhouse gases.

Another form of environmental stewardship that will help demonstrate the importance of reducing greenhouse gas emissions is the notion that government departments could offset greenhouse gas emissions associated with conferences or government travel through forest planting schemes.

Options and assessment

Apart from proposing new initiatives, the Government could enhance existing efforts to demonstrate responsible government behaviour on climate change mitigation by building on some of the initiatives of the Govt^3 programme, or replicating some existing initiatives. Agencies that are actively engaged in climate change policy areas but have not signed up to Govt^3 could also be encouraged to do so.

Looking at initiatives from other countries (namely Canada, the United States and the United Kingdom), the following additional measures could be considered:

- providing funds or grants: agencies engaging in a climate change stewardship programme could be given funding to implement given objectives as part of strategic partnerships. (This perhaps has less relevance if all participating agencies are federal government bodies, which should have the resources to undertake measures. This is perhaps more applicable to municipalities or private business)

- public surveys: the Government could seek input from the public on areas that it considers to be important

- environmental learning centres: some municipalities provide interactive displays that allow the public to learn more about environmentally responsible behaviour

- purchasing green energy: does the green procurement programme include a provision for the purchase of renewable energy? Is it possible for certain Ministries to have on-site examples of renewables?

- building demonstration projects: government buildings could be designed to set an example for climate change-friendly behaviour, including solar panels, for example

- developing a programme for “climate champions”: participants in a programme like Govt^3 could receive ratings based on, for example, the extent of their compliance with established energy-use targets.

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4.4 Energy (non-transport)

Summary

This section:

- summarises current climate change policy settings applying to the energy (non-transport) sector, including both price-based and non-price-based measures
- assesses the rationale for existing non-price-based measures in the energy sector
- undertakes an assessment of each non-price-based measure, including the climate change benefits, any co-benefits, and the cost of the measure.

It concludes:

- there is currently a well-developed package of non-price-based measures in the energy sector, including an appropriate mix of policies
- there is a clear rationale for all existing non-price-based measures in complementing a price-based measure
- based on current cost-effectiveness and gross impact, the Energy Efficiency of Products programme presents the greatest potential for additional energy-efficiency improvements (and therefore emissions reductions)
- the Emprove programme demonstrates positive impacts in terms of emissions reductions, indicating there may be further value (from a climate change perspective) in expanding this programme. Consideration should also be given to a coherent and overarching public awareness campaign on energy efficiency
- it would be appropriate to wait until EECA's review of the NEECS is completed before any decisions are made on adjusting the existing package of non-price-based measures, given the NEECS review will undertake a more comprehensive assessment of energy efficiency and renewable energy policies.

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In 2004, non-transport energy emissions (primarily arising from combustion of coal and gas and discharge of geothermal fluid) accounted for 23% of total New Zealand emissions, a large majority of which are carbon dioxide. A further breakdown follows:

Table 18 - Breakdown of Non-transport Energy Emissions

Energy (non-transport) Sub-sector	Emissions in 2004 (Mt CO_2e)	% of total New Zealand emissions [109]
Thermal electricity generation	6.07	8
Other transformation (emissions from fuel combustion in energy-producing industries including petroleum refining, synthetic petrol production, and oil and gas extraction and processing)	1.12	1
Industry (emissions from fuel combustion in industry, including industrial electricity generation)	5.09	7
Other sectors (emissions from fuel combustion in commercial and institutional buildings, households, agriculture, forestry and fishing)	3.48	5
Fugitive (such as gas venting and geothermal field discharges)	1.58	2
Total	**17.34**	**23**

Source: MED, New Zealand Greenhouse Gas Emissions 1990 - 2004

4.4.1 Current policy settings (including NEECS where relevant)

Current policies targeted at or significantly impacting on greenhouse gas emissions in the energy sector are listed below. The full details of these policies have been outlined in Sections 3.2.4 and 3.2.5.

Price-based measures include:

- the carbon tax
- NGAs
- the PRE programme.

Non-price-based measures include:

- the energy-intensive businesses policy
- a suite of programmes implemented by EECA that aim to improve energy efficiency and the development of renewable energy
- recognition of the benefits of energy efficiency and renewable energy in the RMA
- research and development expenditure of approximately $1.8 million per annum (Ministry for the Environment, 2004e) dedicated to mitigating greenhouse gas emissions in the energy sector
- electricity regulations to require retailers to offer low-fixed-charge tariff options to domestic consumers
- pending regulations on providing access to electricity distribution lines for distributed generation (which will contribute to emissions reductions if generation is based on renewable energy)

[109] Based on 2003 total.

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- Electricity Commission energy-efficiency pilots.

Note that the Electricity Commission pilot programmes are temporary (their lifespan ranges from three months to 18 months) and are subject to their own review process and potential modification or discontinuation. They will therefore not be assessed further below in the context of a sustainable climate change policy package.

4.4.2 Options – price-based measures

The Review has identified three broad options for a price-based climate change measure: proceeding with the current carbon tax/NGA regime, adopting a low-level carbon tax with few exemptions, or postponing adoption of a price-based measure until other countries adopt similar measures. Given the likely exclusion of agriculture from the coverage of any price-based measure (as a result of lack of coverage internationally), the primary focus of a price-based measure will be energy-sector emissions. Energy-sector impacts of these options are therefore generally canvassed under the individual assessments of these options in Section 4.2. Note that the PRE programme is subject to a separate analysis in Section 4.2.5 and the transport component of energy emissions is discussed separately in Section 4.5.

4.4.3 Options – non-price-based measures

Although price-based measures are generally considered to be more effective than a "command and control" or regulatory approach in achieving emissions reductions at lowest cost, non-price-based measures as discussed in Section 4.3 may be necessary (also at Ministry for the Environment, 1999) to:

- market imperfections in the emissions sectors that are covered by a price-based measure
- change in people's tastes and preferences. An inherent attribute of using the market to create incentives for behaviour change is that individuals apply their own sense of values to their decisions. In some cases, it will be preferable to encourage individuals to alter their preferences beyond what price would imply on its own (eg, the Government invests in warning the public about the dangers of smoking and alcohol, despite the heavy externality taxes already applied)
- distributional and equity issues
- emissions sectors not covered by a price-based measure.

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Common market imperfections in the energy sector that may lead to the adoption of a non-price-based measure include:

- lack of information (information is too costly or difficult for individuals to acquire)
- barriers to access to capital
- split incentives: ie, the person making decisions is not the one to face the consequences or benefits of that decision
- some information is underprovided because of its public-good characteristics; eg, underinvestment by the private sector in research and development, given the inability to exclusively capture the benefits.

The following table assesses where non-price-based energy measures (including existing measures) may be necessary to complement or enhance the effect of a price-based measure. It looks at where market imperfections might arise, where distributional and equity issues might arise, and where changing people's tastes and preferences might add further benefit. While there may be other reasons to pursue the non-price-based measures identified (including productivity benefits, local environmental benefits and health benefits), the table basically derives the "climate change rationale" for why these measures might be adopted.

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Table 19 - Potential Non-Price-Based Energy Measures to Complement a Price-Based Measure

	Desired impact of a price-based measure	Is there a market imperfection?	Are there distributional or equity issues?	Would changing tastes and preferences provide further benefit?
Energy Supply (electricity generation, transmission and distribution)	Generators displace fossil fuel generation with renewable generation or more carbon-intensive fossil fuel generation (coal) with less carbon-intensive (gas)	Establishing new renewable generation may encounter resource management obstacles. This issue is targeted by recognising benefits of renewable energy and energy efficiency in the RMA. Some small firms may not have access to information on the benefits of renewable generation, including the option of distributed generation. This issue is targeted through EECA's promotion of renewable energy to potential and existing generators and through its encouragement of the uptake of small-scale renewable energy technology. There may be transaction costs for small generators negotiating connection of distributed generation to transmission lines. To address this issue, regulations to provide for the connection of distributed generation to distribution lines on reasonable terms and conditions are being developed.	Windfall gains will accrue to renewable generators although no efficiency implications arise as a result.	No. Commercial incentives are the primary driver for these firms, although some companies may simply choose to maintain a limited portfolio of generation options that they are expert in; eg, developing a wind or geothermal portfolio requires the development of new specialist expertise.
	Generators adopt more emissions – efficient technologies	No. Firms are well informed, well resourced and well motivated to respond.		
	Generators invest in research and development to develop more emissions-efficient technologies	It is difficult for a firm to exclusively capture the benefits of research and development and use them to gain a competitive advantage (research and development has the traits of a "public good"). This reduces the incentive for firms to invest. This "market failure" is addressed through public funding for climate change mitigation research, which is assesses in 4.4.4.		

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Energy demand-industrial	Firms move to less emissions – intensive fuel types.	No. Firms are well informed, well resourced and well motivated to respond.	No. Costs fall appropriately on those undertaking emissions-inducing activities.	No. Commercial incentives are the primary driver for these firms.
	Firms reduce the emissions intensity of their industrial processes	Firms may lack information on how to reduce energy use and therefore not respond appropriately to the price-based measure. There may also be financial constraints on firms investigating energy efficiency, particularly if energy is not considered part of the core business. The **Emprove** programme aims to address these barriers for high-energy use firms by providing grants for energy audits.		
	Firms invest in research and development to develop new business processes or capital that will improve emissions intensity	As above, the public-good nature of research and development is addresses through **public funding for climate change mitigation research,** assessed in 4.4.4.		

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Energy demand commercial and SMEs	Firms conserve energy or improve efficiency	There may be information barriers to change. As energy use may not be a core cost for these firms, they may lack information on how to reduce energy use and therefore not respond appropriately to the price-based measure. Existing non-price measures targeting this failure include the **4 Million Careful Owners** and **Emprove** programmes. EECA's provision of financial assistance for energy audits under **Emprove** also provides targeted information on reducing energy use. Education for company mangers and staff as part of the **energy-intensive businesses** policy also aims to address this issue. Split incentives may exist, where the party investing in capital may not receive the full resulting benefits; eg. landlord/tenant, builder/occupier, retrofitter/new owner. This issue is partially addressed through changes to the **Building Code** to facilitate the efficient use of energy and the use of renewable energy in buildings. It is also partially addressed by **minimum energy-performance standards**, where require certain types of appliances and equipment to reach a minimum level of energy efficiency. Price signals sent by the price-based measure may be distorted by strategic behaviour. For example, electricity generators or retailers may choose to recoup the impact of the price-based measure through one sector more than another. Aside from applying strict regulations, it is difficult to address this issue through a non-prices measure.	No Costs fall appropriately on those undertaking emissions-inducing activities.	Information and education about the risks of climate change and the importance of conserving energy may encourage these firms to make decisions about their energy consumption that benefit New Zealand overall. This potential benefit is targeted through the **Emprove** and **4 Million Careful Owners** programmes, and training for company directors to influence an energy conservation culture under the **EIB** policy.

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Energy demand commercial and SMEs cont.	Firms conserve energy or improve efficiency cont.	Price signals sent by the price-based measure may be distorted by pricing methodologies. For example, firms on fixed-or mostly fixed-price contracts will not receive immediate signals from the measure. The structure of the electricity market means electricity end users will not receive price signals differentiating renewable and non-renewable electricity. This effect is difficult to avoid without significantly altering market structures. There may be bounded rationality; ie, energy is a low proportion of total expenditure or is perceived as a necessity and hence does not command discretionary attention. This issue is partially addressed through the **EIB** policy, which will involve training for company directors to influence and energy-conservation culture, and through training and information under the **Emprove** programme.		
	Firms move to less emissions – intensive fuel types	The risks associated with new technologies may delay the uptake of these technologies beyond what would be optimal from New Zealand. Demonstration projects under the **energy-intensive businesses** policy aim to address this through providing support for innovation and technology uptake, as does the provision of loans and information through the **Emprove** programme for energy efficiency or small-scale renewable energy investment.		
Energy demand – residential	Households conserve energy or improve energy efficiency	There may be information barriers to change. For example, households may lack information on how to reduce their energy use and therefore not respond appropriately to the price-based measure. Existing non-price measures targeting this failure include the **4 Million Careful Owners** and **Emprove** programmes, and the implementation of **energy-performance labelling** on some products. Split incentives may exist, where the party investing in capital may not receive the full resulting benefits; eg, landlord/tenant, builder/occupier, retrofitter/new owner. This issue is partially addressed through changes to the	Distributional impacts of price-based measures on households are ambiguous: low-income households spend a greater proportion of their income on carbon-intensive commodities such as petrol and electricity, but several commodity types on which higher-income households spend proportionally more will also undergo substantial price	Information and education about the risks of climate change (essentially making people more “climate aware” or “climate friendly”? may help consumers make decisions about their consumption that benefit New Zealand overall. Information provided under the **4 Million Careful owners** programme aims to address this issue

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		Building Code to facilitate the efficient use of energy and the use of renewable energy in buildings. It is also partially addressed by **minimum energy-performance standards**, which require certain types of appliances and equipment to reach a minimum level of energy efficiency. Price signals sent by the price-based measure may be distorted by pricing methodologies. For example, households on fixed-or mostly fixed price contracts will not receive immediate signals from the measure. This issue is partially addressed through regulations requiring electricity retailers to offer a **low-fixed charge tariff** to small electricity users, enabling them to receive more financial benefit from controlling their electricity use. The structure of the electricity market means electricity end users will not receive price signals differentiating renewable and non-renewable electricity. This effect is difficult to avoid without significantly altering market structures.	increases. Kerr concludes a carbon tax on petrol may have the greatest impact on middle-income households. Substantial equity issues are not predicted to arise as the overall impact of a price-based measure on energy prices is expected to be low initially and a large subset of the low-income group most vulnerable to increases in prices will be partially compensated: benefits and superannuation are CPI adjusted and Family Support will be indexed to increases in the CPI from 2008.	
Energy demand – residential Cont.	Households conserve energy or improve energy efficiency. Cont	There may be bounded rationality: ie, energy is a low proportion of total expenditure or is perceived as a necessity and hence does not command discretionary attention. This is partially addressed through information provided through the **4 Million Careful Owners** programme, and through the **residential housing** programme Financial barriers to change may exist. For example, low-income households may not have access to funds to purchase capital to improve their energy efficiency. This issue is partially addressed through the awarding of **grants for the installation of insulation in low-income homes**.		

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The table identifies that there is a rational role for all existing non-price-based energy measures, under a situation where a price-based measure is adopted.

Non price-based measures where there is a broad, low-level carbon tax

One of the price-based measures put forward in the review is that of a low-level (maybe $5 per tonne of CO_2e) carbon tax with few exemptions, which may be ramped up over a period that is compatible with New Zealand's economic objectives. In this situation, the low-level price-based measure would still be a central climate change measure in the energy sector.

However, a low-level tax would be unlikely to initially result in significant emissions reductions. Undertaking an enhanced range of measures in the energy sector could be considered. As a result, a lower threshold may be adopted when assessing the cost-benefit ratio of complementary measures to include in a climate change package.

Non-price-based measures where there is no price-based measure

Price-based instruments are considered to be particularly important as part of New Zealand's policy response to climate change, as they can cover a broad range of emitters and overcome information barriers that make it difficult to construct a "command and control" approach. However, for a number of reasons (including that competitiveness issues arise if other countries are not moving to a similar measure) the Government may wish to postpone the adoption of a price-based instrument in New Zealand. In this situation, it may be appropriate for the Government to adopt a greater range of non-price measures, including in the energy sector, so that New Zealand's climate change policy package is internationally credible.

Little analysis has been undertaken in New Zealand on preferred non-price-based measures in the absence of a price-based measure. Following electricity generation dry years in 2001 and 2003, the Government commissioned a report (Charles Rivers Associates, 2003) examining the effectiveness of various financial incentives in promoting the uptake of energy-efficiency measures among firms. The report looked at direct cash grants, subsidies for equipment purchases, loans and tax concessions.

Overall, direct cash grants appeared to be the preferred intervention. Among their advantages was that they could be used for any qualifying technology or investment, meaning decisions would be based on the benefits delivered as opposed to the specific technology option pursued. Direct cash grants had the most significant impact on investment payback periods. However, it was acknowledged that the direct cost of grants to Government is considerably higher than measures such as loans, as there is no payback.

Financial assistance for equipment purchases were thought to be inferior to grants, as in some cases, vendors may capture some of the assistance through not wholly deducting the value of subsidies from their prices. Moreover, this type of assistance will necessarily steer investments towards particular technologies. Loans and tax concessions were shown to have a minimal effect on payback periods and loans had

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the additional disadvantage of reducing the firm's ability to borrow to fund its core activities (given they will appear as a debt on the firm's balance sheet).

This analysis, however, excluded other non-price-based measures such as regulation and generally was constrained by lack of information on the energy-efficiency opportunities available, existing penetration and take-up rates for energy-efficiency investments, and likely take-up rates of different incentive mechanisms.

The remainder of this section makes some assessment of the climate change benefits of existing programmes. EECA is currently undertaking a review of the NEECS, which provides the strategic context for EECA's package of energy efficiency and renewable energy measures. The Energy Efficiency and Conservation Act 2000 requires the NEECS to be reviewed five years after it comes into force and requires the Minister of Energy to determine whether or not the NEECS needs to be replaced by a new strategy. This first stage will involve a stocktake of current NEECS programmes, an assessment of best practice, and an assessment of programme "gaps". Should the Minister decide that a new strategy is to be developed, a more in-depth assessment of options for additional and expanded programmes will be undertaken. It is therefore recommended that any decisions to adjust the existing package of measures should follow completion of the NEECS review. However, this section provides an initial assessment from an emissions reduction perspective of the value of existing programmes.

4.4.4 Assessment – non-price-based measures

In the context of climate change policies, non-price-based measures should proceed:

- if they promote both economic welfare and emissions reductions: ie, a "win-win" or "no-regrets" measure. A number of non-price energy-efficiency measures are likely to fall into this category, given the potential cost savings associated with energy efficiency; or

- where the measure involves some economic cost but produces emissions reductions that deliver benefits unambiguously sufficient to offset those economic costs. Co-benefits are also an important consideration in assessing overall net benefits.

This section will examine the non-price-based measures identified in Table 19 above. It will attempt to determine where expected economic-welfare gains, in addition to emissions-reduction benefits, make the intervention a no-regrets measure. In situations where an economic cost is expected, the section will attempt to determine whether the climate change benefits outweigh that cost. Where there are clear co-benefits, these will be noted and incorporated in the assessment.

References to energy-efficiency savings and avoided emissions indicate the additional impact per annum from the programme[110], as estimated by EECA for the 2005/06 year. Energy and emissions savings from these programmes are "locked in" and therefore accumulate over time.

[110] Except the potential emissions savings quoted for the EIB programme, which represents a linear level of savings.

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Measuring the benefits, both climate change and otherwise, of non-price energy-sector measures tends to be difficult, given a lack of evaluation and monitoring data and, in particular, difficulty in assessing where benefits are directly attributable to the specific programme.

Energy-intensive businesses (EECA)

Type of policy: information provision and financial incentives

The energy-intensive businesses policy aims to assist small and medium energy-intensive firms (ie, those that do not negotiate NGA agreements) to reduce greenhouse gas emissions and mitigate the possible adverse effects of a carbon tax through improved energy efficiency. The interventions included in the EIB programme were identified in a survey of small and medium enterprises (SMEs) undertaken by PricewaterhouseCoopers to identify potential adverse effects of a carbon tax on competitiveness. International examples of energy-efficiency programmes for SMEs were also reviewed to inform the design of EIB policy.

The grants scheme was assessed as being the most appropriate financial incentive (compared to subsidies, loans and tax concessions) due to low administration costs, flexibility and effectiveness in reducing payback time.

Demonstration projects in targeted firms are considered an effective means of support for innovation and technology uptake to promote energy efficiency in these industries. EECA and The Ministry for the Environment intend to work with industry associations to identify suitable sites to demonstrate technologies that have cost-effective energy savings but low uptake.

Training and education programmes will be targeted at top management, as this is considered to have the greatest influence on behaviour change. It has been identified that energy-efficiency and conservation values are less strongly held in New Zealand-owned companies than in offshore-owned companies operating in New Zealand.

Targeting these measures at areas where the most cost-effective gains are thought to exist will help maximise the benefits derived from available funding.

Climate change benefits

As this policy is only beginning to be implemented, an ex-post assessment of its impact on energy efficiency and therefore emissions reductions is not possible.

The Ministry for the Environment states that the potential for emissions reductions by SMEs is small but not insignificant. It is estimated that SMEs were responsible for around 5Mt of carbon dioxide emissions in 2002. It is thought that there may be proportionately greater potential for energy-efficiency improvements in SMEs than in other, larger firms. Based on results achieved to date through its own programmes, EECA estimates most SMEs are capable of achieving energy-efficiency gains of between 5% and 7%. If all SMEs achieved a reduction of 5% in their energy use as a result of this policy, emissions reductions of 0.25Mt of CO_2 per year would be achieved. However, given that the policy will focus on specific sectors, a

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considerably lower level of emissions reductions (probably under 0.1Mt of CO_2 per year) would be more realistic. EECA has noted that there is a risk that current funding associated with this programme is insufficient to provide credible support to all affected sectors.

Co-benefits

Material improvements in energy efficiency achieved under the policy will have a number of co-benefits, including helping businesses to adjust to the carbon tax through reducing their costs, improving New Zealand's security of electricity supply (through reducing both peak load and overall load), and delaying the need for investment in new generation, thereby reducing local environmental impacts.

Costs

Government funding of $1.482 million (GST exclusive[111]) has been agreed. As EIB policy will focus on providing information to SMEs on the benefits and ways to improve energy efficiency to inform the firms' decisions, costs imposed on firms will be very low.

Conclusion

This policy has been designed to achieve cost-effective energy-efficiency gains with the limited funding available. An ex-ante assessment of the climate change benefits and co-benefits is not possible, as the policy is only beginning to be implemented. Based on EECA's estimates, there appears to be good potential to reduce emissions among SMEs. There would also be a number of co-benefits associated with any energy-efficiency improvements achieved.

Based on the low cost of this policy and these potential benefits, this policy is considered likely to result in a net economic welfare gain and emissions-reduction benefits for New Zealand, and is therefore a no-regrets measure. It would be appropriate for this policy to continue to operate at its current level (allowing for the introduction of the training and education components in 2006/07) until ex-post evidence on its effectiveness is available.

Emprove (EECA)

Type of policy: information provision and financial incentives

The Emprove programme aims to promote business uptake of energy-efficiency measures. It offers grants for energy audits and provides information to raise awareness of the opportunities to improve profitability through good energy management. Loans are also offered to government departments, local authorities and Crown entities to implement energy savings.

Emprove focuses primarily on the top 30 energy-use companies (which consume 71% of business energy use), with a secondary emphasis on the 80 next-largest energy users. In implementing the programme, EECA targets the areas that will

[111] Note that in this section dollar values are GST exclusive unless otherwise noted.

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bring the greatest benefits to businesses and also help to reduce greenhouse gas emissions.

The programme attempts to take a "multiple barrier" approach. It provides focused education and information provision through energy audits, and offers grants to overcome financial barriers. In other countries, a similar approach has helped to develop an active and competitive market for energy service companies. Energy audits are considered to provide a high benefit-to-cost return.

Climate change benefits

EECA have estimated that Emprove will provide 0.2 PJ of annual energy-efficiency improvements and 0.02Mt of avoided carbon dioxide emissions per annum. EECA notes this estimate is reasonably robust, given sound experience with the underlying programme.

Co-benefits

Improvements in energy efficiency resulting from this programme will help to reduce business energy costs (thereby improving economic competitiveness), improve the security of supply of New Zealand's electricity system, and may delay the need for investment in new generation (thereby reducing associated local environmental impacts).

Costs

Total costs of the Emprove programme to EECA are $2.056 million in 2005/06. The programme is therefore estimated to achieve 1 PJ of energy-efficiency savings at a cost of $10.3 million (EECA, 2005). Some energy-savings opportunities identified through audits will be achieved only through investment in new energy-efficient capital or processes. In these cases, firms will face some up-front investment costs. However, up-front costs are likely to be offset through accumulated energy savings. Firms will draw on their own investment criteria in making these investment decisions.

Conclusion

The Emprove programme appropriately focuses on the businesses where there are the highest potential energy savings. It also employs a multi-barrier approach to address both information and financial constraints. The programme has demonstrated a relatively strong history of energy savings, resulting in greenhouse gas emissions reductions and a number of co-benefits.

The programme costs approximately $2 million per annum to implement. Based on a 0.2 PJ per annum energy-efficiency improvement, the programme may be expected to save approximately $5 million per annum in business energy costs.[112] This

[112] Based on an average industrial price of electricity of $25.3 million/PJ (GST incl.), derived from the July 2005 Energy Data File. Note, however, that savings in industrial energy costs will have some impact on the profitability of electricity retailers.

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indicates the programme is likely to achieve a net gain in economic welfare and is therefore a no regrets policy.

A strong benefit-to-cost ratio indicates Emprove might achieve additional cost-effective energy savings if additional resources were available. However, given the programme already focuses on those companies with the highest energy use, expanding the focus of the programme could bring diminishing returns for each additional dollar spent. Overall, with currently available data, the value of expanding the Emprove programme is unclear. Should an overall expansion of complementary energy measures by undertaken, it would be worthwhile exploring the potential benefit of expanding Emprove in more detail.

Building regulations (EECA)

Type of policy: regulations

Building regulations are considered the simplest and most effective way to ensure minimum levels of energy efficiency in new commercial and residential buildings. This programme seeks to influence the review of the New Zealand Building Code to ensure energy-efficiency measures are included in the development of new housing stock. It also involves undertaking some supporting research to increase understanding of energy use in buildings. It is generally considered that incorporating energy efficiency at the design stage delivers good value for money. This measure is used in many countries to address energy use in buildings and provide other benefits.

Climate change benefits

Household energy use in New Zealand is low compared with other developed countries. It is expected that EECA's efforts to improve energy efficiency in this area will result in a slower increase in energy use rather than a significant decrease.

EECA has predicted that a 0.01 PJ per annum improvement in energy efficiency may be possible from this programme, resulting in 1,400 tonnes of avoided carbon dioxide emissions. Actual energy (and emissions) savings may be very difficult to measure.

Co-benefits

Given that anticipated energy savings are very small, associated co-benefits will be small also. In principle, designing energy-efficient buildings will reduce energy costs for the occupant (which, in the case of business, will improve economic competitiveness) and may improve the warmth of these buildings, thereby increasing comfort and reducing negative effects on health. Nationally, improved energy efficiency will improve the security of supply of New Zealand's electricity system, and may delay the need for investment in new generation (thereby reducing associated local environmental impacts).

Costs

The total cost of the building regulations work programme for EECA is $0.3 million per annum. The programme is therefore estimated to achieve 1 PJ of energy-

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efficiency savings at a cost of $30 million (EECA, 2005). Increased private building costs may result from using energy-efficient materials and design, although these may be offset by accumulated energy savings.

Conclusion

Incorporating energy efficiency at the design stage of building construction is considered to give good value for money in the long term. However, measuring realised gains from this programme will be very difficult.

The programme costs $0.3 million per annum to implement. Based on a 0.01 PJ per annum energy-efficiency improvement, the programme may be expected to save approximately $0.37 million per annum in residential and business energy costs[113]. This estimate indicates there may be a marginal economic-welfare gain as a result of this programme. Taking into account associated climate change and co-benefits, plus the long-term locked-in nature of efficiency gains achieved through design and construction practices, it is considered this programme is justified on an overall cost-benefit basis, if not a no-regrets policy.

Given the one-off nature of the Building Code review, it seems unlikely there would be value in expanding this programme on a sustainable basis.

Residential housing (EECA)

Type of policy: information provision and financial incentives

This programme provides information and targeted financial incentives to reduce energy use in the home. It includes the EnergyWise Home Grants programme, which provides financial assistance for installing insulation in pre-1977 homes (when the Building Code introduced mandatory requirements on insulation in new homes) occupied by low-income families. Rental properties are included, which will assist in cases where investment is hindered by split incentives (ie, between landlords and tenants). The programme also includes the Home Energy Rating Scheme, which aims to raise awareness of, and improve, residential building energy efficiency by providing reliable information to encourage home owners to improve the energy performance of their homes. The Home Energy Rating Scheme targets middle-to-high income owners of pre-1977 homes.

The programme focuses on the lower and higher ends of the income distribution spectrum, as these are the households for whom energy efficiency is a low priority. For low-income households, this is due to more general difficulties accessing capital, while for high-income households, it is because they are (and can afford to be) less concerned with their energy expenditure.

Climate change benefits

[113] Based on a national average price of electricity of $37.0 million/PJ (GST incl.), derived from the July 2005 Energy Data File. Note, however, that savings in residential and business energy costs will have some impact on the profitability of electricity retailers.

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As space heating often represents a significant proportion of domestic energy use, insulation can help to achieve substantial reductions in energy use among the target households. EECA have established a target for this programme of an additional 0.07 PJ of energy savings per annum, resulting in 9,800 tonnes of avoided carbon dioxide emissions.

Co-benefits

The installation of insulation in low-income homes has significant co-benefits, including reducing the energy costs faced by these households and improving the average warmth of their homes (thereby increasing comfort and reducing negative health impacts). Studies have shown that the health benefits of warmer homes are considerable and result in fewer doctor visits and less absenteeism. These co-benefits are the primary driver of the EnergyWise Home Grants policy. EECA estimates the value of health benefits arising from this programme to be nearly twice the value of the energy savings. Insulation may also assist in reducing emissions of PM10 particulates into the air, and provide employment opportunities for low-skilled workers.

General improvements to energy efficiency resulting from the EnergyWise Home Grants programme and the Home Energy Rating Scheme programme can also improve the security of supply of New Zealand's electricity system, and may delay the need for investment in new generation (thereby reducing associated local environmental impacts).

Costs

Total costs of the residential housing work programme for EECA are $0.832 million per annum. The programme is therefore estimated to achieve 1 PJ of energy efficiency savings at a cost of $11.9 million (EECA, 2005).

Conclusion

The programme costs $0.832 million per annum to implement. Based on a 0.07 PJ per annum energy-efficiency improvement (ie, EECA's targeted savings for the programme), the programme may be expected to save approximately $3.2 million per annum in residential energy costs.[114] This would indicate the programme, if it meets its targeted savings, is likely to achieve a net gain in economic welfare and would therefore be a no-regrets policy.

However, the primary driver for this programme is the associated health benefits of warmer homes, which EECA estimates have nearly twice the value of the energy savings. An earlier focus for grants funding under the programme was improving the efficiency of lighting and water-heating systems, thought to be the most cost-effective means of improving energy efficiency in homes. However, the measures that result in the highest health and social benefits and have the most permanence are ceiling and underfloor insulation. The focus of the programme has now shifted to whole-

[114] Based on an average residential price of electricity of $46.4 million/PJ (GST incl.), derived from the July 2005 Energy Data File. Note, however, that savings in residential energy costs will have some impact on the profitability of electricity retailers.

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house installations, to ensure these latter benefits are accrued. This has reduced the cost-effectiveness of the programme in terms of energy-efficiency goals.

Given the significance of these health and social co-benefits, they should remain the primary driver for this programme. No adjustment is proposed for this programme on the basis of climate change goals.[115]

Renewable energy to the grid (EECA)

Type of policy: information provision

This programme aims to ensure that electricity generation is sourced from renewable energy wherever that is economically and environmentally efficient. It provides information to existing and potential electricity generators on renewable energy developments and associated issues, and aims to influence local authorities to create a favourable regulatory framework for resource management decisions on renewable energy proposals.

Climate change benefits

In the year to 30 June 2006, it is anticipated that, nationally, New Zealand will have generated an additional 1.4 PJ of renewable energy to the grid. It is not possible to determine the level of renewable energy development that is directly attributable to this programme, given its facilitation and information-provision nature.

Co-benefits

Facilitating the development of renewable energy in place of fossil fuel generation reduces the release into the air of local pollutants such as sulphur and mercury, which can have adverse effects on health.

Costs

Total costs to EECA of the renewable energy to the grid programme are $0.56 million per annum.

Conclusion

Given the inability to directly attribute renewable energy development to this programme, it is very difficult to estimate the programme's cost-effectiveness. Addressing information barriers for generators investing in renewable energy and for local authorities evaluating the benefits of renewable energy will be an important part of facilitating greater renewable energy development. Further evidence should be gathered on the effectiveness of this programme before a decision is made on adjusting it.

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[115] It may be desirable to expand the programme on the basis of the co-benefits noted.

Market development renewable energy (EECA)

Type of policy: information provision and financial incentives

This programme aims to increase the contribution to New Zealand's energy supply of renewable energy derived from small-scale (generally less than 1 MW) technologies such as solar water heating, heat pump water heating, mini and microhydro, small-scale wind and photovoltaics. One of the key mechanisms in this programme is the provision of grants to purchase and install solar water heating systems in residential dwellings. Other activities include promoting the benefits of solar water heating and other renewables, and supporting the development of renewable energy industries.

Climate change benefits

In the year to 30 June 2006, it is anticipated that nationally New Zealand will have generated an additional 0.03 PJ of renewable energy from small-scale renewables. It is not possible to determine exactly the level of additional energy attributable to this programme, although it is thought to be high as a result of the financial incentives provided for solar water heating. The solar water heating industry has grown at more than 40% per annum for the last three years.

Co-benefits

Households installing solar water heating are estimated to save around $350 per year on energy costs. The development of distributed, off-grid generation also contributes to New Zealand's security of supply by diversifying the supply mix and avoids distribution and transmission line losses (thereby improving overall efficiency of the electricity system).

In general, the development of renewable energy in place of fossil fuel generation can bring benefits, including reducing local pollutants. EECA anticipates that distributed renewable generation will play an increasingly important role in New Zealand's energy supply in the future. However, in the short term, it is considered unlikely that the contribution of small-scale renewable generation will have a large impact on the overall mix of new generation.

Costs

Total costs to EECA of the renewable energy to the grid programme are $0.6 million per annum. Homeowners who choose to install solar water heating will still face some investment costs over and above EECA grants, although these will be offset by approximately $350 per year generated by energy savings. Homeowners will use their own investment criteria in making decisions about solar water heating, although the market development renewable energy programme reduces the initial investment barrier.

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Conclusion

Again, it is difficult to directly attribute the development of small-scale renewables to this programme, although recent growth rates in the solar water heating industry indicate it is having a noticeable impact. Given the relative contribution of small-scale renewables to New Zealand's overall energy supply, it is not anticipated this policy will have a significant impact on the energy system or greenhouse gas emissions. EECA also acknowledges that the initial upfront investment in this programme is high relative to the short-term energy gains (EECA, 2005). This would indicate that there is no clear value in expanding this programme relative to other programmes.

Energy efficiency of products (EECA)

Type of policy: regulations and information provision

This programme achieves energy savings by increasing the stock of energy-efficient products in New Zealand through influencing the purchase process. The programme comprises two workstreams: Minimum Energy Performance Standards (MEPS) and mandatory labelling; and the "Energy Star" products endorsement scheme.

MEPS is regulatory and requires selected products to abide by a minimum standard of energy efficiency in order to be sold. Incorporating energy efficiency at the design stage is thought to deliver improved value for money. Products covered are air conditioners, domestic refrigerators, electric water heaters, refrigerated display cabinets and distribution transformers, fluorescent lamps and ballasts for such lamps, and three-phase motors. Fridges, freezers, and domestic air conditioners (single phase) must also display an Energy Rating Label.

The "Energy Star" products endorsement scheme is a voluntary labelling scheme that encourages consumers to purchase home appliances, office products and domestic refrigerators with high energy-efficiency ratings.

Under Trans-Tasman Mutual Recognition Arrangements with Australia, New Zealand and Australia are required to mutually recognise regulatory standards adopted. As a result, standards under the MEPS are agreed in conjunction with Australia. This creates a degree of inflexibility and means that the setting of standards under MEPS will not always be able to maximise the benefit to New Zealand in terms of pursuing policy objectives.

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Climate change benefits

MEPS and mandatory labelling is estimated to contribute 0.73 PJ of energy savings per annum. The "Energy Star" products endorsement scheme is estimated to realise 0.02 PJ of energy savings per annum. The overall Energy Efficiency of Products programme is therefore estimated to achieve 0.75 PJ of energy-efficiency improvements per annum, resulting in 0.13Mt of avoided carbon dioxide emissions per annum. EECA considers these estimates to have a high degree of certainty, given a strong programme history and the direct relationship between regulations and energy use.

Co-benefits

Improvements in energy efficiency resulting from this programme will help to reduce domestic and business energy costs (thereby making households better off and firms more competitive) and improve the security of supply of New Zealand's electricity system, and may delay the need for investment in new generation (thereby reducing associated local environmental impacts).

Costs

Total costs of the Energy Efficiency of Products programme to EECA are $1.815 million in 2005/06. The programme is therefore estimated to achieve 1 PJ of energy efficiency savings at a cost of $2.4 million (EECA, 2005). Manufacturers may experience some additional costs in reaching the standards of energy efficiency set by MEPS regulations.

Conclusion

The Energy Efficiency of Products programme is assessed to achieve the greatest improvement in energy efficiency of EECA's programmes. As well as influencing purchasing behaviour, labelling schemes may encourage manufacturers to develop more efficient products.

The programme costs $1.815 million per annum to implement. Based on a 0.75 PJ per annum energy-efficiency improvement, the programme may be expected to save over $25 million per annum in business energy costs.[116] This indicates the programme is very likely to achieve net economic-welfare gains, making it a no-regrets policy. This strong cost-effectiveness is consistent with the consideration that incorporating energy efficiency at the design stage delivers improved value for money.

The high benefit-to-cost ratio indicates that further gains might be achieved by expanding this programme, most likely by increasing the number of products to which standards or labels are applied, but potentially also by raising the minimum standards associated with currently regulated products. Light bulbs may be considered an obvious example of an additional product to include, although further assessment would be needed to confirm this would be appropriate. However, gains are likely to

[116] Based on a national average price of electricity of $37.0 million/PJ (GST incl.), derived from the July 2005 Energy Data File. Note, however, that savings in business energy costs will have some impact on the profitability of electricity retailers.

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be diminishing if the opportunities for highest energy savings have already been exploited and may also be limited by existing technical potentials. New Zealand's Trans-Tasman Mutual Recognition arrangements with Australia may also result in some inflexibility in expanding this programme.

Nevertheless, should an overall expansion of complementary energy measures by undertaken, it would be worthwhile exploring the potential benefit of expanding the Energy Efficiency of Products programme in more detail.

RMA and government submissions

Type of policy: regulations

Initially, the RMA did not explicitly provide for improved energy efficiency or give particular weighting to the value of renewable energy, despite the fact that these matters bring national benefits. In contrast, matters such as landscape and amenity values were listed as matters of national importance or matters to be given particular regard, creating the potential for imbalance. Consultation at the time indicated there was potential for resource management decisions and council plans to better address national energy objectives, including the NEECS and the Government's climate change policy package.

As a result, the RMA was amended in 2003 to require particular regard to be given to the national benefits derived from the use and development of renewable energy and the efficiency of the end use of energy. Since the amendment was introduced, MED has made numerous submissions to local authorities considering renewable energy developments, noting the amendment and drawing attention to the benefits of these proposals.

Climate change benefits

Greater use of renewable energy and improved energy efficiency are key ways of reducing New Zealand's emissions of greenhouse gases. The RMA (and its implementation through regional and district plans and decisions on resource consents) can have a significant effect on the level and timing of renewable energy projects and investment in upgrading the national electricity grid (which can improve the overall efficiency of the electricity system). The amendments to the RMA will ensure that the national benefits of energy efficiency and renewable energy projects are given appropriate weight in decision-making compared with local environmental and amenity effects.

Since this amendment was passed in 2003, a number of significant renewable energy projects have successfully proceeded through the resource consent process, including Awhitu wind farm (19 MW), Te Rere Hau wind farm (52 MW), White Hill wind farm (70 MW), Tararua wind farm (120 MW) and Hawke's Bay wind farm (225 MW). MED has made submissions to consent hearings for a number of these projects and in doing so, has drawn attention to the benefits of renewable energy and energy efficiency and the related RMA amendment. While it is not possible to directly attribute the successful consenting of these projects to the amendment or

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these submissions, anecdotal evidence suggests they provide additional support for the projects proceeding.

Co-benefits

Facilitating the development of renewable energy in place of fossil fuel generation reduces the release into the air of local pollutants such as sulphur and mercury, which can have adverse effects on health. Improved electricity efficiency may also offset the need for additional generation entirely, thereby avoiding associated local environmental impacts. Renewable energy and energy efficiency also improve New Zealand's security of electricity supply.

Costs

The RMA amendments change the weighting given to a particular matter. Additional administrative costs imposed on local authorities as a result of the amendments are considered low, given it does not require authorities to change their district or regional plans. Similarly, additional costs to consent applicants are thought to be very small. Applicants for resource consents are, where relevant, required to provide information on how their project contributes to or affects renewable energy. However, many applicants have traditionally provided this information anyway.

MED incurs some administration costs when making submissions, although these are minimal, given that the process has largely been standardised.

Conclusion

It is thought that the RMA and its implementation can have a significant impact on the timing and level of investment in renewable energy. Recognising the national benefits of renewable energy development in resource management decision-making is therefore important. Anecdotal evidence suggests the amendments to the RMA to recognise these matters and accompanying submissions from the Government have provided additional support to the development of renewable energy projects, thereby bringing significant climate change and co-benefits. Given that the costs of compliance are minimal, it is considered the amendment to the RMA to recognise the benefits of renewable energy and the efficiency of the end use of energy and the accompanying process of government submissions on individual proposals are no-regrets policies.

Implementation of the RMA amendment to date indicates that it provides a sufficient obligation on local authorities for these benefits to be properly considered. A stronger obligation may risk overriding the protection of other matters such as landscape and amenity values in circumstances where it would be more appropriate for these values to be protected. Moreover, consideration is currently being given to a National Policy Statement on electricity generation, which would provide further guidance to local authorities on making decisions on these developments. It is therefore considered that no amendments are required to the RMA amendment on the basis of climate change objectives.

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Submissions on behalf of the Government are currently being made on most significant renewable energy projects. It is considered no amendment is required to the current submissions process on the basis of climate change objectives.

