CAWTHRON

Scoping Report For An Environmental Assessment Of The NZ Emissions Trading Scheme And Closely Related Measures

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Prepared for the

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EXECUTIVE SUMMARY

Background

In early December 2007, the government introduced into Parliament the Climate Change (Emissions Trading and Renewable Preference) Bill ("the Bill") to provide the statutory framework for a New Zealand Emissions Trading Scheme (ETS). The Bill has been referred to the Finance and Expenditure Committee.

In addition to the ETS, the government has announced a range of other climate change-related measures. These include provision in the Bill for a statutory preference for renewable energy for electricity generation, a separate Biofuels Bill that implements a Biofuel Sales Obligation, the Afforestation Grants Scheme, the New Zealand Energy Strategy and the New Zealand Energy Efficiency and Conservation Strategy. In order to better define the scope of this study, the project has identified a subset of measures from within this broad package that are closely related to the ETS[1]. This set of closely-related measures, together with the ETS, is collectively referred to in this report as "the ETS-plus".

Through the use of price signals and other mechanisms in the closely related measures, the ETS-plus is intended to result in changes to land and natural resource use, patterns of economic activity and operational practices, in order to find the least cost ways of reducing emissions and meeting New Zealand's international obligations.

In addition to promoting a transition to a lower-emission economy, however, these changes in economic activity have the potential to affect the natural and physical environment in a variety of other ways that can be both positive and negative.

The ETS-plus is designed to operate in conjunction with pre-existing environmental legislation and policies, such as the Resource Management Act 1991 (RMA) and the New Zealand Biodiversity Strategy (NZBS). In many cases, existing policies will be sufficient to address the potential environmental effects of the ETS-plus. In some cases, however, additional policy responses might be required.

Purpose of this scoping report

This scoping report aims to identify potential environmental effects of the ETS-plus at a high level over the period 2008 to 2020, identify possible response measures to address these effects, and identify areas where further environmental assessment is

[1] A full description of the suite of measures included in "ETS plus" is included in Appendix 2.

warranted. However, it is not a detailed environmental assessment that attempts to quantify all potential impacts.

The purpose of assessing environmental effects is, in this case, not to assess whether or not to implement an ETS. In the absence of an ETS, the government would likely implement alternative regulatory and policy measures to accomplish its policy objectives, including meeting New Zealand's commitments under the Kyoto Protocol (and any successor agreement) and its objectives under the New Zealand Energy Strategy. Any such alternative policies would also be expected to have some flow-on environmental effects, both positive and negative.

New Zealand entities with emissions obligations under the ETS can satisfy these obligations by choosing the least costly combination of directly reducing emissions or purchasing domestic or international emission units (where doing so is consistent with supporting and encouraging global efforts to reduce emissions). For instance energy suppliers will purchase emission units, domestically or offshore, to account for the emission obligations associated with energy consumption that continues after energy efficiency and conservation efforts.

Complementary measures can help to reduce the reliance on international units, because relying on such units could lead firms and households to embed long-lived high emission technology and infrastructure into the economy and defeat the long term objective. For example, given that agriculture does not enter the ETS until 2013, it is important that changes start being made now to avoid embedding a land use pattern that is unsustainable and costly to reverse. Similar considerations apply to transport and to buildings. In some cases, the current price signal cannot be relied upon to alter decisions that have significant long term consequences, e.g. capital investments and patterns of land use that last for decades rather than a few years. Complementary measures can help address this.

The report assesses the potential environmental effects of the ETS-plus against a base case scenario of policies that were in place on 1 January 2008. It does not, therefore, attempt to assess the ETS-plus against possible alternative designs of the ETS and/or the closely related measures, except to comment on where alternative settings or additional measures might be necessary to reduce the potential for adverse effects or to secure beneficial effects of the ETS-plus.

Potential environmental effects identified in this report should be interpreted as increased or decreased "pressures" on the environment; whether they become actual effects depends on how those pressures are managed.

This report is neither a strategic environmental assessment nor a comprehensive environmental impact assessment – rather, this scoping study identifies where further environmental assessment is warranted.

Sources of uncertainty

The environmental effects that arise from implementation of the ETS-plus are subject to a number of significant sources of uncertainty, including:

- the stringency of international commitments post 2012 and hence the price of emission units (i.e. carbon) on the international market that will be transmitted to New Zealand's ETS;
- the extent to which governments in other countries expose their industries to this price of carbon;
- the price of oil, gas and other forms of energy, both renewable and fossil fuel-based;
- the rate at which climate change occurs and how it affects New Zealand; and
- the emergence of new low-emission technologies and management practices in response to the ETS price signal;

plus two factors that can be influenced more directly by the government:

- the final design of the ETS-plus, for example the point of obligation for the agriculture sector;
- the behavioural response of individuals and organisations to the ETS-plus policies.

Most of these factors are not "discoverable" through further research in advance of ETS implementation, which therefore constrains the nature of any environmental assessment, in particular the degree of detailed investigation that can usefully be undertaken. Nevertheless, a qualitative assessment can serve to identify likely directions of change and to highlight areas where there is significant potential for environmental effects, positive or negative, to arise as a result of the ETS-plus. Further investigation can also help to inform the final design of the ETS-plus.

The conclusions presented in this report are based on information collected from stakeholders and officials at a workshop on 25 January 2008 and in subsequent discussions, a number of reports on the ETS and on New Zealand's environmental management more generally, and the experience and expertise of the authors.

The remainder of this summary briefly describes the most significant potential environmental effects of the ETS-plus and priority policy measures to address them, and then summarises further priority investigations and monitoring that could be carried out to improve understanding of likely effects and inform further policy development.

Greenhouse gas emissions

Overview

Apart from avoided deforestation and new afforestation (discussed below), and notwithstanding any contribution of the ETS to a reduction in global emissions through the purchase of emission units internationally, the overall impact of the ETS-plus on New Zealand's domestic GHG reductions is expected to be limited until 2013. This is largely because the demand for transport fuels is likely to be insensitive to price in the short term, there is likely to be a time lag before renewable electricity displaces fossil-fuel based generation, and because agriculture does not enter the ETS until 2013.

Over the period to 2020, the ETS-plus can be expected to drive some reductions in net domestic emissions relative to the base case in all sectors, thus contributing to the objectives for the ETS. Gross domestic emissions are, however, expected to grow relative to 2008 emissions.

Changes in emissions are difficult if not impossible to predict with any accuracy, as they depend on factors such as the price of emission units and the behavioural response to the price signal and related measures, prices for energy, pastoral products and for products of other major New Zealand industries, and the emergence of new technology in response to these price signals.

To maximise the domestic environmental benefits of the ETS-plus, and to promote absolute domestic emission reductions as part of a long-term transition to a lower-carbon economy, the government could consider significantly strengthening demand-side response measures in the areas of transport and stationary energy use by households and small to medium enterprises.

The more significant expected sectoral effects on greenhouse gas emissions are as follows.

GHGs from Stationary Energy: supply and demand

Over the period to 2020, the ETS-plus is expected to lead to increased development of renewable sources of energy relative to the base case, and this effect is expected to increase as the cost of carbon rises. New baseload electricity generation is expected to be geothermal, and new peaking capacity is likely be either hydro or combined cycle gas, with wind expected to provide a significant but variable proportion of mid-range capacity. Around 90% of electricity is likely to be generated from renewable sources by 2025. This notably contrasts with the base case scenario where coal features as a generation option in the longer term.

Thus, greenhouse gas emissions from electricity supply and industrial process heat are expected to decline relative to the base case. This effect is expected to increase over time. In the short term, emissions from direct coal use are expected to fall and emissions from gas use and electricity generation are likely to increase.

Improving energy efficiency and demand-side management are important in both the long and the short term. In the short term, while thermal electricity is on the margin for peak electricity demand, these measures can make a useful contribution to reducing greenhouse gas emissions. Energy-efficient homes also help to address health concerns from rising electricity prices. In the medium to longer term, energy efficiency and demand-side management serve to reduce the pressure on the environment from renewable electricity supply.

That such measures might be necessary does not indicate that the ETS is misguided or that its design is faulty. Rather, the ETS is likely to meet the objectives the Government set for it, but it will need to be complemented by other measures to incentivise the range of behavioural changes that will move New Zealand more quickly on to a downward long term emissions trajectory.

GHGs from Transport

The transport sector – both the fleet and the nation's transport infrastructure – will have a major influence on how New Zealand meets its emissions targets. The ETS price signal alone cannot be relied upon to alter decisions that have significant long term consequences, and hence complementary measures are crucial in this sector. In the short-term, complementary measures within ETS-plus are likely to exert as much if not more downward pressure on emissions as the carbon price signal in diesel and petrol prices. Suggestions are made to strengthen aspects of the ETS-related measures in order to maximise the synergy between the price signal and the other measures.

The bulk of transport emissions are from land transport, particularly road transport. Decisions in this area are driven by a complex mix of local and national transport planning and funding practices that interact with fuel prices, broader urban planning, availability of alternative technologies such as electric vehicles, and social values. Existing policies, such as the pattern of infrastructure investment, influence transport choices and hence emissions.

