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.

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

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.

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.

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.

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.

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.

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)

- 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).

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>

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.

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.

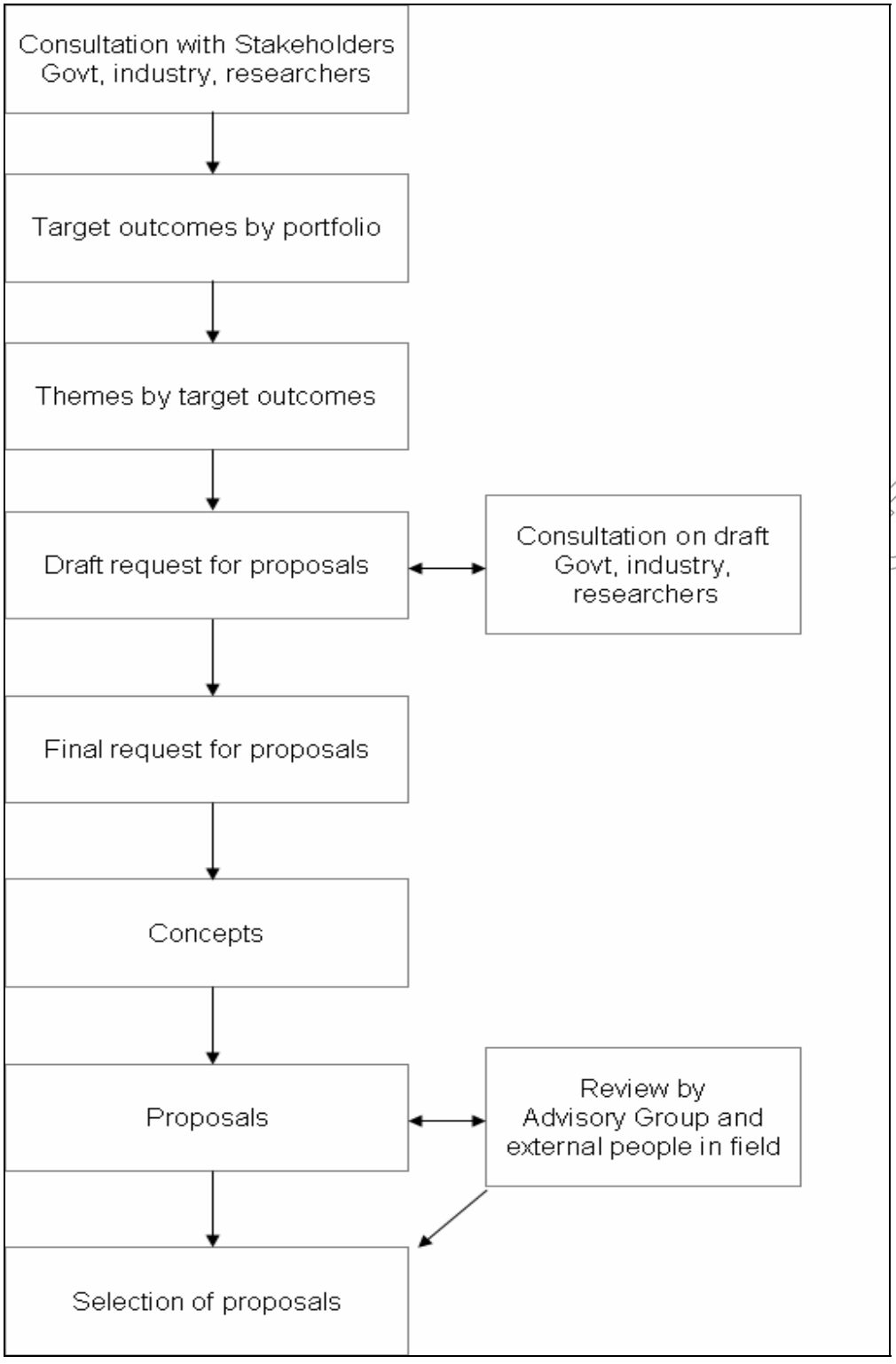
Priority setting

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.

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.