Low-fixed-charge tariffs

Type of policy: regulations

In 2000, the Government committed to a policy of all domestic electricity consumers having a low-fixed-charge tariff option for their electricity supply. A low-fixed-charge tariff allows low-use consumers to reduce their electricity costs and be rewarded for energy conservation. It can also help those on low incomes to save money on power. This policy is described in Section 3.2.5.

Climate change benefits

Low fixed charges, by giving greater emphasis to the variable charge for energy consumed, provide an increased incentive for domestic consumers to invest in energy efficiency and also alternative energy sources such as solar generation. Both these responses help to reduce greenhouse gas emissions. However, it is not possible to provide a quantitative estimate of avoided emissions resulting from this policy.

Co-benefits

High fixed electricity charges have significant negative impacts on consumers with low incomes. A low-fixed-charge tariff provides consumers of small quantities of electricity (who are often on lower incomes) the option of lower fixed charges and higher variable charges, giving these consumers greater control over their bills. As such, a low-fixed-charge tariff can assist those on low incomes to save money on power.

Improved electricity efficiency will improve the security of supply of New Zealand's electricity system and may also offset the need for additional generation entirely, thereby avoiding associated local environmental impacts.

Costs

From an electricity supplier's commercial perspective, low-use consumers tend to be less profitable to supply. A low-fixed-charge tariff that rewards low electricity use may therefore result in a small loss of profitability for retailers.

The Electricity Commission will have some small ongoing costs associated with monitoring the regulations, but these are met within existing baselines.

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Conclusion

Providing appropriate price incentives to domestic electricity consumers to conserve energy is an important element of a well-functioning electricity market. The requirement to offer a low-fixed-charge tariff option will help transmit the price signal generated by a price-based measure to domestic electricity consumers to encourage appropriate behaviour change.

It is clear that these regulations will provide some financial benefit to low-use domestic electricity consumers. However, this may largely come at the expense of electricity retailers. There is therefore no unambiguous economic-welfare gain as a result of this policy. However, co-benefits associated with the policy, including alleviating financial pressure on low-income households (and the corresponding social benefits) and providing incentives for energy efficiency mean that total benefits are clearly greater than total costs. No further adjustment is proposed to this policy on the basis of climate change objectives.

Regulation of line access for distributed generation

Type of policy: regulations

Distributed generation is expected to play an increasingly important role in meeting electricity demand as the cost of smaller-scale and new renewable technologies continues to decline. However, there has been minimal investment in distributed generation in the last few years. One reason appears to be difficulties for potential investors in obtaining clear information about the process and requirements for the connection of distributed generation. Electricity distribution companies (which operate the lines to which distributed generation needs to connect) appear to have weak incentives to effectively facilitate distributed generation. Industry self-governance arrangements have made insufficient progress in addressing this issue.

The Government therefore intends to draft, consult on and introduce regulations to provide for:

- a formal enquiry process to obtain information on connection possibilities or constraints for particular locations
- application forms to be available and application decision timeframes
- access to compulsory dispute resolution when agreement on connection cannot be reached or an application is declined
- rules for network charges for various sizes of distributed generation.

Climate change benefits

Distributed generation is often, although not exclusively, based on renewable sources of energy such as solar and wind. Facilitation of distributed generation will therefore provide further options for renewable electricity to be developed. The development of renewable energy reduces the overall emissions intensity of the energy sector.

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Most distributed generation is between 10 kW and 5 MW in size, although domestic generation may be below this range and some schemes, including industrial cogeneration schemes, may be above this range. While distributed generation is anticipated to play an increasingly important role in New Zealand's electricity supply, it is not possible to accurately predict what level of generation it might provide, and what proportion of this generation might be renewable. Climate change benefits are therefore difficult to determine.

Co-benefits

Distributed generation can improve security of supply by creating diversity of fuel types, locations and technologies, and, where appropriately sited, helps reduce the need for transmission and distribution upgrades. It can also reduce electricity line losses from transmission by locating generation closer to the source of demand, thereby improving the efficiency of the electricity system. Distributed generation may delay the need for larger-scale electricity investment, which may be considered to have proportionately greater local environmental impacts.

Costs

Minimal costs will accrue to the Crown from developing and implementing regulations on line access for distributed generation. It is anticipated that transaction costs for potential distributed generation investors will be reduced. Transmission lines companies are likely to experience a small increase in compliance costs associated with the regulations. Consultation on the drafting of regulations may help to reduce these compliance costs.

Conclusion

It is anticipated that distributed renewable generation will play an increasingly important role in meeting electricity demand. In this regard, facilitating a potentially significant source of renewable generation will contribute to reducing the emissions intensity of New Zealand's energy sector. However, it is not possible to accurately determine the climate change benefits that will arise from regulation of line access for distributed generation.

Distributed generation also has a number of co-benefits for New Zealand's electricity system, including improving security of supply. Costs associated with the regulations are expected to be low. On this basis, regulation of line access for distributed generation is considered a no-regrets policy. No changes are proposed to this policy on the basis of climate change outcomes.

4.4.5 Overall conclusions

Existing programmes to reduce emissions are generally more developed in the energy sector than in other sectors. Strong co-benefits (including economic, social, health and environmental benefits) have resulted in the Government acknowledging and committing to energy efficiency and renewable energy, establishing EECA in 2000 to specifically focus on pursuing potential benefits.

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EECA now has a well-established, although evolving, package of measures. Other regulatory measures also contribute to climate change outcomes in the energy sector, including recognition in the RMA of the benefits of renewable energy and energy efficiency, low-fixed-charge electricity tariffs and the (pending) regulation of line access for distributed generation.

Table 19 examined the need for complementary measures to enhance the operation of a price-based measure in the energy sector. A clear rationale was identified for all existing complementary measures in these circumstances.

It is also considered that there is an appropriate mix of policies in the energy sector, including programmes focusing on business (high-energy-use businesses and businesses in general), residential, energy-supply and cross-sectoral matters. Should further emphasis be placed on reducing emissions in the energy sector, consideration should be given to including a high-profile, coherent and overarching public awareness campaign on energy efficiency. Such a campaign is recommended in the literature as an integral component of any nationwide energy-efficiency intervention package.

EECA currently runs various information programmes, including aspects of the energy-intensive businesses, Emprove, residential housing, and Energy Efficiency of Products programmes. However, these tend to be targeted on specific audiences. The 4 Million Careful Owners campaign presents information on climate change generally, including energy efficiency, but it is not clear that it has generated broad public awareness on ways to reduce energy use.

Consideration should also be given to private initiatives in this area. For instance, Meridian Energy provides information on ways to save electricity free of charge on its website and in newsletters to customers. It will be important that any publicly funded campaign does not duplicate or crowd out these initiatives.

Climate change benefits and programme costs are summarised in the table below, for programmes where data is available. Programmes fostering renewable energy development (including regulatory measures) are not included in this assessment. While these programmes may result in emissions reductions, it is very difficult to attribute the development of renewable energy specifically to government support programmes.

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Table 20 - Programme Cost and Estimated Climate Change Benefits 2005/06

Programme	**Total annual programme cost ($)**	**Total estimated annual CO_2 reductions (tonnes)**	**Programme cost per tonne of CO_2 reduced ($)**
Emprove	2,056,000	20,000	102.80
Building regulations	300,000	1,400	214.29
Residential housing	832,000	9,800	84.90
Energy efficiency of products	1,815,000	130,000	13.96

Source: Derived from the Energy Efficiency and Conservation Authority Business Plan 2005/06

Note that only direct programme costs (ie, departmental budget allocations) are incorporated in "total annual programme cost" and "programme cost per tonne of CO_2 reduced". Increased energy efficiency may have other cost implications, including for the profitability of electricity retailers. Likewise, the overall benefits of these programmes are more diverse than just carbon dioxide reductions. Energy-efficiency improvements also lead to cost savings for businesses and households and generate multiple co-benefits.

The full impact of building regulation changes is anticipated to grow considerably post-2005/06, as Building Code changes are yet to be fully implemented.[117]

There may be potential to further reduce emissions at reasonable cost through expanding some of these measures. Clearly, the Energy Efficiency of Products programme appears to currently provide the greatest overall energy savings, and at the greatest value for money. Further emission reduction benefits might be achieved through expanding this programme, although technical constraints and Trans-Tasman Mutual Recognition arrangement will need to be considered.

The Emprove and residential housing programmes have achieved much lower total emissions savings, at a higher cost per tonne of carbon dioxide. Overall, however, these costs may be offset by co-benefits. Assessment of the Emprove programme indicates there is a high chance it delivers a net gain in economic welfare (as a result of the energy-cost savings it generates for businesses) and is therefore a no-regrets policy. Assessment of the residential housing programme indicates it is likely to deliver a net gain in economic welfare. However, the key driver of this programme is considered to be the health (and comfort) benefits of warmer homes. This objective should therefore dictate the resources invested in this programme.

The impact of the building regulations programme is currently small, although this is to be expected, given that the Building Code changes have not yet been implemented. EECA anticipates a step increase in the impact of this programme in the future.

EECA is currently reviewing the NEECS, which provides an overarching context for energy efficiency and renewable energy programmes. The Energy Efficiency and Conservation Act 2000 requires the Minister of Energy to determine whether or not the NEECS needs to be replaced by a new strategy. This first stage will involve a stocktake of current NEECS programmes, an assessment of best practice, and an assessment of programme "gaps" Should the Minister decide that a new strategy is to be developed, a more in-depth assessment of options for additional and expanded programmes will be undertaken.

The appropriate nature and breadth of future/additional regulatory and supporting interventions to encourage energy efficiency and renewables will be dependent on decisions taken regarding the future shape of any market-based measure (i.e. carbon tax or emissions trading). Broadly speaking, the more closely a domestic carbon tax approximates the international carbon price, the less rationale there is for additional

[117] Cumulative emissions savings between 2005/06 and 2011/12 for the building regulations programme are estimated at 217,000 tonnes of CO_2, an average of 31,000 tonnes per year over this seven-year period, compared to estimated savings of 1,400 tonnes in 2005/06.

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supporting measures (however the need to address barriers to energy efficiency will remain). Whilst there may be a basis for transitional support to help firms adjust to a carbon price, this is offset to the extent that a tax is gradually phased in (the phasing in is, in effect, providing transitional support).

Given EECA's expertise in the area and the fact that the NEECS review timeframes will allow a much more comprehensive analysis to be undertaken, it is appropriate that decisions about energy-efficiency and renewable-energy programme be made after the NEECD review is completed. The existing package of complementary measures are considered to provide adequate climate change policy coverage in the energy sector in the meantime

4.5 Transport sector

Summary
This section:

- sets out a policy framework for considering CO_2 emission reductions for transport, noting both technical and behavioural changes
- summarises current government policies applying to the transport sector under headings of: pricing of transport activities and fuels, networks and infrastructure, energy sources, and vehicle technologies/efficiency
- assesses options for further policy with CO_2 benefits, building on the foundation of a cross-economy economic instrument.

It concludes:

- policies to date have not had a strong impact on CO_2 emissions, but a number of programmes have only recently started
- a number of desirable policies for air quality, health, congestion, urban form and oil security also provide CO_2 reductions, so there are co-benefits from pursuing integrated policies and programmes
- future technology development in transport will largely occur overseas, but there are some under-utilised opportunities to improve the CO_2 performance of the vehicle fleet
- there are no obvious "big win" CO_2 emissions-reduction opportunities at present; rather, the opportunities will generally be through small, incremental gains
- in order to get a substantial reduction in transport emissions, aggressive policies would be required that would impact on the access and mobility needs of sections of society.

As noted earlier in Section 4.1.3, transport-sector emissions have been growing strongly, with emissions currently tied closely to economic growth. There are no obvious "big hit'' actions available for large emissions reductions in the short term, but a number of actions were identified that could have beneficial effects. These actions were categorised under three areas of change as:

1 improve energy efficiency of the transport task

2 change to lower-CO_2-emitting energy sources

3 reduce travel (either the rate of growth or in absolute terms) (passenger kilometres or tonne kilometres).

This section discusses the effectiveness of current policy settings and outlines options for further emissions reductions.

4.5.1 Framework for policy consideration

For the purpose of policy consideration, the framework of actions identified in Table 10 (Section 4.1.3) has been refocused into a more meaningful policy framework. This is because some policy measures apply across all three of the change areas identified, while other policies tend to be sector or mode focused.

The policy framework used here categorises policies under four generic headings:

- **pricing** of transport activities and fuels
- **networks and transport infrastructure** (covering all modes)
- **energy sources** (including fuels)
- **vehicle technologies/efficiency.**

The CO_2 **effect** of policies is a product of the **influence** of the policy (ie, how broadly across the transport sector the policy applies) and the **impact** of the policy (ie, how deeply the policy impacts on the emissions of the policy area targeted). This distinction is useful when considering the likely short-term and longer-term effect of policies (Table 21). For example, in the short term, only transport/fuel pricing is considered to have a high influence on CO_2 emissions across the sector. Shifting to low energy modes (part of networks and infrastructure) can provide high CO_2-emission impacts (eg, switching from a car trip to a zero-emission walking trip), but the short-term influence is likely to be quite low because only a small proportion of people are likely to change their transport behaviour, and for only a proportion of their trips. Policies directed at influencing the efficiency of the vehicle fleet will have a low influence in the short term but, over time, the influence will increase as a greater number of new vehicles entering the fleet will be covered by the policy.

An important aspect is the sequencing of policies so that, over time, there is a movement from predominately low influence/low impact policies towards moderate-to-high influence/impact policies (ie, moving from the lower left box to the upper right box in Figure 40 below).

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Table 21 - Matrix of Transport CO_2 Likely Policy Effect

Policy area	Likely policy effect	
	Short term	**Long term**
Transport/ fuel pricing	High influence Low-mod impact	High influence Mod impact
Networks and infrastructure	Low influence Low-high impact	Mod-high influence Low-high impact
Fuels/energy sources	Low influence Low-high impact	High influence High impact
Vehicle technologies	Low-mod influence Low-mod impact	High influence Mod-high impact

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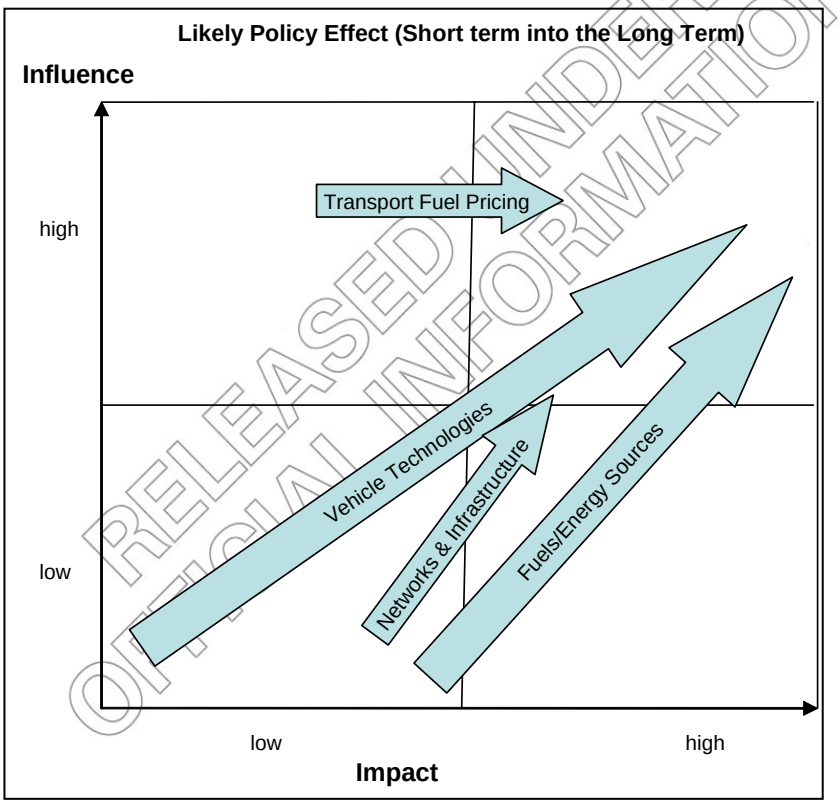
Figure 40 - Desire Lines of Policy Effects, Short Term into the Longer Term



4.5.2 Current Government policies – likely impacts on CO_2 emissions

An overview of the policy setting for transport is detailed in Section 3.2.6.

Most of the current work programmes and policies derive from the NEECS, and flow-on actions from the NZTS and Land Transport Management Act 2003. Actions are primarily focused on reducing emissions from road transport. Note that these actions are not factored into the modelling projections shown earlier (Figure 34 in Section 4.1.3).

The impact of cross-sectoral measures, such as the announced carbon tax, and specific transport sector-focused measures, are discussed below (using the four sub-headings introduced in Section 4.5.1). To the extent possible, conclusions are drawn about their ability to reduce transport greenhouse gas emissions.

Pricing of transport activity and fuels

Announced $15/t carbon charge: The tax will add approximately 3.5 cents to a litre of petrol (excluding GST), and 4 cents to a litre of diesel, aviation kerosene and marine fuels. This would increase petrol prices by about 2.5% and diesel prices by about 4% based on current retail prices (October 2005). These price increases are relatively small compared with the increases caused by the recent oil market instability. Overall, the announced carbon tax at its current level is expected to have only a minor effect on fuel demand – approximately 132kt CO_2 saving by 2020 (<1% of sector emissions).

Despite the anticipated lack of responsiveness from a carbon tax at its announced level, the benefit of an across-the-board price signal is that it is non-discriminatory. A price signal impacts on all three of the change areas discussed in Section 4.1.3, but leaves it to individual consumers and market suppliers to respond in ways appropriate to their circumstances. For example, some consumers might choose to purchase a more fuel-efficient vehicle; others might choose to change their travel patterns; entrepreneurs might be incentivised to develop and market new products and fuels.

In the aviation and coastal shipping industries, there is a potential for the tax to be inconsistently applied. In aviation, it may be possible that some international airlines that have air service agreements with New Zealand could seek to operate domestic services in New Zealand and not pay the carbon tax. For coastal shipping, visiting ships that carry domestic cargo while in transit are likely to avoid paying the announced carbon tax on the fuel oil used in that trip. They will either purchase fuel outside New Zealand or they will seek a rebate because they are en route to leaving New Zealand. According to the MOT the proportion of domestic cargo carried by visiting ships is around 15% (by tonnage) (New Zealand, Ministry of Transport, 2005f).

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Associated measures: These include NGAs and PRE. Some transport activities are included in at least two NGAs, but the overall effect on sector-wide emissions by 2020 will be insignificant. Transport-related proposals focused on biofuels have not been successful in the Projects rounds to date.

Other influences on price: Changes to fuel excise or the road user charge[118] affect the relative price of fuels and the overall cost of transport, and hence the demand for transport and fuel use. Recent decisions include:

- not subjecting fuel ethanol to excise (CAB Min (03) 30/5)
- a 5 cents per litre petrol increase (and road user charge equivalent) from April 2005 to cover infrastructure costs
- linking the road user charge and excise on petrol to inflation from April 2006.

Also, although there was no decision to incentivise LPG, current excise levels advantage LPG in relation to other fuels.

The Land Transport Management Act 2003 also provides for road tolling to be implemented. Depending on the circumstances, tolls could affect travel behaviour patterns (and, by implication, CO_2 emissions) in specific locations.

Networks and infrastructure

Funding for alternative modes and travel-demand management (TDM)[119]: In 1999/2000, central government funding for alternative modes and TDM amounted to $42 million out of a national programme expenditure of $940 million (4.5%). In the current year (2005/06), Land Transport New Zealand expects to spend $265 million in this category out of a total programme spend of $1,783 million (ie, 15% of expenditure), and the expectation for next year is higher still. A large part of the current increased investment is capital expenditure for passenger transport infrastructure in Auckland. In addition, local government has been increasing expenditure on other modes, especially public transport. While only small CO_2 emissions reductions are likely in the short term, over time, modal shifts and changed travel patterns can be expected to be locked in, as long as service levels are maintained and enhanced.

Rail: The Government repurchased the national rail network in 2004 and has committed $200 million to restore and upgrade the network, in line with the National Rail Strategy 2005. The aim is to reposition rail so that commercially viable freight services can be developed as attractive alternatives to road transport, and to enable a sound infrastructure base for urban rail services to be developed in major urban areas. The energy requirements of rail are typically one-quarter to three-quarters those of road-based alternatives. However, at this stage, it is too early to predict the level of trip diversion to rail that will occur, or the consequent CO_2 benefits.

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[118] See Glossary
[119] See Glossary

Urban design: Land-use planning and the design of our towns affects our transport patterns, in both mode and distance travelled. The links between good urban form and transport are recognised in the New Zealand Urban Design Protocol (2005). At the local level, current measures include the regional land transport strategies, and regional and district plans under the RMA, which requires consideration of energy efficiency. A number of the main urban areas are now considering new urban-design approaches that more explicitly link land-use planning decisions and transport infrastructure. There are several reasons: reducing urban sprawl, improving access and reducing congestion, providing for more cost-effective alternative transport modes, and improving energy efficiency. These policies are expected to produce CO_2 emissions reductions as a co-benefit, although the CO_2 benefits will generally be incremental and long term, especially where the fundamental urban form is already established.

Other measures: Small CO_2-emission reduction co-benefits are associated with police vehicle-speed enforcement (for safety management) and managing traffic flows (congestion management).

Construction of roads is also a recognised government policy, supported by targeted funding. New and realigned roads can provide relief from congestion, particularly in the short term. Fuel savings per vehicle could be as much as 6%[120] for the stretch of road relieved of congestion. However, overall CO_2 savings are achieved only if the total kilometres travelled does not change. There is significant evidence, both here and overseas, that new roads relieve congestion only temporarily and the total kilometres travelled tends to increase as individuals absorb the benefit of reduced trip time. Therefore, CO_2 benefits are marginal at best.

Energy sources

Biofuels: The NEECS established an indicative transport renewable energy target of 2 PJ[121] by 2012 (New Zealand, EECA, 2002g). In August 2005, the Government confirmed that it would develop and introduce a mandatory biofuels sales target (CAB Min(05) 29/4). This policy recognised benefits to climate change, as well as benefits to air quality and security of energy supply. If, at a minimum, the NEECS 2 PJ target is achieved, transport CO_2 emissions in 2012 would be reduced by about 0.7%. The mandatory sales target is expected to drive the necessary investment in manufacturing plant. In addition to the target, the current work programme is committed to investigating risks and liability issues and developing legislation to provide for appropriate fuel quality standards. One outcome may be ensuring that vehicle imports are compatible with likely biofuel blends. Changes to supply infrastructure, such as double-skinned tanks at service stations (and tank farms) are beginning to occur concurrently.

Fuel specifications: The 50 mg/l sulphur standard for diesel will be in place by early 2006 and will bring diesel fuel specifications into line with overseas best practice. The emissions-reduction potential will rest largely with flow-on impacts. To date, a

[120] Vehicle manufacturers give different fuel consumption estimates for city urban and highway driving, recognising stop-start driving and congestion; eg, a 2003 Ford Falcon sedan uses 12 litres/100km in city driving and 8 litres/100km on the highway. <http://www.greenhouse.gov.au/fuelguide/search.html>

[121] 2 PJ is approximately 1% of the current total energy consumed per annum by transport in New Zealand.

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number of high specification, very efficient diesel vehicle options have not been sold in New Zealand because low-sulphur diesel was not available.Although this may not be the sole reason – the smallness of the New Zealand market may also be a factor – removal of this barrier enables a wider range of fuel-efficient vehicles to be sold. It is not possible to predict CO_2 emissions reductions at this time but some indication of market trends should be apparent by the end of 2006.

While, in theory, a diesel engine will reduce CO_2 emissions typically by some 15% to 20% compared with an equivalent-sized petrol engine, there may also be some "takeback" if buyers choose larger-sized diesel engine options (or turbo-charging) or drive further because they are using a cheaper fuel.

Current policy also includes further reducing sulphur levels to between 10 mg/l and 15 mg/l by January 2009. However, the fuel-efficient vehicle technologies that can make the most of this ultra-low sulphur fuel are only just emerging and will take a while to penetrate the market.

LPG: Currently, LPG use is incentivised through the much lower rates of tax and levies applied compared with petrol.[122] While the reasons for the pricing differential are related more to administrative complexities around LPG than to deliberate pricing policy, it nevertheless provides some advantages for a locally produced fuel with energy-security benefits. CO_2 emissions from LPG are about 10% less than petrol on an energy basis, so the current pricing regime also supports a slightly lower-carbon fuel choice. There are some vehicle limitations. LPG vehicles currently available (as new) in New Zealand are typically large (equivalent to 3.5 litre petrol vehicles) and our importing provisions make it difficult to bring in LPG vehicles from Europe. As technology for smaller LPG engines develops, wider use may occur naturally. The recent oil price increases have seen an increase in LPG conversions.

Vehicle technologies/efficiency

Vehicle economy information: To date, EECA's EnergyWise Rally[123] has been very successful in promoting energy efficiency and involving a number of the major motor vehicle suppliers (at least four of which are now using the EnergyWise Rally information regularly in their advertisements). The influence at this stage is still relatively low because it is relevant to new car buyers only (and only a certain proportion of them). Over time, the influence should increase as the event is repeated and awareness of fuel economy grows, although its effectiveness may be overtaken by other forms of information (see below).

Other initiatives to provide vehicle fuel economy information to consumers have included: recording data on fuel economy of vehicles entering the fleet (established in March 2005); developing a fuel-economy website, expected to be on line in early 2006; and a commitment to provide point-of-sale labelling, starting initially with new vehicles. Overseas experience suggests around 1% improvement in fuel efficiency is brought about by targeted information to consumers, although much depends on the

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[122] Total excise on petrol is 47.7 cents per litre compared with 10.4 cents per litre for LPG.

[123] See Glossary

other forms of information available to consumers and the overall level of awareness (BTRE 2001).

Vehicle fleets: This measure relates to procurement and supporting measures. The Govt[3] and EECA FleetCheck programmes, by targeting large users of vehicles, have the potential to affect overall emissions, in addition to providing leadership. Emission reductions are not quantified at this stage. Recent changes to the Income Tax Act 1994 create an immediate tax deduction for costs incurred in investigating and testing options for avoiding discharge of contaminants. This improves the feasibility of fleet checks and creates incentives for research on efficient vehicles for businesses.

Summary

Overall, a reduction of about 2% of CO_2 emissions from transport over the period 2012 to 2020 (ie, 2% lower than the projections outlined in Section 4.1.3) seems achievable on the basis of current Government policy. This is in addition to reductions attributed to the announced carbon tax and projected in Figure 34 (Section 4.1.3). The policies having the most effect on emissions are assessed to be the increase in the excise/road user charge (the price effect on petrol is larger than the announced carbon tax) and the anticipated 2 PJ contribution from biofuels. A conservative approach was taken to assessing the emissions implications of modal policies and road tolling because many implementation details are unknown at this stage. However, the policies provide a platform from which further emissions reductions may occur, especially if high fuel prices continue and people choose alternative modes of transport.

An estimate of the impact of existing policies in CP1 is that an average of 1.5% savings of transport emissions could occur. This is equivalent to around 1.3Mt of CO_2.

4.5.3 Options for further policy

Further policy choices and work programmes are outlined based on building on the foundation of current initiatives and a cross-economy economic instrument. Recommendations are provided for the different policy areas.

Options have been categorised as follows.

Further initiatives: Generally, these are extensions of policy covered in Section 4.5.2 above. Further consideration of these areas is generally desirable because of the ability of these policies to meet multiple objectives for transport or because, long term, they imbed a change in technology or behaviour that will assist reductions in CO_2.

Overall, they provide opportunities for:

- additional CO_2 emissions reductions, in the short or long term
- overall net benefits to society

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- policy alignments with existing policies and structures.

However, for some activities, implementing and evaluating current policy is required before committing to further actions. Information gaps, lack of evidence, or societal implications may need to be addressed in order to develop the policy or confirm its appropriateness.

Unlikely/Costly: These are policies for which there is not a strong case to proceed at this stage. They are characterised by:

- presumed, but unclear, CO_2 reductions
- net benefits that have not been assessed or are uncertain
- significant information gaps on assessing or implementing the policy
- costs to particular groups, individuals or industries that are likely to be significant and require additional policies to allow them to meet access and mobility needs.

While these policies are not a high priority for further investigation now, they may still be relevant and viewed more favourably if circumstances change or if they are driven by other transport objectives such as safety or air quality.

Discounted policies: These are policies that were considered and discounted because:

- the CO_2 benefits were unlikely or minimal, or
- the social implications were considered unacceptable.

Further initiatives

Pricing of transport activities and fuels

Realigning road transport pricing/charging regime: Many of the desired lower-CO_2 outcomes identified in this report, and the broader sustainable transport outcomes identified in the NZTS, will be supported and reinforced by an improved system of pricing and charging for transport use.

The main issues with the current system are:

- transport users are not paying for the costs they impose on society (Ministry of Transport, 2005a). Note: that climate change costs are relatively small proportion of these costs
- current methods of charging do not signal costs accurately and appropriately by time, place or vehicle type (ie, they are “blunt instruments”)
- fuel excise is not consistently charged across vehicle types and is subject to future distortions as fuel types and power sources change

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- there is a growing risk that the different charging regimes for light diesel vehicles (covered by the road user charge) and petrol vehicles (fuel excise) will lead to inconsistent treatment as vehicle technologies change over time.

This review anticipates that, in order to meet long-term objectives for sustainable transport, the Government will need to consider a move to a system of comprehensive electronic road pricing. Such a system would charge for both time-of-use/place-of-use by kilometre to cover the cost of infrastructure construction and maintenance, and respond to localised congestion concerns. In addition, the environmental and social costs of the choice of motive power would be internalised in the cost of the fuel. At present this system, while technically possible, will require development of a staged approach, supported by impact assessments, consultation and trials. The work in Auckland on the feasibility and desirability of road pricing and congestion-management options is relevant in this respect. A report on this work is due with the Government in December 2005.

The primary benefits from realigning pricing and charging would be on the grounds of economic efficiency, congestion relief, fairness to users etc. However, to the extent that road users might, over time, be exposed to the full costs of their transport system use, it is anticipated that there will be useful CO_2 emissions-reduction co-benefits. "Proper"[124] road pricing is an essential underpinning element for a sustainable transport system.

A first step could involve restructuring the ratepayer roading contribution. In the current year, local authority rates funding for roading is estimated to be at least $386 million.[125] Some level of current local rates could be retained as an "access charge" but the balance is effectively a subsidy for road users that could be restructured into variable user charges (ie, through the fuel excise and road user charge[126]). A further step could be to (further) variabilise the ACC levy component of vehicle registration (re-licensing). The administrative aspects of these changes are straightforward and the overall effect would be fiscally neutral. Overall, while still not ideal, variabilising these charges would transfer these current fixed charges to use-of-system charges, thus signalling more realistic costs at the margin.

Until further analysis is undertaken on the extent to which the proposed realignment is justified, it is not possible to specify a CO_2 outcome. However, to give an example: in 2004, two-thirds of roading rates plus the ACC vehicle licence fee levy amounted to about $450 million. If this were variabilised and spread across all road transport fuel, it would add about 9 cents per litre.[127] For petrol, this level of price increase should lead to a reduction in long-run fuel demand of 1.5% to 2%.

Key issues to resolve include:

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[124] "Proper" in this sense means a system whereby the costs are allocated appropriately – ie, costs lie where they fall.

[125] Information from Land Transport New Zealand based on estimates of the "local share" required to meet local roading-funding commitments of the National Programme in 2005/06.

[126] There might be concern that putting the charge onto RUC for diesel vehicles would blunt the price signal, and that it would be better to variabilise the costs into the diesel price. One difficulty is that this adds a transport-only charge onto all diesel use and would probably require non-transport users of diesel to be rebated (thus adding an administrative complexity).

[127] In reality, the charge would likely be added to RUC for diesel vehicle users rather than added to the fuel price.

- the levels of charge to be re-distributed
- distributional impacts across society (including the possible need for transitional arrangements)
- the ability to have distributional impacts across the wide range of vehicles currently covered by the road user charge, particularly light diesel vehicles
- institutional arrangements with local government as a result of reducing local rates
- the timeframe over which a change could occur, minimising administrative costs.

The review considers that a work programme be developed to investigate the impact and process of taking a proportion of the rates contribution to roading and the ACC charge currently associated with vehicle ownership and apportioning it to road vehicles through the excise and road user charge.

Networks and Infrastructure

This section covers both urban matters and other modes: (rail and aviation).

Urban policies: modal shifting, TDM and urban design: Current funding commitments made by the Government in this area, have increased significantly. For example, Auckland's preferred transport strategy, recently outlined in the draft Regional Land Transport Strategies (ARC, 2005), has signalled a more than doubling of expenditure on public transport, walking/cycling and a range of TDM measures over the next 10 years ($4,100 million) compared with the expected transport funding available under current arrangements.

The main drivers for these policies are congestion relief, urban access and mobility, and achievement of a more person-friendly "sustainable" urban form. Over time, these policies, including decisions on the layout and size of towns, siting of key services and relationship of public transport corridors to residences and destinations, are expected to have a small but growing effect on fuel use and emissions (largely as a co-benefit of other outcomes). For example, under Auckland's preferred strategy, CO_2 emissions in the morning peak time are expected to be about 1.51Mt by 2016, about 0.04Mt lower than the 1.55Mt estimated for the "do minimum" strategy (ie, the expected growth in emissions to 2016 reduces from a 21% increase to an 18% increase).

Under the road charging regime recommended above, the ratepayer contribution to roading would be reduced, thus providing the potential to transfer rates funding to increase support for modal/TDM measures, particularly in urban areas. However, there is a risk that increased levels of central government funding will also be required. While the short-term CO_2 benefits might be modest, support for these options is important as part of an integrated, sustainable transport approach, especially where user pays and road pricing are the primary policy tools for signalling costs and charges for road users. As road users are required to meet more of the costs they impose on society, means of transport other than the car (particularly within and around urban areas) will be needed.

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Associated with decisions on local transport and infrastructure is consideration of access and mobility needs when land-use decisions are made. There is also a need for regional strategic planning covering the wider issues of urban form, consolidation and the siting of essential services (schools, hospitals, shops), and related issues such as parking policies.

Progress in this area will depend heavily on commitments made by local government through the Long Term Community Plan process, Regional Land Transport Strategies, urban-growth strategies and RMA plans and policies. A key challenge will be developing an integrated approach, in particular ensuring that land-use decisions support long-term sustainable transport outcomes. This will be particularly important in the main urban areas of Auckland, Wellington and Christchurch, and in other areas where strong population growth is projected.

For sustainable transport reasons (rather than CO_2 emissions reduction goals), central government funding will continue to be required over the long term and integration of land-use planning with transport concerns is critical.

Rail: A study of electrification of the Auckland urban network was completed in August 2005 (New Zealand, ARTA, 2005). It concluded that electrification was desired. However, the main benefits were for heath, and resilience in the face of possible future oil-supply concerns, rather than CO_2 benefits. The National Rail Strategy (2005) notes that the key benefit of electrification is reduced toxic emissions from passenger trains. Electrification of other parts of the network may also be beneficial, and agencies involved in developing regional and national rail systems (including ARTA, Toll NZ and OnTrack) are expected to consider electrification options.

Electrification will provide net CO_2 benefits so long as marginal new electricity production and distribution has lower emissions per unit of energy required compared with diesel engines. At present, overall CO_2 emissions reductions might be expected from electrification because a large proportion of new electricity is being derived from renewable resources such as wind and geothermal. For Auckland (and perhaps some other North Island locations), however, it is recognised that a large proportion of electricity may be generated from fossil fuel-based thermal generation in the short-to-medium term and there may be little net CO_2 advantage.

In regard to rail taking a stronger role in moving freight, it is not possible to identify specific policy for CO_2 benefits. The amount of freight that can change modes from road to rail, and the relevant CO_2 gains, are uncertain. However, long term, future land-use decisions such as on the siting of industry and services could benefit from the consideration of rail.

The agencies involved in developing regional and national rail systems are expected to consider electrification of parts of the rail network. This is consistent with the National Rail Strategy and will have some climate change benefits.

Aviation: There is currently no focused work programme that engages with the aviation industry on desired technology and behavioural changes to support climate change objectives. Discussions to date have been around the ability of domestic

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airlines to have NGAs and general liaison with Air New Zealand on wider sustainable business practice such as waste and energy management. Developing issues include the relationship between climate change and tourism objectives, decisions in Europe about including aviation in their emissions-trading scheme, assigning responsibility for "international" emissions and a need to understand the potential for reducing greenhouse gas emissions from aviation.

This review considers that a future work programme should be developed to focus specifically on aviation in recognition that it is one of the fastest-growing elements of the transport sector .

In addition to the areas outlined above, there are some opportunities that have a lower priority but have merit and many will be developed, driven by safety, congestion, or other pressures. They are summarised as:

- further consideration of fuel economy in road network design and construction
- better inter-modal integration between road, rail and coastal shipping.

Energy sources

Additional biofuels: The biofuels contribution could be extended beyond the current 2 PJ NEECS target and an associated mandatory sales target. Overall, 10 PJ of biofuels is assessed as being available from current waste/by-product streams (an additional 8 PJ above the NEECS target).

Production costs are highly dependent on feedstock costs; in particular, the price paid for tallow, which can fluctuate according to international market factors. Commercial risk factors may also require an additional margin. However, studies suggest that most of this tranche of biofuels could be produced at a cost of about 70 cents per litre.[128] This is equivalent to an oil price of about $50 to $60 per barrel[129].

Any increase in the target would need to be evaluated in light of changes in the price of oil and feedstock, and any infrastructure limitations.

There is a promising long-term potential for biofuels sourced from other materials, such as forest wood matter, but further research and product development is required. New Zealand's natural resource advantages and intellectual capability in agriculture and forestry have promised a strong biofuels capability for some time. Much will depend on longer-term oil prices and the technology-development pathway(s) taken by the international motor vehicle industry.

A target above 2 PJ by 2012 is to be evaluated within the work programme to confirm a mandatory biofuels sales target by 2008 (CAB Min(05) 29/4)

The review considers that future work to assess the priority and funding given to biofuels research and associated land use as part of wider consideration of research and development (see Section 4.3.4). is desirable.

[128] Information from EECA.

[129] At the current exchange rate of around $US0.70: $NZ1.00.

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Vehicle technologies/efficiency (road vehicles)

New Zealand is a technology taker with respect to vehicles.

New Zealand's main vehicle suppliers (Japan, Europe and Australia) have varying domestic sales-weighted efficiency-improvement or CO_2-emission reduction targets. They equate to approximately 15% to 25% improvement by 2010.

Potentially, New Zealand's fleet performance could reflect this ongoing improvement, but it may not if:

- the buying patterns over the last few years towards larger, more powerful vehicles are sustained
- New Zealand distributors do not supply some of the more efficient models
- there is a time lag in technology arriving because of the predominance of second-hand imports from the Japanese domestic market.

In terms of policy development, there is a potential difficulty in determining the most cost-effective policies, because we do not clearly know the response to provision of information nor how recent buying trends relate to fuel price increases. Our modelling capacity, in terms of policy options, is also weak. Nevertheless, there are opportunities to improve the vehicle fleet, including working with importers and purchasers overtime to optimise introduction of technologies and fuel efficient vehicles.

Vehicle fuel-economy information: Increased priority needs to be given to getting fuel-economy and vehicle CO_2-emission information that is currently being developed into the public domain and, in particular, into the hands of individual vehicle purchasers and fleet buyers. The current programme has limited resources and could be fast-tracked with additional personnel and funding through reprioritisation. The benefit of this work is that, in addition to direct fuel savings through people considering fuel economy at the time of purchase, recording and providing fuel-economy information is a prerequisite to additional policy focused on the vehicle fleet. This might include identifying the desired average fuel economy for new entrants, and developing targets with importers. The MOT is currently leading this work, but additional support can come from other agencies. This would recognise the operational aspects of the programme: collection of data, support for the website and public awareness of the information.

The value of putting more effort in this area is shown by the variation in fuel consumption within one engine size. Figure 41 suggests there is considerable scope for fuel savings through encouraging purchase of the more efficient models.

Figure 41 - Engine Size and Fuel Consumption for New Vehicles in Australia 2005

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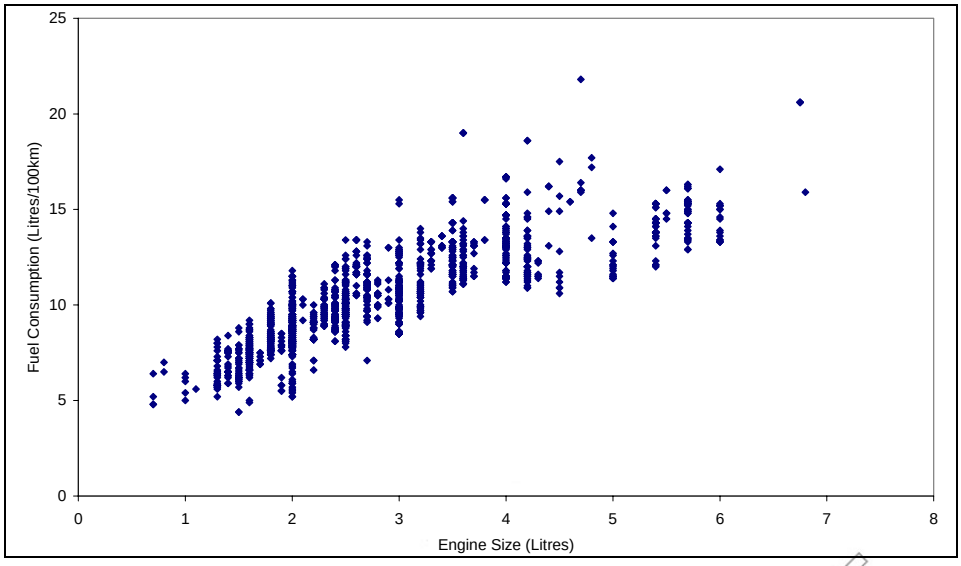

Source: Australian Greenhouse Office, 2005a

Fleet purchases: The main vehicle-fleet purchasers are lease and rental companies, businesses, and government. There is a flow-on benefit to focusing on fleet purchases, since vehicles often end up in the New Zealand second-hand market within two or three years.