The Transport Strategy process provides an opportunity to review and integrate existing policies and practices with the need for long term reductions in emissions. Transport emissions are slow to change but vary significantly in response to policy over the longer term. Decisions to fund infrastructure that facilitates increased use of emission-intensive modes of transport (e.g. private motor vehicles), such as new roads, will also facilitate increased greenhouse gas emissions. Alternatively, funding measures to encourage more efficient modes of transport, e.g. improving the rail network, will help to reduce emissions.

Improving the range of transport choices available, good urban design and more transparent pricing of roads can all deliver significant benefits, even without considering emissions. Although benefits of these changes will emerge only slowly, they are essential for achieving long term reductions in GHG emissions from transport.

GHGs (non-CO_2) from Agriculture

In addition to transport, pastoral agriculture is the other major source of emissions for which little if any absolute reduction can be expected in the short term, at least for non-CO_2 emissions. Under the base case scenario, further intensification of land use is likely prior to the sector's entry to the ETS in 2013. The ETS-plus is expected to slow this trend and the corresponding increase in emissions to some extent, although the large investments behind this land use change will make the emissions growth more difficult to reverse despite the ETS price signal that is proposed to apply to agriculture starting in 2013. That is, there is a risk that some of the potential benefits of the ETS-plus will not be realised.

There is a programme of research underway to identify technologies to reduce on-farm emissions, and the ETS design enables the sector to meet its emissions obligations by purchasing units offshore if that is less costly. However, it is possible that it would be more cost-effective in the long term, and be better for the environment generally, if these costs were more directly factored into land use change decisions from 2008 and some unsustainable land use change avoided. The extent of adjustment in pastoral sector emissions prior to 2013 depends critically on how the price signal will be

transmitted to the farm level and farmer expectations about how the cost of emissions will be borne. Thus, confirming the point of obligation for agriculture sooner rather than later would help to secure the environmental benefits of the ETS-plus, in terms of both GHG emissions and other environmental effects.

The government should also investigate the extent to which the delay in agriculture entering the ETS puts at risk the benefits of the ETS-plus. Such a study should aim to determine the extent to which behaviour, emissions and adverse effects are likely to diverge from "optimal", i.e. from a situation in which future policy settings are known with certainty and fully factored into investment decisions, and consider policy options to reduce any such divergence.

GHGs from Forestry

The anticipated introduction of the proposed ETS, which would place obligations on the forestry sector as of 1 January 2008, has resulted in two significant effects. Actual deforestation was higher in 2007 than had been forecast in 2006[2] and the 2007 deforestation survey indicates that deforestation will be lower over the study period than had been forecast in 2006.

In the short term, this delivers an absolute increase in emissions, due to recently cleared land being added to pastoral production. Further additions to New Zealand's emissions from deforestation and conversion will then decline rapidly, both through avoided deforestation and, avoided methane and nitrous oxide emissions from conversions to pastoral farming. This is expected to be the largest effect of the proposed ETS-plus on net emissions, at least in the short to medium term.

Afforestation is also encouraged by the ETS-plus. New forest establishment is expected to be significantly ahead of the base case over the study period, resulting in increased carbon sequestration, especially in new exotic forests.

Other environmental effects

This report identifies numerous environmental effects that are likely to arise from implementation of the ETS-plus, some positive effects and some negative. In many cases, the timing and significance of these effects will reflect the extent of domestic behaviour change in response to the ETS-plus, which depends on a range of factors as discussed above. Appendix 5 presents a summary of environmental effects by

[2] Manley, 2008 (19,000ha c.f. 13,000ha).

environmental resource. The most significant of these are briefly summarised in the remaining section of this chapter.

Potential positive effects of ETS-plus

Among the likely significant positive effects are the following:

- An increase in afforestation and a reduction in deforestation and conversion to intensive land use (after an initial increase embedded from land use changes prior to 2008), due to the new deforestation liability in the ETS, with an initial large emission reduction and benefits in reduced soil erosion and sediment yield, gains in biodiversity in some areas, and better water quality.
- Improvements in air quality and human health, gradually over the longer term, due to decreased use of fossil fuels in industry, stationary energy and transport, and relative increases in both walking and cycling.
- The increased price of electricity is likely to have some dampening effect on demand for irrigation, with in-stream values benefiting from more natural flow regimes and less pollution from intensive farming runoff.
- The increased price of fuel is likely to lead to a reduction in energy-intensive fishing methods, e.g. seabed trawling, which have relatively more adverse effects than other fishing methods.
- The ETS-plus is likely to slow the trend of land use intensification and thereby reduce GHG emissions as well as other adverse effects on the environment; however, some of these benefits are at risk due to the delayed entry of agriculture to the ETS in 2013.

Potential adverse effects of ETS-plus

Because it is so far-reaching, covering all sectors and all gases, the ETS-plus could also cause a range of unintended adverse environmental consequences unless response measures are put in place to address them. To reduce the likelihood that adverse effects will occur while policy responses are devised and implemented, and to increase certainty for business, climate change and complementary measures should be implemented concurrently where possible, rather than introducing measures in any one policy context in isolation or out of phase.

The current climate change and energy policy concurrence is a good start. Similarly, the work in progress on the Sustainable Water Programme of Action offers an opportunity for climate change policy to proceed concurrently with freshwater policy. Without these types of integrations, resource management in New Zealand will move in unsustainable directions that are likely to be damaging for New Zealand's future prospects.

The scoping review has identified the following as the most significant potential adverse environmental consequences of the ETS-plus as currently designed:

- Loss of some areas of indigenous ecosystem types with high biodiversity values, such as regenerating forest, scrubland and tussock grasslands that are eligible to be cleared and afforested to gain forestry sink credits.
- Increased pressure to dam or divert rivers for generation of electricity with consequent impacts on ecosystems, natural character and alternative uses.
- Increased pressure on natural character and some landscapes, and potential land use and resource conflicts generally, arising from both afforestation and the accelerated development of renewable energy sources, notably hydro and wind, but also possibly marine energy.

These are discussed in turn below.

Increased pressure on biodiversity

The ETS-plus will provide strong signals for forestry planting on post-1989 regenerating indigenous forest, scrubland and tussock grassland on private land, with adverse effects in some areas on indigenous plant and animal species and ecosystems. The protection offered to these areas through national instruments or local plans is variable, and indeed poor in many regions, and therefore significant areas are at risk from the ETS-plus.

However, changes could be made to the design of the ETS-plus to minimise this risk by making land with high biodiversity value ineligible for gaining emission units or afforestation grants by clearing indigenous species. The long-term benefits of retaining indigenous biodiversity (including its potential for more permanent carbon sinks) more than outweigh the slightly more rapid short-term carbon sequestration rates of exotic trees. To enable implementation of such changes to the ETS, and to protect biodiversity values more generally, it is important to complete the identification of high biodiversity areas as a matter of urgency, as well as mapping of land use in 1990 at sufficient resolution to inform land owners of eligibility and to identify indigenous vegetation. The interaction of the ETS-plus with biodiversity needs attention in the design of both the ETS and the AGS, with specific incentives implemented for protection of indigenous biodiversity.

The key proposed response measures are:

- Ensure that areas of high biodiversity value are identified across New Zealand as a matter of urgency.
- Provide criteria in the AGS and ETS to ensure that grants and NZUs are not awarded for planting exotic forestry on areas of high biodiversity value, e.g. significant post-1989 regeneration.
- Provide additional incentives for indigenous afforestation to avoid adverse biodiversity outcomes from the ETS-plus.
- Complete the base map of "land use at 1990" as soon as possible, at sufficient resolution to identify significant indigenous vegetation and to enable owners to see whether or not their land is "Kyoto forest" (post-1989).
- Undertake further environmental assessment if pre-1990 indigenous forests are included in the ETS, or if the ETS-plus is amended to create more flexibility for land use change for pre-1990 forests.

Increased pressure on rivers

The ETS price signal and the renewable energy preference are expected to significantly increase pressure to dam or divert more of New Zealand's rivers. A significant move to electric vehicle technology could further increase this pressure. One possible response measure is to give preference for expansion of capacity on existing facilities or on rivers already dammed or diverted rather than exploitation of new river systems.

More generally, this highlights the need to integrate development and issuance of guidance under the RMA and the Sustainable Water Programme of Action with climate change and energy policy, ensuring that none gets too far ahead of the others.

A more comprehensive investigation is proposed to consider the role of additional large hydroelectric plants in New Zealand's energy future, so that appropriate guidance can be provided to local authorities.

The key proposed response measures are:

- Strengthen measures to enhance energy efficiency and demand side management in the energy sector, especially but not exclusively in relation to electricity.
- Consider undertaking a strategic environmental assessment of the role of further hydroelectric generation in a sustainable energy system.
- Provide guidance on the potential use of freshwater resources for hydroelectric generation via the Sustainable Water Programme of Action.