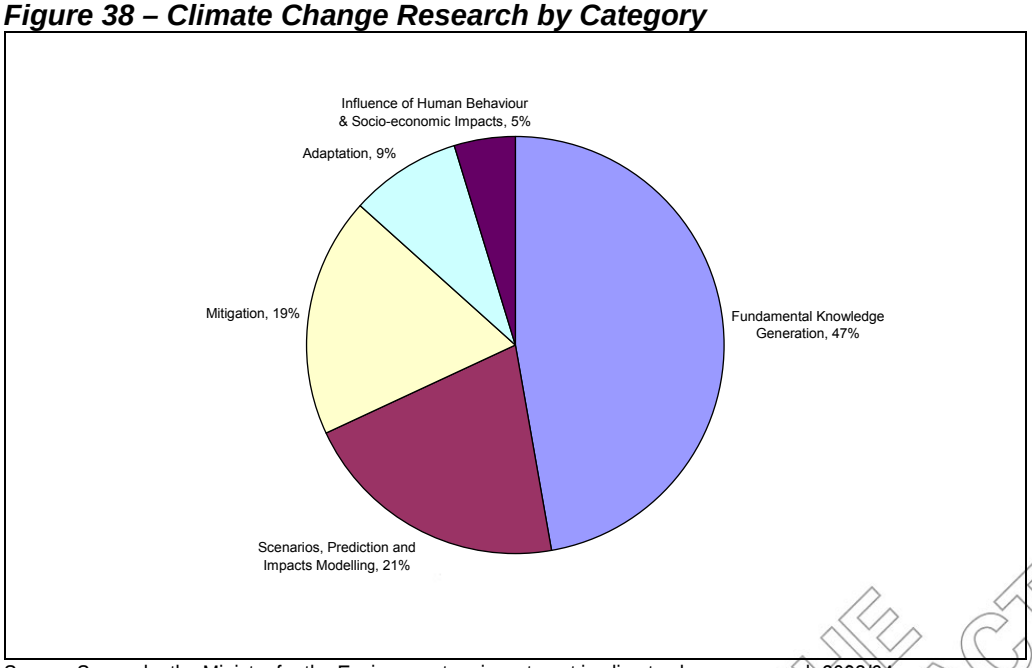
Current New Zealand climate change mitigation research and development

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

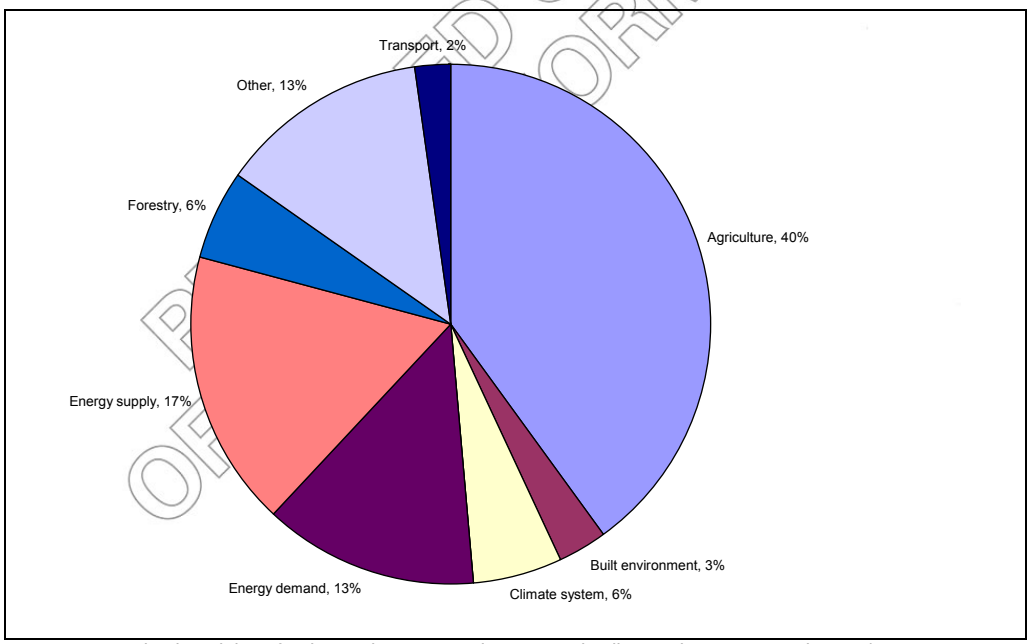


Source: Survey by the Ministry for the Environment on investment in climate change research 2003/04

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

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).

[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.

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.

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

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).

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.

[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.

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

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.

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.

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>

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.

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.

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.

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.

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.

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.

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.

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

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.

[withheld under OIA s9(2)(f)(iv)]

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.

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.

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.