For any one vehicle type, such as commercial van, four-door saloon or three-door hatchback, the fuel economy of different makes and models varies substantially. The informed purchaser can purchase the optimal vehicle without compromising the task required. There may also be savings through careful consideration of the size of vehicle required, fuel-economy features, the fuel used and the optimal mix of vehicles in a fleet.

The focus for policy is twofold:

- review of the fringe benefit tax for opportunities to encourage uptake of more eco-efficient travel choices
- Government leadership role through its own decisions on vehicle fleet purchase and use, and influencing fleets in general.

This work builds on fleet check audits available through EECA and the Govt[3] programme.

The Fringe Benefit Tax (FBT) affects vehicles that are available for an employee to use privately. The employer must pay FBT on the private use of such vehicles. A desired outcome might be a scheme that encouraged employers to purchase more fuel-efficient vehicles for their employees.

However, key issues to resolve for FBT include:

- incentive mechanisms are typically costly, and difficult to monitor over time

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- a deadweight loss would result if the tax advantages to company employers purchasing new vehicles are restricted

- FBTs are less transparent than direct subsidies and there could be high fiscal costs

- FBTs have the potential to be very costly for only minor effects on decision-making

- a tax incentive could distort investment decisions in respect of capital purchases (perverse incentives for companies to buy more vehicles).

The review recommends that high consideration be given to these two areas and in particular:

- continue to support the Govt[3] initiative in regard to influencing government fleet purchases

- investigate the extent to which the FBT system can be used to influence business-vehicle purchases for employees.

Supporting driver training: There are opportunities through training and publicity to maximise fuel savings from appropriate driver technique and ongoing vehicle servicing. In particular, there are gains available in the heavy fleet.

The number of heavy vehicles (trucks and trailers) increased by around 2.9% per annum between 1997 and 2004, but the distance they travelled grew by 1.5 times the rate of change in GDP, or about 4.5% per annum. The greatest increase in distance travelled has been with the larger four-axle trucks and four-axle trailers. Energy savings of at least 10% or 6.1 PJ per annum are estimated to be available from a targeted programme, given that differences in driver behaviour alone can result in variations of up to 35% in the amount of fuel used (New Zealand, CRL, 2005hh). A typical heavy vehicle might consume 30,000 litres a year, travelling 500,000 km (New Zealand, TERNZ 2004b). A 10% saving is equivalent to 8 tonnes of CO_2 a year. There are around 13,500 trucks over 3.5 tonnes and 1,460 passenger coaches in the fleet.

Industry support in this area would assist in making programmes cost-effective. To be successful, any programmes would need to have ongoing management support.

EECA has only limited funds under its EIB[130] programme for a demonstration project for driver training.

There are potential CO_2 savings available through targeting heavy freight vehicles and support programmes focused in this area.

Cleaner vehicle technology: Policy options to address toxic vehicle emissions (eg, CO, NOx, particulates) are currently under development, with the MOT reporting back to the Government by 30 October 2005. Toxic emissions are primarily a function of the efficiency of the combustion process and fuel used, and the extent to

[130] See Glossary

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which post-combustion emission-control technologies such as catalytic converters are used. Because vehicle toxic emissions and CO_2 emissions emanate from the same fuel/combustion process, there is a potential policy synergy available.

This review has identified the need for a strategic approach to this area of policy, seeking to achieve synergy from policy approaches that offer the potential for both CO_2 and toxic-emission outcomes. Several policy options being considered to control toxic emissions would likely have CO_2-emission benefits. These include requirements for optimum maintenance and vehicle entry restrictions.

a) Optimal vehicle maintenance: Analysis suggests there are likely to be some fuel-economy improvements for some vehicles for which servicing is required to meet any emissions standard set for air-quality reasons. However, it is likely to be small, in the order of 0% to 1% over the whole fleet.

b) Vehicle entry restrictions: Stronger regulation at the border, requiring vehicles to have the latest emission technologies, is being considered. This could benefit fuel economy by preventing older, less efficient vehicles from entering the fleet. There might be useful CO_2 benefits from such policies because the average age of used imports is increasing, thus increasing the gap between these vehicles' and current technology. Overseas, fuel-economy technology is improving, so there is potentially an increasing time lag between the New Zealand fleet and best available technology. A challenge for New Zealand will be determining the extent to which we become a "fast follower" in new vehicle technologies, given the lag created by the age and turnover of the current fleet. However, further analysis is required to determine the likely effect on vehicle purchase and retention patterns. A possible perverse effect is that vehicle owners retain their existing vehicles for longer (these vehicles might be older, less fuel efficient and have no emission controls). Also, reducing the availability of second-hand vehicles may affect some people's access and mobility.

The work programmes focused on increasing vehicle maintenance and restricting vehicle entry to obtain enhanced emissions-control technology in the fleet may have co-benefits for CO_2 emissions.

Vehicle fuel economy/CO_2 incentives/disincentives: As noted in Section 4.1.3, a number of countries provide incentive/disincentive mechanisms (such as differential taxes) that encourage purchase of fuel-efficient vehicles. The benefits are seen as better reflecting, if coarsely, the different environment costs the vehicle imposes; an ability to send a price signal that is tax neutral; and encouraging buyer behaviour towards more environmentally friendly vehicles for those who are price sensitive.

Ideally, if a full carbon price signal is operating in the economy, an additional incentive/disincentive should not be necessary. As a transition measure, however, there may be benefit in introducing incentive/disincentive mechanisms such as differential annual fees for vehicles of varying fuel economy, with the overall scheme being fiscally neutral (a "feebate" system). A preliminary analysis suggests that, overseas, differential pricing has not been as successful as other measures.(Covec 2005a). Further investigations analysing new vehicle purchases in relation to the current higher fuel prices and New Zealand's circumstances are recommended.

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This review recommends investigation of opportunities around a differential registration (re-licensing) charge based on fuel economy, including assessment of current purchasing patterns during this time of increasing fuel prices.

Table 22 - Summary of Potential Further Initiatives

Policy Area	**Initiative**	**Rationale**	**CO_2 Benefits** (unless stated, benefits will follow programme implementation)	**Conditions or Potential Issues with the Policy**
Pricing of transport activities and fuels	Transfer a proportion of rates contribution to roading, and ACC charge, across fuel excise and road user charge	• Economic efficiency • Efficiency/equity • Fiscally neutral	Dependent on amount redistributed - possibly up to 1.5% of road transport emissions by 2012 (Estimated CP1 benefits: 0.9Mt)	Institutional arrangements with local government CO_2 benefits assume implementation within the next three years
Networks and infrastructure	Ongoing financial support for travel-demand initiatives and public transport	• Provides alternatives to private car • Complements price-based measures • Co-benefits for urban form, congestion relief, health and safety	Benefits primarily long term and in urban areas	Expected to require increased central government funding
	Rail – opportunities for electrification of track	• Electricity from renewable sources • Fuel economy benefits • Air quality benefits in urban areas	Dependent on source of electricity and efficiency and effect on total electricity demand	No government decision required at present
	Aviation – a work programme to engage with industry on climate change matters	• Aviation a high growth sector and important for NZ economy • International policy developing, eg, in EU.	Uncertain	Include consideration of tourism industry Requires technical and policy support
Energy sources	Biofuels - evaluate raising sales target above 2 PJ/annum (noting target currently not set)	• Biofuels are carbon neutral • Co-benefits for oil	Dependent on level of target – around 2%-3% CO_2 reductions from a further 8	Efficiency of measure reliant on price of oil and feedstocks, and infrastructure limitations

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Policy Area	Initiative	Rationale	CO_2 Benefits (unless stated, benefits will follow programme implementation)	Conditions or Potential Issues with the Policy
	Biofuels and associated land use – prioritisation of research effort	security, and locally for health • Business opportunities	PJ by 2020 (3 PJ of which could be available by 2012 if accelerated). (Estimated CP1 benefits: 0.4 Mt)	Link with wider land-use discussions on agriculture and forestry Increased funding may be required
Vehicle technologies/ efficiency	Increased priority to vehicle fuel-economy information	• Information/learning • Current information deficit	around 1% of light fleet emissions (still to evaluate effect of Government fleet of 21,162 - 0.8% of cars) (Estimated CP1 benefits: 0.9Mt)	Potential budget implications
	Fleets – influence government fleet purchasers and investigate opportunities under FBT system	• Targets main new vehicle purchasers • Government leadership • Highlights new technology • Information/learning		Awaiting information on current government fleet, and opportunities for CO_2 benefits. Use of FBT potentially not cost-effective
	Target drivers of heavy fleets for information and training	• Targets sector responsible for 31% of transport emissions and growing	Around 1-3% (10% of heavy fleet) (Estimated CP1 benefits: 0.6Mt)	Budget implications Requires ongoing effort and industry support
	Support for programmes for vehicle maintenance and fleet entry requirements, noting some co-benefits for CO_2 available	• Existing focus on air quality and safety • Education/learning	0%-1% of road fleet emissions from maintenance Unknown for entry requirements	CO_2 benefits potentially very small Primary benefits to air quality through controlling toxic emissions
	Incentivise purchase of vehicles with high fuel economy/low CO_2 emissions through price differential on annual charges	• Signals the different environmental costs vehicles impose • Opportunity to be fiscally neutral using feebates	Dependent on differential price	Cost-effectiveness reliant on influence of fuel price The tool is a coarse one Requires consideration of both new and second-hand vehicles

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Unlikely or costly

The following policy options are not seen as high priorities to pursue at this stage, primarily because CO_2 reductions are unclear or the net benefits to society have not been assessed or are uncertain.

Accelerated scrapping of old vehicles: Early retirement is not expected to produce significant emissions reductions for the effort. The impact of scrappage policies is likely be short-lived and may be overtaken by increases in future emissions, as early retirement leads to the early introduction of a new (or second-hand) vehicle rather than the later introduction of a vehicle that is more fuel efficient (due to ongoing improvements in vehicle technology). Also, older vehicles generally do not travel high annual kilometres, hence the gains for CO_2 benefits are potentially minor.

Limit the open road speed limit to 90 kmh: It is estimated that reducing the open road speed limit to 90 kmh could reduce annual fuel consumption by 1.42% (3.53 PJ) (Covec, 2005b). There would be significant associated costs related to time lost in travel, in addition to enforcement and signage. This probably makes this option unpalatable, unless it can be supported on safety grounds.

More aggressive policies generally: What measures could achieve a much stronger response, such as a reduction in transport emissions in 2020 by at least 20% on business-as-usual, and a continuing downward trend?

This could occur from a significant change in any one of the three generic change areas: energy efficiency of the transport task; lower CO_2 emissions per unit of energy; or reduction in travel demand. But, it is most likely that a combination of all three would be needed. Action will need to focus on policies that broaden the influence of moderate- to high-impact actions (Table 21 previously).

Much will depend on the future of the world oil price – continued high oil prices will maintain price pressure on consumers to consider energy reductions and alternatives, but declining prices could see a continuation of current trends and behaviours.

Modelling is required of the policy options, but it is most likely to involve a more aggressive implementation of policies already signalled in this report; ie:

- remove roading subsidies and increase transport charges
- substantially increase investment in supportive networks and services, such as public transport, provision for cycling and walking, and alternatives to travel
- increase investment in alternative energy sources
- improve vehicle efficiency (over and above oil price and other drivers).

Such measures would require an environment where there was a high level of awareness and relevant information for transport users. Ideally, the community would need to be accepting of, and generally willing participants in, the change process.

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Aggressively increasing the price of travel based on fossil fuels will have a cost, particularly if imposed rapidly before alternative means of transport are developed. Without low-cost alternatives, those most vulnerable to such policies are low-income households and those who rely on vehicles for their ongoing participation in work and other activities. Rural areas might be particularly affected, as well as the young, old, disabled, those of Maori and Pacific descent, solo parents and large families (where a number of people are affected by a loss of vehicle or a larger vehicle is required). The loss of a car can exclude households from many activities, including health visits, work, shopping, visiting friends and recreation. Access to centralised facilities such as hospitals, educational facilities and supermarkets would be affected. Supporting polices would be required.

Table 23 - No Strong Case at This Stage – Summary

Policy Area	Rationale	CO_2 Benefits	Conditions or Issues
Scrapping older vehicles	• Gives an incentive to remove older vehicles • Encourages introduction of newer technologies	Minor	Old vehicles are not necessarily the problem, as they generally do fewer kilometres than newer vehicles.
Reduce speed limit from 100 to 90 kmh	• Lower speeds lead to reduced fuel use	Around 1.5% of road transport emissions	High cost in time and in enforcement
Much more aggressive pricing and support policies	• A wish to clearly reduce transport emissions	Substantial; eg, up to 20% reduction	Need to address the social implications (access and mobility) of dramatically affecting the cost of travel High fiscal cost of support policies May affect New Zealand's competitive position in the world economy

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Discounted measures

These are policies that were considered and discounted. Either the CO_2 benefits were unlikely or minimal, or the social implications were considered unacceptable.

Differential acquisition fees: Acquisition fees apply to vehicles on first entry to the market. They could apply to new and second-hand vehicles and be based on vehicle type, such as model or engine size. A number of countries have different fees depending on these factors. CO_2 produced per kilometre could also determine the fee.

The policy can increase the relative purchase price of fuel-inefficient vehicles. This can lead to substitution by more fuel-efficient vehicles – a positive CO_2 outcome. However, a perverse outcome can be that the purchaser instead opts for a second-hand vehicle already on the market, regardless of its fuel economy, because that vehicle is not subject to the fee. The result is that second-hand vehicles already in the market have increased market value and their time in the fleet is likely to be

extended. Many of these second-hand vehicles are likely to be not fuel efficient and a differential acquisition fee does not discriminate between vehicles of different fuel economies once they are already in the fleet. Hence, there is a risk that vehicles already in the fleet, which ideally should be replaced by more fuel-efficient vehicles, will instead have a longer life.

Incentives for hybrid vehicles: The main difficulty of this measure is that it is not technology neutral – if such an incentive is justifiable, it should be on the basis of CO_2 emission outcomes, not a specific technology. Some other technologies are capable of achieving similar efficiency and CO_2 outcomes (eg, high-efficiency diesel vehicles) for some particular drive cycles. Also, hybrid technologies (ie, combined petrol engine and electric motor) can be used to give more power to a vehicle rather than reduce fuel use.

Banning certain types of vehicles: (eg, SUVs) At the moment, information on the annual emissions from certain vehicle types is not available. Overall CO_2 emissions might be low, as might be kilometres travelled. To pick on specific vehicle types does not address the core CO_2-emission problem.

Blanket age ban on vehicles: Age is not necessarily a reflection of fuel economy. The main difficulty is that fuel consumption improvement by age is relatively small compared with differences between classes of vehicles, and between vehicles in the same class (PWC et al, 2001). Previous modelling suggests only minor overall CO_2 benefits, with the potential downside of affecting affordability and values in the second-hand car market. Note, however, this measure could be a coarse means of achieving other policy objectives, such as increased emissions-control technology for air-quality reasons or safety objectives.

Table 24 - Discounted Measures at This Stage – Summary

Policy Area	Rationale	CO_2 Benefits	Conditions or Issues
Differential acquisition fees	Price incentive to purchase more fuel-efficient vehicles at entry to the fleet	Potentially negative	Potentially a perverse incentive for fuel-inefficient vehicles to stay in the fleet longer
Incentives for hybrid vehicles	Gives a government incentive for purchase of hybrid technology vehicles	Potentially negative	Picks a technology that does not necessarily equate to the best means of reducing CO_2 emissions
Banning certain types of vehicles	Some vehicles are intrinsically heavy fuel users	Not shown	Need to show link between type of vehicle and total fuel use per annum
Blanket age ban on vehicles	All other things being equal, newer vehicle models have better fuel economy than older ones	Uncertain	Main benefit of policy would be as a blunt instrument for improving toxic emissions-control technology and vehicle safety CO_2 benefits still reliant on purchase behaviour

4.5.4 Conclusions

The drivers for ongoing CO_2 emissions growth in the transport sector

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For around the last two decades, New Zealand has experienced a period of low oil prices and/or relatively high economic growth. Transport patterns have been heavily reinforced by the low oil prices, while key growth areas in the economy are heavily transport-dependent (eg, tourism and freight movement). Overall, this has provided the platform for continued and ongoing growth in transport demand and CO_2 emissions. The use of oil by the road fleet – both heavy and light vehicles – is both the largest use within the transport sector and the fastest growing. Use in aviation is also growing steadily, but from a smaller base. Coastal shipping and rail combined, contribute less than 5% of transport emissions. To date, fuel demand (and, by implication, CO_2 emissions) has been very inelastic to price (ie, demand does not move much with price), with current elasticities for petrol and diesel suggesting only a 2% to 2.5% long-run reduction in demand for a 10% increase in price.

The review has looked at the circumstances in New Zealand. We have a relatively small population spread over two main islands with young geology and an agricultural base. There is a very strong culture of mobility, with a number of self-reinforcing aspects. New Zealanders are travellers, with the ability to travel being a defining part of the Kiwi lifestyle: both overseas, and between rural and city environments. Cities have largely developed within the motor car era and have tended to reinforce a private motor vehicle culture; the costs of transport to date have been relatively low and some transport costs are not paid for by users. Transport usage is further increased by the demand for just-in-time delivery and the availability of relatively cheap vehicle imports from the domestic Japanese market.

The effect of CO_2 policies to date

In general, policies that aim to reduce CO_2 emissions from transport have not had much "bite":

- the signalling of the announced carbon tax has not had much effect. At the proposed level ($15 per tonne of CO_2), it is expected to have little effect on behaviour. The price increase will be largely invisible within the overall movement in fuel prices caused by volatility in international oil markets

- while quite a number of Government activities have been initiated that directly or indirectly promote reduced emissions, most policies are still largely "in the pipeline" and at best only partly implemented. (Examples are the focus on travel-demand management, provision of information on vehicle fuel economy, and biofuels – incentives and research.)

It is estimated that, overall, a reduction of about 2% of CO_2 emissions from transport between 2012 to 2020 seems achievable on the basis of current policy, with an average saving of around 1.5% savings of transport emissions (1.3Mt of CO_2) in CP1.

Looking to the future, further activities are committed to building on current work programmes. There are also new policy initiatives that could start to make an impact on emissions. But, generally, these developments provide small, incremental CO_2 gains, rather than anything that will provide a big "hit". This is a current reality of the transport sector.

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Many of the activities focused on transport to date have occurred because of health, safety, congestion and urban-form benefits. Reduction in fuel use and, hence, CO_2 benefits has been a co-benefit.

International drivers – fuel price and technology

Fuel price and vehicle technology are two key international drivers over which New Zealand has very little control. The recent fuel price increases to around $US60 per barrel have prompted some behaviour change from transport users. Although the precise impacts are still unclear, continued high oil prices will maintain price pressure on consumers to consider energy reductions and alternatives, and a number of lower CO_2 options will be incentivised. The overall effects of this level of oil price may be more influential in reducing CO_2 emissions than the current range of policies. But, declining prices could see a continuation of current trends and behaviours.

A second issue is the current lack of cost-effective technological alternatives that provide significant CO_2 reductions. Unlike the electricity sector, for instance, where relatively low price signals can cause a switch between high emission generation (gas/coal) and low-emission alternatives (renewables), there are few comparable opportunities at this stage in transport. Future vehicle technologies are largely out of New Zealand's hands, as we are essentially technology takers from the global vehicle industry. There are some fuel-switching opportunities, and the recent oil price increases have put the first tranche of biofuels (about 10 PJ) now within the range of potential cost-effectiveness (albeit with the need for a range of supportive Government policies). However, this represents less than 5% of current transport energy demand, and even lower CO_2 emissions-reduction potential.

Much stronger intervention policies designed to change the composition of the vehicle fleet in New Zealand could be contemplated. However, at this stage, it is unclear to what extent this might have lasting, effective outcomes. There are also questions about whether this would be the best way of addressing the issue, and whether potential perverse effects can be addressed. There is a range of options and some of these require further analysis.

Summary of recommended measures

The proposed measures, outlined in Section 4.5.3 and summarised in Table 22, include:

- more efficient distribution of costs to road users by transferring a proportion of the rates contribution and ACC charges across the fuel excise and road user charge
- ongoing financial support for travel-demand initiatives and public transport
- opportunities around electrification of parts of the rail track
- a work programme to engage with the aviation industry on climate change matters
- for biofuels, evaluating a sales target above 2 PJ per annum and prioritisation of research effort

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- increased priority to vehicle fuel-economy information
- for road vehicle fleets, a leadership role for the Government in purchasing and investigating opportunities under the FBT system
- targeting drivers of heavy fleets for information and training
- support for programmes for vehicle maintenance and fleet entry requirements, because of the co-benefits for CO_2 that could be available
- creating incentives for the purchase of vehicles with high fuel economy/low CO_2 emissions through price differential on annual vehicle charges.

Indicatively, these policies could reduce CO_2 emissions by a further 5%, with around 3.0Mt savings in CP1. Identifying the most cost-effective measures is, however, limited by the lack of empirical evidence in New Zealand about the effectiveness of policies in moving from the status quo. Most policy initiatives that have a CO_2 focus (or co-benefits) have been around supply-side investment in alternatives to motor vehicles (eg, passenger transport funding, rail re-investment). There have been few disincentive-type policies (such as pricing measures). There is also a lack of knowledge about preferences or behaviours of transport users, especially factoring in the change in the current environment, triggered by oil price rises and publicity around "peak oil". These factors suggest that pilot programmes and evaluation mechanisms may be useful in this area.

Many actions that have CO_2 benefits do, however, also have co-benefits for other Government objectives, including: improved air quality, health, urban form, access and mobility through public transport; reduced congestion; and oil security. So, even though CO_2 reductions are assessed as small for some work programmes, there can be clear net benefits to society.

More aggressive CO_2 reductions?

If a stronger response to CO_2 emissions reductions from the transport sector is sought, aggressive policies will be required. The future oil price may, by itself, lead to dramatic changes in the way we think about transport. However, this is uncertain. Although we do not have accurate modelling capacity at the moment to show CO_2 benefits, it is most likely that an aggressive policy package would require:

- increasing the cost of fossil fuel use and transport charges
- substantial increased investment in supportive networks and services to provide alternatives as personal car travel becomes expensive
- increase investment in alternative energy sources such as biofuels
- improved vehicle efficiency (over and above oil price and other effects)
- education programmes and appropriate pricing signals to reinforce the importance of fuel economy and appropriate choice of mode, as well as the co-benefits of such behaviour.

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4.6 Land-use change and forestry

Summary
This section:

- explains what a carbon sink is and summarises the Kyoto Protocol rules related to carbon sinks
- provides information on forestry in New Zealand, including the co-benefits resulting from forestry, such as soil conservation
- discusses the uncertainty around the rules related to land-use change and forestry land and the difficulties this creates for determining the benefits and liabilities for New Zealand beyond 2012
- discusses the impact this uncertainty about future rules has on developing robust policies
- considers some policy criteria to assist decision-making for forestry climate change policy
- summarises and assesses current Government forestry climate change policy
- summarises and assesses alternative policy options for forestry.

It concludes:

- the current policy does not send strong, positive signals on land-use change decisions, and anecdotal information suggests that uncertainty about putting the deforestation cap into operation is contributing to land-use change prior to CP1
- for equity and efficiency reasons, it is preferable that climate change policies are land-use sector neutral and do not distort investment decisions
- outlines some options to improve the lack of climate change signals to land managers. These findings will form the basis of a work programme for further analysis
- if certain policy options are to be implemented prior to the commitment period, work should begin immediately
- better information is required to discern the future planting and deforestation intentions of foresters and to understand the decision-making process of land-use change in New Zealand.

4.6.1 Current policies and broader context - recap

Sinks are any natural or man-made systems that absorb and store greenhouse gases, primarily CO_2, from the atmosphere. To be considered a sink, a system must be absorbing more CO_2 than it is releasing, so that the store of carbon is expanding. When a tree or forest is increasing in size, it absorbs CO_2 in the form of carbon (about half the dry weight of wood) in the process of increasing its biomass. A growing forest is a sink. Once the forest reaches maturity, its carbon density remains approximately constant because decay is releasing about the same volume of CO_2 as the forest is absorbing. This is termed a carbon "reservoir".

Forestry activity can influence the amount of greenhouse gases in the atmosphere because forests can act as both a sink and a source of emissions. Forest products can reduce global greenhouse gas levels when used as a substitute for other more energy intensive building materials like steel and concrete or as an energy source (biofuel) that displaces the use of fossil fuels.

The development of the international agreement on sinks has evolved to cover emissions and removals of greenhouse gases resulting from land use, land-use change and forestry (LULUCF). Activities in the LULUCF sector can mitigate and/or contribute to climate change. The relevant Kyoto Protocol articles with respect to LULUCF are Articles 3.3 and 3.4. Further information on these articles is included in Annex 1.

Under Article 3.3, parties have decided that greenhouse gas removals and emissions through certain activities — namely, afforestation and reforestation since 1990 — can be used to meet a country's emission targets. Conversely, activities that deplete forests, namely deforestation, are to be subtracted from the amount of emissions that an Annex I Party may emit over the commitment period. Article 3.4 enables parties to elect additional land-use activities.

New Zealand receives forest sink credits for the carbon sequestered during the commitment period. International reviewers will assess New Zealand's system of determining how many credits we are entitled to.

Under Article 3.4, New Zealand can elect which additional Article 3.4 land use, land-use change and forestry activities, if any, it wishes to account for in CP1. The election of these activities is voluntary for Annex I Parties such as New Zealand.

Slightly anomalous rules exist within the Kyoto Protocol in terms of the treatment between Kyoto forests (planted after 1 January 1990) and non-Kyoto forests (planted prior to 1 January 1990). This distinction is, to some extent, artificial.

These rules mean that New Zealand faces the liability associated with the deforestation (felling and not replanting) of non-Kyoto forests but does not face any liability associated with harvesting (felling and replanting) non-Kyoto forests. In contrast, however, New Zealand faces a liability associated with both the deforestation and harvesting of Kyoto forests.

There is one further major difference between the treatment of Kyoto forests and non-Kyoto forests under the Protocol. The liability faced by New Zealand on the harvesting of Kyoto forests is limited to the amount of carbon claimed previously from that forest. This does not apply to non-Kyoto forests.

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On deforestation of a non-Kyoto forest, the entire carbon liability in the forest is faced by New Zealand. If a non-Kyoto forest is deforested prior to 2008, however, New Zealand does not face any liability associated with the deforestation (although New Zealand is liable for any resulting emissions from agriculture on that land).

The rules under Kyoto are complex and create uncertainty for forestry in the short term. In addition, there are a lot of unknowns about what the situation will be for forestry beyond 2012. This creates issues for managing the benefits and liabilities of forestry in the medium term out to 2020. Domestic policy, however, need not mirror the international rules under Kyoto (eg, removing the "since 1990" distinction between Kyoto and non-Kyoto forests), but should provide adequate signals on afforestation, reforestation and deforestation.

4.6.2 Incidence of liabilities – who should have property rights over forest sinks?

In the short term, it is expected that forest sink credits will offset harvesting and deforestation liabilities. New Zealand's projection for sinks over CP1 is a surplus of 67.8Mt CO_2e.

In the medium-to-longer term, the high planting rates of the mid-1990s mean that, at harvest, there is a potential for New Zealand's net sink position to be in deficit (ie, harvesting liabilities will be greater than the credits earned from sequestration). This deficit assumes that current Kyoto rules remain static or very similar over the medium term and that New Zealand is unable to gain a more favourable agreement (relative to the present agreement) in the future. Under these assumptions, a sustained planting programme would serve only to dampen or push this deficit out into the future.

The long-term climate change benefits of new plantings to New Zealand include:

- a reduction in agricultural emissions (assuming that the land planted was in agricultural production and not scrub)
- immediate sink credits in the event that New Zealand is able to gain a more favourable agreement (relative to the present agreement) in the future
- an ongoing stock of carbon, if the land is replanted and remains in forestry.

Forests are also valued for more than sequestering and storing carbon. Other co-benefits resulting from forestry include:

- soil conservation, catchment management and water quality, and biodiversity
- substitute materials for more emissions-intensive products
- a source of bioenergy.

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4.6.3 Managing future liabilities

In 2002 and 2004, the Government made decisions on climate change and forestry, including to:

- retain all the sink credits from Kyoto forests and their associated liabilities, at least for CP1, and:
    - Kyoto forest owners will not face any deforestation or harvesting liabilities at any stage where the Crown has retained the forest sink credit asset
    - should the Government decide to devolve forest sink credits in future, then associated deforestation and harvesting liabilities would only be devolved in proportion to the credits received by the Kyoto forest owner
- assign a proportion of the credits (or an equivalent value) to provide incentives for establishing and enhancing sinks
- retain deforestation liabilities of the non-Kyoto forests, provided these remain within a cap equal to 21Mt CO_2e. This is the carbon that would be released by the deforestation of approximately 10% of the area of forest reaching maturity during CP1. In relation to non-Kyoto forests, the Government will:
    - consider its policy options (in the unlikely event that significant deforestation may exceed expectations) to manage emissions within the cap. This includes addressing issues such as:
        - how deforestation rights within the cap will be allocated
        - how to monitor and enforce the deforestation cap
        - what actions the Government will take if the cap is exceeded
    - consider the deforestation policies for non-Kyoto forests in the period after CP1 as part of the scheduled Review of Climate Change Policies (2007 and 2010), after the future international rules on forests in the Kyoto Protocol are further clarified
- establish a mechanism to encourage the establishment of permanent protection sinks (the Permanent Forest Sinks Initiative (PSFI)). The initiative has been proposed to encourage permanently converting land to forest. Legislation is currently before the House to implement the initiative
- consider further whether it should elect any additional sink activities under Article 3.4 of the Kyoto Protocol (eg, forest management, revegetation, crop and grazing land management) before 2007 (depending on availability of carbon accounting data).

The Forest Industry Framework Agreement (now the Forest Industry Development Agenda (FIDA)) has also been funded and covers issues such as market development, market access, wood design, labour, skills and bioenergy.

Work has also commenced on implementing New Zealand's Carbon Accounting System (NZCAS) to ensure New Zealand's ability to claim sink credits and account for deforestation.

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Further information on the current forestry climate change policy package is included in Annex 1.

4.6.4 The role of non-climate policies in a sustainable forestry framework

In addition to the above climate change policies, there are other policies and programmes that contribute to positive climate change outcomes from forestry. These include the East Coast Forestry Project; implementation of the Biosecurity Act 1993; and sustainable development (such as the RMA and soil conservation and land management work undertaken by regional councils).

Many other non-climate policies and programmes could assist any move to fuller carbon accounting. These include: implementation of Part IIIA of the Forests Act 1949; work by the Queen Elizabeth the Second National Trust; and forestry research by Crown Research Institutes, universities and the Sustainable Farming Fund, investigating such issues as biosecurity, conservation biology, forest ecology, forest soils and silviculture of indigenous forests. Some of these may have a greater role in future should international negotiations require the accounting of all land-use activities.

Further information on the non-climate change policies is included in Annex 2.

4.6.5 Policy criteria

Regardless of the uncertainties outlined in the previous section about current and future arrangements on land-use change and forestry, policy criteria are needed to guide the inclusion of climate change considerations into land-use change and forestry decisions out to 2020. The policy criteria are not mutually exclusive and achieving some of them will help to achieve other criteria.

The consideration of forestry and land-use change in the medium term (to 2020) should involve policy choices based on:

- appropriate land-use signals
- reduction in uncertainty
- resilience
- equity
- sector acceptance
- maximising co-benefits
- minimising Crown risks
- complying with international obligations
- feasibility.

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These criteria are outlined in greater detail in Annex 3.

4.6.6 Assessment of existing policy

The existing forestry policy has been assessed against the policy criteria outlined above.

Appropriate land-use signals: The existing policy sends limited positive signals on land-use decisions. The policy sends limited positive signals to the owners of Kyoto forests on reforestation or deforestation, because all the benefits and liabilities remain with the Government. However, the PFSI when implemented will send positive signals for continuous canopy forestry, which generally also caters to longer rotation species than *radiata* pine.

For non-Kyoto forests, the uncertainty arising from the deforestation cap sends a signal that there are potential costs with deforestation, and this should be taken into account. The cap also creates incentives to bring deforestation intentions forward to before CP1 or defer them until CP2 to avoid this cost.

Reduction of uncertainty: The Government has made clear policy statements regarding Kyoto forest owners not facing any deforestation liability or harvesting liabilities at any stage where the Crown has retained the forest sink credit asset.

Similarly, with regard to non-Kyoto forests, the Government has stated it will cover deforestation up to 21Mt CO_2e of emissions over 2008 to 2012. There is anecdotal evidence that the uncertainty around putting the cap into operation is leading to a higher rate of deforestation than the historic average. While current policy provides some certainty for Government because the maximum level of the deforestation liability is set at 21Mt CO_2e, non-Kyoto forest owners face uncertainties over how the deforestation cap will be put into operation.

Resilience: The lack of positive signals means that the existing policy is likely to be ineffective, over the long term. This is particularly true when agriculture does not face the costs of its decision-making.

Equity: Current policy treats Kyoto forests and non-Kyoto forests differently. If the deforestation cap is put into operation, non-Kyoto forest owners will face a potential constraint not borne by Kyoto forest owners. This raises some serious equity issues for foresters who planted their forests 30 years ago (intending to deforest after one rotation) and did so without any knowledge of potential constraints on future land-use changes.

There are equity issues between forestry and agriculture, because the change in land use (intensification into agriculture from forestry) for the owners of Kyoto forests raises a liability from the emissions (deforestation) that intensification, eg, from sheep and beef to dairying, does not face.

Sector acceptance: The acceptance of the current policy by the sector is low. The sector considers the current policy is encouraging foresters to deforest now to avoid any potential liability later.

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The reaction among Kyoto forest owners varies. There is low acceptance from those who object to not receiving any value for the climate change benefits arising from their forests. To others, the current policy offers flexibility to make land-management decisions fairly freely.

Maximising co-benefits: The current policy does not send positive signals on the co-benefits of forestry (other than through the FIDA and PFSI).

Minimisation of Crown risks: The Crown's fiscal liabilities arising from the current policy are limited to 21Mt CO_2e from the deforestation cap (for CP1) and the associated decreases in carbon stocks in Kyoto forests. While the sink credit benefit from Kyoto forests outweighs the liabilities from carbon stock decreases, this only reduces the surplus sink component of New Zealand's net position.

Any pre-CP1 deforestation comes at minimal fiscal cost to New Zealand (aside from the decay of soil carbon that may occur during CP1), although there may be opportunity costs incurred through harvesting immature timber. There may also be increased greenhouse gas emissions in the longer term from the resulting land-use change (eg, from increased emissions from agriculture).

Feasibility: The current policy is feasible. Some transaction costs and compliance issues will arise for participants in the PFSI. Aside from participants in the PFSI, the only monitoring requirements are aligned with the monitoring and inventory compliance under the Kyoto Protocol. The current policy does have risks relating to long-term feasibility because of the lack of clarity around putting the deforestation cap into operation.

The assessment of the current policy is summarised below in Section 4.6.7.

4.6.7 Options

There are a range of options for the treatment of forest sink benefits and liabilities under a domestic policy setting for forestry. These options range from policies where the Government retains all benefits and liabilities, to those where the Government devolves all benefits and liabilities. Many other possibilities exist on the spectrum between these two extremes. The section on a New Zealand emissions trading scheme (Section 4.2.4) discusses how devolution of these benefits and liabilities might operate for forestry in an emissions trading scheme.

Five options (including a variant on the current policy) are assessed here. The options below present some possible scenarios, which are assessed against the policy criteria outlined above in Section 4.6.4.

Option One	–	Government retains all Kyoto benefits and liabilities
Option Two	–	Payment for afforestation/reforestation, no devolution of liabilities and no deforestation cap
Option Three	–	The current policy, operationalisation of the deforestation cap and other policies to encourage new planting
Option Four	–	Deforestation charge/afforestation rebate
Option Five	–	Devolution of carbon benefits and liabilities.

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Option One – Government retains all Kyoto benefits and liabilities

Option 1A:

- no deforestation cap on non-Kyoto forests
- no climate change related policies to enhance sinks (eg, PFSI).

Option 1B:

- no deforestation cap on non-Kyoto forests
- retain climate change related policies to enhance sinks (eg, PFSI).

Option Two – Payment for afforestation/reforestation, no devolution of liabilities and no deforestation cap

This option involves a payment for the carbon value in the trees, to return some value from sink credits back to forest owners. The Government would retain all the Kyoto liabilities and benefits under this option, including liabilities associated with deforestation. The deforestation cap would be removed under this option.

This value returned to forest owners would be calculated by:

- The expected value of carbon credits from Kyoto forests in CP1 less
- The expected cost of liabilities of deforesting non-Kyoto forests in CP1 less
- The expected costs of monitoring incurred by the Crown.

Payment could be in respect of:

- all new plantings of Kyoto forests and replanting of non-Kyoto forests
- (and possibly) Kyoto forests that are already planted.

Other issues would need to be worked through, including the relationship between the price of carbon used under this option and any carbon charge elsewhere in the economy.

Option Three – The current policy, operationalisation of the deforestation cap and other policies to encourage new planting

This option is the same as the current policy discussed earlier in this section (4.6.3), but the deforestation cap is put into operation and additional policy is developed to enhance production forest sinks.

Despite the uncertainty over the status of sink credits post–CP1, New Zealand potentially can gain from a policy that develops and enhances sinks (taking into account wider co-benefits such as soil conservation). A sinks enhancement policy could have spin-offs not only for forestry, but for the environment and the economy.

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Approaches to encourage or enhance the capabilities of New Zealand's forest sinks might include:

- establishing forestry joint ventures on Kyoto-compliant Maori land
- the Government purchasing and replanting land intended for deforestation during CP1
- afforestation of some lands transferred to the Department of Conservation as a result of high-country pastoral lease tenure review
- other initiatives aimed at raising the overall economic performance of the New Zealand forest industry
- extension of the East Coast Forestry Project model to other regions with local government assistance.

The deforestation cap could be put into operation through the following sub-options:

- **allocating rights and liabilities.** This could be implemented through a cap-and-trade system for deforestation rights, allocated through alternative mechanisms such as grandfathering, auctioning, direct sale and/or lottery. Forest owners could trade deforestation rights. The size of the pool of deforestation rights to be allocated could be based on the current cap or some other measure.
- **Negotiated Deforestation Agreements (NDAs).** These would establish a transitional arrangement for deforestation of pre-1990 forests. The effectiveness of such an approach would depend on the eligibility criteria for an NDA. To reduce compliance costs, it might be possible to have simplified arrangements or automatic exemptions for very small forest owners.

Option Four - Deforestation charge / afforestation rebate

This option entails a payment to forest owners to encourage afforestation/ reforestation coupled with a charge associated with deforestation. If the land-use change is from a more intensive use to less intensive use (eg, sheep and beef farming to forestry), the Crown would pay a rebate to recognise the reduced emissions and carbon absorbed by the trees. If the conversion is to a more intensive land use, eg, from forest to dairying, then a charge would be imposed.

For forest owners, the scheme offers recognition of carbon sequestration while falling short of full accounting for carbon (with the associated transaction costs). For landowners, the signal is that land-use change coupled with an increase in emissions from agriculture would incorporate carbon costs (albeit at a lesser cost than the full cost of carbon). Government might participate in the purchase of carbon, but equally, as in Australia, businesses could become voluntarily involved in order to off-set their emissions. The option also shifts some liability associated with deforestation to forest owners.

The charge or incentive for land-use change could be based on a nominal value through to full accounting of the emissions associated with the incoming land use. This option would require a system for calculating the amount of carbon that would be released by deforestation or absorbed by sequestration.

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A number of other issues would need to be worked through, including the additional policies that might be needed to complement this option. These would include considering:

- the need for legislation to define the property right
- the need for a cap on deforestation to give the Crown fiscal certainty
- the relationship between the price of carbon used under this option and any carbon charge elsewhere in the economy.

Option Five - Devolution of carbon benefits and liabilities

This option involves the Government devolving some or all responsibilities for the management of carbon to private entities – both benefits (carbon sequestration) and liabilities (decreases in carbon stocks).

The Government could:

- devolve a proportion of the carbon credits and related obligations to land/forestry rights owners and retain a proportion to hold or sell (to cover liabilities from defaulting owners); or
- devolve all carbon credits and related obligations.

Devolution could be mandatory or voluntary (eg, "opt-in" participation).

Any decision on the proportion of carbon credits to be held by the Government can only be made following decisions on the nature of the system to be implemented. This would establish the basis for claiming ownership to the carbon sequestered in Kyoto forests and enable the sink credit to be recognised as a right that could be separated from the trees or land and able to be sold or borrowed against.

Points of obligation or "responsible parties" for forestry emissions would have the same obligations imposed on them as would emitters in other sectors. In addition, forestry points of obligation would be required to measure, report and verify carbon sequestration in order to claim carbon credits. Procedures for measuring, monitoring and reporting carbon sequestration will be essential to ensure that the amount of carbon sequestered, and subsequently credited, is established and verified.

For Kyoto Protocol-compliant credits, the point of obligation in the forestry industry would have to account for emissions from deforestation and for reductions in the carbon stocks of Kyoto forests (eg, through harvesting). A point of obligation for Kyoto forests would be to report reductions in carbon stock over the course of the normal harvest-regeneration cycle, including any deforestation. A point of obligation for non-Kyoto forests would only be to report reductions in carbon stock from deforestation.

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A number of significant issues would need to be worked through for this option:

- any work programme for developing a domestic emissions trading scheme
- determining relevant points of obligation
- monitoring, audit and enforcement
- the degree to which domestic rules mirror Kyoto Protocol accounting, or other international, rules.

4.6.8 Assessment of options

An assessment of the above options has been undertaken using the policy criteria outlined above in Section 4.6.4. This is condensed into Table 28 below.

The assessment of the options in this section can be summarised as follows.