Increased pressure on natural character and landscape

There are expected to be significant environmental effects – potential loss of natural character and landscape values – from afforestation and from increased renewable energy generation, both hydro and wind. This could potentially affect seascapes in future, depending on the type of marine energy development. Some areas potentially affected by biodiversity loss are also notable and valued landscapes, such as the North Island central plateau and parts of Otago. Among the risks to these is increased afforestation, including through wilding conifers spreading into indigenous ecosystems. While it is not possible to anticipate where these pressures will be greatest, at the least it will be a large and contentious issue for local government to manage.

This is an area where local engagement and clear central government guidance are needed. Proposed response measures include development of a national instrument to guide identification and recording of high value landscapes. In addition, wind and marine energy development should be addressed in the review of the New Zealand Coastal Policy Statement, and the scope of the proposed National Policy Statement on renewable energy could be expanded to address potential adverse environmental effects.

The key proposed response measures are:

- Develop a national instrument to guide identification, recording and protection of high value landscapes.
- Address wind and marine energy development in the Coastal Policy Statement review.

Other issues

Pressure on air quality could temporarily increase in some areas due to fuel-switching to wood by both households and industry; these issues need to be managed through stronger co-operation between central and local government.

Effects on human health from changes in fuel prices are also potentially significant, especially for lower income households, but the Government has signalled that a response package will be announced. The overall effect of the ETS-plus on human health needs to be reassessed once that is announced.

The proposed response measures are:

- Address air quality and domestic heating through improved co-ordination between central and local government.
- Provide assistance to lower income households to minimise the effect of the ETS in exacerbating New Zealand's "cold home" problem.

These and other proposed response measures are described in Chapter 5 and summarised in Chapter 7.

Further investigations

Further work will be needed to consider and design policy response measures to address the issues identified above, including the more strategic assessment of the role of additional hydroelectric generation and an investigation of the risk that some benefits of the ETS-plus will not be realised due to the delay in agriculture entering the ETS.

In addition, the report proposes further investigation of the following issues:

- ***Biofuels*** – Review the likely effects of increased domestic use of biofuels on New Zealand and global CO_2 emissions and on domestic air and water quality, and assess pressures on the environment arising from increased domestic production of biofuels.

- ***Electric vehicles*** – Assess the most appropriate roles and technology for electric vehicles in the New Zealand transport sector, the potential for their widespread adoption, and the implications for New Zealand's energy and waste systems.

- ***Transport demand*** – Assess the factors influencing the responsiveness of demand in New Zealand to price changes from for various transport modes and functions, and for different groups of users.

- ***Investigate the effects of nitrification inhibitors on the nitrogen cycle, water quality of streams and wetlands*** - Complete current work now underway, fill gaps in knowledge and scale up to consider effects at a whole catchments level where there are stream systems and wetlands at risk.

Monitoring

In some cases, possible adverse effects are too uncertain to warrant an immediate policy response, and more in-depth assessment seems unlikely to yield policy-relevant information. In such cases, the appropriate response is to monitor the situation closely so that any problems can be detected early and a policy response devised as quickly as possible. Problems can and do arise unexpectedly, and if good monitoring data is available, policy measures are more likely to be implemented in a timely manner.

A robust monitoring framework will also provide essential data to inform the review of the ETS, which the Bill specifies will occur in 2013 and at regular intervals thereafter. These reviews offer the opportunity to re-assess the environmental effects of the ETS as well as its effectiveness in relation to greenhouse gas emissions.

Chapter 6 of this report provides some specific suggestions where monitoring should be improved, and where analytical capacity to utilise monitoring data also needs to be enhanced.

1. INTRODUCTION

1.1. Background

In early December 2007, the government introduced into Parliament the Climate Change (Emissions Trading and Renewable Preference) Bill ("the Bill") to provide the statutory framework for a New Zealand Emissions Trading Scheme (ETS), and to restrict the use of fossil fuels for electricity generation. The Bill was referred to the Finance and Expenditure Committee, which invited written submissions on the Bill by 29 February 2008, and will proceed with oral hearings.

The objective of the ETS, as stated in the "General policy statement" in the Bill, is as follows:

> *That a New Zealand Emissions Trading Scheme support and encourage global efforts to reduce greenhouse gas emissions by:*
>
> - *reducing New Zealand's net emissions below business-as-usual levels; and*
> - *complying with our international obligations, including our Kyoto Protocol obligations;*
>
> *while maintaining economic flexibility, equity, and environmental integrity at least cost in the long term.*

As the Bill is drafted, the ETS will be implemented in a staged manner across the economy, such that all major emitting sectors are included by the start of 2013. It will be linked internationally to the Kyoto trading market in order to ensure liquidity and reflect the international price of emissions in the New Zealand economy. To support the economic transition into emissions trading, free allocation of emission units will be given to the forestry, industry, and agriculture sectors, but not to fuel suppliers or electricity generators, who can pass emission costs down the supply chain. Transitional support will also be provided to households and businesses outside of the ETS.

The ETS is a market-based mechanism that is designed to operate in conjunction with pre-existing environmental legislation and policies, such as the Resource Management Act 1991 (RMA) and the New Zealand Biodiversity Strategy (NZBS). Through the use of price signals, the ETS will result in changes to land and natural resource use, patterns of economic activity and operational practices.

These changes will, in turn, affect the natural and physical environment in positive or negative ways.

In addition to the ETS, the government has also announced a range of other new climate-related initiatives. These include legislation for a preference for renewable energy for electricity generation and a Biofuel Sales Obligation, as well a range of other initiatives in relation to forestry, agriculture and energy. These are outlined in material released by the government in October 2007 at the same time as the report 'The Framework for a New Zealand Emissions Trading Scheme'. These measures are in addition to previously existing climate change policies.

With input from the Climate Change Leadership Forum and other stakeholders, the government decided to conduct further work with regard to assessment of the environmental effects of the ETS and closely related aspects of the new sectoral policies and measures. Such assessment will help ensure that the ETS has broad environmental integrity designed into the scheme from the start, and is broadly consistent with the government's overall sustainability goals. The outcome from such environmental assessment can be considered by policy makers prior to finalising the design of the ETS and complementary measures, and balanced against other considerations driving the implementation of the ETS.

As a first step in an environmental assessment, the government's Emissions Trading Group contracted a team of consultants[3] to prepare a scoping report on the environmental effects of the Government's ETS and closely related new measures (hereafter referred to as "ETS-plus"). The scope and methodology for this scoping report are attached as Appendix 1.

Section 1.3 below describes the ETS-plus policy package.

1.2. Context and purpose of this report

The ETS is an all gases, all sectors policy measure, affecting businesses and households directly or indirectly, designed to enable a variety of different responses in order achieve the government's objectives at least cost in the long term. It is important to note that the ETS-plus package is *intended* to drive

behavioural change across the economy. ETS-plus aims to reduce New Zealand's net emissions, in conjunction with global efforts to stabilise atmospheric concentrations of greenhouse gases, and to move the economy onto a lower emission trajectory at the lowest economic cost over the long term.

This scoping report aims to identify, at a high level, potential environmental effects of the ETS-plus that are likely to arise as a result of the ETS and related measures during the period 2008 to 2020. The report then identifies possible response measures to address these effects, and suggests terms of reference for possible further investigations of particular areas of concern or uncertainty.

The purpose of assessing environmental effects is not to assess whether or not to implement an ETS. In keeping with its international obligations, the government has a degree of short-term ambition in emissions reduction, with an ETS being the preferred tool for finding most of those emissions reductions. In the absence of an ETS, the government would likely implement alternative regulatory and policy measures to accomplish its policy objectives, including meeting New Zealand's commitments under the Kyoto Protocol (and any successor agreement) and its objectives under the New Zealand Energy Strategy. Any such alternative policies would also be expected to have some flow-on environmental effects, both positive and negative.

New Zealand entities with emissions obligations under the ETS can satisfy these obligations by choosing the least costly combination of directly reducing emissions or purchasing domestic or international emission units (where doing so is consistent with supporting and encouraging global efforts to reduce emissions). For instance energy suppliers will purchase emission units, domestically or offshore, to account for the emission obligations associated with energy consumption that continues after energy efficiency and conservation efforts.

Complementary measures can help to reduce the reliance on international units, because relying on such units could lead firms and households to embed long-lived high emission technology and infrastructure into the economy and defeat the long term objective. For example, given that agriculture does not enter the ETS until 2013, it is important that changes start being made now, to avoid embedding

[3] The team consists of Jim Sinner (Sustainable Business Group Manager, Cawthron Institute), Judy Lawrence (PSConsulting), Roland Sapsford (Sustainability Solutions) and Paul Blaschke (Blaschke and Rutherford).

a land use pattern that is unsustainable and costly to reverse. Similar considerations apply to transport – both the fleet and the nation's transport infrastructure, and to buildings. In some cases, the current price signal cannot be relied upon to alter decisions that have significant long term consequences, e.g. capital investments and patterns of land use that last for decades rather than a few years. Complementary measures can help address this.

Thus, the purpose of the scoping study is to identify potential environmental benefits and priority areas or "pressure points", and thereby identify where the ETS design and other aspects of the government's policy framework may need to be adapted to address any environmental sustainability concerns and opportunities arising from the ETS-plus.

1.3. Policy scenarios

For this report, effects of the ETS and closely related policy measures are being assessed against a base case scenario of environmental and resource management policies as of 1 January 2008.

In addition to the ETS itself, the policy scenario being assessed (ETS-plus) consists of the following "closely related measures": the preference for renewable electricity generation capacity, the biofuel sales obligation, the Afforestation Grants Scheme, and a range of measures from the New Zealand Energy Strategy and the New Zealand Energy Efficiency and Conservation Strategy (NZEECS).

See Appendix 2 for a fuller description of the ETS-plus package being assessed.

The base case consists of all other existing policies and measures as of 1 January 2008 unless otherwise specified. Measures that are already established and funded – for example, the Permanent Forest Sinks Initiative – are in the base case scenario and their interaction with the ETS is assessed in that context.

Pending waste management policy is also in the base case category – on the assumption that Parliament will enact the Waste Minimisation (Solids) Bill, and that it is not driven primarily by climate change considerations. On the other hand, the scenario excludes policies that have goals or targets but no definitive

measures[4], although measures to achieve these goals could form part of new policy responses to address environmental concerns.

Finally, of policies related to agriculture and forestry, only the ETS itself and the proposed Afforestation Grants Scheme are in the ETS-plus policy scenario; other measures in the Government's Plan of Action on Sustainable Land Management and Climate Change are in the base case scenario. They have either already been confirmed or are sufficiently independent of the ETS to not be considered a "closely related measure".

Appendix 2 also describes the elements of the base case scenario in more detail. Appendix 2 not a definitive list of all measures in the base case; rather it highlights some of the key measures affecting emissions that form part of the base case, and helps illustrate more clearly the distinction with the ETS-plus.

1.4. Emissions leakage

The possibility of "emissions leakage" was frequently raised by stakeholders during the workshop conducted for this project. "Leakage" occurs when policies that put a price on greenhouse gas (GHG) emissions, such as an ETS, lead to exported products becoming uncompetitive, or products imported from countries with less stringent climate policies being substituted for domestic products. This leads to changes in the international distribution of production and thus, the international pattern of GHG emissions—reducing them in countries with a carbon price and increasing them in countries without a carbon price and no emissions cap. Production and emissions thus decline in the countries with an emissions price, but with no net reduction in global emissions. Indeed, differences in efficiency or additional transport requirements could even raise net global GHG emissions (Greenhalgh et al, 2007).

A climate policy with a sole objective of reducing global GHG emissions would seek to minimise emissions leakage, but this comes at a cost to the economy in the short and possibly the long term as well. In the short term, minimising emissions leakage generally entails compensating trade-exposed industries for some or all of the cost of emission obligations, e.g. through free allocation. This means that the cost of that industry's emissions must be borne by the taxpayer or somehow cross-subsidised by other sectors through the ETS. There is a range of possible policy

[4] For example, the goal of a 40% reduction in per capita CO_2 emissions from transport by 2040.

designs that seek to maintain an incentive to reduce emissions while avoiding leakage (*ibid.*), but they all shift at least some of the emissions obligations onto other members of society. As part of the ETS design, the government has proposed to give eligible trade-exposed industries a free allocation equal to 90% of their 2005 emissions (excluding emissions from liquid fossil fuels) from 2010 to 2013, declining to zero free allocation by 2025.

Policies to minimise leakage can also impose long term costs on the country by postponing the necessary transition to a carbon-constrained economy. The extent of this cost depends on:

- the length of time that the industry is exposed to competitors who do not face a similar price of carbon (and therefore the duration of the assistance that the government needs to provide), and
- the magnitude and distribution of any social impacts of industries curtailing production if they are not sufficiently protected, and
- whether the industry is likely to be competitive in the longer term if and when all countries are competing on the same basis.

Some emission-intensive industries may disappear entirely over time as low emission alternatives emerge, so even if a domestic company is competitive within its global industry, it is not necessarily in the country's long term interest to protect it. Of course, none of these factors is easy to predict, which makes it difficult to determine the appropriate policy setting. Ultimately, leakage is most effectively addressed through international agreement regarding the treatment of trade-exposed industries, e.g. through sectoral agreements that harmonise across countries the price of carbon for a given industry.

This study does not take a view as to whether, how or to what extent ETS design should seek to avoid emissions leakage. That is a matter for the government to decide, in determining how to balance the various components of its objectives for ETS design. The terms of reference for this study call for an identification of the domestic environmental effects of the ETS-plus. However, because leakage has some implications for the broader environmental objective that ETS is targeting, the study notes where emissions leakage is more likely to occur, so that policymakers can then make a more informed decision about ETS design.

2. METHODOLOGY AND POLICY SCENARIOS

2.1. General approach

2.1.1. Information and analysis

Given time and budget constraints, this report has been compiled utilising existing documents and reports, information gathered at a workshop of stakeholders and experts, additional discussions with other stakeholders and experts, and the project team's expertise and existing knowledge. The project team analysed this information using a matrix approach, that is, considering the response of the main economic sectors to the ETS-plus and also considering how various natural and physical resources could be affected by changes in human activity prompted by the ETS-plus.

2.1.2. Meaning of 'Environment"

For the purposes of this scoping report, the term "environment" here has the same meaning as it does in the Resource Management Act 1991[5] and the Environment Act 1986, *except* that the scope of the assessment will not include social, economic or cultural impacts of the ETS-plus. Government advises that these aspects are being considered through other mechanisms. However, the report does consider human health effects where these are directly caused by changes in the environment or by direct price effects.

The scoping study is a preliminary assessment of the domestic environmental effects of the ETS-plus policy package. Domestic environmental effects, and assessment thereof, fall into two distinct categories.

The first effect is the impact of the ETS-plus on domestic GHG emissions.

[5] The RMA definition (s.2) says: "Environment includes---
(a) Ecosystems and their constituent parts, including people and communities; and
(b) All natural and physical resources; and
(c) Amenity values; and
(d) The social, economic, aesthetic, and cultural conditions which affect the matters stated in paragraphs (a) to (c) of this definition or which are affected by those matters:"

This relates in part to the effectiveness of the ETS-plus at achieving one of its intended objectives - *Reducing New Zealand's net emissions below business-as-usual levels* (see Chapter 1). For the purposes of this report, the "business as usual" is defined as equivalent to the base case scenario (see section 2.3). If the ETS-plus clearly reduces gross emissions and enhances sinks in the long term, in comparison with the base case, its net emissions objective is met.[6]

The report also comments on the effect of the scheme on domestic emissions more generally. At issue here is the more general question of the extent to which the ETS-plus in its current form will contribute to absolute reductions in GHG emissions in the longer term.

Thus, this report –

(i) comments on the extent to which GHG emissions are likely to be reduced both compared to the base case scenario, and in absolute terms
(ii) proposes possible high-level policy response measures to enhance domestic emission reductions.

The report makes no comment on the global implications of alternative approaches to emission reduction, nor does it comment on the implications of these for the ETS-plus or New Zealand generally. This subject, while important, is outside the terms of reference for the scoping study.

The report also examines at a high-level the effects of the ETS-plus on pressures on the environment (as defined above) within New Zealand. Thus, in addition to GHG emissions, effects on the environment are assessed under the following headings:

- Air Quality
- Biodiversity - Terrestrial
- Biosecurity
- Coastal and Marine
- Historic Heritage
- Human Health

[6] Note, however, that the base case clearly goes beyond a true "business-as-usual" case, because it includes some measures specifically targeted at climate change issues.

- Land and Soil
- Landscape, Amenity and Natural Character
- Water Quantity
- Water Quality.

2.1.3. Descriptive framework

This scoping report is a qualitative assessment of the significance of possible environmental effects (both positive and adverse) arising from ETS-plus. In describing changes, the report adopts the language of the recent report *Environment New Zealand 2007* (MFE, 2007a) in respect of "pressures" on the environment. The report therefore comments on how environmental pressures will change relative to the situation without ETS-plus. Except in the most general terms, this report cannot assess the quantitative impacts of ETS-plus in specific situations; rather where appropriate it notes the extent to which significant impacts are expected on the basis of existing information.

2.1.4. Uncertainty

The environmental effects that arise from implementation of the ETS-plus are subject to a number of significant sources of uncertainty, including:

- the stringency of international commitments post 2012 and hence the price of emission units (i.e. carbon) on the international market that will be transmitted to New Zealand's ETS;
- the extent to which governments in other countries expose their industries to this price of carbon;
- the price of oil, gas and other forms of energy, both renewable and fossil fuel-based;
- the rate at which climate change occurs and how it affects New Zealand; and
- the emergence of new low-emission technologies and management practices in response to the ETS price signal;

plus two factors that can be influenced more directly by the government:

- the final design of the ETS-plus, for example the point of obligation for the agriculture sector;

- the behavioural response of individuals and organisations to the ETS-plus policies.

Most of these factors are not "discoverable" through further research in advance of ETS implementation, which therefore constrains the nature of any environmental assessment, in particular the degree of detailed investigation that can usefully be undertaken. Nevertheless, a qualitative assessment can serve to identify likely directions of change and to highlight areas where there is significant potential for environmental effects, positive or negative, to arise as a result of the ETS-plus. Further investigation can also help to inform the final design of the ETS-plus.