The current policy

This option does not send strong positive signals on climate change implications of land-use change decisions. The PFSI will provide positive signals for those who opt in to grow continuous canopy forestry under the initiative. The lack of positive signals under this option means that it does not have long-term resilience and may not assist in meeting the Government's climate change goal or with new international climate change arrangements. Anecdotal evidence suggests uncertainty over the deforestation cap is contributing to land-use change prior to CP1. The Crown's fiscal liabilities arising from this option are limited to 21Mt CO_2e from the deforestation cap (for CP1) and any decreases in carbon stocks from Kyoto forests. The option is feasible in the short term because transaction costs and compliance issues will only arise for participants in the PFSI. However, the policy does have risks relating to its long-term feasibility because of the lack of clarity around the operation of the deforestation cap. Some serious equity issues arise for owners of non-Kyoto forests from the deforestation cap, if it were put in place.

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Option One – Government retains all Kyoto benefits and liabilities

Sub-option 1A - No deforestation cap on non-Kyoto forests, no policies to enhance sinks (eg, PFSI)

Under this option, no positive or negative signals would be sent on the carbon value of land-use change and forestry decisions. The option, therefore, would not be effective in achieving either the Government's overall climate change goal or, possibly, a new goal. The approach provides certainty for forest owners about their liabilities (or lack thereof) because there is no cap on deforestation. However, there is no certainty about liability for the Crown and, if deforestation rates are high because of market conditions for forestry relative to other land uses, the situation might become untenable. The option would be feasible because it removes the complexity associated with implementing the deforestation cap.

Sub-option 1B - No deforestation cap on non-Kyoto forests, retain policies to enhance sinks (eg, PFSI)

This option would send some positive signals for continuous canopy forest under the PFSI. For this reason, it is an improvement on option 1A.

The remainder of the assessment is the same as for Option 1A.

Option Two – Payment for afforestation/reforestation, no devolution of liabilities and no deforestation cap

This option sends some positive signals on some land-use decisions; namely, new plantings and replanting of non-Kyoto forests. But it does not send a signal on deforestation because the liabilities remain with the Government. It does, however, remove some uncertainty for the forestry sector around the deforestation cap. This option does not reduce the level of certainty on deforestation for the Government, because it retains the liability (although provision is made for the Government to cover this from the surplus of carbon credits). While this option provides some resilience for encouraging afforestation and reforestation, it does not provide long-term resilience for deforestation, and there is no lever for Government on this issue. This option becomes more complicated than Options 1A and 1B because the Government must administer a cash payment programme for some planting activities, while managing other activities (such as deforestation) centrally.

Option Three – The current policy, operationalisation of the deforestation cap and other policies to encourage new planting

This option addresses some issues for incentivising new plantings of forests, although the effectiveness of this would depend on the level of incentive relative to other negative external factors. Clarity on how the deforestation cap would come into effect would require further work to determine which proposals are suitable and how to implement them. Bringing the cap into operation would provide some certainty but also raise some serious equity issues for forestry investment decisions that were made 30 years prior (or longer). However, any proposal that brings the cap into effect would send signals about the climate change implications of deforestation, and removes some fiscal risk for the Government.

Option Four - Deforestation charge/afforestation rebate

This option sends stronger signals on land-use decisions than Options 1A, 1B, 2 or 3 because the costs for deforestation and the benefits of afforestation/reforestation are devolved, albeit as a proxy for a carbon price. This option also sends positive signals on the co-benefits of forestry. The rebates could recognise co-benefits explicitly, although any widening of the rebates to recognise the co-benefits raises the complexity associated with multiple objectives. The degree of flexibility in land-use decision-making provided by this option depends on the level of the charge for deforestation. Similarly, the forest owner can undertake afforestation or reforestation and receive a rebate for CP1. The obligations would be clearly spelt out for CP1 and indicate that in the future, under different climate change arrangements, the charges

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and rebates will be modified to suit the new situation accordingly. This option is more complicated than previous options. Further work would be required on the goal(s) or bounds of the scheme, uptake, equitability with other sectors and cost.

Option Five - Devolution of carbon benefits and liabilities

This option would send a strong market signal on the climate change impacts of afforestation, reforestation and deforestation. This option provides some certainty for the forestry sector for the period 2008 to 2012. There could also be uncertainty, however, around the market price for carbon credits. There could be uncertainty arising from liabilities for devolved credits if the international rules change (eg, if there are changes to eligible activities). This option does not send positive signals on the co-benefits of forestry, because planting will occur according to conditions related to the market for the carbon credits and other factors (such as land price).

The sink credits create an equal contingent liability if the forest is ever harvested or otherwise degraded. Should, as is probable, the price of credits rise over time, forest owners may in fact face a substantial capital loss. Devolution may place a greater burden on forestry and land-use change than on other parts of the economy, if other sectors do not face the liabilities as directly as the forestry sector. The Government would face responsibility for the defaulting owners of forests and emissions liabilities, because under the Kyoto Protocol liabilities ultimately fall to the Government (even if they had been devolved). Therefore, strong domestic law would be required to enforce any obligations. Further work is required on the feasibility of the approach. This is strongly linked to any work undertaken on an emissions trading scheme (see Section 4.2.4). A fully functioning emissions trading scheme would likely be a pre-condition for the full devolution of sink benefits and liabilities.

A snapshot of the assessment

From the assessment above, and from the contents of Table 28, decisions on which of the options are preferable or most desirable depends on the relative importance placed on the criteria.

If, for example, the criterion of "appropriate land-use signals" is considered important, then Options Three, Four and Five are preferable because they send stronger signals on the climate change implications of afforestation, reforestation and deforestation. These options, however, tend to be more complex and have issues around meshing national-level monitoring and reporting with compliance and monitoring at a forest block level. But if "feasibility" is considered to be an important criterion, Options Three, Four and Five tend to rank lower on that criterion compared with Options One and Two.

If the "reduction of uncertainty" criterion is important, Options One and Two have reduced uncertainty for the forest owner because of the removal of the deforestation cap and associated concerns about how this will be put into effect. These options result in increased uncertainty for Government because there are no bounds on the deforestation liability faced. Therefore, these options tend to rank lower on the "minimisation of Crown risk" criteria. The options that include a carbon price, such as Options Four and Five, provide increased certainty about their obligations and rules,

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but increased uncertainty about the future price of carbon associated with those obligations.

If "resilience" is considered an important criterion, then Options One and Two offer resilience, but do not send any signals on deforestation (although afforestation and reforestation are addressed in Option Two). Option Five ranks low in resilience because, if rules change beyond CP1 after the benefits and liabilities have been devolved, this raises serious issues for any new arrangement. Options Three or Four can be varied to suit any arrangement after CP1, with Option Four having the rebate and charge altered to align with any climate change obligations post-CP1.

If "equity" within the forestry sector is considered important, Options One and Two rank highly because there are no liabilities for both the owners of Kyoto forests and non-Kyoto forests. Option One does not recognise the benefits of forestry, however, whereas Option Two involves a payment for this. Option Five would not be equitable across the forestry sector if the devolution of the benefits and liabilities were based on the rules in the Kyoto Protocol because non-Kyoto forests would not attract benefits.

If "sector acceptance" of the policy option is considered important, the options that remove the deforestation cap (Options One and Two) and offer payments for the benefits of forestry (again Option Two) will rank more highly. Options with a more mixed response in terms of acceptance will be those with increased liabilities for deforestation, including Options Three, Four and Five.

This snapshot highlights that none of the options is considered perfect and all have shortcomings/tradeoffs.

4.6.9 Summary and conclusions

Uncertainty about the LULUCF rules beyond 2012 is a major impediment to developing a resilient domestic policy package. Without certainty on future rules (including targets, definitions, accounting and interpretation), it is difficult to evaluate the benefits and liabilities to New Zealand in the medium-to-longer term. However, it is important to note that the design of domestic climate change policy for land-use change need not necessarily mirror international rules. While New Zealand must adhere to issues related to compliance, domestic policy design has the flexibility to determine how appropriate signals can be transmitted in relation to afforestation, reforestation and deforestation (eg, through charges and rebates).

Forestry and agriculture compete for land use. For equity and efficiency reasons, it is preferable that climate change policies are land-use sector neutral and do not distort investment decisions. Similarly, substitutes for wood products should also be treated the same. Furthermore, flexibility in land-use decision-making is desirable.

Forestry can assist New Zealand in the transition towards a more climate-friendly economy. Forest sinks "buy time". However, any discussion on the benefits of forestry must not be divorced from the liabilities associated with harvesting and deforestation. Growing forests absorb carbon dioxide, harvesting and deforestation emit carbon dioxide.

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In the short term, forest sink credits will offset harvesting and deforestation liabilities. New Zealand's projection for sinks over CP1 is a surplus of 67.8Mt CO_2e.

In the medium-to-longer term, the high planting rates of the mid-1990s mean that, at harvest, there is a potential for New Zealand's net sink position to be in deficit (ie, harvesting liabilities will be greater than the sequestration benefits). This deficit assumes that current Kyoto rules remain very similar over the medium-to-long term and that New Zealand is unable to gain a more favourable agreement (relative to the present agreement) in the future. It is noted that a sustained planting programme would serve only to dampen or push this deficit out into the future.

The long-term climate change benefits of new plantings to New Zealand include a reduction in agricultural emissions (assuming that the land planted is in agricultural production and not scrub), immediate sink credits in the event that New Zealand is able to gain a more favourable agreement (relative to the present agreement) in the future, and an ongoing stock of carbon if the land is replanted and remains in forestry.

Forests not only sequester and store carbon, but can deliver co-benefits. Options that send positive afforestation and reforestation signals could be used to maximise other co-benefits associated with forestry such as:

- reduced agricultural emissions
- improved soil conservation, catchment management and water quality, and biodiversity outcomes
- enhanced ability to produce substitute materials for more emissions-intensive products
- a potential source of bioenergy.

The lack of information and in-depth analysis precludes any recommendation in this review on a preferred policy option for climate change land-use policies. Of the range of options assessed (from Government retention of all benefits and liabilities to the devolution of all benefits and liabilities) none is clearly preferred, and all have shortcomings/tradeoffs to various degrees, as illustrated in Table 28 and outlined in the discussion in Section 4.6.7.

As assessed against the policy criteria outlined in Section 4.6.4, the current policy package does not send appropriate climate change signals to land managers regarding the benefits and costs of land-use change.

It is recommended that Option One not be progressed further because, while it would provide greater certainty for forest owners in the absence of the deforestation cap, the lack of signals and bounds on the liability for the Crown means the situation would likely become untenable.

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The review highlights some possible avenues to improve the lack of climate change signals to land managers. These findings will form the basis of a work programme for further analysis. Those options include:

- Option Two - A payment for afforestation/reforestation and removal of the deforestation cap

- Option Three - The current policy package - clarification of the policy relating to the deforestation cap, additional policies to encourage new planting

- Option Four - Deforestation charge/afforestation rebate

- Option Five - Devolution of carbon benefits and liabilities (in conjunction with work on an emissions trading scheme).

A preferred option is dependent on the practical detail, which is yet to be worked through. It also depends on which of the criteria are considered to be most important.

Options Three, Four and Five offer greater certainty and improved signals but are technically complex. They raise considerations related to feasibility, compliance, enforcement and compliance costs. It is considered that a pre-condition for the full devolution of sink benefits and liabilities (Option Five) is a fully functioning emissions trading scheme (refer to Section 4.2.4).

The options should be investigated urgently to ensure that any policy changes can be implemented prior to CP1.

A work programme is also required to investigate the consistency of the above options against the World Trade Organisation and other international agreements obligations.

Better information is also required to discern the future deforestation intentions of foresters and to understand the decision-making process of land-use change in New Zealand.

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Box 2 - A Forest Sink Offset Scheme

The Australian Greenhouse Office has a functioning forest sink offset programme. Projects are approved as "Greenhouse Friendly" subject to the following eligibility criteria:

- **type of project**. The physical features of the forest must meet specified requirements. (New Zealand has defined "forest" in the context of the Marrakech Accords; the definition is wider than previously reported but includes production forests.)

- **additionality**. The project must be beyond business-as-usual. Not all forest plantings will be eligible. (For forestry, New Zealand has looked to compliance with the Kyoto Protocol rules as evidence of additionality. Nevertheless, the concept is well developed in other programmes where Government is involved with forestry, such as the East Coast Forestry Project, which distinguishes "target land").

- **permanence**. The carbon offset must be secured on a permanent basis. (New Zealand has its own Permanent Forest Sinks Initiative. But the Australian scheme also includes *Pinus radiata*. "Permanence" means a commitment to maintain abatement for at least two rotations - 70 years in the Australian situation).

The Australian scheme also provides that existing commercial forests may be eligible:

> "Existing, commercially viable forest projects may be able to generate eligible abatement where it can be sufficiently demonstrated that management decisions were or will be taken to preserve or enhance the carbon value in the forest beyond that factored into the preceding business plan."

On the supply side, an element currently absent in New Zealand approaches is legal taxation and contractual mechanisms to support **carbon pooling**. A carbon pool is an investment vehicle that joins together the carbon purchaser; the carbon supplier; those providing management services such as verification; and potential investors or underwriters.

In the Australian experience, purchasers include both **emitters** (companies seeking to offset greenhouse gas emissions from other sources or activities to greenhouse gas regulatory requirements or to enhance their environmental performance) and **public interest purchasers** (buyers seeking social and environmental objectives, including government agencies, altruistic organisations and business actors seeking marketing or reputation benefits).

Considering the role of Government, while there is some involvement on the purchasing side of the market, the key task has been to develop the legislation to support carbon pooling, clarifying the carbon property right. The matching of supply and demand, including the setting of the carbon price, occurs entirely within the private sector.

New Zealand officials have not yet carried out a detailed investigation of the Australian programme, considering whether it can be adapted for our circumstances. Australia is not a signatory to the Kyoto Protocol and we do not know, for example, what the Kyoto Protocol interface might entail. Nevertheless, we are informed that the scheme has been very successful in terms of uptake and broad acceptability to business.

Source: Australian Greenhouse Office publications (2005 b,c and d)

Table 25 – Analysis of Alternative Forestry Policy Options

	Criteria	Options					
		1A	1B	2	3	4	5
		Government retains all benefits and liabilities (no PFSI)	**Government retains all benefits and liabilities (retain PFSI)**	**Payment for afforestation/ reforestation and replanting, no devolution of liabilities and no deforestation cap**	**The current policy, operationalisation of the deforestation cap and other policies to encourage new planting (includes PFSI)**	**Deforestation charge/afforestation rebate**	**Devolution of carbon benefits and liabilities**
A	**Appropriate land-use signals**	Poor No positive or negative signals sent on climate change, although flexibility of land-use change is high.	Slightly better than 1A because signals sent by PFSI.	Medium Some signals sent by payment. Lack of deforestation cap means no signals sent on effects of deforestation.	Medium Improved – clear policy on deforestation cap and others encouraging planting (plus PFSI).	High Clear positive and negative signals sent through payment and rebate system.	High Strong and clear signals sent by accounting for carbon sequestered or released.
B	**Reduction of uncertainty**	Reduced uncertainty because deforestation cap is removed.	Reduced uncertainty because deforestation cap is removed.	Reduced uncertainty because deforestation cap is removed.	Certainty provided by operationalising the deforestation cap.	Certainty for forestry sector from having clear rules and price signals for activities.	Certainty about rules and obligations for credits. Uncertainty about carbon price.
C	**Resilience**	High The absence of a strong policy signal leaves future options open, but no long-term signals sent.	High The absence of a strong policy signal leaves future options open, but no long-term signals sent.	Medium Payment for plantings can be altered to suit any new situation beyond CP1. No resilience on issue of deforestation.	High Can be altered to suit new situation beyond CP1.	High Can be altered to suit situation beyond CP1.	Poor After devolution of benefits and liabilities, issues arise if forestry rules change beyond CP1.
D	**Equity**	High No liabilities for owners of KFs or non-KFs - equitable. No recognition of benefits from forestry through allocation of proportion of benefits.	High No liabilities for owners of KFs or non-KFs - equitable. No recognition of benefits from forestry through allocation of proportion of benefits (aside from PFSI).	High No deforestation cap removes the equity issue for the owners of non-KFs. Depends on start date for payment.	Potential inequity arises for owners of non-KFs from operationalising the deforestation cap. Depends on start date for policies to enhance plantings.	Some land owners will pay charge for deforestation, while not receiving the payment for earlier planting. Depends on start date for charge and rebate.	Not equitable for owners of non-KFs if the Kyoto Protocol rules are followed.
E	**Sector acceptance**	High – because of removal of the deforestation cap. Loss of PFSI would not impact greatly on sector acceptance.	High – because of removal of the deforestation cap.	High No deforestation cap and also receive payment for benefits of forestry.	Mixed Operationalising the cap will have negative effect, but policies on planting may improve sector acceptance.	Okay Sector buy-in would be reasonable as payment recognises some, but not all, forestry. Deforestation charge may not be acceptable to sector.	Depends on the circumstances Negative for owners of non-KFs, and positive for KF owners, if Kyoto Protocol rules followed.

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Table 25 (continued) – Analysis of alternative forestry policy options

	Criteria			Options			
		1A	1B	2	3	4	5
		Government retains all benefits and liabilities (no PFSI)	**Government retains all benefits and liabilities (retain PFSI)**	**Payment for afforestation reforestation and replanting, no devolution of liabilities and no deforestation cap**	**The current policy, operationalisation of the deforestation cap and other policies to encourage new planting**	**Deforestation charge/afforestation rebate**	**Devolution of carbon benefits and liabilities**
F	**Maximising co-benefits**	Poor Co-benefits not incentivised. Co-benefits lost through deforestation not addressed, in absence of cap.	Poor (better than 1A) Co-benefits not incentivised, aside from the PFSI. Co-benefits lost through deforestation not addressed, in absence of cap.	Payment may assist with co-benefits. Co-benefits lost through deforestation not addressed, in absence of cap.	Potential from co-benefits depending on how policies to enhance plantings are implemented.	Would result in some new planting and associated co-benefits – could link payments to where the co-benefits were desired.	Poor. No influence over maximising co-benefits – location of planting driven by market.
G	**Minimisation of Crown risk**	Uncertain Removal of deforestation cap means that the level of liability is unknown.	Uncertain Removal of deforestation cap means that the level of liability is unknown. Fiscal cost of the PFSI is minimal.	The fiscal liability from deforestation is unknown because it is not capped. Fiscal costs associated with payments are unknown (but remains within the surplus of sink credits above the level of deforestation liabilities).	Costs capped at 21Mt CO_2e for non-KFs and clear policy for operationalising the deforestation cap. Fiscal costs of any new policies to enhance plantings is unknown.	No deforestation cap and therefore fiscal risk depends on the response of the sector to the charge. The fiscal cost of the afforestation rebate depends on the degree of uptake. If the option is undertaken as a forestry off-set scheme (see Box 1), this latter cost is transferred to the purchasers of the sink units.	Removes 67.8Mt CO_2e of liability from the Crown account.
H	**International obligations**	Unknown – further work required on this.	Unknown – further work required on this.	Unknown – further work required on this.	Unknown – further work required on this.	Unknown – further work required on this.	Unknown – further work required on this.
I	**Feasibility**	High Easy to implement, with some issues relating to national-level monitoring.	High Implementation of PFSI makes option slightly more difficult than 1A.	Medium Managing some activities through payments and deforestation centrally (with no deforestation cap).	Difficult Complex arrangement of multiple programmes.	More difficult Measurement and verification for payments and rebates. Enforcement issues.	Most difficult - monitoring - enforcement - transaction costs - point-of-obligation issues.

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4.7 Non-energy emissions from agriculture

Summary
This section:
- assesses emission trends and the effectiveness of the current policy package
- considers alternative or additional policies to increase abatement and reduce future liabilities, using price or regulatory measures, research and extension, and special treatment of agricultural emissions in future international agreements
- highlights the importance of the national greenhouse gas inventory to capture farm-level mitigation actions, and of the links between agriculture mitigation and other climate change policies.

It concludes that:
- current research and development and technology take-up, land-use planning and on-farm decisions do not explicitly factor in the cost of agricultural greenhouse gas emissions
- sole reliance on voluntary research and development initiatives is therefore unlikely to deliver emissions reductions that would come at a net cost to farmers, even if and where this cost might be less than the international carbon price
- a key barrier to implementing an effective price-based measure is the accurate measurement, monitoring and reporting of emissions at the farm level, and the limited ability to reflect mitigation actions in the national emissions inventory. The use of proxies would preferentially stimulate changes in sector output and land use rather than a more efficient production system
- taxation of nitrogen fertilisers presents a feasible but very limited price-based mitigation option for CP1
- analysis to date has not assessed the full potential for mitigation in response to a price signal. Bottom-up assessment of technology and farm-management options and their aggregation to sector-wide impacts would be useful
- key decisions are required by the Government to guide further policy development:
  - does the Government want to move towards including agricultural emissions in a price- or regulatory-based system?
  - as New Zealand is unique in the developed world with its high proportion of agricultural emissions, does the Government want to seek to negotiate special treatment for agriculture in future climate change agreements?
  - how does the Government wish to approach further research and development investment in this area?
- there are synergies and trade-offs between the above policy directions and their implementation, and no-regrets measures and voluntary arrangements that need to be considered before concrete decisions are made. Decisions about agriculture policies will also influence alternative land uses such as forestry.

4.7.1 Current policy settings, trends and projected liabilities

Current policy settings

Livestock agriculture and associated processing industries earn about $13 billion in total export values and contribute about 10% of GDP. Most of New Zealand's

agricultural produce is destined for export and therefore subject to competition with producers in other countries on the global market.

Agricultural emissions reductions are difficult due to the international competitiveness of the sector, the apparent absence of significant mitigation options without reducing output, and the limited ability to monitor and report abatement at the farm level. As indicated in Section 3.2.5, the policy package of 2002 therefore exempted the agricultural sector from an emissions tax, with the liability for emissions borne by the Crown. Instead, the policy focused on increasing research efforts into cost-effective mitigation options through the joint government-industry consortium PGGRC.

The PGGRC set a voluntary goal of reducing agricultural emissions by 20% below business-as-usual by 2012. However, the current research prospects and limited efforts to prepare for implementation and reporting of mitigation options at the farm level appear unlikely to meet this goal. With the exception of nitrification inhibitors, which have the potential for much wider uptake over coming years, it is not clear whether any additional mitigation tool would be commercially cost-effective or come at a net cost to farmers. The absence of a price signal at the farm level means that farmers have no incentive to implement mitigation measures that come at a net cost to their operation even if the cost is small, unless there are other benefits from undertaking such actions.

This section considers additional policy options to enhance mitigation outcomes during CP1, and the sustainability and effectiveness of such options beyond 2012.

Emission trends

Total agricultural emissions were calculated to represent almost 50% of New Zealand's total greenhouse gas emissions in 2003, with more than 98% of these emissions from livestock through enteric fermentation and agricultural soils. Emissions are estimated to be above 1990 levels by about 25% (8.2Mt) in 2010 and over 35% (11.6Mt) in 2020.

Emissions growth is being driven by increasing intensification of agriculture production, increasing performance per animal and increased nitrogen fertiliser use. Changes in environmental regulations, fiscal interest and exchange rates, domestic value of land and alternative land uses, and international trade conditions influence activity in agricultural industries and can therefore alter projected agricultural emissions.

Since methane and nitrous oxide emissions are correlated with total production (both the number of animals, and metabolised energy and nitrogen throughput per animal), absolute emissions from the sector in 2010 would be expected to be higher than in 1990, even if the emission-reduction objective of the PGGRC could be fully achieved. This brings into sharp focus the challenge that a growing agricultural sector represents against fixed emission targets.

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Projected costs and liabilities for CP1

The excess emissions from agriculture above 1990 projected for CP1 are estimated to cost the Crown approximately $350 million to offset through credit purchases. The value of total agricultural emissions over this period is estimated over $1.7 billion.

Under current policy settings, the only direct costs to the sector result from its investment into research under the PGGRC, currently at about $1.6 million per year (PGGRC, 2005). Mitigation research is supported indirectly through other research programmes on farm efficiency, resource use, animal genomics and field trials carried out under the Pastoral Genomics research, BoviQuest and RED efficiency-improvement programmes.

The Crown is currently contributing an equal amount of funding to the mitigation research by the PGGRC. If investment remains at current levels to 2012, the total direct investment by New Zealand into agricultural mitigation research until the end of CP1 would be about $33 million, shared equally between the Crown and industry. Government also funded improvements to the national emissions inventory.

Post-2012 scenarios and possible targets, commitments, liabilities and costs

As indicated in Section 2.3, there is considerable uncertainty around the international framework for climate change post-2012. The costs and liabilities for non-CO_2 emissions beyond 2012 will depend on any future emission or policy targets that New Zealand may accept under a future international framework. Domestic policy decisions regarding the point of obligation or sharing of burdens (eg, Crown, industry, or individual farmers) will also be important in determining these costs and liabilities.

Proposals and options for commitments and targets for agricultural non-CO_2 emissions under future international agreements could include:

- economy-wide emissions targets for both CO_2 and non-CO_2 gases
- intensity-based emissions targets per unit of agricultural output
- quantitative or qualitative commitments to investment in development, deployment, and international transfer of mitigation technologies and practices
- an argument to exempt agricultural non-CO_2 emissions from future emission targets, or to reflect the export component of emissions from agricultural production
- absence of international agreement on climate change targets immediately after 2012, and hence no direct obligations to mitigate agricultural emissions.

Most of these options are not necessarily exclusive but could co-exist or be considered as complementary ways for countries to meet their obligations under future agreements. The first three options would likely imply additional, more stringent requirements and obligations on New Zealand with regard to emissions reductions from agriculture and/or enhanced research efforts.

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4.7.2 Assessment of current policy package

Key gaps and limitations of current policy package

The current policy settings contain some obvious gaps and limitations that could become more pronounced under climate change obligations beyond 2012. These include:

- agricultural land-use decisions are being made without regard to the cost associated with emissions
- there is limited knowledge about the possible response of farmers to an emission tax through changes in farm management and intensity. For example, little attention has been given to management changes to reduce greenhouse gas emissions through changes in timings for calving, milking and slaughter
- sole reliance on research means that any low-cost mitigation options will not be taken up even if they are less than the international price of carbon (unless there are other drivers or benefits of doing so). This leads to increased net abatement costs across the entire economy
- there are limited incentives to develop practical tools for monitoring and reporting farm-level greenhouse gas emissions and providing extension services to farmers that help them access and routinely use such tools
- there has been little work on how to reflect the abatement effect of possible farm management choices or on the use of nitrification inhibitors in the national greenhouse gas inventory system
- there is no agreed consequence for industry if it fails to meet the PGGRC's target to reduce emissions by 20% below business-as-usual levels by 2012.

The first four of these issues, as far as any mitigation options exist, are largely due to the current absence of any taxes on agricultural non-CO_2 emissions, and the result that farmers lack incentives for early mitigation actions unless they are commercially viable through productivity gains. Although the Government is considered to be responsible for developing inventory methods at a national level, there is some overlap with industry in the responsibility for monitoring and reporting the effect of mitigation actions at the farm level, and the integration of this information into the national inventory.

Effectiveness of policy package to date

Research efforts and mitigation options

The Government-private research consortium, PGGRC, set up to develop cost-effective mitigation options, has resulted in effective collaboration between major industry bodies and has also led to a productive and collaborative working relationship between industry, government departments and science providers (MAF, AgResearch and National Institute of Water & Atmospheric Research (NIWA).

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Section 4.1.4 outlined the current prospects for mitigation. Based on evidence to date and the long lead time it generally takes for new technologies to be tested and taken up by the market, it appears unlikely that the current research and extension efforts will lead to reductions in actual on-farm emissions by 20% below business-as-usual by 2012, as set out in the PGGRC research strategy.

Given the typical time lags between research and practical results, even a substantial increase in research investment would not be expected to significantly increase the chances of reaching the emissions-reductions goal by 2012, but it would improve the chances of emissions reductions over the longer term.

As discussed in Section 4.1.4, the main success of research has been the development of nitrification inhibitors, which have the potential to reduce nitrous oxide emissions by a few percent from business-as-usual by the end of CP1. However, the long-term effectiveness, sustainability and cost implications of are yet to be confirmed by further modelling and field trials. To date there has been little information as to the uptake of these despite having been on the market for two years. Another question is the energy balance between the production of nitrification inhibitors and that of nitrogen fertilisers. The total life-cycle greenhouse gas emissions of nitrification inhibitors need to be taken into account before policy decisions are made to encourage their use for climate change mitigation.

Some limited research has been done on farm-management practices specifically aimed at reducing emissions. Preliminary studies indicate that, for some dairy farms, the use of wintering stand-off pads could reduce seasonal nitrous oxide emissions, but that gains in this area could be offset by increased methane and carbon dioxide emissions resulting from more intensive and supplementary feed regimes.

Engagement at farm level on mitigation

There has been limited engagement at farm level on the subject of greenhouse gas emissions management and the roles that management decisions and technology choices by individual farmers could play. While the nutrient budgeting tool OVERSEER contains a module that allows reporting of greenhouse gas emissions at farm level, it can reflect only some possible mitigation actions. There has been very limited effort to integrate the use of greenhouse gas monitoring or reporting into standard farm practice.

The sector does not currently face any direct costs associated with greenhouse gas emissions resulting from land-use decisions. As a consequence, long-term strategic agri-business planning for growth and future profitability does not generally factor in the cost of greenhouse gas emissions.

4.7.3 Overview of additional policy options

Additional policy options can be grouped into three broad categories:

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- providing incentives to farmers to use low-cost mitigation options through introduction of a tax and/or regulatory measures for agricultural non-CO_2 emissions
- continued focus on research, and extension to farmers, to develop and deploy commercially cost-effective mitigation tools, and develop and disseminate monitoring and reporting tools for on-farm greenhouse gas emissions
- **[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]**

These approaches are not mutually exclusive. Synergies and trade-offs between them will be discussed in Section 4.7.8. Particular questions, challenges and practical limitations of these broad options are discussed in more detail in Sections 4.7.4 to 4.7.6.

4.7.4 Assessment of emissions tax and/or regulatory measures

The main options for emissions taxes and/or regulatory measures that provide abatement incentives while limiting overall economic impacts on the sector include:

- sector-wide price signals through an emissions tax that either applies to all methane and nitrous oxide emissions or is set relative to some intensity target
- partial price measures on a subset of total emissions where the effect of mitigation actions can be easily measured – mainly for nitrous oxide emissions resulting from the use of nitrogen fertilisers
- a regulatory approach for nitrogen inputs that focuses on environmental co-benefits as well as greenhouse gas (nitrous oxide) emissions
- positive incentives and support for uptake of low-cost mitigation actions.

Options for sector-wide price measures

A sector-wide emissions tax faces three main challenges:

- uncertainty about abatement opportunities and the effects of a tax
- the economic cost to the sector, which will face international competition from competitors not subject to a similar tax
- difficulties in monitoring and reporting on-farm greenhouse gas emissions and the effect of mitigation actions.

If the Government wishes to explore possibilities of moving towards a sector-wide tax on non-CO_2 emissions, the following actions are a priority:

- understand the economic impact and likely mitigation responses, and/or structural adjustment of the sector and regions, to different options for taxes, points of obligation and the possible use of proxies for farm-level emissions

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- develop and deploy monitoring and reporting tools that provide accurate, practical and cost-effective estimates of on-farm greenhouse gas emissions that can account for the effect of technological or farm management mitigation actions

- develop methods and data systems to reflect mitigation actions at farm level, in the national greenhouse gas inventory, consistent with good-practice requirements under the UNFCCC.

A further issue regarding potential methane-mitigation technologies, such as vaccines and feed additives, is their long-term environmental sustainability and their acceptability by domestic and international consumers.

Full emissions tax

Estimates of the economic impact and abatement resulting from a tax on agricultural non-CO_2 gases are based on either economy-wide computable general equilibrium model studies, or models that estimate the expected change in land-use resulting from an emissions tax.

Land-use based models (Hendy and Kerr, 2005; Sin *et al*, 2005) suggest that a price of $25 per tonne of CO_2e would result in an average land-based tax burden of $109 and $42 per hectare per year for dairy and sheep/beef land, respectively. Depending on annual profitability, this equates to a reduction in average net trading profits of about 17% to 30% for dairy farms, and about 15% to 32% for sheep or beef farms.[131] Assuming that farms can change only land-use but do not change management practices or land-use intensity, the model suggests that a tax at this level would reduce total non-CO_2 emissions by 3%. This relatively small change in emissions is due to the fact that despite reduced net trading profits, alternative land-uses are estimated by the model to be even less profitable in many instances.

Computable general equilibrium model studies do not specifically consider alternative land-use options, but assume that economic activities can adjust between all sectors. Recent modelling for New Zealand by Australian Bureau of Agricultural and Resource Economics (ABARE, 2005) suggests that for a tax of $13 per tonne of CO_2e, total output from dairy and beef sectors would reduce by between 2% and 3%, and wool outputs would reduce by over 11%. These changes in outputs (except for wool) are broadly similar to the modelled effects of the same tax on CO_2 emissions from the iron and steel and primary aluminium sectors.

The general equilibrium model estimates that a tax of $13 per tonne of CO_2e would reduce total non-CO_2 emissions by 3.8Mt CO_2e or over 9% of total non-CO_2 emissions, significantly higher than the abatement suggested by the land-use based model. The reasons for this discrepancy have not been explored, but will be influenced by the equilibrium model's assumption that other sector activities can replace agriculture outputs without being constrained by possible land-uses in different regions.

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[131] Sin et al (2005) calculated relative impacts on net trading profits for the years 2002/03 and 2003/04. Higher or lower net trading profits would imply a proportionally lesser or greater impact of an emissions tax in any given year.

A lower tax level, as discussed in Section 4.3.3, could generally be expected to result in lesser economic impacts on the sector. The main drawback of a reduced tax level would be that it proportionally reduces abatement incentives.

If agricultural non-CO_2 gases are excluded from an emissions tax, the equilibrium model suggests that outputs and exports from agriculture sectors would reduce by significantly less, with any remaining impacts due to the cost of energy and flow-on effects from the adjustment of other sectors. A discussion of effects across the entire economy when agriculture is included or excluded from an emissions tax can be found in Section 4.12.

A general drawback of all model studies to date is that they do not explicitly consider possible changes in management practices or intensity of land-use, the possible use of new mitigation technologies, and do not fully account for land-use transition costs and time requirements. They also assume that all emissions reductions can be fully accounted for at the farm level at no cost. Additional desk-top studies and real-world testing through demonstration farms would assist with a better understanding of the actual response options, net economic impacts, and abatement at the farm level in response to a tax.

Two alternative options for reducing the economic impact of a sector-wide price measure, while providing a full abatement incentive, are:

- a tax on excess emissions relative to some reference year
- a tax/rebate arrangement relative to intensity-based targets.

Tax on excess emissions relative to a reference year

Using a reference year (or fixed-reference emissions level) would limit the total economic impact on the sector but provide the full price abatement incentive. The overall economic impact of a tax on excess emissions relative to a reference year would be proportional to the amount of excess emissions, and can be estimated based on the impact of a tax on full emissions.

A major disadvantage of a tax on excess emissions is that it could create economic distortions between sub-sectors that have contracted or expanded since the reference year, and could also create problems for new industry entrants after the reference year if the point of obligation is at the farm level. An example in agriculture is dairying, which has grown substantially in response to favourable economic conditions since 1990, while sheep farming has contracted, and some farmers have switched their operations from sheep to dairying. Setting the reference year as 2005 would eliminate historical distortions, but would remain inflexible with regard to future changes in economic performance and output from specific sub-sectors, and new entrants after 2005.

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Tax based on intensity targets

Intensity targets are usually defined as allowable greenhouse gas emissions per unit of output. This means that the reference level for taxable emissions is determined by the actual overall future output of the sector. The possible function of intensity-based targets in agricultural emissions is explained in detail in Box 3 specifically for the dairy sector.

The advantage of an emissions-intensity approach would be that, similar to taxes on excess emissions, the sector faces only small overall costs or even positive returns from such a price measure, while the full marginal abatement incentive is maintained. In contrast to a tax on excess emissions relative to a fixed reference year, intensity-based targets would avoid the economic distortions that can result for sub-sectors that have contracted or expanded in output since the reference year.

The main drawback of an intensity-based tax is that absolute emissions from agriculture would be uncertain, and may entail a substantial liability for the Crown if future international agreements entail fixed emission targets that include agriculture emissions.

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Box 3: Example of Intensity-based Emission Targets for the Dairy Sector

Intensity-based emission targets offer the opportunity for an effective abatement incentive without penalising economic growth. They generally operate by setting an emissions-intensity target (eg, non-CO_2 emissions per kg milk solids) for a specific sector. The actual emissions target for any given year would then be defined by the actual output from the sector (eg, total milk solids produced) and the intensity target. A tax/rebate system could then be applied to emissions from the sector that exceed or undercut the emission target calculated for each year.

Example (hypothetical numbers)

Assume that an emissions-intensity target of 8.5kg CO_2e per kg of milk solids is set for 2010. This intensity target would be based on assumed improvements in emissions intensity under business-as-usual as well as possible mitigation options.

The actual target emissions for 2010, in CO_2e, would be calculated at the end of the year, based on the actual milk solids produced during 2010:

Target emissions = (actual milk solids produced in 2010, in kg) × 8.5kg CO_2

The sector would have to pay the full price of carbon on emissions that exceed these target emissions, but would receive a rebate if it undercut the target emissions. A similar calculation and fee/rebate would apply every year where the intensity-based price measure applies.

The actual emissions target for any given year would therefore vary with the actual output of the sector during each year. If the total output of milk solids increases from one year to the next, its emissions target would adjust accordingly, and there would be no financial penalty as long as the emissions intensity of production meets the specified target. Likewise, if the output from the sector contracts because of unfavourable economic conditions, the emissions target would also reduce and there would be no windfall gain to the sector as would occur with fixed-emission targets.

Intensity targets could, in principle, be set relative to milk solids, slaughter weights and wool production, and could thus cover virtually all main agricultural sub-sectors. The total economic impact of an intensity-based target would depend on the intensity target. If the intensity targets were set at zero, the economic impact would be the same as for a full emissions tax. At the other extreme, if the target intensity is set close to the expected business-as-usual intensity, the total economic impact of the tax would be zero but would still provide the same marginal abatement incentive to the sector. However, the definition of future "business-as-usual intensity" may involve considerable negotiation and discussion with industry, if intensity target levels are to be set as part of a negotiated agreement with industry rather than a unilateral decision by the Government. NGAs with major energy users may provide useful lessons for this.

The need to measure both greenhouse gas emissions and outputs to determine the actual intensity increases monitoring and reporting difficulties. In most cases, outputs of key quantities at the farm gate are well known, since they are the key source of income (eg, total amount of milk, wool, and meat sold), but intensities would have to be averaged over the course of a year to provide meaningful figures. Year-to-year variations in productivity at farm level could also create hardships that need to be explored further.

Other considerations for a sector-wide emissions tax

It appears, therefore, that a sector-wide tax at a lower level, or one based on intensity targets, could avoid the large negative economic impacts across the sector that a full tax would entail. Three additional points need to be considered to assess the feasibility of a sector-wide price signal:

- mitigation options and structural responses to a price signal
- information, monitoring and reporting requirements needed to administer the tax
- choice of an appropriate point of obligation for the tax incidence.

Mitigation options and structural responses to a price signal

The main purpose of a price signal is to provide incentives to decision-makers to undertake abatement measures.

Relevant responses to a price measure on agricultural emissions would be the use of available mitigation technologies or management practices, and/or a structural adjustment of the sector through changing land use or reducing outputs.

As discussed in Section 4.1.4, there are some, albeit limited and uncertain, mitigation technologies and management options that could be taken in response to a price signal. There appear to be opportunities to reduce nitrous oxide emissions through nitrification inhibitors, wintering stand-off and feed pads, and optimisation of the application of nitrogen fertilisers. Opportunities for optimising total on-farm greenhouse gas emissions through changes in stock management and seasonal timing of calving, milking and slaughtering may also exist but have not yet been explored in any detail. There are currently no feasible technological options such as vaccines or feed additives to achieve major methane emissions reductions from individual animals. The effect on net emissions of all or any of these options is therefore uncertain.

Beyond such mitigation options, a price measure would mean a change in farm profits and/or a resulting structural adjustment of the sector through reduced outputs and possible land-use changes. If cost effective mitigation options are not available, then structural adjustment will be the only effective response. This structural adjustment may impose higher transition costs and occur over longer timeframes.

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If New Zealand accepts binding emissions targets, including for its agricultural emissions, under future international agreements, a structural adjustment of the sector may be inevitable. However, the uncertainty about future commitments implies that it may be desirable to limit these structural adjustments until New Zealand's future obligations are clearer.

Information, monitoring and reporting requirements

For a tax to be effective in stimulating mitigation responses, reliable mechanisms have to be in place to allow any actual reductions in greenhouse gas emissions at farm level to be reflected in the tax burden. The mechanism for accounting for greenhouse gas emissions under a tax system would need to be clearly defined before such a tax is announced and applied.

At present, there are few practical, cost-effective and accurate tools for monitoring and reporting greenhouse gas emissions at farm level, including the effect of nitrification inhibitors and management changes, for the variety of farming conditions in New Zealand. The nutrient budgeting tool OVERSEER has a module to estimate greenhouse gas emissions at farm level, but it currently reflects only some of the potential mitigation options. The level of use of OVERSEER is limited; even in dairying, which has the most intense nutrient cycling. Only 17% of Fonterra suppliers were reported to be using OVERSEER or other nutrient budgeting tools in 2004. The level of use in other farming systems is likely to be lower still.

Use of proxies

In the absence of monitoring and reporting tools for greenhouse gas emissions at the farm level, any sector-wide price measure would have to operate through proxies for average greenhouse gas emissions, such as:

- total fertiliser use
- animal numbers
- farm area
- production outputs such as milk solids, slaughter weights, or wool.

While the use of proxies – animal numbers, land area or production outputs – would be efficient from a transaction point of view, it would not provide a fully effective abatement incentive, since the use of neither nitrification inhibitors nor stand-off pads, nor most other potential mitigation technologies or practices, would affect the emissions tax burden at farm level.

The main response to an emissions tax based on these proxies would therefore be a structural adjustment through changes in stock numbers or land use.