Such an assessment can then point to a range of possible policy responses to avoid or minimise any unintended adverse consequences and/or maximise benefits, while also identifying where further investigation and monitoring would be useful for policy makers. That is the purpose of this scoping study.

In identifying the significant environmental effects that could arise from the ETS-plus and assessing their likely significance, the project team has relied upon its professional judgement and assessment of the information available from the range of stakeholder views and reference material to reach a qualitative view about a number of dimensions of uncertainty.

The sources of uncertainty outlined above give rise to uncertainty in the following attributes of potential environmental effects of the ETS-plus:

- Whether a particular behavioural change will occur;
- The rate at which the behavioural change will occur;
- The magnitude of the behavioural change;
- The direction of the behaviour change; and
- The relationship between the behavioural change and associated environmental effects, and the significance of those effects.

Each of these attributes has a probability component, i.e. is more or less likely depending on the underlying drivers (i.e. sources of uncertainty).

2.1.5. Terminology regarding probability relating to qualitative judgements

To describe different levels of probability, this report uses an approach generally similar to that used by the IPCC in its Fourth Assessment Report. In this report:

> "***It is expected that***" means that there is strong probability, based on stakeholder views and reference material, that a behaviour change or environmental effect will occur – this is the highest level of probability attached to potential outcomes described in this report.
>
> "***It is likely that***" means that a behaviour change or environmental effect is reasonably likely to occur. The outcome is considered much more likely than unlikely.
>
> "***It is possible that***" means that it is reasonably plausible that a behaviour change or environmental effect will occur, but the probability is at the low end.

2.2. Project workshop

The project team (i.e. the consultants) held a workshop on 25 January 2008 to gather information for this report. The workshop served as an information-gathering exercise for the consultants, to help them identify potential environmental effects across various sectors of the economy.

Those attending the workshop included 32 stakeholders (including Māori, business and environmental NGOs, as well as local government officials) and 16 officials from central government departments, in addition to the four project consultants and two observers from the office of the Parliamentary Commissioner for the Environment. A list of participants is provided in Appendix 3. The results of the workshop are summarised in a report available on the Ministry for the Environment's website[7].

Participants were invited to attend as individuals rather than representatives of their sectors or organisations – input was accepted as personal knowledge, views and information, rather than as an industry or organisation position.

Most of the workshop was conducted in small break-out groups that considered particular sectors of the economy, as follows:

[7] http://www.mfe.govt.nz/publications/climate/workshop-summary-scoping-report-feb08/index.html

- Stationary Energy — *Electricity Supply & Demand*
- Transport — *All transport modes*
- Land Use — *Pastoral agriculture (intensive and extensive) and Forestry*
- Industry — *Chemicals, Metals, Ag & Forestry Processing, Mining, Seafood*
- Waste — *Solid Waste*
- Services — *Tourism and other services*

There is some overlap between sectors, e.g. virtually all sectors are users of transport and stationary energy. These linkages are noted where they have significant environmental implications.

For each sector, the workshop collected information and views on the following three questions[8]:

1. How will activity in the sector change as a result of the ETS-plus?

E.g. will output increase, decrease or be unaffected by the ETS-plus? Will there be fuel-switching or changes in other inputs or production practices? What information is available to answer this question, where are the gaps in information and how could we get a better understanding?

2. What will be the domestic environmental effects of the changes referred to in (1)?

Where are these effects likely to be concentrated and when are they likely to occur? What information is available to answer this question, where are the gaps and how could we fill these gaps?

3. What additional policy measures might be needed to capture any potential positive effects and minimise potential negative effects of the ETS-plus?

Response measures could well be outside of ETS-plus design, and could include such things as additional monitoring and assessment, national policy statements or environmental standards under the RMA or other statutes, additional funding for new or existing programmes, additional research, moral suasion, etc.

[8] In this context, "ETS" also includes the associated closely related measures that are part of the scenario being assessed. See the next section of this chapter.

Information was also elicited from other individuals prior to and after the workshop to supplement the input obtained at the workshop. These people are also listed in Appendix 3.

2.3. Nature of Analytical Approach and Conclusions

This report seeks to scope the possible environmental effects of ETS-plus. By its nature, the perspective it adopts is broad rather than deep. As a consequence a wide range of potential effects, both positive and adverse, have been identified.

The approach outlined in the questions for the workshop is also reflected in the overall document. The report first outlines the behaviour changes expected from households, businesses and other institutions. On the basis of these a range of potential environmental effects are identified. The report then makes a preliminary assessment as to the significance of effects.

Significance is a qualitative judgement based on the above factors, and information from a range of sources, including information on the existing state of the environmental resource in question. For this report, four broad and overlapping categories have been adopted:

- **LOW** - the expected change in environmental pressure is not significant. This judgement should be revisited during any review of the ETS but no additional response or further investigation is proposed at the present time.
- **MODERATE** - the expected change in environmental pressure is of some significance but is likely to be able to be managed through existing mechanisms. However the effectiveness of these existing response measures needs to be assessed and, where necessary, enhanced. Ongoing monitoring of environmental pressure is usually required and further investigation may be proposed.
- **HIGH** - the expected change in environmental pressure is highly significant in the near term. New response measures may be required to ameliorate adverse effects or reinforce positive changes or both. Further investigation may be proposed, either to better understand likely effects or to inform design of response measures.
- **UNCERTAIN** - there is insufficient information to even undertake a preliminary assessment of the significance of the effect in the near term and no

suggestion that a precautionary approach is appropriate. Further investigation, rather than more active policy response measures, will be proposed.

Significance combines judgements about the size of immediate and longer-term impacts arising from the ETS-plus, the rate at which change will occur, the importance of early action, and the state of the relevant environmental qualities. The results of applying this categorisation are shown in detail in Appendix 4; the more significant effects are considered for possible policy responses in the latter part of this report.

For a small range of effects judged to be of moderate-high significance, response measures are proposed with some specificity. For most others, the report offers some general observations as to options for proceeding. This approach reflects the fact that this is a scoping report rather than an environmental assessment of the ETS-plus.

2.4. Adequacy of the RMA and other existing policies

This report identifies a number of potential adverse environmental effects, and a range of positive effects, that could arise as a result of the ETS and closely related measures. These effects range across a number of environmental resources in addition to the climate system: land and soil, freshwater, air quality, coastal and marine resources, biodiversity, landscape and natural character.

With only a few exceptions, these matters are intended to be managed by district and regional councils under the Resource Management Act 1991 (RMA). By identifying potential effects on these resources in Chapters 3 and 4, the report is not necessarily saying that the RMA is inadequate to manage these effects or that the effects will necessarily occur despite the RMA and its associated policies and methods.

The authors of this report are well aware of both the powers of the RMA and its limitations. We do not assume, just because the RMA provides the necessary authority for policies and measures to avoid, remedy or mitigate adverse effects on the environment, that this will be achieved. There is ample evidence that the plan-making process of the RMA is time-consuming and resource-intensive for local authorities, that local government has been inadequately supported by national guidance and direction, and that for these and other reasons RMA policies and

methods cannot always keep pace with the rate of change (Ministry for the Environment, 2004; Walker et al, 2006; Young, 2007).

The failure of regional councils to manage adequately the adverse effects of dairy intensification over the past decade is perhaps the best example of this (PCE 2004). In 2000, Environment Waikato initiated a process to address the threat to Lake Taupo from land use intensification; eight years later the plan awaits a hearing in the Environment Court and is not yet operative. The same council has been aware for several years of on-going large-scale conversion of forestry to dairy farming in the upper Waikato River catchment and the consequent risks to the hydro lakes and lower catchment, but has yet to notify a proposed plan, or announce draft policies and measures, to manage these risks. The reports cited above (MfE, 2004; Walker et al, 2006) raise similar issues for the management of resources under the RMA across New Zealand generally.

This report therefore identifies the potential environmental effects, both positive and negative, that might arise as a result of behavioural changes prompted by the ETS and closely related measures. In considering the significance of these potential effects, the authors have considered the likely adequacy of existing policies and measures to manage the effects in a timely manner. Where existing measures are considered likely to be insufficient, the report proposes additional policy responses. These involve the use of national level RMA instruments or the provision of guidance and information to assist local government in its RMA role and thereby manage potential impacts more quickly and consistently than would otherwise happen.

The report takes a similar approach to other existing legislation and policies that are included in the base case scenario, e.g. the Fisheries Act, Conservation Act, Forests Act, and the New Zealand Biodiversity Strategy. Where these are assessed at a high level to be adequate to manage potential adverse effects or to secure potential positive effects, no additional response measures are proposed. Where existing measures are considered likely to be insufficient, the report proposes additional policy responses.

3. CHANGES AND ENVIRONMENTAL EFFECTS BY SECTOR

This chapter consists of sector by sector assessments of the possible environmental effects of the ETS and closely related measures. For each sector, the discussion is organised based on the questions considered at the workshop, which are the focus of this scoping report. The summaries also distinguish which of the measures in the policy scenario are the main drivers of behavioural change for a given sector, which in some cases is important for consideration of policy response measures.

3.1. Stationery Energy Supply – electricity and direct sources of heat

3.1.1. Behavioural Changes

Overview

Fossil fuels used for electricity generation, manufacturing and commercial and residential use (excluding transport) account for around 45%[9] of New Zealand's GHG emissions from energy[10] in 2006. Energy accounts for over 42% of total GHGs in the 2004 National Inventory. Carbon dioxide emissions from thermal electricity generations have increased by 138% between 1990 and 2006 and, with transport emissions, account for the bulk of the increase in GHG emissions from the energy sector since 1990[11].

The short-term effects of the ETS-plus on electricity and gas demand are hard to predict but the longer-term effects are reasonably clear. The ETS-plus is expected to result in an increase in the proportion of electricity supplied from renewable energy sources over the longer term. Use of coal within New Zealand, and coal production for domestic use, is expected to decrease and gas use is also likely to decline relative to the base case in the longer term[12].

[9] Page 6-8, MED (2007a). Manufacturing and thermal electricity generation account for 39.3% of energy-related GHG emissions, and "Other Sectors", which includes household and commercial direct use of fossil fuels accounts for a further 9.5%. According to Table 2.7 on p15, around 60% of the 9.5% is household and commercial energy use.

[10] Energy GHG emissions are around 97% CO_2 on a CO_2 equivalent basis - *ibid.* Table 1.1, p3.

[11] *ibid.* Fig 2.4, p7

[12] Officials advise that change in gas use under an ETS is complicated. For example, New Zealand is expected to still need some fossil fuel electricity generation and gas could take up the slack as coal is

These changes are largely the result of the cost of emissions being incorporated into investment decisions through the ETS. The impact of the preference for renewable energy (the so-called "thermal moratorium" or "thermal restriction") is less clear.

Renewable Electricity

Generation and Transmission Investment

The ETS-plus is expected to lead to increased development of renewable sources of energy[13] relative to the base case, and this effect is expected to increase as the cost of carbon rises (MED, 2007d, p.12). Over the period of this study, new baseload electricity generation plant is expected to be geothermal, and new peaking capacity is likely be either hydro, combined or open cycle gas or distillate[14], with wind expected to provide a significant but variable proportion of mid-range capacity[15]. Around 90% of electricity is likely to be generated from renewable sources by 2025 (*ibid.*). This notably contrasts with the base case scenario where coal features as a generation option in the longer term.

The precise locations, scale and timing of new renewable generation between now and 2020 are somewhat unclear. These are commercial decisions that depend on the scale and sequence of investment in both generation and transmission, and the spatial pattern of electricity demand, as well as its overall level. Options for larger scale wind, geothermal and hydro development are limited by the location of the energy source (and transmission infrastructure), and this has been reasonably well documented[16]. Industry sources also suggest new hydro schemes are unlikely to have significant storage and will be more "run of river" schemes. This is understood to reflect both relative construction costs and planning issues.

phased out. At some point in the future, cost-effective Carbon Capture and Storage technology could be available which may result a big increase in gas use for electricity generation and direct industrial use of gas.

[13] The term "renewable sources of energy" is normally understood to mean a natural energy source, the use of which (within limits) will not permanently deplete energy sources of that kind. Use and development of renewable energy may of course generate adverse, indeed irreversible, environmental impacts. For example, the potential energy in water at altitude is a renewable source of energy; developing a high hydroelectric dam to harness that energy is likely to have adverse effects.

[14] Stakeholders with knowledge in the area have expressed a range of views on this topic.

[15] These comments reflect the views of stakeholders consulted during the preparation of this exercise, which coincide with modelling undertaken by the Electricity Commission - see for example the Grid Planning Assumptions - generation scenarios at http://www.electricitycommission.govt.nz/opdev/modelling/gpas/Oct2007/Generation/index.html#scenarios

[16] Refer EHMS(2005) for a detailed discussion of these issues; the supply curve in NZES(2007) reflects this information to some extent. For transmission information see EC(2007c), EC(2007d) and EC(2007e).

Increased use of renewables has implications for the overall level of generation. Greater emphasis on renewables requires a higher-level of installed capacity to deliver security of supply in a dry year (EHMS, 2005; EC, 2007c; EC, 2007d; EC, 2007e)[17]. MED figures indicate both costs and excess capacity could be expected to rise markedly as the share of renewables exceeds 90% (MED, 2007d, pp.13-14), but that the extra requirements are expected to be moderate below this level. The extent of the extra capacity required also depends upon the extent to which demand-side management and distributed generation and/or distributed storage[18] options are in place.

A further issue in relation to hydroelectric generation specifically is that water availability for hydroelectricity is likely to be influenced by climate change over the lifetime of any new facilities. The extent and direction of this influence is unclear[19].

The short-term variability of wind generation has led some stakeholders to question the extent to which increased wind investment will require new investment in other forms of electricity generation in order to provide security of supply. On the basis of studies to date (Energy Link-MWH NZ, 2005; Strbac et al, 2006)[20], stakeholders expect:

(i) the variability effect to be limited[21]; and
(ii) there to be capacity within the existing system to incorporate considerably more wind capacity than presently exists; and
(iii) that existing hydro can provide the short-run reserve power for the bulk of the 2008 to 2020 period covered by this study.

[17] This relative effect is true for any given level of overall demand and interruptible load, and any desired level of security of supply. The absolute level of extra capacity required of course depends on all these factors.
[18] "Distributed storage" involves storing cheaper off-peak electricity remotely - for example through on-site storage batteries or even on-site pumped hydro - for use at times when electricity prices are high. Some officials have expressed doubt about the technical and economic viability of distributed storage while some stakeholders have commented that it is under active investigation.
[19] Personal communication, Brian Bull, Electricity Commission, 4 February 2008.
[20] Strbac et al estimate the extra capacity required when wind forms just under 20% of total capacity to be around 3% of total capacity.
[21] Some stakeholders advise that the overall variability of wind is much less than the variability at a given site.

On this basis increased wind capacity is more likely to affect the timing and location of transmission investment rather than the level of reserve generation capacity. Increased use of geothermal energy for electricity generation also has implications for transmission investment (EC, 2007e). The scale of new transmission investment expected is unclear (Strbac et al, 2006; EC, 2007d). Transmission capacity investment in turn will affect the viability of different sites and types of renewable electricity generation.

Compared with combined-cycle gas plants, geothermal and wind investments are likely to have notably longer lead times and hydro investment lead times can be expected to be even longer. Similar lead-times could be expected for non-traditional renewables such as marine energy. Stakeholders suggest this difference reflects investigation and design needs as much as planning issues. How this factor will influence decisions is unclear - it may lead to more distributed generation and a heavier emphasis on demand management, or it may lead to more large projects being proposed, on the basis that only some will proceed.

Pricing and distributed generation

Wholesale electricity prices in New Zealand vary regionally and by time of day. These create incentives for avoiding peak usage (i.e. high price) times, typically for large or wholesale consumers who are exposed to such prices. This could occur, for example, through scheduling production activities to avoid these times or through on-site generation or storage.

Stakeholders have indicated that there is uncertainty regarding the extent to which regional wholesale electricity prices will actually reflect the cost of emissions at times when, for example, coal is at the margin for generation. To the extent that this cost is reflected in wholesale prices, the ETS can be expected to affect the daily pattern of demand.

Some stakeholders also suggest that larger users are already investigating ways to avoid peak electricity charges. This includes active investigation of on-site generation and distributed storage. If the ETS accelerates this change, this can be expected to have implications for the overall pattern of demand and affect the viability of various proposals (e.g. rapid adoption of electric cars) that rely upon a pool of lower cost off-peak electricity.

According to some industry sources, demand is increasing for distributed generation solutions at a small enterprise and farm level. The economics of distributed generation from a household to major industry scale is likely to be influenced by both the price of delivered electricity and the nature of connection agreements and pricing[22]. A further influence on distributed generation will be the form of the replacement for the existing supply obligation on lines businesses, which is due to expire in 2013[23]. Moreover the extent to which local and central government facilitate distributed generation will also influence the pattern of development.

The preference for renewable energy

The preference for renewable energy forms part of the ETS-plus package. MED has advised[24] that its purpose is to preclude new baseload electricity generation from fossil fuels, while allowing for peaking and mid-range plants. The supply curve for new generation in the New Zealand Energy Strategy (NZES, 2007, p.38) suggests that renewables - largely wind and geothermal - and combined cycle gas are the next most economically viable increments of supply. Some industry sources believe the economics of new gas plants to be marginal, even without the renewable preference. This stems from the expected prices of both emissions and gas, the latter a function of the limited availability of domestic gas for new generation after 2016.

One clear impact of the renewable preference is to eliminate the possibility of rapid development of new thermal plant in the event of a major gas find in New Zealand[25]. It is also expected to discourage the development of an LNG import facility. The sunk cost of such a facility would make future gas generation relatively more economic, so the renewable preference could exert a significant influence on longer-term trends in this scenario. The possibility of a new coal-fired baseload power station is also eliminated by the renewable preference, even if it were viable in the presence of the significant emissions cost of burning coal.