The only area where a proxy could bear a relatively close relationship to actual emissions is a tax on nitrogen fertilisers. The national inventory methodology

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calculates that each tonne of nitrogen fertiliser results in 6.8 tonnes of CO_2e emissions, although actual nitrous oxide emissions may still vary depending on soil conditions and level of application. However, emissions from nitrogen fertilisers are responsible for only 7% of total agricultural emissions. This may, however, be a useful first step towards including agriculture in the climate change framework. The use of fertiliser as a proxy for nitrous oxide emissions would also have the advantage that any changes in fertiliser use would directly translate into the national greenhouse gas emissions calculations. The likely economic impact and abatement from a tax on nitrogen fertilisers is discussed in more detail below.

Points of obligation

An important consideration for the practical implementation of any tax is where to place the point of obligation, and what transaction costs and information requirements would result.

Where the point of obligation is close to the decision-maker, the incentives to mitigate are strongest, but the costs of reporting, monitoring and administration are high. Where the point of obligation is far from the decision maker (say, at the level of an industry body) the mitigation incentive is weak, but the costs are low.

Placing the point of obligation at farm level would allow farmers to use their creativity and knowledge to optimise practices with regard to greenhouse gas emissions and individual economic and other environmental objectives. It also signals that the agricultural sector, over time, will need to engage in mitigation activity. The major disadvantage of this point of obligation is the very limited availability and use of cost-effective, practical and accurate tools to estimate actual non-CO_2 emissions at the farm scale, including the effect of these mitigation actions. The use of such tools to determine emissions tax levels may also result in resistance to the use of nutrient budgeting tools at farm level.

The alternative is to place the point of obligation as high up as possible; ie, on large companies such as Fonterra, meat-processing plants and national industry bodies. This approach would reduce transaction and administration costs due to the limited points of contact, the ability to use more generic tools to account for non-CO_2 emissions consistent with the national greenhouse gas inventory, and flexibility for industry sector organisations on how to distribute costs across their suppliers.

However, they would have to be based on output proxies such as milk solids, slaughter weights and wool. This would provide no direct incentive for individual farmers to take mitigation actions, as the only efficient response would be to reduce their outputs. If industry bodies simply passed the costs on to farmers through an industry levy, the end result would be identical to the situation where imperfect farm-level proxies are used.

Issues and options for emissions-trading schemes

Issues similar to those for the design and administration of an emissions tax also apply to the potential design and implementation of an emissions trading scheme. Key points include:

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- allocation methods and allowance levels
- monitoring and reporting tools
- points of obligation.

Without accurate, practicable and cost-effective monitoring and reporting tools, an emissions trading scheme would entail the risk of high transaction costs and related inefficiencies but would not create any greater abatement opportunities than a taxation system at this stage. These difficulties suggest that an emissions trading scheme involving agricultural non-CO_2 emissions would be unlikely to be efficient or effective in the near future.

Partial price measure – taxation of nitrogen fertilisers

A tax on nitrogen fertilisers could be a first, small step towards including the agricultural sector in the climate change framework. Given the small contribution to overall farm emissions, fertiliser use is a poor proxy for total nitrous oxide emissions at farm level. However, it does have the advantage of providing an abatement incentive that farmers can respond with measures that do not necessarily require a reduction in productivity (ie, through the supplementary use of nitrification inhibitors and targeted nitrogen budgeting).

The total costs and benefits of a nitrogen tax on fertilisers for total farm production would depend on the relative cost increase of nitrogen fertilisers and the availability, applicability and actual use of nutrient budget management tools to optimise fertiliser application. It also would depend on the relative costs and benefits of nitrification inhibitors.

Sheep and extensive beef farms tend to use less nitrogen fertilisers and therefore would face lower cost increases, but nitrification inhibitors would also tend to be less cost-effective. Areas affected by clover root weevil rely heavily on nitrogen fertiliser to replace lost nitrogen fixation.

The main advantages of a tax on nitrogen fertilisers are:

- nitrogen fertiliser inputs could be used as an effective proxy for nitrous oxide emissions created by use of the fertiliser
- farmers can respond to the tax by measures than do not necessarily require reducing productivity (ie, through supplementary use of nitrification inhibitors)
- if large enough it may reduce stocking densities and therefore methane emissions (if farmers respond to the price signal). However, current information we have suggests the tax level would be too small to make a material impact on stocking densities
- any changes in fertiliser use would be directly reflected in the national greenhouse gas inventory.

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The arguments against a tax on nitrogen fertiliser are:

- fertilisers are directly responsible for only 7% of agricultural emissions
- for some farming systems, alternative means to ensure high pasture productivity are significantly more expensive than nitrogen fertiliser; in these situations, the demand for nitrogen fertilisers is likely to be resistant to an emissions tax and actual use may change very little
- net farm emissions could increase if stocking densities increase through use of nitrification inhibitors that lead to increased pasture production.

Applying a tax on nitrogen fertilisers during CP1 would require additional analysis:

- what is the actual cost of the tax for a range of farming systems?
- what are the mitigation options and likely overall response by different farming systems to a tax, and how would this change the cost?
- what options exist for the Government and industry to reduce the economic impact of the tax and enhance its acceptability at the farm level (eg, by increased extension of nutrient budgeting tools and improved management of clover root weevil)?
- what is the likely overall change in nitrous oxide and total greenhouse gas emissions as a result of the tax, including through changes in farm productivity?

Regulatory approach to nitrogen loading

An alternative approach to greenhouse gas management is to focus primarily on the local environmental benefits of limiting total nitrogen loading in catchments with regard to nitrate pollution and water quality. This approach would deliver reductions in nitrous oxide emissions largely as a national-level co-benefit of local environmental protection.

The core of such an approach would be to set caps on the total nitrogen loading in individual catchments, based on the combined input from animal excreta and fertilisers, and the leaching of nitrate into water ways. A permit system could then allow trading of nitrogen permits between permit holders within catchment-specific caps. Limiting the total amount of nitrogen loading in catchments would implicitly control the nitrous oxide emissions associated with urine and dung deposits and fertiliser application.

The main advantage of a catchment-specific nitrogen cap-and-trade system would be that it reflects primarily local environmental concerns and may therefore have greater support from local communities and farmers themselves than a tax motivated by a greenhouse gas that is intangible at local level. Wider use of tools to monitor and report total nitrogen loadings and nutrient budgets would also deliver practical benefits to farmers.

Such an approach at national level would represent a substantial shift from current practice. Currently, only the Lake Taupo catchment has a nitrogen cap proposed, driven by environmental concerns about water quality.

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The actual costs of a cap-and-trade approach cannot be fully determined as part of this review and would require further work. Methods for allocation of permits would require additional work to ensure they are efficient and equitable. Transaction and administration costs could be substantial and would likely fall on local government (regional councils) and farmers or other permit holders. There could also be considerable costs to central government, since such a system would likely take many years to design and implement on a national scale.

The main disadvantage is that it may have limited or no effect on nitrous oxide emissions in regions where caps are based primarily on local water quality and nitrate leaching. The scheme would have to be implemented on a national scale to allow tightening of targets as mitigation options are defined. This would place significant resource requirements on smaller councils and could also cause tensions with land-holders.

A National Environmental Standard or a National Policy Statement would probably be required to detail methods for setting catchment caps and to administer the scheme. This would avoid regional inconsistencies and give guidance to regional councils on how to balance local environmental objectives (ie, water quality) and national objectives (ie, nitrous oxide emissions reductions).

A further risk of a nationwide regulatory approach to nitrogen loading is that the goodwill that currently exists under the Clean Streams Accord may be eroded, harming the relationship between the farming sector, industry, and local and central government. The accord includes provisions for comprehensive use of nutrient budgeting tools on dairy farms and protection of water ways.

If the Government wishes to further explore the options for a nitrogen cap-and-trade system, the following issues would require priority attention:

- identification of measures to define acceptable nitrogen loading in different catchment types
- assessment of the types of monitoring and reporting tools
- information requirements to operationalise a permit system
- evaluation of the most efficient and equitable allocation of permits
- analysis of the transaction and administration costs for a trading system
- analysis of the implications of creating a property right through emissions allocation and consequences for flexibility in changing catchment caps
- assessment of the likely overall costs to farmers and land-holders, and comparison of these costs against benefits of water quality
- assessment of the capacity of local government to set caps and administer such a scheme

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- assessment of the likely change in nitrous oxide emissions resulting from caps in different catchments, and the national benefits of such emissions reductions.

The current proposal for a nitrogen cap for Lake Taupo, despite its much smaller scale compared to a general nitrogen cap-and-trade system, is an important pilot area that can help further identify possible implementation and administration issues, costs and benefits. The complexity and novelty of such an approach limits the speed with which a nationwide cap-and-trade system could be implemented.

Direct financial support for uptake of mitigation options

If the Government does not wish to apply any price or regulatory signals to agricultural greenhouse gas emissions, it is likely that no mitigation options that come at a net cost to farmers would be taken up. If and where low-cost mitigation options exist, the Government could consider direct financial incentives and support for the use of relevant tools and practices. This would be efficient if it allows the Government to achieve measurable emissions reductions at a cost below the international price of carbon.

The main area where, based on current information, such an approach might be feasible would be financial support for the use of nitrification inhibitors where their use is not commercially cost-effective, and support for marketing of mitigation tools. The best mechanism would be an analysis of emissions and costs by relevant industry bodies for specific regions and catchments. How and whether these emissions reductions could be included in the national inventory would also need to be assessed.

Such an approach could be taken as an independent programme, or it could be integrated into a partnership arrangement between industry and the Government on mitigation research and extension.

Timing considerations

The options outlined in this section for sector-wide or partial price measures or regulatory approaches face different constraints in terms of their possible timing.

During CP1

Sector-wide price signals are limited by the lack of farm-level monitoring and reporting tools, and by difficulties of capturing the effect of farm-level mitigation actions in the national inventory. A sector-wide price measure could nonetheless be implemented through the use of other proxies for emissions such as stock numbers and land area. However, this would not be a fully effective abatement measure, since it would emphasise structural adjustment over incentives for more efficient production.

The only price measure that would send an effective abatement signal would be a tax on nitrogen fertilisers, which would cover only a small part of total agricultural emissions. Such a tax would require no additional monitoring and reporting tools. The main analysis that would need to be carried out is the detailed economic impact and responses by the sector, and the effect on actual total greenhouse gas emissions.

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If the Government does not wish to introduce any price on emissions, it could consider providing direct financial support for any identified low-cost mitigation options where the cost to the Government of supporting such mitigation actions is less than the international price of carbon for the avoided emissions.

By the end of CP1

A move towards a sector-wide price signal on all agricultural greenhouse gas emissions could be implemented by about 2012 if dedicated efforts are made to develop and deploy on-farm monitoring and reporting tools and establish systems to collect the necessary information on farm-level greenhouse gas emissions.

Alternatively, the Government could initiate and continue direct financial support for low-cost mitigation options where the cost to the Government of supporting such mitigation actions is less than the international price of carbon for the avoided emissions.

Both options are likely to be relevant only if there is a cost associated with agricultural greenhouse gas emissions in international agreements beyond 2012.

Long-term alternative option

As a fundamental alternative to a price measure, the Government could consider addressing nitrous oxide emissions from agriculture primarily through the co-benefits to managing local environmental effects of nitrate leaching on water quality. The development and implementation of nationwide cap-and-trade systems for nitrogen loadings would require significant additional work and consultation with a range of stakeholders. Actual reductions of nitrous oxide emissions under this approach are likely to occur only over the long term beyond 2012.

4.7.5 Research, extension services and voluntary approaches

The current research approach has the potential to deliver mitigation technologies, but:

- it is unlikely that the current research and farm extension arrangements will result in the PGGRC's goal of reducing emissions by 20% below business-as-usual by 2012
- current arrangements do not clearly develop and maintain long-term scientific capacity to underpin mitigation research
- there are limited provisions for developing internationally acceptable national inventory methodologies to reflect farm-level mitigation options
- research focus may under-emphasise research into farm-level greenhouse gas management options and does not currently plan for farm extension issues and the development and dissemination of monitoring and reporting tools
- given the typical time lags between research and practical results, even a substantial increase in research investment would not be expected to

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significantly increase the chances of reaching the emissions reductions goal by 2012, but it might improve the chance of emissions reductions over the longer term.

The following are key steps that the Government may wish to consider to ensure continued and possibly increased research funding, as well as the extension of research results and information and reporting tools at farm level:

- develop an overarching strategy for mitigation research and farm extension needs, including:
    - development and deployment of farm-level monitoring and reporting tools
    - national inventory methodologies to account for mitigation options
    - underpinning research and scientific capacity
- consider total funding requirements and opportunities from the Government and industry, using existing bottom-up assessments and criteria for strategic outcomes and targets
- consider the role it wishes price measures to play in achieving mitigation outcomes
- discuss with the main industry bodies their preference for a clearer definition of mitigation targets and consequences for non-achievement, or a partnership approach in funding and management of strategic research, extension and capacity needs
- clearly define industry-Government mutual responsibilities and targets across research, extension, inventory and reporting needs
- consider benefits and risks of different sources of ongoing and additional Government investment, including the reprioritisation of general agricultural productivity research
- work with industry to evaluate the possible benefits and risks of developing a "climate-friendly" brand for access to overseas markets
- work with industry to develop a process for developing, testing and disseminating mitigation tools and practices through monitoring and demonstration farms
- work with industry to integrate monitoring and reporting tools into standard farming and performance measurement and reporting practices.

Current research arrangements

All existing targeted mitigation research is being carried out through the PGGRC research consortium, which is funded to equal amounts by FRST and industry members of the consortium. The total funding level is $3.28 million in 2005, with

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funding approved for the FRST contribution until 2007. Research is driven by the commercial expectations of industry participants, based on the underlying research strategy.

Mitigation research is supported indirectly through other research programmes on farm efficiency, resource use, animal genomics and field trials carried out under the Pastoral Genomics research, BoviQuest and RED efficiency-improvement programmes.

Mitigation research funding has been agreed only to June 2007. The PGGRC has expressed a willingness to consider further funding from 2007 onwards until 2012. However, this is likely to require an equal commitment by the Government through FRST. The memorandum of understanding that governs the relationship between PGGRC and the Crown is also due for review in 2007. The need to renegotiate future investment into PGGRC research will enable reconsidering the adequacy of current funding levels, and of opportunities for increasing research funding by industry and/or government.

Crown Research Institutes and universities, through FRST contracts, are undertaking ongoing research related to greenhouse gas inventory methodologies and verification options estimated at over $1 million per annum. At present, there is little operational research funding by government departments for further inventory methodology development.

Other important initiatives that could support greenhouse gas mitigation and extension options include the dairy industry consortium "Dairy 21" and other research into agricultural productivity and environmental sustainability funded by FRST. At present, there appear to be few efforts to directly link greenhouse gas emission-reduction targets and management options to achieve emissions reductions with industry productivity research. The cost of monitoring emissions in field trials would require a re-prioritising of overall outcome expectations from such broader research programmes to include greenhouse gas mitigation objectives.

Adequacy, capability and focus of current research approach

Adequacy

As outlined earlier, the current research and farm extension arrangements are unlikely to result in an actual reduction of agricultural greenhouse gas emissions by 20% below business-as-usual by 2012. Given the typical time lags between research and practical results, even a substantial increase in research investment would not be expected to significantly increase the chances of reaching the emissions-reductions goal by 2012, but would increase the chance of emissions reductions over the longer term.

In comparison with general agricultural research and development (Scobie and Eveleens, 1987), and with energy research, the research current extent of agriculture mitigation and extension may need to be reconsidered. A comparison of investment levels for agriculture with those for energy research and extension services is particularly relevant when considering that New Zealand is generally regarded as a "technology taker" with regard to energy technologies, whereas there is little doubt that

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New Zealand will have to develop its own research and technology options with regard to agricultural greenhouse gas emissions. Successful research outcomes, particularly if they also address other productivity or environmental sustainability concerns, could also offer opportunities to sell products on markets overseas.

It is also noteworthy that, traditionally, New Zealand has spent almost as much on extension (ie, dissemination and training of farmers in using research results) as on agricultural research itself (Scobie and Eveleens, 1987). While investments in dissemination of mitigation technologies may seem premature before mitigation technologies themselves have been developed, this suggests that total mitigation research investment may have to increase over time to fully capture through farm extension the potential benefits that mitigation technologies could bring.

Capability

A concern of the current commercial consortium model is the lack of focus on developing and sustaining underpinning scientific capacity. A number of key researchers will reach retirement age by 2012, and Crown Research Institutes report that both funding levels and uncertainty make it difficult to attract young researchers.

A further bottleneck is the limited funding for developing further inventory methodologies. As outlined in more detail in Section 4.7.7, it is not currently clear how the use of nitrification inhibitors or farm management choices such as the use of stand-off pads could be reflected in the national emissions inventory. Development of a robust inventory methodology requires operational efforts with a sound scientific basis. This is unlikely to be delivered under science provider-driven research contracts with FRST.

Inventory research is specifically excluded from the scope of the PGGRC strategy as agreed under the memorandum of understanding that inventory development was the responsibility of the Government under requirements of the UNFCCC and Kyoto Protocol.

Focus

In terms of exploring farm management options and their implications, the main management focus has been on the use of stand-off pads. However, studies have not explored systematically, even at the desk-top level, to what extent other possible changes in milking and slaughtering timing, stock numbers and densities, and balance between different age classes could reduce the impact of a tax on non-CO_2 emissions.

As a consequence, there is still limited knowledge on whole-farm management options and the overall cost implications of these options on farm productivity and economic returns.

Practical, accurate and cost-effective on-farm monitoring and reporting tools for greenhouse gas emissions could be regarded as an example for research extension. The development, deployment and dissemination of such tools is not currently funded

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by the PGGRC, and the current research arrangements leave it unclear whether the Government or industry carries the lead for developing and disseminating such tools.

Options for continuing or increasing research efforts

If the Government agrees that:

- a greater research effort on agricultural mitigation and extension is in the national interest, or
- the risks identified to the sustainability and efficiency of the current approach need to be addressed,

then the main question is how the burden of any additional research should be shared between the Government and industry, and where responsibilities for specific components of the research effort (mitigation technologies, farm management options, inventory development, and farm extension) should sit.

Options and risks for private-sector engagement

Motivations for the agriculture sector in New Zealand to invest in mitigation research are:

- to make a case for exemption from price measures on emissions
- to reduce future costs associated with prices on greenhouse gas emissions and increase flexibility in responses to price and regulatory measures
- to develop commercial opportunities for new technologies.

The most appropriate option for the Government to engage industry in research funding depends on policy options. The potential strategies (not necessarily exclusive) for engagement are:

- price measures on emissions, which would provide a direct incentive for industry to undertake research to reduce its tax liability. In that case, decisions about the focus and quantity of research would be at the discretion of industry
- possible industry desire to negotiate targets for research and mitigation outcomes in return for a continued exemption from an emissions tax. Targets could be negotiated as **intensity-based** or **absolute emission** targets, but would need to include clear consequences for failure. Targets expressed relative to business-as-usual would require a clear definition of business-as-usual
- a strategic partnership approach through co-funding arrangements that consider the overall programme of work. Such an approach would require industry and the Government taking joint ownership of all issues related to agricultural emissions management.

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As described in Section 4.3.4, there are advantages and disadvantages with relying on either a price measure to drive research and development investment or strong Government engagement.

The general benefit of relying on a price measure is that it leaves research and development investment decisions to industry to determine the most effective and promising research and extension needs to achieve on-farm emissions reductions. In the case of agricultural mitigation research, the main risk of this approach is that it would widen the gap between industry-driven research into mitigation tools at the farm level, and government-driven research at national level for inventory development tools to monitor and report emissions at the point of obligation for an emissions tax. Managing this risk would require early consultation with industry bodies about how to define responsibilities and collaboration for overlapping research and extension issues to ensure that mitigation actions can be reported and accounted in the national inventory. The long lead time for agricultural research also means that price signals would have to be stable for a decade or more in advance to provide reliable returns on research and development for industry. Similar benefits and risks would arise from negotiating specific research and development outcome targets with industry.

The benefit of a strong Government-private partnership approach in agricultural research is that it would allow an integrated and strategic look at New Zealand's long-term interests and minimise gaps between mitigation tools, their implementation, and reporting at farm level and in the national inventory. It would, however, require a close collaboration, shared vision and distribution of core responsibilities between industry and the Government. This could create management conflicts between commercial and Government interests and expertise that need to be managed. This could lead to high administrative costs and reduced effectiveness of market mechanisms to find the most-effective research solutions or other market responses.

Government funding

If the Government decides that its contribution should increase in line with a general increase in agricultural mitigation research, as suggested in the preceding analysis, a key question is: where should the additional funds come from? Three main options exist:

- additional appropriation
- re-prioritisation of other climate change research funding
- re-prioritisation of other agricultural productivity and sustainability research.

Additional appropriation would be justified if the Government decides to continue to carry liability for greenhouse gas emissions and does not wish to impose financial penalties on the sector if it does not achieve mitigation target outcomes.

Reprioritisation of existing climate change research would need to be based on a clear analysis of the Government's research priorities for climate change. A prioritisation process would require clear guidance about political priorities as well as scientific

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advice and the value of underpinning science capacity. New Zealand also has to consider its international credibility in choosing its science priorities and international collaborations. The possible role, benefits and criteria for a strategic reprioritisation of the Government's climate change research investment are discussed further in Section 3.4.4.

To date, there has been little priority given to directly address mitigation objectives within other agricultural productivity and sustainability research. Given that, mitigation tools and practices need to be consistent with the sector's overall goals and industry structure, and investment levels may be more appropriately weighed up against other research needs within the same sector. Such an integration could offer better avenues for extension of research results at farm level, and the development of tools.

[withheld under OIA s9(2)(b)(ii), s9(2)(f)(iv), s9(2)(j)]
If the Government decides that funding support on this scale is appropriate, this research programme could offer an important opportunity to integrate climate change mitigation research into a portfolio of issues covering overall productivity increases, economic performance, and sustainability within a broad range of environmental constraints and externalities.

Voluntary approaches and industry accords to encourage mitigation

Voluntary measures and industry accords are normally the preferred option for achieving environmental objectives due to the greater buy-in from farmers and suppliers to industry-led initiatives. Voluntary approaches avoid unnecessary and unforeseen costs to farmers because they are not bound by hard input or emission caps. Voluntary approaches also reduce the risk of using insufficiently tested mitigation tools without evaluation of their long-term sustainability.

Many farmers are motivated by a genuine desire to be positive stewards of the land they farm, but have to balance environmental concerns with commercial reality. They are also concerned that regulatory or price-based approaches would increase costs without recognising current land management actions by farmers. Monitoring and reporting of greenhouse gas emissions at farm level, as well as many other agricultural data collection efforts, rely heavily on voluntary participation by farmers.

A voluntary approach with support from farmers is likely to be more robust and sustainable than regulations and taxation that may require legislation to enforce the collection and provision of farm-operations data to government agencies. A stringent regulatory approach could also have substantial negative spill-over effects into other areas that are based on cooperation between farmers and local and central government agencies.

Engagement by industry and at farm level in agricultural greenhouse gas mitigation has been hampered by significant fundamental information barriers. Many farmers and farming organisations are not sufficiently aware, or do not communicate to their members, that, under current policy setting, all taxpayers are carrying the cost of

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agricultural greenhouse gas emissions, while farmers are the direct beneficiaries from any productivity improvements associated with mitigation technologies.

While there is growing appreciation of the local environmental externalities of farming on water quality through nitrate leaching, there is still a very limited appreciation and understanding that emission of methane from ruminants represents a net energy loss from the production system, and that effort to reduce this loss could contribute to increased productivity as well as reduced global environmental externalities.

Communication channels should include the use of monitoring and demonstration farms to explore and demonstrate the impact of possible farm management changes on emissions and economic performance. The use and co-benefits of monitoring and reporting tools for greenhouse gases, nutrient budgets and nitrate leaching provide tangible measures of environmental externalities.

Additional incentives for the use of such tools could come through a number of sources:

- voluntary standards set by industry bodies and major companies for their members and/or suppliers, possibly as part of existing accords with the Government
- individual leadership, branding, certification and labelling schemes that give recognition to farmers that monitor and control their nitrogen and greenhouse gas emissions as part of broader environmental sustainability objectives
- requirements as part of resource consents and Regional and District Plans under the RMA, where they encompass provisions for land use.

In contrast to the issue of water quality, public support for stringent controls on greenhouse gas emissions and domestic market premiums for "climate-friendly" products and operations appear too low to exert a strong pressure on the sector to take significant voluntary mitigation actions. A market premium may assist with market access to some niche markets. However, this market brand is currently not sufficiently developed to motivate the sector to undertake substantial mitigation action beyond no-regrets actions.

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A number of international research efforts and partnerships provide examples of countries committing to major research programmes:

- Australia leads a Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC), which researches the logistic, technical, financial and environmental issues of storing industrial carbon dioxide emissions in deep geological formations. The total cash and in-kind funding for this centre by the Australian government and participating research organisations and companies is about A$17 million per annum for seven years to 2010. Three New Zealand companies are involved in this initiative

- the United States initiated the Carbon Sequestration Leadership Forum (CSLF), a plurilateral partnership for the capture and storage of carbon dioxide from fossil fuel power plants. Twenty-five nations participate in collaborative research efforts.

Funding is contributed in kind by participating countries, which are interacting at technical, policy and ministerial levels

- the United States also initiated the Partnership for the Hydrogen Economy (IPHE), another plurilateral partnership for the development of hydrogen technologies. As with the CSLF, the IPHE's main role is to leverage research funding and coordinate research efforts undertaken as in-kind contributions by participating countries, which also takes place at the technical, policy and ministerial level

- the United States, Australia, China, South Korea, India and Japan have recently announced the Asia-Pacific Pact for Clean Development and Climate, a partnership initiative to promote the development and deployment of clean-energy technologies in developing countries. Details about this initiative are yet to emerge.

A comprehensive research programme on mitigation of agricultural non-CO_2 emissions could also expand opportunities for international collaboration and increasing critical mass of research funding. There is growing interest in some research centres in Australia, the United States and Europe in New Zealand's research programme into mitigation of agricultural non-CO_2 greenhouse gases.

A comprehensive research programme on mitigation of agricultural non-CO_2 emissions could:

- expand opportunities for international collaboration and increase critical mass of research funding
- lift New Zealand's profile further without having to provide funding levels similar to those of Australian Cooperative Research Centres
- increase industry-to-industry collaboration. (At present, the main focus of partnerships is with science-to-science or government-to-government collaboration; eg, under the bilateral climate change partnerships between New Zealand and Australia and the United States.)

A significant expansion of New Zealand's research efforts and extension into an international research consortium would involve some risks. New Zealand might find it harder to control the direction of mitigation research and to ensure that farm-level solutions meet the needs of New Zealand's farming situation and can be incorporated into New Zealand's national emissions inventory.

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4.7.7 Other considerations

A number of other measures and uncertainties need to be considered to ensure climate change policies for the agriculture sector are robust and sustainable. The key issues are:

- national inventory requirements to reflect mitigation actions at farm level
- scientific risks and uncertainties regarding levels and trends of agricultural emissions
- general communication of climate change issues to the farming sector.

Inventory requirements

Mitigation of greenhouse gas emissions is ultimately driven by the need to meet New Zealand's international obligations and emission targets. Any mitigation action taken at the farm level "counts" only if it can be reflected in the national greenhouse gas inventory. With the exception of limiting fertiliser use, none of the potential agriculture mitigation options discussed in this review are or can be reported in the current national greenhouse gas inventory.

Emissions are reported at national level through annual national greenhouse gas inventories. These must meet international standards of "good practice" based on guidelines developed by the IPCC and endorsed by the Conference of the Parties to the UNFCCC. While specific rules and definitions for greenhouse gas reporting could be changed beyond 2012, the general requirement that reporting greenhouse gas emissions be consistent with internationally accepted and peer-reviewed methodologies is highly likely to remain.

For any mitigation policies to be effective, the agriculture emissions inventory must capture the effect of farm-scale mitigation actions at national level.

A robust and comprehensive inventory is also important to be able to test the effect of policies and mitigation actions on total greenhouse gas emissions at national level, and to provide crucial underpinning and scientific capacity for further development of mitigation options.

The credibility of mitigation technologies and practices will depend on the scientific robustness and level of detail of the agriculture emissions inventory methodology. Any substantial emissions reductions claimed as a result of specific mitigation technologies is likely to undergo significant international expert scrutiny and peer review.

Inventory improvements required to reflect mitigation options

Reductions in fertiliser use would be directly reflected in the national inventory and therefore need no specific inventory development. The most important other currently identified mitigation options are the use of nitrification inhibitors and stand-off pads.

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Research needs to quantify the effect of nitrification inhibitors on nitrous oxide emissions for a range of soils, climates, livestock types and stock-management regimes. This also includes seasonal effects, the long-term effects of the use of nitrification inhibitors on New Zealand ecosystems and their efficiency in reducing nitrous oxide emissions, and quantification of the life-cycle of greenhouse gas emissions from nitrification inhibitors compared with those of conventional farming practices.

Relevant research needs to be published in internationally recognised scientific journals, and findings need to be combined into a credible inventory methodology that meets the guidelines and good-practice requirements defined by the IPCC. Consideration also needs to be given to how the application of nitrification inhibitors can be recorded and monitored to ensure that national data is available for use in the annual greenhouse gas inventory.

Because the scale of nitrous oxide emissions reductions that could potentially be achieved through nitrification inhibitors is large, a comprehensive inventory research programme is likely to be cost-effective at the national scale.

Using stand-off and feed pads presents challenges to the national inventory system because it is difficult to monitor and verify the effect of such management options at a national scale, and provide credible evidence of their use to international expert review. Capturing the effect of such management changes in the national inventory is likely to require investment for publishing scientific studies in the international literature, and adapting annual animal production surveys that collect and store information on farm management choices that affect the national emissions inventory.

The only other mitigation technology that shows some potential for reducing methane emissions is sodium monensin; its primary use is to control bloat in lactating dairy cows. To be able to account for the effect of monensin, it would be necessary to undertake and publish scientific studies that demonstrate its effect on emissions, and incorporate this effect in the national inventory methodology. While the maximum effect of monensin on total emissions is thought to be small (less than 1%), it may nonetheless represent an important trial for such inventory development, including the necessary international expert review, since a similar process would have to be followed to incorporate almost any other future mitigation technology, such as a methane vaccine, into the national inventory.

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Inventory improvements to provide more accurate reporting and accounting

For the purposes of accounting under the Kyoto Protocol, parties are required to routinely update their inventory methodology, estimate uncertainties and prioritise efforts to improve the accuracy of inventories in the future. There are several areas where preliminary analysis suggests that the current inventory methodology may not estimate emissions as accurately as possible:

- nitrous oxide emission rates from hill country

- refinement of emission factors for different livestock and age classes
- recognition of methane adsorption by forest soils.

In some areas, the current methodology may overestimate agricultural greenhouse gas emission trends. These are generally thought to be small, but more accurate accounting would be expected to reduce the excess emissions accounted for in CP1, and thus would have a similar fiscal effect to the implementation of mitigation measures. Preliminary estimates indicate that inventory improvement that leads to more accurate reporting in these areas would have a high benefit/cost ratio.

Changes in carbon stored in agricultural soils

Under Article 3.4 of the Kyoto Protocol, countries can choose whether they want to account for carbon dioxide emissions and absorptions arising from the management of agricultural soils. Current information on actual carbon dioxide flux in New Zealand's agricultural soils, resulting from changes in management practices, is not sufficient for developing a robust inventory consistent with good-practice requirements under IPCC guidelines. It is not clear whether, for the whole of New Zealand, changes in agricultural soil management have resulted in positive or negative carbon dioxide emission trends over the past few decades. Therefore, the current policy position is not to account for carbon emissions or absorptions to or from agricultural soils.

Accounting for soil carbon changes could become a binding requirement under future international climate change agreements. At present, it is not known whether such a requirement would reduce or increase New Zealand's net greenhouse gas emission trends, or to what extent specific reporting and accounting rules could influence the direction and magnitude of reported emissions.

An area of potential significance is soil erosion. The net effect of soil erosion on atmospheric carbon dioxide is uncertain because the carbon removed may be deposited elsewhere and does not necessarily lead to carbon dioxide emissions to the atmosphere. However, significant amounts of carbon can be absorbed and stored in soils where erosion is reverted and a stable humus layer rebuilt.

FRST currently funds some work on these issues, but substantial additional investment would be necessary to provide robust estimates of soil carbon changes across New Zealand farm and crop lands. Future climate change agreements requiring mandatory reporting and accounting for carbon changes in agricultural soils would create a significant uncertainty with regard to New Zealand's projected future liabilities, and would likely require increased funding for scientific systems to monitor, report and account for soil carbon changes.

The New Zealand Carbon Accounting System aims to provide information on soil carbon changes associated with land-use change from forestry to agriculture and back again, and within indigenous forests. But, it does not address the question of soil carbon changes within existing land uses. Climate change impacts could also alter emissions from soils.

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Scientific uncertainties

Estimates of agricultural greenhouse gas emissions generally have to rely on a combination of field trials and spot measurements (usually for a few days and small numbers of animals for methane), extrapolation and verification at farm and national levels, and reporting according to international good-practice guidelines. Significant assumptions and uncertainties are associated with scaling up to the national level.

Uncertainties are associated with each of these steps. New scientific knowledge could change calculated absolute emissions and emission trends in future:

- further refinement of the national inventory methodology and changes in default emission factors could lead to changes in absolute emissions and trends. The uncertainty of emission trends, if there are no changes to default emission factors, is estimated to be less than 5%. The uncertainty of absolute emissions is about 50% for methane and 70% for nitrous oxide

- the effectiveness of non-CO_2 gases is translated into a common currency using the so-called global warming potential (GWP) relative to the warming effectiveness of CO_2. The GWP of gases is subject to scientific uncertainties and possible revisions. Recent studies have increased the GWP of methane from 21 to 23, and further revisions cannot be ruled out. The GWP also involves policy choices for time horizons over which the global warming effectiveness is measured. Future international agreements could choose different time horizons, or an entirely different method to compare the effect of different greenhouse gases on global warming. Such choices could alter the relative importance of non-CO_2 greenhouse gas emissions in New Zealand's national inventory.

National inventory methodology alterations that cause changes in emission trends and absolute emission levels would be relevant for both CP1 under the Kyoto Protocol and any future climate change agreements. Changes in the GWP of non-CO_2 gases would not be relevant during CP1, as the GWPs have been fixed, to provide certainty to all parties. However, future agreements are likely to use the most up-to-date information and so changes in GWPs could affect the balance between CO_2 and non-CO_2 emissions as reported by New Zealand.

General communication on climate change issues with the farming sector

Apart from contributing a large part of New Zealand's greenhouse gas emissions, agriculture as an industry is exposed to the impacts of climate change (see Box 4).

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Box 4: Climate Change Impacts and Adaptation Issues for Agriculture

Most of the expected positive impacts are related to gradual changes in mean climate and atmospheric conditions. The most important factors are:

- higher winter temperatures leading to an extension of the growing season
- higher CO_2 concentrations supporting growth and more efficient use of water
- higher average temperatures increasing range of crops that can be grown
- reduced occurrence of frosts and late winter snow storms.

Negative impacts of climate change are related to some changes in averages, but in particular to changes in extremes:

- reduced winter chilling reduces bud set in some fruit crops
- warmer winters lead to higher survival rates of pests and diseases, and higher summer temperatures encourage the spread of subtropical low-quality pastures and increased biosecurity risks
- increased frequency and intensity of droughts in already dry regions could jeopardise some dryland farming systems and/or increase water demand
- changes in seasonal availability of fruits may not match international demand
- increased risk of flooding increases erosion and loss of soil nutrients
- increased heat puts stress on crops and animals during hot summers.

Adaptation can reduce risks and increase opportunities, but will in itself incur costs. The most relevant issues are costs related to changing production, processing and transport centres, changes in land use to suit new crops, forced retirement of land that is becoming uneconomical with irrigation requirements, and social and cultural issues arising from changing production patterns and increased competition for water.

The costs and benefits of climate change impacts, and costs and social-adjustment issues of adaptation, are insufficiently quantified to allow reliable economic estimates.

The possible impacts of climate change on agriculture raise two policy-relevant issues:

- are there opportunities to combine information about climate change impacts and adaptation options with the need to get greater engagement at the farm level about mitigation options and needs?
- if climate change impacts impose costs or produce benefits for the agricultural sector, should these costs and/or benefits be considered in decisions about overall price measures related to greenhouse gas emissions?

Farmers are increasingly aware of the possible impacts of climate change and the need to adapt their activities to such changes. A series of workshops and case studies at farm level has caused significant engagement by some leading farmers, especially in dry eastern regions, where changes in water availability and pasture composition could pose significant risks over the coming decades (Kenny, 2005).

This bottom-up mechanism for engagement on adaptation has been highly productive and has contrasted strongly to the top-down engagement on mitigation. Further climate change discussions aimed at engaging the grass-roots level of farmers should include a similar bottom-up approach; tapping into the local knowledge and interests of farmers encourages them to consider climate change from a farm resilience and sustainability perspective.

4.7.8 Conclusions and recommendations

Key decisions

Based on this review, the Government will need to make three inter-related key decisions to guide further policy development:

- does the Government want to move towards price or regulatory measures for agricultural greenhouse gas emissions?
- **[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]**
- does the Government want to reconsider the extent of current agriculture mitigation research, extension, inventory methodology development and maintenance of scientific capacity optimal?

Move towards price-based or regulatory measures

The review suggests that a sector-wide price measure during CP1 would be feasible but not fully efficient – it would have to rely largely on proxies for emissions at the farm level. The use of proxies would tend to reduce sector output and change land use to lower-emission regimes, rather than make the production system more efficient. In addition, estimates of the economic impacts of a price measure on the sector and its likely structural responses are still subject to considerable uncertainties.

If the Government wishes to explore possibilities for moving towards sector-wide price signals that encourage mitigation, the following actions are recommended:

- developing a more realistic understanding of the economic impact and likely mitigation responses, and/or structural adjustment, of the sector, sub-sectors and regions to different price signals
- testing the long-term practical and environmental sustainability of mitigation technologies, and acceptance by international customers of agricultural products

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- developing and deploying monitoring and reporting tools that provide accurate, practical and cost-effective estimates of on-farm greenhouse gas emissions, including technological or farm management mitigation actions

- developing methods and data systems to reflect mitigation actions at farm level in the national greenhouse gas inventory consistent with UNFCCC good-practice requirements.

There are alternatives that could avoid some of the shortcomings of sector-wide emissions taxes. Some of these would allow the Government to send an early signal of its longer-term intention to move towards a sector-wide price measure in agriculture.

The main alternatives to a sector-wide price measure are:

- a tax on nitrous oxide emissions associated with the use of nitrogen fertilisers

- regulation of total nitrogen loadings in catchments

- direct financial support for the uptake of low-cost mitigation technologies.

The only price measures that appear feasible, practical and effective in providing full abatement incentives during CP1 are a tax on nitrogen fertilisers, and/or direct financial support for the uptake of mitigation technologies that are below the international price of carbon. The nitrogen tax would cover only 7% of emissions and the net effect on total emissions is uncertain. These partial options have specific risks and benefits that need further analysis; the Government will have to decide whether it wants to investigate these options further.

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Research, farm extension, and voluntary approaches

Research into mitigation options, farm extension, and inventory development must continue to underpin climate change policies for agriculture to increase cost-effective and practical mitigation options.

The review suggests that current research and extension arrangements should be reconsidered in terms of total funding levels, coverage of research and sharing of responsibilities between industry and the Government. It would be desirable to assess the current research responsibilities and efforts between industry and government for any critical gaps between mitigation research, the need to develop the national greenhouse gas inventory, and the development, extension and dissemination of mitigation, monitoring and reporting tools at farm level.

This review cannot suggest a robust figure for overall research funding requirements. Decisions about price measures and expectations about future obligations and emission targets will influence the amount of research effort required. Development of the national inventory for capturing any mitigation actions taken at the farm level will be of high priority, regardless of other policy settings, and this is likely to remain the Government's responsibility.

Decisions about the overall agricultural research strategy and outcome expectations will help determine optimal funding levels and the possible sharing of responsibilities between the Government and industry, and ensure no critical gaps in overall efforts jeopardise the national interest.

Synergies and trade-offs between policy elements

These decisions and their mode of implementation are not independent from each other. The following links appear critical:

- moving towards price signals could erode the current joint approach to mitigation research, as well as other voluntary approaches by the industry to environmental management and voluntary reporting of information. Early engagement with the sector would be critical to manage these risks

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- the current lack of a price measure limits incentives for developing and disseminating farm-level greenhouse gas monitoring and reporting tools, and for fully exploring innovative management options aimed at minimising the economic impact of an emissions tax. The lack of knowledge about mitigation options and the aggregate impacts of a price measure on the sector in turn make decisions about the future implementation of an effective price measure difficult. The development and deployment of mitigation tools, case studies, and emissions reporting tools must be undertaken well before any price measure is considered.

Farmers tend to consider the entirety of their farm operations and respond better to policies that allow them to use their own expertise, local knowledge and innovation. A package approach that considers the overall sustainability of farm operations in a context of climate change impacts, environmental externalities (arising from greenhouse gas emissions and nitrate leaching), and overseas market access and branding issues may be received better at the farm level than policies that focus on mitigation only. Emissions monitoring and reporting tools are more likely to be accepted if they can act as practical indicators for farm performance and efficiency, rather than if they only provide estimates of greenhouse gas emissions.

Links of agriculture with other land uses, particularly forestry

Agriculture is only one of a range of possible land uses. Since the total amount of land available is limited, changing incentives for other land uses will have an indirect effect on land area and total stock numbers in agriculture; this will impact on agricultural greenhouse gas emissions. The key linkages are:

- any price incentives for forestry, in recognition of their role as carbon sinks, would reduce the relative value of land for agricultural purposes. The effect of carbon-sink incentives on overall emissions will be greater than the amount of carbon stored in newly planted trees since it will also, to some extent, replace some agricultural activity

- other restrictions on land uses and land-use changes under the RMA can also influence agricultural activities. While it is not generally cost-effective to use such regulations specifically to control greenhouse gas emissions, where such regulations are undertaken for other purposes, they would also affect emission trends.