[22] In particular, the price obtained for exported electricity - ie electricity beyond the distributed generators own requirements.
[23] For details of the review refer http://www.med.govt.nz/templates/ContentTopicSummary____25527.aspx
[24] Cabinet Minute - CAB Min (07) 34/18: Options to Limit New Thermal Capacity: Further Advice; http://www.med.govt.nz/templates/MultipageDocumentTOC____32995.aspx
[25] Of particular relevance here is a major gas find that could be developed to supply the domestic market without a significant increase in the domestic wholesale price of gas. A gas discovery that required export of gas (as LNG) for development of the field is less relevant.

Some stakeholders have expressed a concern that the renewable preference could encourage development of hydroelectric capacity earlier than would otherwise be the case (i.e. with the ETS alone). In the view of some stakeholders, the use of combined cycle gas, for example, may provide a better transition path to non-traditional renewables such as marine energy. As noted above regarding the likely electricity supply curve, it is not clear the extent to which the renewable preference alone will actually influence investment decisions towards hydro rather than gas.

A more technical version of the stakeholder argument above is that the renewable preference will mean more hydro needs to be built to provide reserve capacity for new wind. In the absence of the renewable preference, some stakeholders have argued, this reserve capacity would be more likely to be provided by peaking thermal plants (although this is counter to the view that gas plants are marginal economically even without the renewable preference). However, the renewable preference in its present form would not exclude peaking gas (or indeed diesel or coal) plants as a source of reserve energy to complement wind power; it only creates a need to apply for an exemption. Until it is clear how this exemption will be administered, it is difficult to draw definite conclusions about the additional effects, if any, of the renewable preference in relation to reserve capacity.

The Ministry of Economic Development is currently modelling the combined effects of the ETS and the thermal renewable preference and expects the results to be available in the near future.

Sources of Process and Space Heat

The ETS is expected to increase demand for renewable sources of process and space heat, as well as electricity, over time. This is largely the result of fuel switching away from fossil fuels as heat sources, although gas may substitute for coal to some extent.

Woody Biomass

In the short to medium term, the use of woody biomass as a fuel is likely to increase as a result of the ETS.

Recent estimates suggest that there is a significant amount of wood available for use as feedstock for process and space heating (EHM, 2005). Other stakeholders suggest that these estimates are low, possibly significantly so. Demand for woody

biomass as a fuel source is expected to rise under the ETS-plus compared with the base case. Stakeholders and studies (EHM, 2005, pp. 36-40) suggest that a substantial part of this demand could come from the forestry processing sector itself (EHM-Scion, 2007).

The extent to which wood will be available for other uses (institutional heating, electricity generation or cogeneration, domestic heat) if large industrial consumers in the forestry industry were also to increase demand for woody biomass as a solid fuel, is unclear. The ETS is expected to increase afforestation. However, varying views have been expressed by stakeholders as to whether expansion of plantation forest as a result of the ETS-plus is likely to increase the supply of wood as a solid fuel.

The availability of wood over time is also dependent on harvesting and planting cycles, both of which are expected to be affected by the ETS (refer to the Forestry section of this chapter)[26]. In addition, the economics of using wood as fuel at a site distant from where wood is grown depends on both transport and drying costs as well as production costs.

The potential for wood farming close to urban areas has also been identified by some stakeholders; i.e. combining wind on ridges with fuel forestry on slopes. The economics and public acceptability of this approach are also unclear.

Direct use of geothermal heat

Geothermal energy is a major source of direct heat as well as a feedstock for renewable electricity generation. It is possible that energy-intensive industry will relocate or establish close to geothermal energy sources. There is also potential for co-location between geothermal electricity generation and activities requiring lower grade process or space heat, possibly including drying of woody biomass.

Non-traditional Renewables

Marine Energy

Investigation of marine energy sources for electricity generation is likely to be accelerated compared with the base case, although the speed of this, and the form it takes will depend somewhat on research and development work in the next few

[26] For example, some stakeholders have suggested that the ETS may lead to reduced harvesting of post-1989 forests due to the need to surrender units when harvesting.

years.[27] At present, officials advise that the cost of marine energy prohibits its commercial deployment

On the basis of comments from stakeholders:

(i) it is likely that pilot projects will be established over the next decade; and

(ii) it is unlikely that marine energy sources will meet a significant proportion of energy demand before 2020; and

(iii) there is an awareness of possible future resource use conflicts arising from development of marine energy.

Solar Energy

There is little information on the role of solar energy outside households and institutions, and few stakeholder comments were received. The ETS-plus can be expected to increase incentives for the use of solar energy (provided higher energy costs do not also increase the capital cost of solar technologies significantly). On the basis of information produced by MED[28] the main use of solar energy is likely to be passive design changes in buildings, together with direct water heating in households and small institutions over the study period. Increased use of solar energy for commercial water heating is also possible.

The uptake of photovoltaics is likely to increase, albeit from a low base. It is possible this could be accelerated if use of heat pumps creates a daytime peak in household electricity demand, when photovoltaics are most cost-effective.

Significant changes in solar technology and cost are possible, especially in regard to photovoltaics, as this area is under active investigation internationally.

3.1.2. Potential Environmental Effects Arising from Behavioural Changes

Greenhouse gas emissions

In the medium term, the ETS is expected to reduce greenhouse gas emissions from electricity supply and industrial process heat relative to the base case. This effect is expected to increase over time. In the short-term, emissions from direct coal use are expected to fall and emissions from gas use and electricity generation are likely to increase.

[27] The Marine Energy Fund has been established under the NZES and provides a contestable $8 million fund over four years to support the early deployment of marine-based electricity generation, such as wave or tidal.

Biodiversity, Freshwater quality and quantity, Landscape and Natural Character

Increased renewable electricity generation is expected to increase pressures in a range of areas. The scale and significance of adverse effects depends on the size and nature of the projects, and their location.

Wind generation is likely to affect landscape values, amenity and natural character, and possibly affect biodiversity. The extent of these effects is very site specific. For some people and some sites, amenity effects can be positive.

Greater development of geothermal energy is also likely to have localised effects on biodiversity and landscape values, and may possibly affect water quality and quantity if fluids are not reinjected. These effects are potentially more significant than with comparable fossil fuel plants due to the reduced flexibility in the location of a geothermal power plant. These effects could also be more significant if industry relocated towards geothermal energy sources.

The expected increase in hydroelectric generation compared with the base case means an expected increase in the pressure, especially over the medium to longer-term. Aspects of the environment likely to be affected include:

- the quantity of fresh water available, as power generation is a competing use for water
- instream values and ecosystems, landscape and natural character, and freshwater quality

Hydroelectric development creates largely irreversible local environmental changes, and in the view of some stakeholders these are substantial in comparison with the increment in electricity generation. While these effects are local, the values affected, such as biodiversity, may also be national or even international values. Furthermore, climate benefits only arise where a renewable project is displacing thermal generation, rather than alternative renewable sources or demand-side activity.

Land with conservation values (both publicly and privately owned) is likely to come under pressure for both hydro development and wind development, as stakeholders indicate that a proportion of sites identified as suitable for wind and hydro are located on such land.

[28] Refer EHM(2005): Chapters 6 and 7 for details.

Effects arise not just from the location of renewable projects but also from construction activities associated with their development. The location of these effects is driven by the location of the wind and water resources and by proximity to transmission facilities (and reserve energy to some extent).

The location, nature and need for future upgrades of the electricity distribution system to deal with higher levels of renewables are also likely to result in increased pressure on landscapes and natural character from transmission investment, compared with a base case where thermal generation may be located closer to sources of demand. To the extent that distributed generation increases, this may counter some of the need for augmentation of the transmission system. Some additional investment in transmission is expected in any event; the ETS-plus is expected to change the pattern of that investment and may result in additional investment being needed.

Overall, pressures from renewable development can be expected to be significant between now and 2020. Where the sector ends up is also likely to depend on the sequencing of decisions. For example, larger scale renewable generation accompanied by transmission investment could possibly to crowd out smaller scale distributed solutions, and energy efficiency, and lead to further larger scale projects. Large scale renewables tend to result in concentrated local impacts and increased pressure on hydro resources, but fewer dispersed effects overall. Smaller scale distributed solutions could mean relatively more local issues of amenity and visual impacts, and possibly increased transmission investment, but less pressure on rivers.

The extent and pattern of demand growth, as well as the direct influence of the carbon price, and investment decisions will shape the extent and location of pressures.

Other Effects

Local air quality

Changes in local air quality as a result of changes in stationary energy supply arising from the ETS are likely to be small but positive. These will arise from reduced emissions from fossil fuel combustion for stationary energy and process or space heat. There is also a possibility of localised adverse effects in the short-term due to discharges from thermal electricity generation.

Land and Soil

To the extent that coal mining is reduced by the ETS, environmental pressure on land from mining will also reduce. The likely extent of any change is unclear as a significant proportion of domestic coal production is exported.