Most farmers take a whole-farm perspective on their operations and do not distinguish between forestry and agricultural activities. A sector-wide price measure on agricultural emissions would receive greater support if it allowed offsets of agricultural emissions through the planting of trees. Such a scheme would raise a wide number of issues regarding monitoring, verification, and liabilities associated with carbon sinks,

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some of which are discussed in Section 4.6. It is recommended that options for farm-level offsets be considered only if a decision in principle is made to explore sector-wide price measures for agricultural emissions.

The interaction between policies that affect agriculture and forestry is also of relevance to equity considerations for Māori. Māori have a relatively higher stake in forestry than in dairying, and would therefore be affected differently by a policy approach that provides no price signal on agricultural emissions.

4.8 Moving towards a purchasing strategy

Summary

This section explores issues the Government would need to consider in developing a purchasing strategy in the context of our net deficit for CP1 and the limited scope for domestic mitigation to close this gap.
It concludes that:

- New Zealand's purchasing strategy will be determined by a range of factors, including consideration of the most appropriate objectives, and issues of managing risk, timing and price
- although there is considerable uncertainty about future supply and demand in the international carbon market, it is very possible that the price of carbon will rise in the future and that there will be considerable volatility in the market
- to position New Zealand as well as possible to purchase units in the international carbon market, early work on determining our most appropriate purchasing strategy would be extremely useful and valuable.

Recent projections suggest that under current policies, New Zealand is likely to face a significant net deficit under the Protocol for CP1. The limited scope for further domestic mitigation to close this gap without unduly impacting on the Government's other objectives, including growth, mean that it is sensible to consider the option of purchasing emissions units as part of any overall strategy to meet our Kyoto obligations.

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Were the Government at some later stage to move to put in place an emissions trading scheme (see Section 4.2.4) an option under this would be for firms to meet their obligations through the international purchase of units.[132] As this option is not being recommended during CP1, purchases by individual firms are not considered further in this section, although many of the issues raised below would remain relevant.[133] This

[132] For example, under the European Emissions Trading Scheme, private entities can directly purchase via CDM or JI units to meet their obligations.

[133] Depending on the future evolution of any carbon tax, one could consider allowing firms to offset their tax obligations by purchasing units internationally and then surrendering them to the Government.

section therefore explores issues the Government would need to consider in developing a purchasing strategy.

The flexibility mechanisms

The Kyoto Protocol established a number of flexibility mechanisms that allow Annex I Parties to purchase emissions units from other countries as part of a strategy for meeting their obligations under the Protocol.

These flexibility mechanisms arose from recognition that the cost of reducing greenhouse gases was likely to vary across countries, with different countries facing a different range of options depending on the particular structure of their economy, level of development and the technology in place. The flexibility mechanisms potentially allow the least-cost mitigation options to be taken up at a global scale, reducing the cost of achieving climate change goals.

There are four mechanisms for purchasing emissions units provided under the Kyoto Protocol:

- International Emissions Trading (IET) – the trade of allowable emissions units, or assigned-amounts units between countries. Where emissions from an Annex I country fall below its assigned level – ie, it has a Kyoto surplus – it may sell the excess units

- Clean Development Mechanism (CDM) – purchase of projects-based units from a Non-Annex I country

- Joint Implementation (JI) – purchase of projects-based units from an Annex I country. Generally, the supply of these units is associated with economies in transition. There are two forms of JI – Track I and Track II – distinguished by the nature of their particular arrangements for project approval

- Removal Units (RMU) – these are issued on the basis of LULUCF activities.

Both the CDM and JI are mechanisms that involve generating emissions reductions as a result of investment in actual projects.[134]

4.8.1 Possible objective guiding a purchasing strategy

There are a variety of objectives that might underpin a purchasing strategy. The particular objective(s) chosen will affect the range of purchase options available, the cost of purchasing units, and the most sensible purchase method. Possible objectives (these are not all mutually exclusive) include:

[134] The basic accounting units implicit within the Kyoto Protocol are assigned-amount units (AAUs); removal units (RMUs), which are associated with forest sinks; emission-reduction units (ERUs), which are associated with Track II JI projects; and certified emissions reductions (CERs), which are associated with CDM projects.

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- purchasing units at the **lowest possible cost** in order to meet New Zealand's specific obligations under Kyoto. This implies no preference between the different types of units available under the Kyoto mechanism or as to which countries/companies/projects they are secured from. In purchasing, the key decision criterion would be price, with the consideration of the quality of units limited to issues of delivery risk

- purchasing units in a way that the Government can have confidence that the purchase will **credibly contribute to the reduction in global greenhouse gas emissions**. The use of the international emissions trading mechanism may or may not be consistent with this particular objective. Precisely which units are bought, and from whom, will influence whether this objective is met. The surplus of units that a number of countries are expected to hold in CP1 arose as a result of the emission targets secured in the international negotiation process. A number of countries have, to date, signalled that they will not purchase these units or that they will only undertake purchases where revenues generated are invested in projects that will reduce emissions – so-called green investment schemes

- **leveraging co-benefits** from purchase, either in terms of foreign relations objectives or New Zealand business development. For example, the use of CDM may complement New Zealand's aid strategy, say, by priority being given to purchases from particular countries. Selection criteria for projects under either CDM or JI might include consideration of participation by New Zealand firms in, say, project design or technology provision.

Generally, the more stringent the objectives chosen for a purchasing strategy, the less the available opportunities to purchase and the higher the likely price of units. On the other hand, a purchasing strategy that seeks, to some extent, to go beyond meeting the narrowly defined Kyoto obligation may enhance the public acceptability of purchasing units from overseas.

4.8.2 Factors impinging on the supply and demand for units

The Kyoto market for emission units is still emerging and reasonable uncertainty surrounds how it will evolve over the next few years. This has implications for the likely supply and demand of available units and, therefore, the likely cost of purchasing units. It can also be expected that the market will show some level of volatility. Contributing factors are outlined below:

- the buying and selling intentions of individual Annex I countries is still emerging. While a number of Annex I countries have already commenced a purchasing programme (eg, the Netherlands), as the commencement of CP1 approaches, others are evaluating their likely Kyoto position and purchase options. Canada and Japan have signalled an intention to purchase units and are expected to purchase large volumes. Individual member states of the European Union have indicated that they intend to purchase 500 million to 600 million tonnes of CO_2 credits for 2008 to 2012 collectively. Similarly, the extent to which Annex I countries with surplus emission units will seek to sell these in CP1 or "bank" them for future

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period(s) is unclear. A critical factor will be the assessment these countries make about the probability of a post-2012 international framework including binding targets and emissions trading. Further, the extent of any surplus held by these countries will depend, among other things, on the level of growth within these economies

- uncertainty surrounds whether certain Annex I countries will meet the requirements by 2007, particularly in relation to inventory reporting, and therefore be allowed to participate in emissions trading. Failure to satisfy these requirements would mean that these countries would be able to sell only via the project-based JI track II mechanism

- the efficiency of arrangements for the supervision of the CDM and JI mechanisms has implications for project supply and cost. Underpinning these mechanisms are governance arrangements designed to ensure that projects are "additional" in the sense that they will lead to a lower level of emissions than would have otherwise occurred, and that these reductions are accurately quantified, monitored and verified. It is expected that the supervisory arrangements for Track II JI projects will be finalised at the forthcoming Montreal meeting of parties to the Protocol. While the CDM arrangements have been in place for a number of years, approval of projects has to date been slow and some projects proponents have found it difficult to demonstrate "additionality". It is not clear whether this simply reflects start-up factors or will be an ongoing constraint. Standard methodologies are being developed to help streamline project approval. The efficiency of CDM processes has been identified as a key issue at Montreal.

4.8.3 Factors impinging on a purchasing strategy

The characteristics of the projects mechanisms – CDM and JI – have particular implications that need to be taken into account in considering a purchasing strategy:

- the approval processes associated with CDM and Track II JI processes give rise to specific transaction costs and are time consuming. In regard to CDM, depending on the specific nature of the project, approval can currently take three to ten months (and potentially longer for less conventional projects). The costs associated with project design, validation and verification to meet approval requirements is also significant. In regard to CDM, Det Norske estimate total costs as €275,000 for normal projects and €117,000 for small projects[135] (other estimates of this are lower)

- the lead time associated with development and construction. For example, the typical lead time for small-scale renewable-energy projects, energy-efficiency projects and waste-to-energy projects is two years. Large hydro and geothermal projects and fuel switching can take up to five years

[135] Source – Presentation to climate change officials. Small-scale projects are defined in three different ways: renewable energy projected with a maximum installed capacity of 15MW, energy-efficiency projects that generate 15Gwh/yr or less, and projects that emit no more than 1,500 tonnes of CO_2e.

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- the need to manage specific country and project risks, with this reflected in specific contractual provisions between the seller and purchaser.

More generally, these factors highlight that emissions units (including those that are not project-based) are not a homogeneous commodity and prices will vary depending on the particular characteristics of the unit in terms of quality, risk and timing. In this sense, it is a misnomer to think in terms of a single international price of units, or that there is an "international carbon market".[136]

An additional factor that will affect New Zealand's purchasing strategy is the uncertainty around how many units New Zealand will need to purchase. There is considerable variability around the most likely scenario in our recently calculated net-emissions position. New Zealand's actual net emissions position for CP1 will not become clear until well into (or even after) the commitment period. This implies that New Zealand may need to stagger its purchases of units over time somewhat.

4.8.4 Purchasing options

There is a variety of options for the Government to purchase emission units:

- the Government could establish its own carbon purchasing programme. This would involve it going into the market and purchasing units. Units purchased could be AAUs, CERs, ERUs or RMUs[137]

- the Government could outsource the purchase of emission units to the private sector

- the Government could buy into an existing fund such as that run by the World Bank.

Much more detailed assessment would be required about the appropriate balance between these arrangements, in light of the specific objectives of a purchasing strategy agreed by the Government and issues of managing risk, timing and price.

4.8.5 The price of carbon

A key issue that is related to a buying strategy is price. As noted in this section, the more stringent the objectives chosen for a purchasing strategy, the less the available opportunities to purchase, and the higher the likely price of units. The objectives chosen, however, will not be the only determinant of price.

It is not easy to predict future trends in prices for emission units or, more accurately, international carbon prices. There are significant uncertainties about both the demand for, and the supply of, Kyoto-compliant units.

This said, there must be a reasonable chance that the price of carbon will rise in the near future. There is a large possible demand for units, and if major potential buyers

[136] For sake of convenience, the term "international carbon market" is used throughout this report.

[137] There are various sources of units. For example, the Government could seek to purchase JI or CDM units, or could seek to purchase units allocated to companies under the Projects to Reduce Emissions initiative.

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such as Canada and Japan enter the market, it is very possible that prices of Kyoto-compliant emission instruments (AAUs, CERs, ERUs and RMUs) will increase, perhaps significantly. It is also possible that there will be significant volatility in prices for emission instruments in the future, given the unstable state of these markets (given these factors, hedging and forward-contracting may well be critical to New Zealand's success in the market).

In addition to New Zealand's objectives in the area, and supply and demand in the market, the other determinant of price relates to risk profiles. There are risks associated with projects, ranging from contract risks and project risks to country risks. Depending on whether the associated risks are borne by the buyer or the seller, different price premiums are to be expected.[138]

4.8.6 Conclusions

The variety of issues that surround the development of an appropriate and effective purchasing strategy highlight the need for the Government to immediately put in place a work programme, if the option of purchasing units to meet some of our CP1 obligation is to be kept. Early commencement of this work would allow the greatest scope to develop a strategy that met purchasing objectives while managing fiscal risk. Given the considerable uncertainty that surrounds the future price of emission units, it would be sensible to be in a position to purchase at least some units during 2006.

It is therefore recommended that work commence as soon as practicably possible on determining potential buying strategies for New Zealand that reflect New Zealand's objectives in this area and our risk profile, along with issues of management, timing and price. Especially if international carbon markets prove to be volatile in the future, early agreement of a buying strategy may prove to be extremely useful and valuable.

4.9 Alternative approaches to meeting New Zealand's commitments in CP1

Summary

This section discusses the results of economic modelling undertaken to help determine the economic effects of New Zealand using the Kyoto flexible mechanisms to meet its Kyoto shortfall, and of including or excluding agriculture in the coverage of a domestic price-based measure.

It concludes that:

- it is cheaper and more efficient to meet at least some of our target through

[138] In a recent survey of potential CDM market players, 82% of Japanese respondents believed that differences in the "quality" of CERs would result in price differences. The same work suggested that respondents are most concerned about the risk that the units would eventually not be acceptable under the CDM. Contract risks, such as the sellers' credibility, also command a high premium. Asuka and Okimura, 2005.

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international emissions trading

- the more we seek to achieve emissions reductions via the imposition of a domestic carbon tax rather than international emissions trading, the more preferable it is to impose it on all sectors of the economy
- achieving domestic mitigation is likely to impact on some (more emissions-intensive) sectors more heavily than others.

4.9.1 Introduction

As part of the background work to the Review of Climate Change Policies, modelling on the economic impacts of different strategies for emission abatement in CP1 has been undertaken.

The modelling was undertaken by ABARE. ABARE is an Australian government economic research agency and has been involved in modelling climate change policy since 1993 (see the Annex for a description of the model). Previous ABARE analyses on the economic impacts of climate change policies are available on the Ministry for the Environment's website and ABARE (www.abareconomics.com).

The ABARE modelling is designed to help New Zealand answer the following questions:

- should New Zealand use flexibility mechanisms contained in the Kyoto Protocol, which include international emissions trading and the CDM, in meeting its CP1 commitment?
- from an economic viewpoint, should emissions from agricultural sources be subject to a carbon tax?

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4.9.2 Modelled scenarios of New Zealand greenhouse emissions paths

To help answer the first of the questions posed above, three emissions paths for New Zealand were developed: low, medium and high. These are similar, but not identical, to the optimistic, most likely, and pessimistic scenarios that were developed when New Zealand's net emissions position was calculated in May 2005.[139] All of these scenarios model emission levels and prices in 2010, and draw results for CP1 from the 2010 year as representative of average conditions of the 2008 to 2012 period.

For each of the emissions path scenarios, effects on the New Zealand economy have been estimated assuming that New Zealand meets its CP1 commitment through a combination of domestic abatement and purchasing units using the Kyoto flexibility mechanisms. To contrast with these results, the effects on the New Zealand economy

[139] The low emissions path specified in the ABARE modelling has net emissions in 2010 slightly lower than our CP1 target would imply.

if New Zealand meets its CP1 commitments solely through domestic emissions reductions have also been estimated.

The estimated level of domestic abatement flows from the carbon price implicit in the model – where it is assessed to be cheaper to reduce emissions than pay the carbon price, then domestic emissions reductions occur. The scenarios outlined in Table 26 below assume that all sectors of the New Zealand economy are included, with no NGAs.

Where it is assumed that New Zealand meets all its required emissions reductions domestically, the carbon price in the economy rises until the required level of domestic abatement is attained. In cases where New Zealand meets its Kyoto obligations by a mix of purchasing international units and domestic abatement, in effect, the model estimates the international carbon price and imposes this international carbon price on the domestic economy.

4.9.3 Key results from the ABARE model runs

Key results from the ABARE modelling are shown below.[140]

Table 26 - Results as at 2010 – Effects on the New Zealand Economy

Emission Path	Low emissions path		Medium emissions path		High emissions path	
Internationally linked or domestic abatement only	Int. link	Dom. only	Int. link	Dom. only	Int. link	Dom. Only
Scenario	1	2	3	4	5	6
Abatement or purchase of units required to meet Kyoto commitment (Mt)	-1.1	-1.1	8.0	8.0	18.9	18.9
Abatement undertaken domestically (Mt)	4.8	0	5.1	8.0	5.5	18.9
Units purchased internationally (Mt)	-5.9	0	2.9	0	13.5	0
Effect on GDP of abatement	-0.02%	0.00%	-0.02%	-0.05%	-0.03%	-0.24%
Carbon price in 2010 ($/t CO_2e)	10	10	10	18	10	51

Source: ABARE

The interpretation of these results is not entirely obvious. To assist the reader, the figures from scenario 3 are explained below.

140 There are some rounding errors in the results presented.

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Scenario 3 relates to a medium emissions path in which New Zealand meets its Kyoto commitments through a combination of international trading and domestic abatement measures. Under this scenario:

- the difference between our net emissions and our Kyoto target is 8.0Mt CO_2e in 2010. In order to meet our Kyoto commitment, New Zealand must either purchase units internationally or reduce its emissions domestically, or a combination of the two
- according to the model results, this amount would be met through domestic abatement, in response to a carbon price in the economy, to the tune of 5.1Mt CO_2e in 2010, and the Crown purchasing units internationally relating to 2.9Mt CO_2e in 2010
- the cost of meeting our Kyoto commitments (due to the combination of purchasing units internationally and abating domestic emissions) are estimated by the model to be 0.02% of GDP in 2010
- the international carbon price as predicted by the model, and assumed to be implemented in the New Zealand economy, is $10 per tonne of CO_2e in 2010.

Modelling results pertaining to agriculture

Separate modelling was undertaken to estimate the effects of including or excluding agriculture from New Zealand's domestic policies.[141] This involved running two different comparisons for the inclusion or otherwise of agriculture. All of the scenarios presented use the medium emissions path described above. The results presented also include modelled effects on output levels for some sectors of the economy.

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[141] In the scenarios where agriculture was excluded from the carbon price, it was assumed that agriculture would continue to face the carbon price embedded in inputs such as fuel.

Table 27 - Results Pertaining to Agriculture

	Domestic abatement only		Internationally linked	
	Ag. included	Ag. excluded	Ag. included	Ag. excluded
Scenario presented	A	B	C	D
Required abatement	8.0	8.0	8.0	8.0
Abatement undertaken	8.0	8.0	6.4	2.6
Purchases internationally	0.0	0.0	1.6	5.4
GDP effect	-0.05%	-0.19%	-0.04%	-0.04%
Carbon price	18	67	13	13
Sectoral impacts – Change in outputs relative to 2010				
Dairy	-4.3%	-0.8%	-2.9%	0.0%
Meat	-2.4%	0.7%	-2.0%	0.2%
Electricity	-0.9%	-2.9%	-0.6%	-0.9%
Iron and steel	-4.5%	-18.4%	-2.9%	-4.4%
Primary aluminium	-6.2%	-21.9%	-4.3%	-4.3%
Services	0.2%	0.3%	0.2%	0.0%

Source: ABARE

Scenarios A and B compare the effects of including or excluding agriculture from domestic policy settings assuming that New Zealand meets its Kyoto commitments through domestic abatement measures only. In contrast, scenarios C and D compare the effect of including or excluding agriculture from domestic policy settings assuming that New Zealand meets its Kyoto commitments (at least partially) through purchasing Kyoto units internationally.[142]

The key result from this modelling is that the cost of New Zealand meeting its Kyoto commitment (in terms of effect on GDP) is likely to be less if agriculture is faced with a carbon price, as opposed to agriculture being excluded from a carbon price, in the case that New Zealand seeks to meet its Kyoto commitments through domestic abatement only. If New Zealand is linked to international carbon markets, the model suggests there is no difference (in terms of effects on GDP) whether it includes or excludes agriculture from its domestic policy settings.

Implications for other sectors of the economy

[142] Scenario A from Table 2 is the same as scenario 4 from Table 1. Scenario C from Table 2 is similar, but not identical, to scenario 3 from Table 1. The key point is that the comparisons between scenarios A and B, and between scenarios C and D, are both valid.

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The model generally indicates that emissions-intensive sectors (such as iron, steel and aluminium production and, if included, agriculture) would be significantly more negatively affected than low-emissions sectors such as general services.

If agricultural non-CO_2 emissions are included in a carbon charge, the model estimates that the impact on agricultural production would be broadly comparable with the impacts of the same carbon charge on iron, steel and primary aluminium production.

If agricultural non-CO_2 emissions are excluded from a carbon charge, the impacts on agricultural outputs are reduced significantly. The effect on other sectors of excluding agriculture depends on whether New Zealand meets its obligations entirely by domestic actions or uses international emissions trading. With international emissions trading, the impact on other sectors is modelled to be relatively small. However, if New Zealand relies entirely on domestic abatement, excluding agriculture from a price measure would require a significantly higher domestic carbon charge for CO_2-emitting sectors. In this case, the model estimates significantly larger economic impacts on emission-intensive sectors such as iron, steel and aluminium production.

4.9.4 Discussion of the modelling results

The modelling results are broadly comparable with those from earlier model runs previously provided by ABARE (ABARE undertook a major tranche of work in 2001 on this topic), in that they anticipate a negative impact on economic growth from domestic emissions abatement, via the exposure to price on carbon (dollars per tonne of CO_2e).

There is a variety of limitations in any modelling exercise such as this. These limitations are described below:

- the model assumes that structural adjustment within the economy is costless. That is, it assumes that resources from one sector (eg, aluminium smelting) can be entirely (and without cost) deployed to others (eg, services)
- the model assumes that the implicit structural adjustment takes place in a steady manner. In reality, this is unlikely to be the case, and it is likely to take some years for the economy to fully adjust to the structural changes implied. It is not possible to estimate with any certainty the timing of such adjustment
- there is no account in the model for the costs of measuring emissions, or account taken of associated difficulties and inaccuracies in implementing the carbon price in the economy. In reality, there are costs of measuring emissions. Furthermore, and possibly more importantly, there are difficulties associated with measuring emissions accurately and at a point of obligation that enhances effective decision-making from a carbon-mitigation viewpoint (especially in agriculture)
- the model also assumes that decision-makers have access to, and will use, perfect information about costs and abatement opportunities, and will make decisions that will minimise their costs in the long term without constraints due to short-term transition costs

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- offsetting these factors to some extent, the model excludes the effects of non-price and supporting policies designed to offset the costs to the economy of undertaking abatement. It also does not anticipate new patterns of industry behaviour or technological improvements beyond those currently available.[143] Furthermore, ABARE does not model the effects of new forestry plantings in generating new sink credits (any effect would, of course, be dependent on domestic policy settings vis-à-vis forestry).

The first two of these reasons are thought to be particularly significant. In reality, there is a cost to structural adjustment (at the minimum), and there are some resources that are unlikely to be able to be allocated elsewhere in the economy in an economic manner.

In terms of timing, a review of the ABARE model stated that a "new long-run equilibrium industry configuration could take 10 to 20 years to complete, with many downside adjustments occurring faster than many upside adjustments".[144] Effectively, this means that the costs in 2010 may be greater than those outlined in the results presented. Having said this, the reviewer was careful to point out that there is no clear direction of bias caused by the range of issues that he identified with the ABARE model – in his view, the ABARE model "is appropriate for a long-run analysis of the issues at hand".

4.9.5 Conclusions

Broad conclusions that follow from the model's results are:

- if we seek to meet our Kyoto obligations entirely through domestic abatement, the cost to the economy will be substantially higher than if we purchase units on the international market. That is, the domestic carbon price required to achieve sufficient mitigation is much higher than the prevailing international carbon price. This suggests that it is cheaper and more efficient to meet at least some of our target through international emissions trading
- if we seek to achieve emissions reductions by imposing a domestic carbon tax, it is preferable to have a broad-based tax that includes all sectors of the economy. The model's results suggest that excluding agriculture, for instance, increases the costs imposed on the remaining sectors of the economy (while agriculture is itself advantaged). The difference between including or excluding agriculture is significant if New Zealand wishes to meet all its obligations through domestic abatement, although the model does not suggest there is a difference if New Zealand uses international emissions trading
- achieving domestic mitigation (whether it be through trading or a domestic carbon tax) is likely to impact more heavily on some (more emissions-intensive) sectors

[143] Technological change is incorporated to the extent that existing technologies become cost-effective (and hence deployed) at particular carbon prices.

[144] In his 2002 review of ABARE and NZIER modelling to analyse the effects of the Kyoto Protocol on New Zealand, Grimes noted that although there is no clear direction of bias caused by this range of issues, these timing effects could mean that the present value of the costs of adjustment could well exceed those documented by ABARE.

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than on others. The impact flows through into exports, hence affecting our terms of trade. However, excluding particular sectors has risks, as outlined above.

There are other relevant factors that a modelling exercise of this nature does not take into account. These relate to social and redistributive effects, and also to the extent that decisions implicitly influence New Zealand's emissions position post-2012.

The ABARE modelling does not attempt to model the transitional effects of any policy such as "temporary" unemployment. The model assumes that prices adjust to ensure full employment of resources; in practice, this is not often the case, particularly for the low-skilled elements of the workforce or where there is little regional mobility. As such, even if the economy did adjust in time to a new equilibrium, there is no measure of any social or redistributive effects implicit in this adjustment.

In terms of New Zealand's emission position post-2012, the decision on how much, if any, of its emissions deficit New Zealand chooses to abate domestically will influence its emissions position in 2012 and post-2012 and potentially, therefore, the ability and cost of meeting any future obligations that it may accept. Although this is self-explanatory, it is a relevant factor in determining the extent to which New Zealand should meet its Kyoto commitments by purchasing units internationally.

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5 New Zealand's strategic climate change goal

5.1 Towards a downwards carbon path?

In 2002, the Government adopted a strategic climate change goal for New Zealand as follows:

> "To enable New Zealand to make significant greenhouse gas reductions on business-as-usual and be set towards a permanent downward path for total gross emissions by 2012."

Cabinet was advised that the Government would be seeking the following outcomes for New Zealand by 2012 if the goal was to be met:

- New Zealand will be on a path to reshaping its energy use
- there will be an increased rate of technology uptake on renewables, energy efficiency, and lower emissions production
- all sectors will be addressing emissions and positioning themselves greenhouse-wise on world markets
- research findings will have been transferred to agricultural practice
- new buildings, dwellings, plant, vehicles and machinery will be at the optimal edge of efficiency
- there will be a population knowledgeable about greenhouse gases and taking responsibility for them.

It is arguable whether all of these outcomes are likely to be achievable by 2012 on current policy settings. Some of them are subjective (a and b), although others involve commitments that are less ambiguous (c and e). More importantly, projected greenhouse emissions trends indicate a continuous "upwards" rather than a "downwards" path by 2012 (see Figure 42 below).

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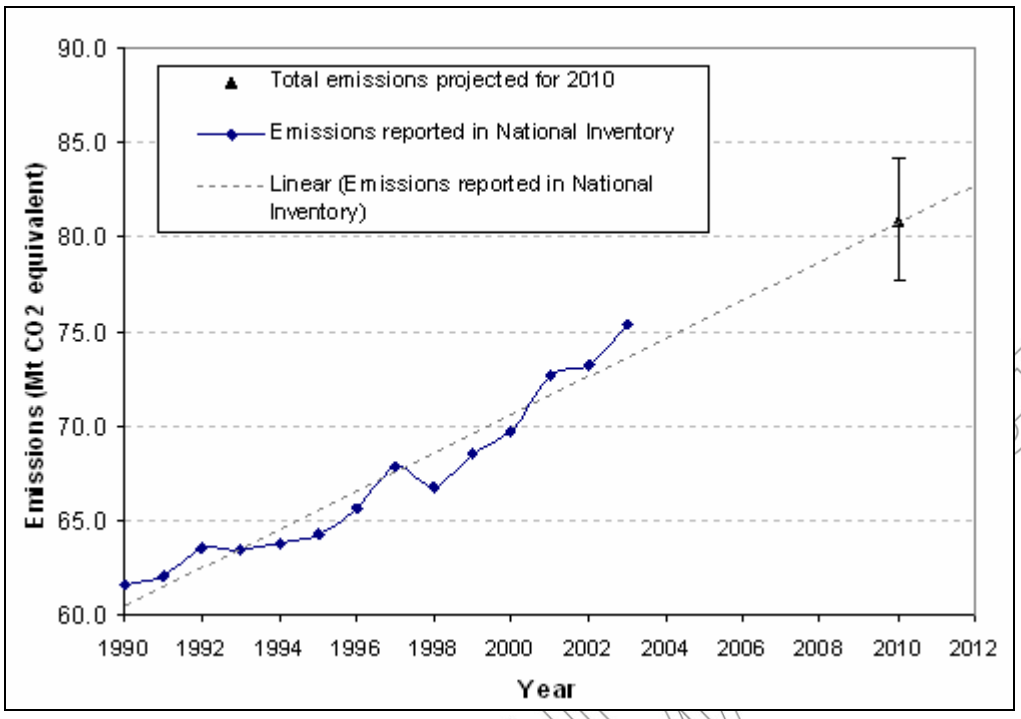
Figure 42 - Projected Emissions for 2010, Total Emissions Reported in the National Inventory from 1990-2003 and a Linear Extrapolation of Previous Emissions



Source: Ministry for the Environment

The review has identified a limited number of further greenhouse mitigation options that the Government can consider. These include specific sectoral measures (eg, in transport) and the application of price-based measures (carbon taxes and emissions trading). However, in the absence of imposing a carbon price at a level that will have stringent growth and welfare trade-offs, the available additional measures to 2012 would only allow New Zealand to change the trajectory of the "upwards carbon path". They would not credibly position New Zealand to move towards a "downward carbon path". Of course, whether or not New Zealand is, at any point in time, "set towards" a downward carbon path will always be open to debate. As it is a subjective goal, it will always be **possible** for the Government to maintain that satisfactory progress is being made in its achievement. However, the more important question is whether the goal is credible, and useful as a guide to policy choice.

5.2 Choosing strategic climate change objectives

The Government may wish to consider whether it wishes to replace the current strategic goal with multiple objectives that it can use to guide its choice of climate change policies.

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The timeframes that are attached to any new objectives may be important. At this time, it is arguably unproductive (for the reasons outlined above) to establish a revised climate change goal that incorporates either a quantitative, or even a qualitative, "downwards emissions path" or "target". The review has provided the Government with broad alternative options to meet New Zealand's Kyoto obligations in the period 2008 to 2012. These options include some further domestic mitigation action and utilising the Kyoto flexible mechanisms to acquire Kyoto units. Meeting New Zealand's current Kyoto commitments is a manageable task for New Zealand. Importantly, the Government still has choices about how it meets these commitments. However, the point remains that none of the short-term options that the review presents will position New Zealand towards a downwards carbon path by 2012.

While a quantitative goal may not be helpful in guiding policy choice in the next five to seven years, that may not hold in the period beyond the next 15 to 20 years. Over a longer time period, technological change – eg, in agriculture – may allow New Zealand to pursue polices that do deliver an emissions profile that does take the country towards a "downward carbon path".

5.3 Considerations in developing a goal

5.3.1 Key considerations

The following considerations are pertinent to consideration of an appropriate goal that might provide guidance for the development of climate change policy:

- **New Zealand is dependent on effective global action if it is to manage the risks of climate change.** New Zealand's emissions amount to only about 0.24% of global greenhouse gas emissions, reflecting our small population base. This means that any actions taken by New Zealand to reduce its own greenhouse gas emissions will not significantly influence the amount of global climate change[145]
- **it is desirable that New Zealand engages internationally to seek to secure effective global action.** To be credible in this process, New Zealand, as a developed country, needs to itself take action that seeks to contribute to reducing global emission levels, either through domestic mitigation or assisting the reduction in emissions in other countries through using the Kyoto flexible mechanisms and international emissions trading. Judgement of what constitutes an appropriate level of New Zealand commitment needs to take account of the fact that, in practice, New Zealand has limited ability to influence other countries. There is little that New Zealand can do to persuade major emitters like the United States, Australia, China and India to agree to limit or significantly reduce their emissions where they have formed a judgement that this is not in their national interest

[145] This situation is shared with a number of other industrialised countries that also have commitments under the Kyoto Protocol. Examples include Austria (0.23%), Finland, Denmark and Ireland (0.20%), Sweden (0.19%), and Switzerland and Norway (0.15%).

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- **it is desirable that New Zealand positions itself to promote its national interests in the design of international agreements to address climate change.** An important precondition for such successful positioning is that New Zealand maintains its credibility by demonstrating its intention to deliver on commitments it has adopted
- **there is no international agreement on how to deal with climate change post-2012.** The positions of key players are far apart and it is likely there will continue to be a period of uncertainty until the international community gets closer to some agreement on future action. The European Union continues to promote a policy target that would not allow the global temperature to increase more than 2ºC above pre-industrial levels. As a consequence, the European Union is promoting 15% to 30% emissions-reduction targets for Annex I countries by 2020 relative to 1990 baselines.

Clearly, if New Zealand agreed to adopt the emissions-reduction obligations to 2020 that are being promoted by the European Union, this would have major implications for the policies that New Zealand needs to consider **now**, and the type of strategic climate change goal that should be adopted. Section 6 provides detailed analysis of New Zealand's international engagement on climate change and a strategy for our participation in the Conference of the Parties (COP11) in Montreal in December 2005.

5.3.2 Considerations for New Zealand in post-2012 emissions targets

It is important that New Zealand's domestic policies align with whatever future international targets we agree to (if any). New Zealand's emissions-mitigation task for the 2008 to 2012 period remains manageable. The future decision for New Zealand, with higher domestic economic stakes, is what "carbon path" we may wish to adopt post-2012. If that path is ambitious, that would mean that early, more ambitious, mitigation action would be desirable. The problem facing the Government in that scenario - "move early to position for post-2012 targets" – is that the review has not identified any policies that would allow New Zealand to achieve the types of 2012 to 2020 emissions-reduction targets that are being advanced by the European Union. Such targets would be achievable by New Zealand only if one or more of the following conditions applied, and were acceptable to the Government:

- **significant reductions in economic growth are acceptable**, at least in the medium term while the economy undergoes structural change away from a large number of energy-intensive industries; or
- **[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]**
- **New Zealand is able to meet ambitious emissions-reduction targets, largely by paying for emissions reductions in other (probably developing countries) on a large scale**:

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- a 20% to 30% reduction in emissions from 1990 levels in 2012 to 2020 would require reductions in gross emissions from an annual projected level of around 80Mt CO_2e to around 50Mt (this is based on the 2010 business-as-usual projections, so is very conservative)

- if New Zealand were to "pay" for all of these reductions through facilitating emissions reductions in developing countries, at current carbon prices and exchange rates, the cost would be in the order of $250 million annually (or in the order of $2 billion over the period from the end of CP1 in 2012 to 2020).

5.3.3 Technology standards and production efficiencies

New Zealand is an importer of many technologies in the industrial, residential and commercial sectors, but also exports a range of products and expertise overseas. New Zealand products and services will therefore have to meet relevant international standards and expectations to be competitive, and to make efficient use of imported technology in domestic applications.

This need for alignment with international trends means that some international greenhouse gas and air pollutant emission, energy-efficiency and technology standards may become de facto standards in New Zealand.

5.3.4 Conclusion

The discussion above highlights just some of the possible international constraints on New Zealand's choices on greenhouse gas emissions paths over the next few decades.

None of these considerations is sufficient in itself to dictate any emissions pathway that New Zealand must follow. However, it will be important for the Government to avoid raising expectations internationally – through participation in negotiations – that it is willing to adopt carbon paths that are not consistent with the types of domestic policies that it finds acceptable. An alternative climate change goal could be established based around the principles of 'international engagement' and 'policy sustainability

An alternative climate change goal could be established based around the principles of "international engagement" and "policy sustainability".

If the current climate change strategic goal is unsustainable, the question is: What should replace it? The answer depends in part on how the Government makes choices across different dimensions of this review. These include:

- how New Zealand wishes to position itself in international negotiations on climate change policy over the medium term

- the time horizon that it considers important in evaluating policy options:

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- o is it important for New Zealand to adopt policies that will be sustainable over the next 15 years? or
- o are we simply concerned about meeting our current Kyoto commitments, and therefore are content to adopt a "wait and see" approach to future international commitments and the choice of policies?

A climate change goal should be a tool to help the Government choose between different domestic policies and international negotiation strategies. It is also important that there are realistic expectations of how long a climate change goal may remain relevant before it needs to be modified. Following this reasoning, the Government may wish to adopt a goal that guides New Zealand's actions only over the next few years. If it does emerge that an international consensus is reached on future action, and New Zealand has clear obligations in the period beyond 2012, the goal could be updated appropriately.

With such a strategy in mind, this could lead New Zealand to adopt a strategic Climate Change Goal with the following elements:

- **New Zealand will engage with the international community** on responses to climate change in an attempt to secure broad and balanced participation and action, in particular by all the world's major emitters, including developed and developing countries, to effectively manage the risks from human-induced climate change
- **New Zealand will adopt policy measures** to address greenhouse emissions that meet the following criteria:
  - o policy settings allow us to meet the international commitments we take on – eg, through a combination of achieving domestic abatement and international emissions trading
  - o policy settings are sustainable*, efficient and flexible*
  - o policy settings are *compatible with New Zealand objectives in relation to economic growth and social cohesion*
- **New Zealand manages the risks, opportunities and impacts** arising from the effects of climate change and ensures **adaptation** as smoothly as possible.

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6 International setting, New Zealand position and strategy for UNFCCC COP11

6.1 International setting

6.1.1 Introduction

There is a growing consensus within the international community, stemming from greater scientific evidence, that climate change poses significant global risks over the medium-to-long term and that further steps are needed to tackle the problem.

The UNFCCC continues to be endorsed as the primary forum for intergovernmental discussion on climate change. However, there is currently no agreement by parties to the UNFCCC to begin a process of considering future action beyond 2012. Climate change is increasingly coming up in other contexts and fora beyond the UNFCCC, complicating the international situation.

While the creation of the UNFCCC emerged from an international will to deal with a growing environmental problem, national economic interests (both short and long term) are now firmly in the mix when countries weigh up what action they are prepared to take on climate change. (Increasingly, there is a development dimension as well.) Competitiveness issues are important: while these were partially addressed through Kyoto – in that the Protocol envisaged all developed countries, but not developing countries, would take on binding targets – with the United States and Australia deciding against ratification, the playing field has become skewed.

6.1.2 Summary of key player positions

There is no international agreement on how to deal with climate change post-2012. The positions of key players are far apart.

United States

United States climate change policy has three basic components:

- slowing the growth of greenhouse gas emissions (through cutting greenhouse gas intensity by 18% by 2012)
- laying the groundwork for current and future action through major investments in science and technology, and institutions (in the 2005 fiscal year, approximately $US5 billion was allocated to the United States Climate Change Science Program and the Climate Change Technology Program)

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- promoting international cooperation (such as the plurilateral Asia-Pacific Partnership on Clean Development and Climate, and bilateral partnerships, of which it has 14, including with New Zealand).

The United States is not willing to accept limits on emissions that might restrict economic growth – witness its decision in 2001 not to ratify Kyoto -

[withheld under OIA s6(a), s6(b)(i)]

[withheld under OIA s6(a), s9(2)(g)(i)]

[withheld under OIA s6(a), s9(2)(g)(i)]

Current United States policy is to re-examine this position in 2012 (when the President's plan to address climate change will be reviewed).

[withheld under OIA s6(a), s9(2)(g)(i)]

Australia

[withheld under OIA s6(a), s6(b), s9(2)(g)(i)]

Australia insists that negotiations should be broad-based, including major emitters, so as to ensure environmental effectiveness and economic fairness.

[withheld under OIA s6(a), s6(b), s9(2)(g)(i)]

Australia is one of the founding members of the Asia-Pacific Partnership on Clean Development and Climate (along with the United States, China, India, South Korea and Japan), indicating a willingness to pursue plurilateral pathways. It also has (five) bilateral climate change partnerships, including with New Zealand, and is a member of several technology partnerships.

European Union

The European Union continues to promote a multilateral process with ambitious targets for Annex I Parties. In March, a European Council decision confirmed a policy target to not allow the global temperature to increase more than 2ºC above pre-industrial levels, and endorsed earlier calls from European environment ministers that Annex I Parties should consider 15% to 30% emissions-reduction targets by 2020 relative to 1990 baselines.

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[withheld under OIA s6(a), s9(2)(g)(i)]

The United Kingdom will hold the presidency of the European Union at UNFCCC Montreal. Climate change has been one of the key priority areas for the presidency, driven by Prime Minister Blair, including at the G8 Gleneagles Summit in July. Following comments made by Blair in September, the media have raised questions about the United Kingdom's commitment to Kyoto; United Kingdom officials have since sought to clarify that the United Kingdom position remains unchanged and that Blair's comments do not signal a move away from support of the Protocol.

Non-EU Annex I countries: Canada, Japan, Norway

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Canada, Japan and Norway have been supportive of starting international discussions on future action under the UNFCCC.

[withheld under OIA s6(a), s9(2)(g)(i)]

Japan is the only Kyoto Annex I Party in the new Asia-Pacific Partnership for Clean Development and Climate.

Major developing countries

Part of the challenge of engaging all major emitters in a future international regime to address climate change is securing action from developing-country parties. Major developing countries (China, India, Brazil) continue to state that they cannot restrict economic growth by restricting emissions.

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[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

Pacific Island countries

Climate change is an issue of high importance for the Pacific, and a large number of individual Pacific Island countries are involved in the UNFCCC process. Working as part of the Alliance of Small Island States (AOSIS), these countries carry the weight of moral authority in the multilateral process in calling for further action to address climate change. Many are on the front line of impacts, whereas their contribution to the problem is negligible. As well as providing a voice of support to Pacific Island country concerns, New Zealand made a voluntary commitment in 2001 of $NZ5 million (to come on stream in 2005) to support developing countries, including funding provided through NZAID, the Global Environment Facility and support to multilateral climate change funds.

Tuvalu has, to date, been the most outspoken of the Pacific Island countries, often as a lead voice for AOSIS, but Papua New Guinea and Samoa have increased their profile in recent meetings. Papua New Guinea has led the formation of a Rainforest Coalition to "reconcile forest stewardship with economic development", to lobby for developing countries to be allowed to trade in carbon credits in return for conservation of rainforests. This issue will be on the agenda for COP11 in Montreal; Papua New Guinea also raised the issue at the 36th Pacific Island Forum leaders' meeting.

6.1.3 Possible approaches to international action

With a divergence of views among major players, it is likely that there will continue to be a period of uncertainty until the international community gets closer to some agreement on future action. For the moment, there are a number of different approaches, formal and informal, under discussion or under way. A multi-track approach, with different elements being pursued by ad hoc groupings and at different speeds, may be a way forward. At this stage, it may be possible to identify some of these tracks.

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[withheld under OIA s6(a), s6(b)(i), s9(2)(j)]

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[withheld under OIA s6(a), s6(b)(i), s9(2)(g)(i)]

G8 (and other action by major economies)

The G8 provides a useful forum for dialogue between the major developed- and developing-country emitters. At the summit in July, a Gleneagles Plan of Action on

Climate Change, Clean Energy and Sustainable Development was agreed to take forward action in transforming energy systems, powering a cleaner future, promoting research and development, financing the transition to cleaner energy, managing the impacts of climate change and tackling illegal logging. Leaders also decided to establish a Dialogue on Climate Change, Clean Energy and Sustainable Development, and invited other interested countries with significant energy needs to join in. The United Kingdom will host the first meeting of the new Dialogue in November. **[withheld under OIA s6(a), s6(b)(i)]** New Zealand is not involved in this process.

Asia-Pacific Partnership on Clean Development and Climate

This partnership, announced in July, has the potential to make a useful contribution, bringing together some major emitters (United States, China, India) and technology leaders (United States, Japan), with a focus on technology transfer. There is, however, no detail yet beyond a general vision statement.

[withheld under OIA s6(a), s9(2)(g)(i)]

The partners have stressed that the framework is intended to complement Kyoto and is not an alternative to it.

[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

Other plurilateral partnerships

There are a number of international technology and research and development partnerships, often with their genesis in the United States, including the International Partnership for the Hydrogen Economy, the Carbon Sequestration Leadership Forum, and the Methane to Markets Partnership.

[withheld under OIA s6(a), s9(2)(g)(i)]

Sectoral tracks

Climate change is also being tackled in a number of non-governmental think tanks; eg, the Pew Centre on Global Climate Change and the Center for Clean Air Policy. One of the areas of focus in think tank discussions is the contribution to emissions reductions that could be made by different sectors (eg, energy, oil, transport) in setting standards and developing low-emission technologies.

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[withheld under OIA s9(2)(g)(i), s9(2)(j)]

6.2 New Zealand position and strategy

6.2.1 New Zealand's position to date

New Zealand is an active player in the UNFCCC process. New Zealand's most recent presentation was at the UNFCCC Seminar of Governmental Experts, held in Bonn in May. The key messages delivered were:

- New Zealand treats climate change seriously and is taking action, both domestically and in support of Pacific Island countries
- national circumstances are important; New Zealand is different from other developed countries
- we urgently need a constructive dialogue on how to take meaningful action on climate change, and at the same time provide for future economic growth and development aspirations.

On the last point, it was noted that New Zealand welcomed the entry into force of the Kyoto Protocol and that a constructive dialogue was urgently needed on what the international community should do next on climate change to build on the first step of Kyoto. It was noted that New Zealand had no predetermined view on the best future global framework, building on Kyoto's CP1 commitments, to address climate change and that we were still working on our position on future action. In doing so, we were looking to answer some difficult questions: How can we get a constructive dialogue started now on what the international community should do next to tackle climate change? How can we make climate change measures compatible with future economic growth and development aspirations? How do we recognise that some economic sectors, such as agriculture, currently have limited technology solutions? How do we get all of the major emitters involved? The presentation concluded by noting that New Zealand was open to considering all constructive options proposed to deal with climate change.

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[withheld under OIA s6(a), s9(2)(g)(i)]

New Zealand has bilateral climate change partnerships with the United States and Australia, through which it engages on climate change with two important non-Kyoto parties.

6.2.2 New Zealand's position and strategy for COP11 and beyond: assumptions

With the potential for further discussions, and perhaps negotiations, on future action on the near horizon, it is appropriate to consider what position and strategy New Zealand might take to UNFCCC Montreal and beyond into 2006. It is helpful to make explicit some key assumptions underpinning consideration of a New Zealand position and strategy. These are as follows:

- New Zealand faces economic risk if climate change is not kept to tolerable levels. Accordingly, it is in our national interest to support effective international action to reduce climate change and to minimise its impact
- there are no easy mitigation options for New Zealand
- decisions are yet to be made by the Government, following the Climate Change Policy Review, about what future package of actions New Zealand might take on climate change
- New Zealand's position on climate change should be informed by, and consistent with, positions on other issues, such as trade policy, sustainable development and energy security, and should be mindful of bilateral and regional relationships
- uncertainty surrounds the prospects for further international action on climate change and what form this might take. This uncertainty makes decisions on appropriate future New Zealand domestic policy settings difficult
- given this uncertainty, it is also difficult to plot a clear New Zealand international strategy. We should have a better idea of the options that are emerging after UNFCCC Montreal in November/December
- it will not be easy in future negotiations to strike the right balance between maximising climate change reductions and minimising economic cost
- **[withheld under OIA s6(a), s9(2)(j)]** l
- New Zealand is reliant on global action to achieve effective action against climate change
- to tackle climate change effectively, future action requires the active participation of all major emitters, both developed and developing countries. New Zealand has consistently emphasised the need for "broad and balanced participation"

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- developed countries are required to take the lead in future action
- **[withheld under OIA s6(a), s9(2)(j)]**
- New Zealand's constituency and key relationships are diffuse. We will need to work hard to identify partners and build allies, perhaps on an issue-by-issue basis
- **[withheld under OIA s6(a), s9(2)(j)]**
- **[withheld under OIA s9(2)(j)]**
- New Zealand has specific interests in any future climate change negotiations (reflecting our unique emissions profile) that are not shared by other developed countries and are discounted by developing countries. We therefore need to participate in negotiations to ensure that these are taken into account in future international measures
- New Zealand is a minor player and has little ability to influence the position of major emitters. **[withheld under OIA s6(a), s9(2)(j)]**
- any future commitments should be equitable and should not unfairly impact on New Zealand or our competitiveness vis-a-vis other trading partners
- there will not be a "silver bullet" solution to climate change. Tackling the issue will require making progress on a number of different fronts
- technology will play a part in addressing climate change in the future; however, the technology to deal with methane and nitrous oxide will take longer to develop than that for emissions from industry and energy. Methane and nitrous oxide will therefore require a different approach; eg, longer timeframes, credit for research and development, and more realistic targets. These distinctions currently have little resonance in international discussions and proposals are not yet developed to address this issue
- **[withheld under OIA s6(a), s9(2)(j)]**
- forest sinks may remain important as a mitigation tool for New Zealand in the future. The review has presented new information and has developed a series of

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options for Ministers to consider. A decision on these options will inform New Zealand's detailed position on the future treatment of sinks in any future regime

- **[withheld under OIA s6(a), s9(2)(j)]**

- **[withheld under OIA s6(a), s9(2)(j)]**

- allocating emissions targets on a *per capita* basis would put New Zealand at a disadvantage, given our agricultural base and geography

- Pacific Island countries are highly vulnerable to the effects of climate change, and we should continue to support their concerns and to promote greater international efforts to assist in adaptation.

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7 Conclusions

The Government should consider formulating an alternative climate change goal for New Zealand that better manages the risks, opportunities and impacts associated with our net emissions position while engaging with the international community in an attempt to secure broad and balanced participation and action on climate change policy.

Underpinning issues relating to our domestic policy settings going forward is a question of the appropriate mix of price-based measures (e.g. taxes), or regulatory and support-based policies. Broadly speaking, in a situation where New Zealand has binding emissions targets, the more closely a domestic carbon tax approximates the international carbon price, the less rationale there is for additional regulatory or supporting measures in those sectors of the economy subject to the tax.

It is unrealistic in the short-term (CP1) for the Government to introduce a new programme to offset New Zealand's Kyoto liability by subsidising large-scale new forest planting because relatively little carbon would be sequestered during CP1.

Although it is unclear what level of domestic emissions reductions can be achieved in CP1, the level of domestic reductions that can be achieved in a cost-effective manner is likely to be small relative to New Zealand's net emissions position. Given this, New Zealand would be prudent to meet its Kyoto commitment by, partially at least, purchasing some Kyoto-compliant units internationally.

A work programme should be commissioned to determine potential buying strategies for New Zealand that reflect New Zealand's objectives in this area and our risk profile, along with issues of management, timing and price. Given the considerable uncertainty that surrounds the future price of emission units, early agreement by the Government to a buying strategy may prove to very important.

7.1 Introduction

This chapter acts as a summary of the Review report and brings together its key conclusions. In doing so, the chapter focuses on the following:

a. a discussion of New Zealand's climate change strategic goals

b. a high-level discussion of different approaches to policy settings, more specifically, price-based mechanisms (PBMs), and regulatory and support-based policies

c. a discussion of two types of PBMs, carbon taxes and emission trading schemes, and a brief discussion of the Project to Reduce Emissions (PRE) programme, a support-based policy which has been underway for some time

d. a discussion of issues around the use of PBMs, and regulatory and support-based policies, on a sector-by-sector basis

e. a summary of high level options for reducing domestic emissions in CP1

f. a discussion of a possible buying strategy for New Zealand and the factors to be taken into account

g. a discussion of principles to inform New Zealand's international negotiating position.

7.2 New Zealand's Strategic Climate Change Goals

7.2.1 Preface

Climate change matters to New Zealand for several reasons. New Zealand is vulnerable to the impacts of climate change through its coastline, the strong role of agriculture in its economy, infrastructure, and unique ecosystems. This was an important consideration in framing the Government's climate change policies in 2002.
This review has been primarily concerned with presenting the Government with strategic choices around climate change mitigation policies. It has not attempted to undertake any evaluation of the potential costs of climate change adaptation in New Zealand, or of the weight that New Zealand should attach to adaptation strategies in the future. This is an area that will warrant further policy investigation over the next few years.

7.2.2 Where did the Government aim in 2002?

The Government established the following strategic climate change goal in 2002:

> ***"To enable New Zealand to make significant greenhouse gas reductions on business as usual and be set towards a permanent downward path for total gross emissions by 2012."***

The goal was established against the following context:

a. New Zealand would be a net seller of emission units in the first commitment period of the Kyoto Protocol, with a projected surplus of 55 million units – 17.9% of our Kyoto "Assigned Amount Units"

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b. additional policies would be required *before* 2008 to prepare the New Zealand economy for the first, and importantly, subsequent commitment periods beyond 2012 (New Zealand Government, 2002a). The key policies that were subsequently initiated included:

- projects to Reduce Emissions (PRE)
- negotiation of Negotiated Greenhouse Agreements (NGAs) for "at risk" firms
- joint industry/Government -funded agricultural research.

c. additional policies would be required *after* 2008 as an international price of emissions emerged. The key polices are:

- a **carbon tax** that approximates the international carbon price;
- **application of the NGAs** for "at risk" firms
- continued **agriculture research**
- the **forestry and land use policy** as announced (with a key feature being retention by the Government of forest sink credits and liabilities but with a deforestation cap aimed at limiting liability to the government from large-scale deforestation)

If it were maintained, and taken seriously, the strategic goal, as established in 2002, would have pointed New Zealand to adopt relatively ambitious long-term emission reduction policies. However, the emission forecasts at the time did not indicate that such policies would be required for New Zealand to meet its current Kyoto commitments, because of the "windfall" from forest sinks. An ambitious target did serve the purpose of ensuring that New Zealand meets its Kyoto obligations cost-effectively by undertaking domestic abatement as well as using its forest sink credits, and for positioning New Zealand for what were expected to be more stringent emission reduction obligations beyond 2012, provided that the mitigation polices achieved the necessary emission reductions.

New Zealand can meet its commitments under the Kyoto protocol through a combination of the following broad approaches:

a. by reducing emissions through domestic action

b. by establishing additional forest sinks to offset emissions

c. by buying credits through the Kyoto Flexibility mechanisms to offset emissions.

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7.2.3 What has changed since 2002?

Some fundamentals have changed

There have been some important contextual changes in underlying levels/ rates of emissions:

a. underling emissions growth is higher, and forestry planting rates are lower

b. compared to initial estimates, less forest can be counted as "Kyoto forests"

The net result of these changes is that it is estimated that New Zealand will be in net deficit of 36.2 Mt CO_2e in the first commitment period.

It is important to note that there is uncertainty around that figure and although our methodology for assessing our net emissions position stands up well to international scrutiny, it will be some time until the uncertainty in our net emissions position is reduced to small levels

It is also worth pointing out that other countries are facing similar Kyoto-related issues.

Some of the key policies announced in 2002 will be less effective in delivering emission reductions than expected:

- **Experience has shown that firms eligible for NGAs are likely to be close to "world best practice" in relation to greenhouse emissions from their operations. This suggests that emission reductions achieved through NGAs may be modest.**
- **Preliminary evaluation of the PRE programme concludes that it is unclear whether the expected CP1 emission reductions resulting from PRE exceed the emission units allocated.**
- **Agricultural industry expectations that agricultural research could lead to a reduction of 20% in agricultural emissions by 2012 appear overly optimistic.**

What does this mean for New Zealand's capacity to reduce emissions?

It will be more difficult for New Zealand to meet its current Kyoto commitments than was anticipated when current policies were set in 2002. However, the task is manageable, particularly if New Zealand makes use of the Kyoto Flexible Mechanisms to partly meet our Kyoto target.

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It is impossible to predict now when New Zealand might be able to achieve a "downward carbon path" or how long such a transition might take. With some confidence, we can predict that in the period to 2012, during which New Zealand will have a binding emissions target, New Zealand emissions will continue to grow. Mitigation actions will be directed at reducing the *rate of growth*. Beyond 2012, the picture is less certain. It would be risky now to assume that "new and easy" emissions reductions will be achievable in the immediate period after 2012. In that case, New Zealand could probably only meet any binding "downwards" emissions targets soon after 2012 by paying for emission reductions in developing countries. However, looking to 2020 and beyond, it is only possible to speculate on the opportunities for significant reductions in emissions.

7.2.4 Consideration of Alternative Strategic Climate Change Objectives

The Government may wish to consider replacing the current strategic goal with multiple objectives that it can use to guide its choice of climate change policies.

A quantitative goal may not be helpful in guiding policy choice in the next 5 – 7 years, but that may not hold in the period beyond the next 15 – 20 years. Over a longer time period, technological change in areas such as agriculture for example, may allow New Zealand to pursue polices that do deliver an emissions profile that does take the country towards a "downward carbon path".

The following considerations are pertinent in considering an appropriate goal that might provide guidance for the development of climate change policy.

- New Zealand is dependent on effective global action to manage the degree of climate change
- it is desirable that New Zealand engage internationally to seek to secure effective global action
- the level of New Zealand's emissions will have little direct impact on the degree to which human-induced climate change occurs
- it is desirable that New Zealand positions itself to promote its national interests in the design of international agreements to address climate change
- there is no international agreement on how to deal with climate change post-2012
- it is important that New Zealand's domestic policies align with whatever future international targets we agree to (if any).

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7.2.5 An alternative Climate Change Goal could be established based around the principles of "international engagement" and "policy sustainability"

The Government should consider formulating an alternative climate change goal for New Zealand that better manages the risks, opportunities and impacts associated with our net emissions position while engaging with the international community in an attempt to secure broad and balanced participation and action on climate change policy.

The Government may wish to consider an alternative strategic climate change goal around the following elements:

a. **New Zealand will engage with the international community** on responses to climate change in an attempt to secure broad and balanced participation and action, in particular by all of the world's major emitters, including both developed and developing countries, to effectively manage the risks from human-induced climate change

b. **New Zealand will adopt policy measures** to address greenhouse emissions that meet the following criteria:

   i. policy settings that allow us to demonstrate that we will meet the international commitments we take on – e.g. through a combination of achieving domestic abatement and international emissions trading

   ii. policy settings that recognise New Zealand's unique national circumstances

   iii. policy settings are *sustainable, efficient, and flexible* and

   iv. policy settings that are *compatible with New Zealand objectives in relation to economic growth, social cohesion, and other environmental objectives*.

c. **New Zealand will manage the risks, opportunities and impacts** arising from the effects of climate change and ensure **adaptation** as smoothly as possible.

7.3 Policy Choice - Price-Based Mechanisms (PBMs), Regulation and Support Policies

A critical decision going forward relates to the balance that New Zealand places on price-based mechanisms (PBMs), and regulation and support-based policies (i.e. specific subsidies).

The key difference between the different approaches is that under a PBM, there is no attempt to centrally determine the areas in the economy in which New Zealand is best placed to reduce its domestic emissions.

The use of regulatory mechanisms, or support-based policies relies on a central determination of areas upon which to focus climate change mitigation efforts. In contrast, the use of a PBM allows private firms and individuals to determine the most

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appropriate responses throughout the economy in response to the relative change in prices that is implicit.

Broadly applied PBMs are likely to result in changes across a whole range of economic activities. This may lead to:

a. a large number of small changes in behaviour over time, many of which are imperceptible:
   - these changes in behaviour are likely to occur right throughout the value chain
   - there will be a strong signal that the price of carbon will be faced by all emitters (or all emitters within scope) going into the future thus providing an incentive to seek carbon-reducing activities and technologies where the benefits to the firm concerned outweigh the cost.

b. structural change where some firms or industries become uncompetitive as a result of the need to face a price of carbon.

Regulatory or support-based mechanisms have the capacity to affect a small number of areas of the economy quite significantly. These types of mechanisms can be used to create large changes in the economy in the areas that are highlighted. One downside is that the costs of these interventions are often unclear. This can make it difficult to confidently determine whether the benefits of the intervention will outweigh the costs. Another downside is that regulatory or support-based policies can result in uneven incentives and behaviours across the economy (Of course, a poorly designed PBM can also have this downside).

An issue for New Zealand to balance going forward is the appropriate mix of these different types of mechanisms. As a general rule, the more that PBMs are employed (and the closer that a PBM is to the world carbon price), the less reason there is for employing either regulatory or support-based mechanisms in the sectors that are subject to a PBM. Therefore it would still be rational to have a PBM across a wide subset of the economy, and to use a regulatory approach in areas where it was not efficient, or practical to impose a PBM.

PBMs, regulatory approaches, and support-based policies all impose costs on the economy. Similarly, a policy mix that relied on not implementing any measures to reduce our domestic emissions would impose a cost on the economy – through the use of taxpayer funding to purchase Kyoto-compliant units internationally. The respective costs are likely to fall on different areas of the economy and are often difficult to determine. The challenge therefore, in determining the most appropriate policy package going forward, is to meet our Kyoto commitments (and position New Zealand as well as possible for going forward beyond CP1) while minimising both the social and economic costs to New Zealand.

The sections below discuss the two types of PBMs that are most commonly employed; carbon taxes and emission trading schemes. There is also a brief discussion of *Project to Reduce Emissions (PRE)*, a support-based policy which has been underway for some time.

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Following this, **Section 7.5** examines the use of PBMs, and regulatory and support-based policies, on a sector-by-sector basis. One focus of this section is on discussing options that have the potential to reduce domestic emissions in CP1.

Underpinning issues relating to our domestic policy settings going forward is a question of the appropriate mix of price-based measures, such as taxes, or regulatory and support-based policies. Broadly speaking, in a situation where New Zealand has binding emissions targets, the more closely a domestic carbon tax approximates the international carbon price, the less rationale there is for additional regulatory or supporting measures in those sectors of the economy that are subject to the tax.

7.4 Carbon Taxes and Emissions Trading

7.4.1 Assessment of the Carbon Tax as Announced by the Government

The exemptions to the carbon tax that are applied to the agricultural sector and NGA firms create unequal incentives across the economy to reduce emissions and are therefore a significant source of inefficiency. If maintained, the current policy will not allow New Zealand to achieve long-term abatement at the lowest possible cost to the economy.

The carbon tax as announced might be used as a basis to move to an alternative price-based measure in the future. This could, however, be difficult. Once the tax has been enacted and implemented it would seem unlikely that a *fundamentally different* regime would replace it for some time.

If the Government wishes to introduce a price-based measure to address New Zealand's emissions, it would be preferable for an effective and sustainable regime to be established soon, rather than to persevere with the announced carbon tax and associated NGAs.

Alternatively, the Government could defer a decision until (probably) 2010, taking an explicit decision to meet New Zealand's immediate Kyoto commitments without using a carbon tax.

Alternative carbon tax options are presented in Section 7.4.2.

7.4.2 Alternative Carbon Tax Options

The Review identified a variety of alternative models for progressing the concept of a carbon tax. These are:

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<u>Option 1a</u>: A low-level broad-based tax, implemented in the near future, gradually increased over time
<u>Option 1b</u>: A broad-based tax at world price, with targeted recycling of tax revenue (e.g. energy efficiency, structural adjustment)
<u>Option 2a</u>: A deferral of any decision on a price based measure
<u>Option 2b</u>: A tax on large industrial emitters that do not meet (i.e. are worse than) world best practice emissions intensity

A tabular evaluation of these is set out below, followed by a brief discussion of this evaluation.

The Review assessed these alternative models against the following criteria:

- forecast effect on domestic emissions in CP1
- potential impact on domestic emissions beyond 2012.
- economic impacts.
- sustainability, flexibility and feasibility.

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Schematic Comparison of Carbon Tax Models against Assessment Criteria

KEY

✓ Positive impact on emission reduction goal, or growth, or sustainability
X Negative or negligible impact
? Unknown impact

	Effect on domestic emissions in CP1	Effect on domestic emissions beyond CP1	Impacts on medium term economic growth	Sustainability, flexibility and feasibility
Announced carbon tax	**✓ 13 Mt reduction**	**? Depends on whether policy survives "overheads" of negotiating NGAs**	**X Negligible**	**X Large overheads of NGAs means sustainability questionable**
Option 1a: low-level broad-based tax, rising over time	**X Negligible in CP1**	**✓✓✓ (With agriculture in.) ✓✓ (With agriculture out.) Potentially substantial to 2020 (*Depends on the level to which the tax can be raised)***	**?**	**✓✓ Provided community buy-in**
Option 1b: broad-based tax at world price, targeted recycling	**✓✓**	**? Depends on the nature of the targeted assistance**	**?**	**? This option would face major sustainability barriers – fiscal pressures**
Option 2a: defer decision on primary price based measure	**X**	**X**	**X This option would create substantial regulatory uncertainty.**	**X Unlikely to be sustainable to 2020**
Option 2b: tax on large industrial emitters that do not meet world best practice emissions intensity	**X Negligible emission reductions**	**X**	**X This option would create substantial regulatory uncertainty**	**X Unlikely to be sustainable to 2020**

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The difference between **Option 1a** and **Option 1b** is effectively timing and transition to a state where the "world price" of carbon is reflected in domestic policy settings (Option 1a allows for a more staged and gradual adjustment than Option 1b). This report argues that such an approach, with few or zero exceptions, would be most likely to result in an appropriate resource mix from a carbon viewpoint in the longer term, and would be most likely to lead to significant reductions in domestic emissions in the longer term.

Important to note though is that it is very possible that the technical and administrative issues involved in getting to this point will not be easily (or quickly) overcome. In particular, measurement issues face the application of a carbon tax to agriculture; these imply that the use of proxies would be necessary in the short to medium term. In terms of forestry, issues relating to deforestation would still need to be overcome.

Either **Option 1a** or **Option 1b** would be far more suited to remain in place for a significant period of time than either **Option 2a** or **Option 2b**. **Option 1a** or **Option 1b** would provide an important signal to all sectors of the economy that the price of carbon is a genuine issue that New Zealand faces, and that the price of carbon will be reflected in domestic policy settings in the future. As such, firms would have an incentive to invest in technologies that would reduce the emissions intensity of production and consumption.

7.4.3 A New Zealand Emissions Trading Scheme

A New Zealand emissions trading scheme could be considered as an alternative to the carbon tax.

An **emissions trading scheme** (ETS) is potentially a very powerful policy instrument.[146] An ETS could lead to innovative ways of meeting climate change objectives that would otherwise be very difficult, if not impossible, to achieve. For an ETS to be effective, there are a number of administrative and transactional issues to overcome. These include:

a. being able to accurately measure emissions performance (e.g. at the farm level) and tie individual businesses' obligations to New Zealand's overall obligation

b. ensuring that scheme participants are accountable for their emissions

c. ensuring that emission permits are easily tradable, with no excessive transaction costs.

For an ETS to be effective, there would need to be an acceptance that it is here to stay, at least for CP1 but preferably longer. Given this, consistency of policy settings is important, as is a high-level of buy-in, both politically and within the economy. The difficulty of design, and time required for the design, of an ETS implies that, ideally, an ETS would be used for more than one commitment period.

[146] An ETS requires all emitters within the scope of the scheme to hold (and then surrender to the Government) a tradable permit to cover their emissions. The permits have a market value; this allows the lowest cost emission reductions to be identified.

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It would be preferable to include as many New Zealand emitters and major greenhouse gases in a New Zealand ETS as possible. There are difficulties associated with including agriculture and forestry. It would be more practical to add these sectors to an existing ETS rather than develop a new ETS including agriculture and/or forestry. Also, an ETS would be most effective if it included all types of land-use decisions that have significant climate change implications, such as afforestation and deforestation rates, changes in stock numbers (especially cattle), fertiliser application and use of technology.

It is arguable whether there is an effective, and suitablle international carbon market for a NZ ETS to link into. A market of this nature is necessary to avoid the highly problematic exercise of setting a limit on total New Zealand emissions. An international emissions market would, ideally, allow New Zealand firms to access low-cost emission permits from overseas at low transaction cost.

The Review recommends that the Government not develop a New Zealand ETS to apply in CP1 – i.e. up to 2012. Depending on the nature of any successor to the Kyoto Protocol, New Zealand should seriously consider developing a NZ ETS, to be introduced after 2012.

It is important that any domestic policies developed in the short term are designed to enable a transition to an ETS.

7.4.4 Projects to Reduce Emissions (PRE)

The key objective of PRE is to reduce New Zealand's emission profile in the 2008 to 2012 period. Enhancing New Zealand's energy security was also identified as a desirable outcome of the first assessment round.

A high proportion of units allocated under PRE went to electricity projects.
Modelling as background to the Review suggests that the bulk of New Zealand's additional electricity capacity (apart from one new combined-cycle gas turbine station) is likely to come from renewable sources in the immediate future.

The Review concludes that it is unclear whether the expected CP1 emission reductions resulting from PRE exceed the emission units allocated under PRE.

The Review recommends that PRE not continue in its current form.

If the Government decides to change current policy on the carbon tax (linked to the international price of carbon, capped at $25 per tonne of CO_2e, starting on 1 April 2007 at $15 per tonne), firms' expectations of future prices (in particular for fossil fuels and electricity), and their assessment of the financial viability of different electricity generation projects and projects that would reduce emissions, are also likely to change.

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The assessment that the bulk of New Zealand's additional electricity capacity (apart from the one CCGT) is likely to come from renewable sources in the immediate future[147] may change too, although current modelling suggests that this is unlikely.

The third round of PRE, which was agreed by Cabinet earlier in 2005, should not proceed.

If the Government wished to pursue the PRE model (this may be appropriate depending on any decisions on the future of the carbon tax), the following questions should be considered:

- **Is the PRE model worth continuing?**
- **If so, what should the scope of any future PRE include? (Any non-electricity project? Any non-energy project?)**
- **How can any future PRE programme fit with other policies such as the carbon tax, or policies arising from the Climate Change Policy Review, in order to avoid "double-incentives"?**
- **[withheld under OIA s9(2)(b)(ii)]**
- **Should units (of uncertain value) be allocated to successful firms or is a cash payment more suitable?**

7.5 Sectoral Analysis

7.5.1 Agriculture

Agricultural emissions account for almost half of New Zealand's total gross emissions. The comparable figure for the European Union is just 10%. The significance of agriculture in our emissions profile reflects our traditional comparative economic advantage in pastoral land-use activities. Cost-effective significant mitigation options are currently limited and are likely to remain so, at least over the next decade.

The Government faces three key decisions to guide further policy development:

a. does the Government want to move towards price or regulatory measures for agricultural greenhouse gas emissions?

b.

[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

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[147] Based on modelling by the Ministry of Economic Development.

[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

c. does the Government accept that the current approach to research, extension, inventory methodology development and maintenance of scientific capacity is sub-optimal? How does it want to approach future Research and Development arrangements?

Does the Government want to move towards price or regulatory measures for agricultural greenhouse has emissions ?

A Sector-wide Price-Based Approach

A sector-wide price measure during CP1 would be feasible but not fully efficient – it would need to rely largely on proxies for emissions at the farm level, e.g. a poll tax based on animal species and age. The use of proxies would tend to reduce sector output and change land use to lower-emission regimes, rather than make the production system more efficient (from a carbon viewpoint). In addition, estimates of the economic impacts of a price measure on the sector and its likely structural responses are still subject to considerable uncertainties.

If the Government wishes to explore possibilities for moving towards sector-wide price signals that encourage mitigation, the following actions are recommended:

- **Developing a better understanding of the economic impact and likely mitigation responses, and/or structural adjustment, of the sector, sub-sectors, and regions to different price signals**
- **Testing the long-term practical and environmental sustainability of mitigation technologies, and acceptance by international customers of agricultural products**
- **Developing and deploying monitoring and reporting tools that provide accurate, practical and cost-effective estimates of on-farm greenhouse gas emissions, including technological or farm management mitigation actions**
- **Developing methods and data systems to reflect mitigation actions at farm level in the national greenhouse gas inventory consistent with UNFCCC good-practice requirements.**

Partial Approaches

There are alternatives that could avoid some of the shortcomings of sector-wide emissions taxes. Some of these would allow the Government to send an early signal of its longer-term intention to move towards a sector-wide price measure in agriculture. The main alternatives to a sector-wide price measure are:

- a tax on nitrous oxide emissions associated with the use of nitrogen fertilisers

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- regulation of total nitrogen loadings in catchments
- direct financial support for the uptake of mitigation technologies.

The price measures relating to agriculture that appear to be most feasible and practical in providing abatement incentives during CP1 are a tax on nitrogen fertilisers, and/or direct financial support for the uptake of mitigation technologies below the international price of carbon. Other proxies are available but have weaknesses.

The nitrogen tax would cover 7% of agricultural non CO_2 emissions and the net effect on total emissions is likely to be low. These partial options have specific risks and benefits that need further analysis; the Government will have to decide whether it wants to investigate these options further.

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[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

How does the Government want to approach future Research and Development arrangements?

Research into mitigation options, farm extension, and inventory development must continue to underpin climate change policies for agriculture to identify and implement cost-effective and practical mitigation options.

Current research and extension arrangements are considered sub-optimal and should be reconsidered not only in terms of total funding levels, but also with regard to the total coverage of research and sharing of responsibilities between industry and the Government.

It would be desirable to analyse existing arrangements and objectives for any critical gaps in efforts between mitigation research, the need to develop the national greenhouse gas inventory, and the development, extension and uptake of mitigation, monitoring and reporting tools at farm level.

Synergies and trade-offs between policy elements

These decisions and their mode of implementation are not independent from each other. The following links are critical:

- moving towards price signals for agriculture could erode the current joint approach to mitigation research, as well as other voluntary approaches by the industry to environmental management and voluntary reporting of information. Early engagement with the sector would be critical to manage these issues.

- **[withheld under OIA s6(a), s9(2)(j)]**

[withheld under OIA s6(a), s9(2)(j)]

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Links of agriculture with other land uses, particularly forestry

Agriculture is only one of a range of possible land uses. Since the total amount of land available is limited, changing incentives for other land uses will have an indirect effect on land area and total stock numbers in agriculture; this will impact on agricultural greenhouse gas emissions. The key linkages are:

- any price incentives for forestry, in recognition of their role as carbon sinks, would reduce the relative value of land for agricultural purposes. The effect of carbon-sink incentives on overall emissions will be greater than the amount of carbon stored in newly planted trees since it will also replace agricultural emissions.

- other restrictions on land uses and land-use changes under the RMA that can also influence agricultural activities. It is not generally cost-effective to use such regulations specifically to control greenhouse gas

emissions. But where such regulations are undertaken for other purposes, they would also affect emission trends. There may be a need for consistency of RMA decisions in relation to this i.e. in some areas restrictions are placed on forestry planting due to water catchments effects.

Most farmers take a whole-farm perspective on their operations and do not distinguish between forestry and agricultural activities. A sector-wide price measure on agricultural emissions would receive greater support if it allowed offsets of agricultural emissions through the planting of trees. Such a scheme would raise a wide number of issues regarding monitoring, verification, and liabilities associated with carbon sinks.

7.5.2 Energy

The key means of achieving emission reductions in the energy sector is through improvements to energy efficiency (in terms of both technologies and behaviour) and increasing the proportion of renewable energy in New Zealand's energy supply.[148]

Analysis suggests there is some potential for further uptake of cost effective energy efficiency measures in the economy. The key to "unlocking" this potential is understanding the nature of impediments or disincentives to adopting such measures, so that appropriate policy responses can be developed and targeted.

New Zealand's electricity system is already low in emissions intensity by world standards. While the contribution of some new renewables (in particular, wind) is projected to increase over the next 10 years, New Zealand's scope for mitigation from fuel switching is more limited than for many other countries. Potential emissions savings still exist through increasing the use of renewable energy in generation of process heat.

A key decision for the Government in the energy sector is whether to proceed with the announced carbon tax or adopt an alternative arrangement (including postponing implementation of any price-based measure).

A price-based measure will be an important mechanism for encouraging renewable generation, as well as fostering demand response through investment in energy efficiency and changes in behaviour. However, a tax focussed solely on the energy sector would have significantly reduced efficiency. If the Government decides not to proceed with a carbon tax, it could consider the benefits of expanding a selection of existing non-price based measures, although decisions on these programmes should wait until EECA's review of the National Energy Efficiency and Conservation Strategy (NEECS) is completed.

Existing regulation and support programmes to reduce emissions are generally more developed in the energy sector than in other sectors. Strong co-benefits (including economic, social, health and environmental benefits) have resulted in the Government

[148] Note that transport energy comprises a significant proportion of overall energy use, although emissions reductions from transport are discussed separately in Section 7.2.5

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acknowledging and committing to energy efficiency and renewable energy, establishing EECA in 2000 to specifically focus on pursuing potential benefits.

EECA now has a well-established, although evolving, package of measures. Other regulatory measures also contribute to climate change outcomes in the energy sector, including recognition in the Resource Management Act of the benefits of renewable energy and energy efficiency, low-fixed-charge electricity tariffs and the (pending) regulation of line access for distributed generation.

EECA is currently leading an interdepartmental process to review NEECS. NEECS provides a strategic context for EECA's package of energy efficiency and renewable energy measures. The Energy Efficiency and Conservation Act 2000 requires the NEECS to be reviewed five years after it comes into force and requires the Minister of Energy to determine whether or not the NEECS needs to be replaced by a new strategy. This first stage will involve a stocktake of current NEECS programmes, an assessment of best practice, and an assessment of programme "gaps". Should the Minister decide that a new strategy is to be developed, a more in-depth assessment of options for additional and expanded programmes will be undertaken.

The review of climate change policy has therefore not attempted to provide detailed policy recommendations in the energy sector, although an initial assessment of the climate change costs and benefits of measures has been undertaken. This assessment suggests most current energy sector measures are "no regrets" policies, based on the economic gains they deliver and associated co-benefits.

While EECA's current suite of programmes is broadly well-balanced across the range of appropriate interventions, the ability to achieve more significant gains will depend on facilitating widespread behavioural change. However, due to the tight coupling of energy growth and economic activity, the gross emission benefits from such gains will risk being diluted by population growth and societal change, and economic growth more generally.

EECA already has in place a programme of regulatory-based minimum energy performance standards, which is scheduled to expand both in terms of scope and stringency. Whilst these planned regulations represent good value for money from a fiscal perspective, any additional expansion of the programme would need to consider the possibility of diminishing returns in light of technical potentials, as well as trans-Tasman alignment of standards (an important focus of the current programme). Other programmes in place address information problems (via product labelling, energy audits and education/information provision), capital barriers (subsidies and low cost loans) and split incentives (the current review of the Building Code).

The appropriate nature and breadth of future/additional regulatory and supporting interventions to encourage energy efficiency will be dependent on decisions taken regarding the future shape of any market-based measure (i.e. carbon tax or emissions trading). Broadly speaking, in situations where New Zealand has binding emissions targets, the more closely a domestic carbon tax approximates the international carbon price, the less rationale there is for additional supporting measures (however the need to address barriers to energy efficiency will remain). Whilst there may be a basis for transitional support to help firms adjust to a carbon price, this is offset to the extent that a tax is gradually phased in (the phasing in is, in effect, providing transitional support).

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Decisions about energy-efficiency and renewable-energy programmes should only be made after the NEECS review is completed.

7.5.3 Forestry and Land use change

Uncertainty about the Land Use, Land Use Change and Forestry (LULUCF) rules beyond 2012 is a major impediment to developing a resilient domestic policy package in this area. Without certainty on future rules, including targets, definitions, accounting and interpretation, it is difficult to evaluate the benefits and liabilities to New Zealand in the medium-to-longer term. However, it is important to note that the design of domestic climate change policy for land-use change need not necessarily mirror international rules. While New Zealand must adhere to issues related to compliance, domestic policy design has the flexibility to determine how appropriate signals can be transmitted in relation to afforestation, reforestation and deforestation.

Forestry and agriculture compete for land use. For equity and efficiency reasons, it is preferable that climate change policies are land-use sector neutral and do not distort investment decisions. Similarly, substitutes for wood products should also be treated the same as wood products. Continued flexibility in land-use decision-making is desirable.

Forestry can assist New Zealand in the transition towards a more climate-friendly economy. Forest sinks "buy time". However, any consideration of the benefits of forestry must not be divorced from the liabilities associated with harvesting and deforestation.

In the short term, forest sink credits will offset harvesting and deforestation liabilities. New Zealand's projection for sinks over CP1 is a surplus of 67.8 Mt CO_2e.

In the medium-to-longer term, the high planting rates of the mid-1990s mean that, at harvest, there is a potential for New Zealand's net sink position to be in deficit (ie, harvesting liabilities will be greater than the sequestration benefits). This deficit assumes that current Kyoto rules remain very similar over the medium-to-long term and that New Zealand is unable to gain a more favourable agreement (relative to the present agreement) in the future.

A planting programme could potentially dampen or push this deficit out into the future. However, such a programme will only be effective in the longer term if significant areas of pasture are permanently converted back to forest.

Description of Options Considered by the Review

The lack of information and in-depth analysis done to date precludes any recommendation on a preferred policy option for climate change land-use policies.
The Review has identified five broad options for consideration by the Government:

- Option One – Government retains all Kyoto benefits and liabilities

- Sub-option 1A - No deforestation cap on non-Kyoto forests, no policies to enhance sinks (e.g, PFSI)

- Sub-option 1B - No deforestation cap on non-Kyoto forests, retain policies to enhance sinks (e.g, PFSI)

- Option Two – Payment for afforestation/reforestation, no devolution of liabilities and no deforestation cap

- Option Three – The current policy, giving effect to the deforestation cap and other policies to encourage new planting

- Option Four - Deforestation charge/afforestation rebate

- Option Five - Devolution of carbon benefits and liabilities.

Of the range of options assessed none is clearly preferred, and all have shortcomings and involve tradeoffs. The most preferred of the options should be investigated urgently to ensure that any policy changes can be implemented prior to CP1.

(See Section 4.4.7 for further analysis.)

Key conclusions of the Review are as follows:

- The current policy package does not send appropriate climate change signals to land managers regarding the benefits and costs of land-use change.

- It is recommended that Option One not be progressed further because, while it would provide greater certainty for forest owners in the absence of the deforestation cap, the lack of signals and bounds on the liability for the Crown means the situation would likely become untenable.

The review highlights some possible avenues to improve the lack of climate change signals to land managers. It is recommended that these findings form the basis of a work programme for further analysis. Those options include:

- Option Two - A payment for afforestation/reforestation and removal of the deforestation cap

- Option Three - The current policy package - clarification of the policy relating to the deforestation cap, additional policies to encourage new planting

- Option Four - Deforestation charge/afforestation rebate

- Option Five - Devolution of carbon benefits and liabilities (in conjunction with work on an Emissions Trading Scheme).

Options Three, Four and Five offer greater certainty and improved signals but are technically complex. They raise considerations related to feasibility, compliance, equity, enforcement and compliance costs.

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A pre-condition for the full devolution of sink benefits and liabilities (Option Five) is a fully functioning Emissions Trading Scheme.

A work programme is also required to investigate the consistency of the above options against WTO and other international agreements obligations.

Better information is also required to discern the future deforestation intentions of foresters and to understand the decision-making process of land-use change in New Zealand.

Should Forestry Policy be used to affect New Zealand's CP1 Commitments?

A unique feature of New Zealand is the significance of plantation forestry as a land use. New Zealand's liability under the Kyoto Protocol is vulnerable to changes in land use; specifically, the conversion of forest to other land uses in the period 2008-2012.
At the same time, under the Kyoto sink mechanism the afforestation of new areas since 1990 can be credited as sinks to offset emissions during the period of tree growth. However, when the forest is harvested, under the current rules there is a requirement to "pay back" these credits.

This leaves the question as to whether the Government should encourage large-scale forest plantings as part of a specific strategy to offset New Zealand's greenhouse emissions, and so reduce the forecast deficit in the first Kyoto commitment period. Practical and biological factors mean that such an approach will not be effective in reducing emissions over the short term (2008-2012) because new plantings would sequester relatively little carbon over CP1. The primary benefit of such planting would be to offset emissions growth in second and subsequent commitment periods.

It is also not possible at this time to provide precise costings for such an incentive scheme. This is because it is difficult, ex ante, to determine the subsidy required to generate a rate of return sufficient to induce the private sector to undertake large-scale new plantings. This would also need to be considered against the cost of the Crown investing directly in afforestation including afforestation/revegetation of Crown land. Any such strategy would need to take into account the full costs and benefits (including co-benefits), and be ranked against the cost of purchasing emissions units on the international market. In some areas the co-benefits are compelling i.e. East Coast hill country erosion.

It is unrealistic in the short-term (CP1) for the Government to introduce a new programme to substantially offset New Zealand's Kyoto liability by subsidising large-scale new forest planting because relatively little carbon would be sequestered during CP1. Such plantings have the potential to provide a benefit for future commitment periods and have the potential to provide significant co-benefits. However, they will also create a liability that will be incurred on harvesting.

7.5.4 Transport

For around the last two decades, New Zealand has experienced a period of low oil prices and/or relatively high economic growth. Transport patterns have been heavily reinforced by the low oil prices, while key growth areas in the economy are heavily

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transport-dependent (e.g., tourism and freight movement). Fuel demand (and, by implication, CO_2 emissions) has been very inelastic to price (i.e., demand does not move much with price), with current elasticities for petrol and diesel suggesting only a 2% - 2.5% long-run reduction in demand for a 10% increase in price.

- **the signalling of the announced carbon tax was not expected to have an effect on transport emissions. At the proposed level ($15 per tonne of CO_2), it is expected to have little effect on behaviour. The price increase will be largely invisible within the overall movement in fuel prices caused by volatility in international oil markets**

- **a number of current policy initiatives are still to be fully implemented. However, these will provide only small, incremental CO_2 gains in the short to medium term.**

Fuel price and vehicle technology are two key international drivers over which New Zealand has very little control. The recent fuel price increases to around $US 60/bbl have prompted some behaviour change from transport users. Although the precise impacts are still unclear, continued high oil prices will maintain price pressure on consumers to consider energy reductions and alternatives, and a number of lower CO_2 options will be emerge in response to a sustained fuel price shift.

The overall effects of a sustained, higher, level of oil price may be more influential in reducing CO_2 emissions than the current range of policies.

A second issue is the current lack of cost-effective technological alternatives that provide significant CO_2 reductions. Unlike the electricity sector, for instance, where relatively low price signals can cause a switch between high emission generation (gas/coal) and low-emission alternatives (renewables), there are few comparable opportunities at this stage in transport. Future vehicle technologies are largely out of New Zealand's hands, as we are essentially technology takers from the global vehicle industry. There are some fuel-switching opportunities, and the recent oil price increases have put the first tranche of biofuels (about 10 PJ) now within the range of potential cost-effectiveness (albeit with the need for a range of supportive Government policies). However, this represents less than 5% of current transport energy demand, and even lower CO_2 emissions-reduction potential.

Much stronger intervention policies designed to change the composition of the vehicle fleet in New Zealand could be contemplated. However, at this stage, it is unclear to what extent this might have lasting, effective outcomes. There are also questions about whether this would be the best way of addressing the issue, and whether potential perverse effects can be addressed.

If a decision is made to delay the carbon tax or to set it at a very low level, then there are implications for transport policy. In the absence of a full carbon price signal affecting fossil derived transport fuels, alternative price incentives or disincentives for transport become more important.

The Review considers that the following options should be considered by the Government. All of them require further analysis:

- more efficient distribution of costs to road users by transferring a proportion of the rates contribution and ACC charges across fuel excise and RUC

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- ongoing financial support for travel-demand initiatives and public transport ;
- opportunities around electrification of parts of the rail track
- a work programme to engage with the aviation industry on climate change matters
- for biofuels, evaluating a sales target above 2 PJ per annum and prioritisation of research effort
- increased priority to vehicle fuel-economy information
- for road vehicle fleets, a leadership role for the Government in purchasing and investigating opportunities under the FBT system
- targeting drivers of heavy fleets for information and training
- support for programmes for vehicle maintenance and fleet entry requirements, because of the co-benefits for CO2 that could be available
- creating incentives for the purchase of vehicles with high fuel economy/low CO2 emissions through price differential on annual vehicle charges.

There are a number of potential policies relating to transport that could, potentially, reduce CO_2 emissions from transport by 5%. These require further analysis.

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7.6 Meeting our Kyoto Obligations in CP1 – the Broad Choices

Section 4.9 presented the results of ABARE modelling of the economic impacts of different approaches to meeting our Kyoto obligations.

The Review has drawn the following conclusions from that analysis:

- **if New Zealand decides to adopt new policies sufficient to allow the nation to meet its Kyoto obligations <u>entirely through domestic abatement</u>, the cost to the economy will be <u>substantially higher</u> compared to the option of purchasing some units on the international market.**
- **more work is required to determine the <u>optimum trading strategy</u> for New Zealand, and the <u>optimum mix of new domestic abatement and international emissions trading</u>.**

- **<u>the total economic cost to New Zealand of excluding agriculture is high if New Zealand wishes to meet all its obligations through domestic abatement</u>. This is important, because as the Review has concluded in Section 4.8, there are practical limitations to imposing an emissions price on most agricultural emissions in the short term. If these limitations prevail in the design of future policy, this will amplify the potential advantages to New Zealand of using international emissions trading to meet at least some of its Kyoto commitments.**

7.7 Prospects for Reducing New Zealand's Domestic Emissions in CP1

It is estimated that New Zealand will face a deficit of 36.2 Mt CO_2-e in CP1. In order to meet our Kyoto commitment for this period, New Zealand must reduce its domestic (net) emissions by this amount, or purchase units internationally commensurate to this amount, or combine both approaches.

From the information currently available, it is not possible to determine exactly the extent of possible (cost-effective) domestic emission savings in CP1. This is dependent on a range of factors such as the rate of technological development, the outcomes of specific reviews, plus factors beyond New Zealand's control such as the relative price of agricultural and forestry products on the international market. Further to this, there is some uncertainty as to the exact deficit that New Zealand will face in CP1. Again, this is dependent on a wide variety of factors such as the level of economic activity in New Zealand and offshore, the price of oil, and a range of issues relating to the measurement of our Kyoto obligations.

It is important however to gain a general feel for the level of domestic emission reductions that are possible in CP1. These should be regarded as potential emission reductions which are possible regardless of whether New Zealand chooses to employ a PBM, or regulatory or support-based policies in CP1. Depending on the mix of policies New Zealand employs in CP1, not all of these savings will be "unlocked". The list below does not aim to be comprehensive by any means, and it focuses on possible emission reductions that are likely to be cost-effective.

7.7.1 Opportunities to Reduce New Zealand's net emissions in CP1

Agriculture	Limited opportunities to reduce emissions in the short term. Opportunities exist around the changes at the margins of production system in the use of nitrogen fertilisers and of nitrogen inhibitors.
Energy	If implemented, the announced carbon tax is projected to achieve total savings of 13 Mt of $CO2_e$ across CP1, largely in the energy sector. It is recommended that decisions on energy-efficiency and renewable-energy programmes are made once the NEECS review is completed.
Forestry and Land-Use Change	Because relatively little carbon would be sequestered during CP1 from new forest planting, the potential for new plantings to affect our domestic net emission position in CP1 is relatively small. Changes in estimated deforestation rates would have some effect.

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Transport There are no obvious "big win" CO_2 emissions-reduction opportunities at present; rather, the opportunities will generally be through small, incremental gains. These gains may result in reductions in New Zealand's net emissions position of approximately 10% of its deficit although the costs associated with these gains is unclear.

It is unclear what level of domestic emissions reductions can be achieved in CP1 in a cost-effective manner. What does appear to be the case however is that the level of domestic reductions that can be achieved in a cost-effective manner is likely to be small relative to New Zealand's net emissions position. This is consistent with the results from the ABARE modelling. Given this, New Zealand would be prudent to meet its Kyoto commitment by, partially at least, purchasing some Kyoto-compliant units internationally.

7.8 A Strategy for Purchasing Kyoto units using the Kyoto "Flexible Mechanisms"

There are a variety of issues (i.e. identifying the most appropriate objectives for a buying strategy, determining the most appropriate risk profile and managing timing of entry into the market) that surround the development of an appropriate and effective purchasing strategy for New Zealand to acquire Kyoto-compliant units. These issues highlight the need for the Government to urgently commission a work programme, if the option of purchasing units to meet some of New Zealand's CP1 obligations is to be available.

Early commencement of this work would allow the greatest scope to develop a strategy that met purchasing objectives while managing fiscal risk. Given the considerable uncertainty that surrounds the future price of emission units, it would be preferable for New Zealand to be in a position to purchase at least some units during 2006.

A work programme should be commissioned to determine potential buying strategies for New Zealand that reflect New Zealand's objectives in this area and our risk profile, along with issues of management, timing and price. Given the considerable uncertainty that surrounds the future price of emission units, early agreement by the Government to a buying strategy may prove to very important.

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7.9 International Engagement

The international framework for dealing with climate change post-2012 is uncertain **[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]**

While there is a growing consensus within the international community that climate change poses significant global risks over the medium to longer term, there is a divergence in views about the required pace of change and the best way forward.
One "top down" approach is characterised by the definition of further emission reduction targets for developed countries in the near term based on projected long term climate change outcomes; such an approach might build on Kyoto Protocol or draw on

the tools developed in that framework. The alternative "bottom up" approach is focussed on technology development and deployment and sector specific policies and measures, with less attention given to achieving an explicit emissions target within a particular time frame. Within each of these broad approaches there are is a spectrum of possible specific arrangements, each with different nuances and implications.

The complexity of the climate change issue has also increased as countries' experience has demonstrated that securing emissions reductions is more difficult than originally anticipated. National economic interests, both short and long term, are now firmly in the mix when countries weigh up what action they are prepared to take on climate change. An increasing push for linkages between climate change and other agendas such as development, energy security and biodiversity is also apparent.

This uncertainty and complexity surrounding the evolution of a future international climate change framework combined with the difficulties New Zealand faces in reducing its emissions in the short to medium term entails important risks for New Zealand. International dialogue which leads to effective global action is essential to manage the degree of climate change we face. In addition, the particular circumstances and interests of Pacific Island Countries are important to New Zealand. There is a need also to manage the risk that an international process does not lead to a future framework which has a disproportionate impact on us. Our unique emission profile, economic structure, including the significance of agriculture and plantation forestry, and our geographic location means that we have particular interests which are not represented by other parties. The pace of emission reductions advocated by some countries would be difficult for New Zealand to deliver, without significant tradeoffs in other domestic policy objectives.

The next opportunity for international discussion on future action will be at the UN Climate Change Conference in Montreal, beginning 28 November. **[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]**

Kyoto parties will also discuss at Montreal whether to begin consideration of further commitments for Annex I parties to Kyoto.

[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

Looking beyond the UN Climate Change Conference, Montreal, ongoing international engagement to encourage effective action while managing the attendant risks to New Zealand will be required.

[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

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[withheld under OIA s6(a), s9(2)(g)(i), s9(2)(j)]

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Annexes

Annex 1: Background on forestry and rules

Forestry in New Zealand

Production forestry

- New Zealand has a forest resource that is a crop rather than a product of a natural ecosystem. This provides flexibility to manipulate the crop through management. Productivity and quality gains have also resulted from New Zealand's strongly developed forestry research and development capability. New Zealand recognises the important role that forests play as sinks and reservoirs of greenhouse gases. As at 1 April 2004, there were 1.82 million ha of sustainably-managed planted forest in New Zealand. The predominant species is *Pinus radiata*.

- More recently, there has been a decline in commercial forestry plantings, which has been driven by a combination of factors. These include: a relatively strong New Zealand dollar; substantial increases in shipping costs; negative sentiment attached to Government policy; tough international market conditions; and competition for land from alternative uses (which have pushed up land prices). There are no indications that the level of new planting will increase under current market conditions.

Indigenous forestry

- New Zealand indigenous forests represent a considerable reservoir of carbon. It is not known whether this reservoir is expanding or shrinking, but work is under way to monitor changes in indigenous forests (see the material on the Carbon Monitoring System below).

- Indigenous forests occupy 6.256 million ha, of which 5.187 million ha is owned by the Crown. The vast bulk of the Crown resource is managed for its conservation values. A further 1.069 million ha of natural forest is privately owned; half by Maori, with 124,000ha of this considered commercially viable for wood production under current market conditions. Less than 0.005% of New Zealand's total commercial wood production is from indigenous forests.

Climate change forestry policy for New Zealand: further detail

The significant policy areas that have been developed since the announcement of this policy package have included the PFSI and the FIFA. Work has also commenced on implementing the NZCAS to ensure New Zealand's ability to claim sink credits and account for deforestation.

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Permanent Forest Sinks Initiative

The PFSI enables forest owners to receive carbon credits in proportion to the carbon sequestered by a given stand, in return for covenanting (registered against the land title) and managing the land to create a continuous canopy forest. Under the contract, the Crown agrees to provide an amount of tradable carbon credits equal to the amount of carbon sequestered by new forest stand over CP1. Forest owners would receive "returns" only after the amount of carbon sequestered has been measured and verified. All costs and risks associated with the release of the carbon from a stand would be borne by the forest owner. Forest owners would also be liable for ongoing monitoring, verification and administrative costs.

The mechanism is voluntary. The only forests that will be eligible to earn carbon credits over CP1 are Kyoto forests. No restrictions are placed on the selection of species that may be planted under the mechanism.

The mechanism has wide-ranging benefits beyond climate change, including retiring marginal land, bringing benefits through biodiversity enhancement, soil and water conservation, and improved flood protection. Legislation is currently before the House of Representatives to establish the Permanent Forest Sinks Initiative.

Forest industry initiatives

The Government noted that without measures additional to the above policy package, the decision to retain sink credits and liabilities, including capped deforestation liabilities, would have the following consequences:

- New Zealand generally under-investing in new forest planting, leading to forgone economic benefit from additional carbon sequestration
- higher levels of agricultural emissions than would otherwise be the case, as new forests tend to displace agriculture
- fewer sink credits being generated in the future, perhaps limiting the Government's ability to utilise forest sinks to manage future risks and liabilities and protect New Zealand's competitive position
- increasing emission liabilities as a result of relatively higher rates of deforestation during CP1.

To address these issues, the Government agreed to assign a proportion of the credits (or an equivalent value) to provide incentives to retain and enhance forest sinks. The only implementation of this policy to date has been a package of measures intended to enhance the general profitability of forestry and wood processing through the FIFA. The FIFA measures were not directly tied to planting or replanting behaviour; therefore, any incentive effects for retaining or enhancing forest sinks is minimal. Initiatives under this package included market access, bioenergy, labour and skills, alternative species promotion, and market development.

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Monitoring carbon stocks and stock changes
Under the UNFCCC and the Kyoto Protocol, New Zealand is obliged to report greenhouse gas emissions and removals arising from LULUCF activities.

We have not yet fully defined "forest" in relation to Kyoto accounting but our definition is likely to differ from how we have previously reported vegetative cover and land use. Production forestry will certainly be included, as will exotic and native trees planted for soil and water protection and biodiversity enhancement.

The overall aim of the NZCAS is to provide a robust and comprehensive accounting and reporting system that meets the IPCC's Good Practice Guidance and:

- is appropriate for UNFCCC LULUCF sector reporting
- enables reporting under Article 3.3 of the Kyoto Protocol in the first (and subsequent) commitment periods
- ensures New Zealand's eligibility to participate in international carbon trading
- supports and underpins New Zealand climate change policy development through to 2012 and beyond.

The NZCAS comprises five modules: natural forests (indigenous forest and scrublands); planted forests (both pre- and post-1990 plantings); a soil carbon monitoring system; land-use monitoring; and a database to store all point and spatial data and provide an accounting and reporting function.

The Carbon Monitoring System for indigenous forest and scrublands will be fully in place by May 2007. Some 1400 grid point locations meeting the land-cover criteria have been identified and randomly allocated to a five-year cycle to install the permanent plots. The system is expected to also consolidate and standardise existing forest information currently held by various agencies.

The United Nations Framework Convention on Climate Change and the Kyoto Protocol

Convention and Protocol articles

Article 4.1 (d) of the UNFCCC calls on all signatories to the Convention to:

> "promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs… including biomass, [and] forests..."

The UNFCCC defines a "sink" as "any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere". A growing forest is a sink. A "reservoir" is a component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored. Forests can also be "reservoirs" for carbon dioxide.

The development of the international agreement on "sinks" has evolved to cover emissions and removals of greenhouse gases resulting from LULUCF. Activities in the

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LULUCF sector can mitigate and/or contribute to climate change. The relevant Kyoto Protocol Articles with respect to LULUCF are:

Article 3.3 of the Kyoto Protocol

The net changes in greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990, measured as verifiable changes in carbon stocks in each commitment period, shall be used to meet the commitments under this Article of each Party included in Annex I. The greenhouse gas emissions by sources and removals by sinks associated with those activities shall be reported in a transparent and verifiable manner and reviewed in accordance with Articles 7 and 8.

Article 3.4 of the Kyoto Protocol

Prior to the first session of the Conference of the Parties serving as the meeting of the Parties to this Protocol, each Party included in Annex I shall provide, for consideration by the Subsidiary Body for Scientific and Technological Advice, data to establish its level of carbon stocks in 1990 and to enable an estimate to be made of its changes in carbon stocks in subsequent years. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session or as soon as practicable thereafter, decide upon modalities, rules and guidelines as to how, and which, additional human-induced activities related to changes in greenhouse gas emissions by sources and removals by sinks in the agricultural soils and the land-use change and forestry categories shall be added to, or subtracted from, the assigned amounts for Parties included in Annex I, taking into account uncertainties, transparency in reporting, verifiability, the methodological work of the Intergovernmental Panel on Climate Change, the advice provided by the Subsidiary Body for Scientific and Technological Advice in accordance with Article 5 and the decisions of the Conference of the Parties. Such a decision shall apply in the second and subsequent commitment periods. A Party may choose to apply such a decision on these additional human-induced activities for its first commitment period, provided that these activities have taken place since 1990.

Under Article 3.3 of the Kyoto Protocol, parties have decided that greenhouse gas removals and emissions through certain activities — namely, afforestation and reforestation since 1990 — can be used to meet a country's emission targets. Conversely, activities that deplete forests, namely deforestation, are to be subtracted from the amount of emissions that an Annex I Party may emit over the commitment period. Article 3.4 of the Protocol enables parties to elect additional land-use activities.

The Marrakech Accords[149] provide additional detail to the Kyoto Protocol text. They elaborate definitions and the accounting for the activities described in Table 31 below.

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149 See <www.unfccc.int/resource/docs/cop7/13a01.pdf#page=54>

Table 31 - Summary of LULUCF Activities

Activity	Kyoto Protocol Article	Start	Accounting	Base year	Cap
Afforestation	3.3	"to have begun on or after 1 January 1990"	Mandatory	Gross-net	
Reforestation					
Deforestation					
Forest management	3.4	"to have occurred since 1 January 1990"	Voluntary		Cap per country
Revegetation				Net-net	No cap
Cropland management					
Grazing-land management					

Source: Marrakech Accords

Article 3.3 of the Protocol - Kyoto forests

Under Article 3.3, it is mandatory for New Zealand to account for greenhouse gas emissions and removals as a result of new forest planting since 1990. New forests planted since 1990 are commonly referred to as Kyoto forests. Deforestation can occur on any forest land regardless of when that forest was first established. Non-Kyoto forests refer to forests established prior to 1990 and subsequently replanted following harvest post-1990.

The harvesting of *Pinus radiata* production forest planted post-1990 would not normally occur until 2020 at the earliest. So, to a large extent, the harvesting rules are only hypothetical at this stage.

"Forest" is defined under the Marrakech Accords, which provide additional detail to the Kyoto Protocol text. New Zealand's elected choice of parameters is bolded within the following definition. "Forest" is a minimum area of land of 0.05 to **1.0**ha with tree crown cover (or equivalent stocking level) of more than 10 to **30**%, with trees with the potential to reach a minimum height of 2 to **5** metres at maturity *in situ*. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest. Young natural stands and all plantations that have yet to reach a crown density of 10 to 30% or tree height of 2 to 5 metres are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest.

The activities of afforestation, reforestation and deforestation are further defined as follows.

"Afforestation" is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources.

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“Reforestation” is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For CP1, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989.

“Deforestation” is the direct human-induced conversion of forested land to non-forested land.

Article 3.4 of the Kyoto Protocol – forest management

Under Article 3.4 of the Kyoto Protocol, New Zealand can elect which additional Article 3.4 LULUCF activities, if any, it wishes to account for in CP1. The election of these activities is voluntary for Annex I Parties such as New Zealand.

Benefits and liabilities under the Kyoto Protocol

As well as providing benefits, the Protocol also imposes a number of liabilities and obligations on New Zealand. In the first instance, all benefits, liabilities and obligations under the Protocol arise to the Crown.

Table 32 below indicates the benefits and liabilities for New Zealand’s forest sinks under current Kyoto rules.

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Table 32 – Kyoto and non-Kyoto Forest Sink Credits and Liabilities

Sink Credits and Harvesting/Deforestation Liabilities (CP1) for Kyoto and non-Kyoto Forests			
	Sink Credit Benefits	**Emissions Liability upon Harvest**	**Emissions Liability Upon Deforestation**
Kyoto forest (forest planted on land since 1990 that was in some other land use on 31 December 1989)	Yes. Equal to the carbon sequestered over CP1 on eligible lands	Yes. Equal to the carbon released through harvesting **but** not more than the sink credits received over the same period	Yes. Equal to the carbon released at harvest
Non-Kyoto forest (established pre-1990 – also applies to forest that has been replanted following harvest after 1990)	Yes, if this activity is elected under Article 3.4 ("forest management"). However, this is subject to a cap (NZ – 1 MtC over CP1)	Yes, if this activity is elected under Article 3.4 ("forest management") and equal to the change in carbon stocks on the land accounted for over the CP1 No, if this activity is not elected under Article 3.4 ('forest management') and forest is replanted	Yes, whether or not "forest management" is elected and equal to the carbon released at harvest

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Slightly anomalous rules exist within the Kyoto Protocol in terms of the way Kyoto forests and non-Kyoto forests are treated. This distinction is, to some extent, artificial.

These rules mean that New Zealand faces the liability associated with the deforestation (felling and not replanting) of non-Kyoto forests but does not face any liability associated with harvesting (felling and replanting) non-Kyoto forests. In contrast, however, New Zealand faces a liability associated with both the deforestation and harvesting of Kyoto forests.

There is one further major difference between the treatment of Kyoto forests and non-Kyoto forests in terms of treatment under the Protocol. The liability faced by New Zealand on the harvesting of Kyoto forests is limited to the amount of carbon claimed previously from that forest. This does not apply to non-Kyoto forests.

On deforestation of a non-Kyoto forest, the entire carbon liability in the forest is faced by New Zealand. If a non-Kyoto forest is deforested prior to 2008, however, New

Zealand does not face any liability (although New Zealand is liable for any resulting emissions from agriculture on that land).

In general, the number of credits (or debits) generated under Article 3.3 is equal to:

> carbon in Kyoto Forests as at 31 December 2012 minus
> carbon in Kyoto Forests as at 1 January 2008 minus
> (carbon as at 1 January 2008 in lands deforested between 1 January 1990 and 31 December 2012 minus carbon as at 31 December 2012 in lands deforested between 1 January 1990 and 31 December 2012).

Note that deforestation requires both the harvesting of trees and a conversion in land use. If the forest is harvested and replanted or even left to naturally regenerate, it does **not** create a deforestation liability because there has been no land-use change.

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Annex 2: The role of non-climate policies in a sustainable forestry framework

Production forestry also offers a range of co-benefits, including improved water quality, erosion control, and biodiversity. Reference is made here to these key non-climate policies and programmes.

In addition to the above climate change policies, there are a range of other policies and programmes that contribute to positive climate change outcomes. These are listed here in Annex 2, but not discussed in detail. Some will have a greater role in future should international negotiations require the accounting of all land-use activities.

East Coast Forestry Project

The East Coast Forestry Project addresses eroding soils on pastoral land in the Gisborne Region by encouraging sustainable land use through a contestable fund for landowners to plant trees or allow the land to revert to scrub.

The aim of the project is to cover 60,000ha of the most erosion-prone land in trees and encourage retirement of some land so it can revert to native forest. Since the project's inception in 1992, 32,000ha of planted forest has been established. This includes about 17,000ha of the targeted at-risk land with the balance being adjacent land established to form sustainable forest management stands.

Biosecurity Act 1993

The importance of biosecurity for forestry in terms of loss of productivity resulting from an incursion of a damage-causing pest is obvious. Under current policy, the Government has a vested interest to ensure that forest resources that generate forest sink credits are adequately protected. Any reduction in carbon stocks results in liabilities.

Forest biosecurity has both active and passive surveillance programmes in place that are developed to detect the emergence of any previously unknown pest, and to detect any changes in the health status of New Zealand's commercial and urban forests. The forestry industry recognises this critical issue and the majority of corporate investors operate (or contribute to) regular monitoring programmes.

Sustainable-development frameworks

The Government has in place a number of statutes that create the conditions for sound management of natural and physical resources. The New Zealand forestry industry and its processing sectors rely heavily on the quality of these natural and physical resources.

In addition to this, the Government is developing, improving and supporting existing systems such as environmental indicators for land, research, new policy tools, market incentives and regulations.

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The **RMA** promotes the sustainable management of natural and physical resources. Its core purpose is to help achieve sustainability in New Zealand. The Act governs the use and development of our land, air and water resources, concentrating on managing the environmental effects of human activities.

The overriding purpose of the **Soil Conservation and Rivers Control Act 1941** is to provide for the conservation of soil resources and the prevention of damage by erosion, and to better provide for the protection of property from damage by floods. A number of activities are undertaken by regional councils under this Act, including the use of forestry for catchment-control purposes.

Regional councils also undertake farm planning programmes under the **Local Government Act 2002**. The use of **Environmental Farm Plans** offers a method for local government to give landowners technical and scientific information that is matched to their individual property, including the planting of trees where this is a more appropriate land use than current alternatives.

Space planting of trees on hillsides, the establishment of protection and production-protection forests and farm woodlots have all provided slope stability to significant areas. Much of this work has been achieved through cost-sharing programmes involving Government, local government and landowner funds. The various regional programmes administered by regional councils continue this work, along with contributions from individual planting by farm foresters and forestry companies.

Other policies – Article 3.4 and full carbon accounting

Many other non-climate policies and programmes contribute to climate change outcomes and could assist any move to fuller carbon accounting (eg, accounting for practices under Article 3.4).

Sustainable Forest Management under the Forests Act 1949 (Part IIIA)

MAF administers the indigenous forestry provisions of the Forests Act 1949, under which indigenous timber can be produced only from forests that are managed within acceptable ecological limits, so that they are maintained in perpetuity.

Research on forestry

Crown Research Institutes such as Scion (New Zealand Forest Research Institute) and Landcare Research undertake research on forestry management and biomaterials science. This work also contributes to the development of the NZCAS.

The School of Forestry at the University of Canterbury examines the multiple benefits of forestry. The findings from this research are published nationally and internationally. This research investigates such issues as biosecurity, conservation biology, forest ecology, forest soils and silviculture of indigenous forests.

The Sustainable Farming Fund, administered by MAF, provides project-based grant funding to help the land-based primary production sectors solve problems and take up opportunities to overcome barriers to economic, social and environmental viability. The Fund has funded a number of forestry-related projects.

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Queen Elizabeth the Second National Trust

The Trust was established by the Queen Elizabeth the Second National Trust Act 1977 "to encourage and promote the provision, protection and enhancement of open space for the benefit and enjoyment of the people of New Zealand".

The trust works with a wide range of people and organisations, from individual land owners through to representatives of local and central government. The trust receives base funding from the Crown, along with funding for biodiversity advice and condition-improvement funding. It also receives donations from organisations and private individuals.

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Annex 3: Policy criteria

Regardless of the uncertainties outlined in the forestry Section (4.6) about future arrangements on land-use change and forestry, or interpretation of the current rules on LULUCF, policy criteria are needed to guide the inclusion of climate change considerations into land-use change and forestry decisions out to 2020. The policy criteria are not mutually exclusive and achieving some of them will help to achieve other criteria.

The consideration of forestry and land-use change in the medium term (to 2020) should involve making policy choices based on the following criteria.

Appropriate land-use signals: Appropriate signals are sent to decision-makers involved in land use and land-use change regarding the Government's overall climate change goal and any obligations under international climate change arrangements (such as the Kyoto Protocol). This means that foresters, potential foresters and landowners face appropriate incentives to invest or divest in forestry, taking into account as many costs and benefits as possible. This includes economic costs and benefits and Kyoto Protocol/climate change implications.

Reduction of uncertainty: This requires reducing the uncertainty facing forest owners about both the international situation and domestic policy settings. This could include the removal or reduction of uncertainty around how liabilities will be treated during CP1. Similarly, it could also involve less uncertainty around the treatment of forest benefits and liabilities post-2012.

Resilience: Any policy response needs to be robust and effective over time under new international climate change frameworks or changes in targets and rules within existing international frameworks. Resilience also includes adjusting to achieve any change in New Zealand's overall climate change policy goal and being able to achieve other Government non-climate policies. Furthermore, this resilience also includes and provides for flexibility in land-use decision-making, given the appropriate signals discussed above.

Equity: Any policy response needs to consider equity between the treatment of different land uses and different forests (ie, Kyoto forests versus non-Kyoto forests), and in relation to other parts of the economy.

Sector acceptance of policy: Acceptance of the policy will aid its implementation. This includes acceptance by the owners of Kyoto forests and non-Kyoto forests.

Maximising co-benefits: There are other positive externalities that may arise from the climate change policy when applied to forestry (eg, soil conservation benefits, nutrient management and biodiversity). To the extent possible, these should be maximised.

Minimisation of Crown fiscal risk: There may be fiscal risks for the Crown; eg, retention of liabilities, or deadweight costs for the economy associated with devolution where expenditure results in no behaviour change, only a wealth transfer.

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International obligations: The policy is consistent with New Zealand's international obligations (eg, the World Trade Organisation and bilateral-trade agreements and other multilateral environmental agreements such as the CBD).

Note that the options outlined in this section were not assessed against this criterion, because greater detail about each option is required in order to assess the implications of the options against any international obligations.

Feasibility: The practicality of the policy approach (eg, data needs, monitoring requirements, compliance requirements, transaction costs and enforceability).

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Annex 4: The European Union Emissions Trading Scheme

Box 5: The European Union Emissions Trading Scheme (EU ETS)

The largest and most publicised carbon market is the European Union Emissions Trading Scheme (EU ETS). This works through 25 countries and covers emissions from four broad sectors:

- production and processing of iron and steel
- minerals (eg, cement, glass)
- energy
- pulp and paper (forestry is not included, the focus is on industrial emitters).

This is a cap-and-trade system (ie, an overall cap is placed on emissions and trading may occur within the cap). It covers about 45% of European Union CO_2 emissions or 30% of its overall greenhouse gas emissions (CO_2 emissions only are covered in the EU ETS).[150] In total, 12,000 installations are covered in the EU ETS.

European Union Member State governments are required to set an emission cap for all installations covered by the scheme. Within this cap, each installation is allocated emission allowances for the particular commitment period in question (the EU ETS covers the 2005 to 2007 period and then the 2008 to 2012 period).

A company can purchase allowances on the EU ETS if it plans to pollute more than its allocated number of allowances would imply. Similarly, it can sell allowances if its emissions reduce. Considerable penalties apply if a firm has insufficient permits to cover its emissions. Given this, an incentive operates for polluters to invest in technologies/work practices to reduce their emissions – if the cost of reducing emissions is less than the cost of purchasing allowances then it is sensible for firms to reduce emissions (and vice versa).

For the second period of the EU ETS (2008 to 2012), there will be the ability for member states to use the Kyoto flexibility mechanisms (the CDM and JI initiatives – credits from nuclear facilities and land-use change and forestry activities are not accepted).

There is a limit on the number of emission permits allowed to enter the EU ETS through the Kyoto flexibility mechanisms. This means that much of the CO_2 mitigation must occur within the European Union (and reflects a specific European Union policy decision). As a result, the price of emissions permits within the EU ETS is significantly higher than the price of emission reduction units under the Kyoto flexibility mechanisms.

[150] Consideration is being given to including other sectors of the economy and other greenhouse gases in the EU ETS.

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Annex 5: Computable General Equilibrium Model

Outline of the Global Trade and Environment Model

ABARE has developed a computable general equilibrium model known as the Global Trade and Environment Model (GTEM) to specifically address policy issues with global dimensions. ABARE developed GTEM from the internationally respected Global Trade and Analysis Project (GTAP) model, developed at Purdue University (Indiana, USA), which is used worldwide for global trade analysis. GTEM simulates the impact of policy changes or specific events on a large number of economic variables of a particular national/regional economy, including GDP, consumption, production, trade, investment, greenhouse gas emissions and carbon prices.

Computable general equilibrium models such as GTEM are built up from microeconomic foundations and account for all transactions within an economy. Depending on the level of sophistication of the specific model, the model can represent a diverse range of economic agents, including households, industries, regions, government(s), investors and international trade.

The strength of computable general equilibrium models for climate change modelling lies in their detailed representation of industry, captured through the input-output tables. The input-output structure of the models traces resources and materials used in the economy, starting with the production of raw materials from agriculture and mining through to final products for consumption or trade. The accounting of emissions and prices from raw materials to final goods can easily be represented in this input-output structure, and shows how carbon is integrated into the production chain.

GTEM can represent up to 68 regional economies (corresponding to individual countries or country groups) that are linked through trade and investment flows, allowing for detailed analysis of the direct as well as flow-on impacts of policy and changes for individual economies – the model tracks intra-industry trade flows as well as bilateral trade flows, allowing for detailed trade policy analysis. The detailed international trade links are important, as these determine where production, particularly carbon-intensive production, will shift as international abatement costs increase.

GTEM is a dynamic model accounting for capital and debt accumulation and solving for population growth, which enables the model to account for transactions between sectors and trade flows between regions over time. As a dynamic model, it accounts for the impacts of changes in labour force and investment on a region's production capabilities.

GTEM has a comprehensive international greenhouse emissions database accounting for combustion and non-combustion carbon dioxide, methane and nitrous oxide emissions, which account for around 98% of global anthropogenic greenhouse gas emissions. Methane and nitrous emission from waste and agriculture residues, and synthetic and industrial-process emissions, are not covered in the emissions database.

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GTEM has a detailed representation of international energy supply and demand. The database distinguishes a number of different fuels, including three types of coal (brown coal, or lignite; black coal, or steaming coal; and coking coal), natural gas and oil. Electricity may be generated through seven technology types, including brown coal, steaming coal, oil, natural gas, nuclear (New Zealand uses no nuclear energy by assumption), hydroelectricity and geothermal, and other renewables (eg, biomass and wind generation), and generation by technology substitutes with the relative cost of generation.

Other considerations

As with all models, GTEM has imperfections from a policy-analysis viewpoint.

GTEM is only able to estimate the economic costs associated with climate change abatement policies and cannot project the economic impact of climate change.

The technology response in GTEM to climate change policies is limited. Increasing the costs imposed on carbon-intensive industries will reduce emissions intensity through fuel switching (eg, natural gas for coal), substituting towards less carbon-intensive industries (eg, steel making in electronic arc furnaces from blast iron furnaces), and new proven technology may be introduced as it becomes economic. However, GTEM (as with most economic models) is unable to solve for endogenous technical change, such as new energy-saving technology, alternative fuels and research and development.

The most recent official input-output table for New Zealand from Statistics New Zealand represents 1995/96. Although the input-output table has subsequently been updated using synthetic methods, the method of updating does not guarantee the database represents the current structure of the New Zealand economy. Typically, computable general equilibrium model results have not been overly sensitive to updates in the official input-output tables.

GTEM does not include waste-sector emissions and policy options for abatement in the waste sector. Furthermore, forestry sinks and land-use and land-use-change emissions are not policy responsive in the model.

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GLOSSARY OF TERMS

Afforestation
Planting new forests on lands that historically have not contained forests.

Annex I Parties
The industrialised countries listed in this Annex to the Convention, which have sought to return their greenhouse gas emissions to 1990 levels by the year 2000 as per Article 4.2 (a) and (b). They have also accepted emissions targets for the period 2008 to 2012 as per Article 3 and Annex B of the Kyoto Protocol. They include the 24 original OECD members, the European Union, and 14 countries with economies in transition. (Croatia, Liechtenstein, Monaco, and Slovenia joined Annex 1 at COP-3, and the Czech Republic and Slovakia replaced Czechoslovakia.)

ARC
Auckland Regional Council.

ARTA
Auckland Regional Transport Authority.

Biofuels
Fuels derived from biomass – organic plant matter, in particular wood and biogas, either deliberately grown or from waste products.

Biomass
In the energy context, any recent organic matter originally derived from plants as a result of the photosynthetic conversion process.

Carbon dioxide equivalent
A measure used to compare different greenhouse gases based on their contribution to climate change. The UNFCCC currently (2005) uses global warming potentials (GWPs). The GWPs are calculated as the ratio of the radiative forcing of one kilogram of greenhouse gas emitted to the atmosphere to that of one kilogram of CO_2 over a period of time (100 years).

CNG
Compressed Natural Gas, a substitute for gasoline or diesel fuel. It is considered to be an environmentally "clean" alternative to those fuels. It is made by compressing purified natural gas, and is typically stored and distributed in hard containers.

CO
Carbon monoxide, a colourless, odourless, flammable and highly toxic gas. It is a major product of the incomplete combustion of carbon and carbon-containing compounds.

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CO_2
Carbon dioxide, the main greenhouse gas emitted from the energy sector.

COP
Conference of the Parties.

COP/MOP
Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol.

Deforestation
The direct human-induced conversion of forested land to non-forested land.

EECA

Energy Efficiency and Conservation Authority.

EIB

Energy-intensive businesses.

Emissions trading

A mechanism under the Kyoto Protocol through which parties with emissions commitments may trade units of their emissions allowances with other parties. The aim is to improve the overall flexibility and economic efficiency of making emissions cuts.

Energy efficiency

Defined by the EECA Act 2000 to mean a change to energy use that results in an increase in net benefits per unit of energy.

EnergyWise Rally

The EnergyWise Rally, a public demonstration of the fuel efficiency and environmental friendliness of new cars, conducted over a challenging mixture of roads from one end of the North Island to the other.

EU

The European Union, an inter-governmental and supra-national organisation made up of European countries. It currently has 25 member states.

Fuel economy

Usually expressed as the amount of fuel used per unit distance; for example, litres per 100 kilometres (L/100 km). In this case, the lower the value, the more efficient a vehicle is.

GHG

See Greenhouse gas, below.

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Govt^3
A programme for government agencies to improve the sustainability of their activities. The "Govt" in Govt^3 stands for "government" and the "3" stands for the "three pillars of sustainability": environmental, social, and economic.

Greenhouse gas
A gas in the atmosphere that retains more energy from outgoing infra red radiation than from incoming solar radiation. These gases are responsible for causing global warming and climate change. The major greenhouse gases are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_20). Less prevalent - but very powerful - greenhouse gases are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

Hybrid vehicles
Fuel-electric **hybrid-fuelled** vehicles that can use conventional fuels (eg, petrol or diesel) and electricity, generally via a battery and motor. These can use either fuel in a hybrid manner, with respective conversion devices to provide propulsion. So, they are most accurately termed hybrid fuelled, which implies that they can also be hybrid powered.

International transport
For the purpose of the national inventory, any trip (carrying passengers and freight) between countries by air or sea. It does not include operations carried out within a country by foreign operators. These are considered domestic trips and are included in that country's inventory.

IPCC
Intergovernmental Panel on Climate Change.

Kyoto Protocol
An international agreement standing on its own and requiring separate ratification by governments, but linked to the UNFCCC. Among other things, the Protocol sets binding targets for the reduction of greenhouse gas emissions by industrialised countries. The Protocol entered into force on 16 February 2005.

Land use, land-use change, and forestry (LULUCF)
Refers to the impact of human land use - and changes in such land use - on greenhouse gas emissions. Expanding forests reduce atmospheric carbon dioxide; deforestation releases additional carbon dioxide; various agricultural activities may add to atmospheric levels of methane and nitrous oxide. These gases, however, are not part of the LULUCF sector.

LPG
Liquified Petroleum Gas, a mixture of hydrocarbon gases used as a fuel in vehicles. It is also increasingly replacing fluorocarbons as an aerosol propellant and a refrigerant to reduce damage to the ozone layer.

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Marrakesh Accords
Agreements reached at COP-7 that set various rules for "operating" the more complex provisions of the Kyoto Protocol. Among other things, the accords include details for establishing a greenhouse gas emissions trading system; implementing and monitoring the Protocol's CDM; and setting up and operating three funds to support efforts to adapt to climate change.

NEECS
National Energy Efficiency and Conservation Strategy.

Non-Annex I Parties
Countries that have ratified or acceded to the UNFCCC and that are not included in Annex I of the Convention (ie, developing countries).

NO_X
Generic term for a group of highly reactive gases - oxides of Nitrogen. Nitrogen oxides form when fuel is burned at high temperatures, as in a combustion process in vehicles. NO_2 (nitrogen dioxide) is one the compounds responsible for smog and is a health concern causing respiratory problems.

Note: Nitrous oxide (N_2O) is not a concern in regard to local air quality and is not regulated for as part of controlling vehicle toxic emissions. It is generally not considered to be part of the NO_X family.

OnTrack
Owner and manager of New Zealand's railway infrastructure.

Particulates
Tiny particles of solid or liquid suspended in the air. Of concern are those of 10 microns or less (PM10) in diameter, which behave like a gas entering the lungs and cause respiratory problems. Also referred to as “fine particles”.

PJ
Petajoule, a unit of energy equal to 10^{15} joules.

Reforestation
Replanting forests on land that was previously forested but subsequently converted to other use.

Reservoir
A component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored. Trees are "reservoirs" for carbon dioxide.

RMU
Removal unit (generated among Annex I Parties by LULUCF activities that absorb carbon dioxide). Commonly referred to as “sink credits” or “carbon credits”.

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Road user charge
The road user charge applies to all diesel vehicles and every vehicle (regardless of motive power) over 3.5 tonnes. It is used to fund infrastructure costs that, for petrol, are covered by excise duty.

Sink
Any process that removes a greenhouse gas from the atmosphere. The major sinks are forests and other vegetation that, through photosynthesis, remove carbon dioxide. Under the Kyoto Protocol, developed countries, in their calculation of net greenhouse gas emissions, may deduct from their totals the removal of greenhouse gases through the expansion of sinks. That may help them to meet their mandatory emissions targets. However, calculating the effects of sinks is methodologically complex and the standards for doing so still need to be clarified.

Travel demand management (TDM)
Tools and programmes offering people better travel choices and encouraging them to reduce the negative impacts of their travel (including choosing not to travel if circumstances allow).

Toll NZ
A freight transport and distribution company. The Company offers an integrated national network of rail, road and sea freight transportation, distribution and logistics management services, and interisland and urban passenger services.

UNFCCC
United Nations Framework Convention on Climate Change.

Walking school bus
A fun, safe and active way for children to travel to and from school with adult supervision. Each bus walks along a set route with at least one adult "driver", picking children up at designated stops and walking them to school. The process is reversed in the afternoons.

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