Increased pressure due to increased afforestation for woody biomass is possible, although the short-medium term additional effect of this is likely to be small compared with other drivers of afforestation.

Turning to renewable energy generation, geothermal energy development is likely to have localised effects on land and soil, and public concerns remain about the potential for subsidence of land when underground geothermal fluids are extracted.[29] These effects are likely to be minor but could be more significant if industry relocated towards geothermal energy sources.

For hydroelectric development, effects are possible due to the inundation of land, and alterations in sediment balances, although the extent of these is very site specific.[30]

Coast and Marine

Coastal areas are significant sites for wind generation and it is likely expected that there will be further pressure on coastal landscapes from wind generation projects, and possibly from associated transmission projects.

In the longer term, the possibility of marine generation adds a potentially competing use to inshore waters. The impacts of this form of electricity generation are unknown, as are potential conflicts with uses such as aquaculture, fishing, recreation and navigation.

[29] EHM (2005) p28.
[30] EHM (2005) p23. Inundation of land was seen as a moderately significant issue with the formerly proposed Project Aqua, for example.

3.2. Energy Demand

3.2.1. Behavioural Changes

This section focuses on the effects of the ETS-plus on energy demand from households, small to medium size enterprises and public institutions. The effects of the ETS-plus on energy demand from industrial sectors are addressed in the discussion of those sectors. This section focuses on the effects of the ETS-plus on energy demand from households, small to medium size enterprises and public institutions.

The influence of price changes in the short to medium term

The Regulatory Impact Statement contained in the ETS legislation suggests retail price rises of 5-10% for electricity and 2-4% for retail gas[31], compared with a 40-67% increase in the wholesale price of coal (assuming emission prices of $15 and $25 per tonne of CO_2-e, respectively).

Over the next few years, increased electricity demand at peak times is likely to be met by increased use of thermal electricity generation.[32] During periods of peak demand, all renewable energy is likely to be online and thermal plants are needed to meet the extra demand. This is likely to affect electricity prices as the emissions price is incorporated into electricity prices in the short to medium term. This influence may possibly become less marked towards the end of the study period as the relative share of renewable electricity increases.[33]

The impact of these price changes alone on overall energy demand is likely to be limited in the period immediately following the entry of stationary energy to the ETS. The exception is coal use, which is expected to fall. Electricity and gas prices have risen significantly in recent years[34] and the demand response has

[31] There is a typo at page 29 of the Bill, which gives the retail gas price change as 11% for $15/tonne CO2-equivalent. This is the wholesale price change. The correct figure for retail gas at $15/tonne, as advised by the Emissions Trading Group at the Treasury, is 2%.

[32] "Likely" rather than "expected" because the actual stations at the margin at any time will depend on the location and timing of demand, and factors such as the extent of hydro storage and wind available at a particular time.

[33] For example, the Electricity Commission 90% renewable scenario sees Huntly being decommissioned around the middle of the next decade - see http://www.electricitycommission.govt.nz/opdev/modelling/gpas/Oct2007/Generation/index.html#scenarios

[34] Real (ie inflation adjusted) household electricity prices have risen 59% between 1990 and 2006 and 32% between 2000 and 2006. Real gas price increases for these periods are 115% and 28%. Refer MED (2007b), Chapter I.

overall been modest. Nonetheless, significant changes in energy demand from households, small businesses and public institutions are expected as a result of increased fuel prices for electricity, coal and gas resulting from the ETS over the period to 2020.

In general these price changes can be expected to encourage:

- a switch to less carbon intensive fuels (e.g. electricity and/or wood or gas for coal); and/or
- increased direct use of solar energy, especially for water heating; and/or
- increased attention to efficient use of energy; and/or
- reduced use of energy.

The exact combination of those effects will vary between individual households and businesses. There is good international and New Zealand evidence that energy use varies widely between households.[35] There is also evidence that some New Zealand households are already restricting home heating for price reasons.[36]

Understanding of direct fuel use by households has been greatly improved by the Household Energy End-use Projecy (HEEP).[37] Direct use of coal by households is expected to fall as a result of the ETS and electricity, gas and/or wood use may rise, depending on the relative impact of the ETS on electricity and gas prices. Changes in electricity and gas prices as a result of the ETS are forecast to be similar at lower emissions costs so demand for both fuels may increase, at least until emissions costs become more significant.

The availability of wood for household use following the entry of forestry into the ETS is uncertain, however depending on availability and relative price, there is the possibility of increased direct use of wood for home heating. Studies by the ARC indicate that wood scavenging is a significant source of fuel for a significant number of households[38] and this activity could be expected to increase.

[35] Perkins and Hamnett (2005) compared both direct energy use and embodied energy between households in an inner-city suburb and households on the suburban fringe in Adelaide, South Australia. They found that annual non-transport energy use can vary by over 100% between similar households. For New Zealand, Isaacs et al (2006, p iv.) noted similar patterns in aggregate household energy use

[36] Isaacs et al, 2006, p vi.

[37] *Ibid.* Stakeholders advise that the work by Isaacs et al has led to revisions to the Ministry of Economic Development's Energy Data File, to include household use of wood.

[38] Figures in a draft ARC technical report expected to be published in March indicate that 29% of households use a solid wood burner as their primary heating source and, of those, 65% source their wood through scavenging. Contact Kevin Mahon or Gerda Kuschel at ARC for further details.

Similarly, the extent and rate at which hospitals and schools convert boilers from coal to wood or shift to heat-pumps or solar water heating will depend very much on the information, programmes and incentives (including the relative costs of fuel) these institutions encounter. There has been little feedback from stakeholders on the likely response of small enterprises and public sector institutions generally. Some NZEECS programmes, such as the pilot programme to convert school boilers to wood pellet burners, do target these groups specifically.

The influence of the NZEECS in the short to medium term

The size and exact nature of the demand responses over the short to medium term is expected to depend in part on the impact of programmes within the NZEECS, which have the potential to increase responsiveness to price changes. It is also expected to depend on:

- the ease of access to high quality information about options to improve energy efficiency,
- the cost of new technologies,
- the nature of government adjustment assistance to households, and
- the level of public acceptability and understanding of the ETS and its effects (including attitudes to price rises).

The nature of the demand response over time is also expected to depend on the size of energy cost in relation to total budgets and the availability of affordable capital to undertake changes. In the absence of direct financial assistance, lower income households are more likely to reduce consumption (most likely directly and, in some cases, through low cost energy efficiency measures) and budget-constrained public institutions (e.g. hospitals) may experience increased financial pressure if they wish to maintain energy services. Other users are more likely to consider alternative technologies such as solar heating, and substantial energy efficiency improvements. A number of NZEECS programmes seek to address these differences.

The measures contained in the NZEECS are expected to significantly improve comfort levels for some households and reduce demand somewhat (Isaacs et al,

2006).[39] The NZEECS as a whole contains a broad range of actions to promote energy efficiency in all households, ranging from direct financial assistance to awareness raising campaigns to promote the benefits of investment in energy efficiency measures. However, at their present scale, the specific NZEECS programmes considered as part of ETS-plus will directly affect a much smaller group than the price effects of the ETS, which is expected to affect electricity prices more quickly than energy efficiency measures can be ramped up. This raises questions about the public response and the nature and timing of any adjustment assistance for households.

Longer-term issues

Second-round effects of changes in patterns of energy demand (e.g. fuel switching) are complex. For example a rise in the demand for electricity due to a switch from direct heat to electrical heat-pumps may raise the overall level of electricity demand and change patterns of demand if heat pumps are also used for summer air conditioning. Informal advice from some industry sources is that the system is not capacity constrained in December-January and an increase in demand could be met from existing capacity (although the extent of this may depend on location and timing of extra demand). A sustained increase in demand over three to four months[40] would however raise capacity issues.

In addition, the Household Energy End-Use Project reveals that the level of household warmth depends in part on fuel type; houses with solid fuel heaters tend to be warmer than those with electric or gas heating (Isaacs et al, 2006). The reasons for this observed pattern are unclear; possibly it reflects the lower overall cost of wood once scavenging is taken into account. If some of these households with a higher ambient temperature switch to electricity, a significant increase in demand is possible.

Over the longer term it is likely that, in the face of rising prices, many households become relatively more energy efficient and in doing so reduce overall energy use as well as increasing comfort and service levels.[41] Officials advise they are

[39] Isaacs et al (p. v) suggest the expected energy savings effect may be modest (around 5% on average) compared with international experience.
[40] Some stakeholders have noted that warmer summers in eastern parts of New Zealand are expected as a result of climate change. This would increase the likelihood of sustained use of air conditioning once it is installed.
[41] The point here is that the "rebound effect", whereby increased energy efficiency results in increased use of energy services rather than just reduced energy use, is reduced in the face of rising prices.

already seeing increased investment in energy efficiency in response to energy price increases and greater awareness of the wider impact of energy use decisions.

The speed and scale of response by smaller users is expected be heavily influenced by the nature of the existing and new building stock, both residential and commercial, and the extent to which it is constructed or modified to reduce energy demand. The nature of the building stock will in turn depend on both the expectations of users and developers and the extent to which Government programmes (including regulation) lead to more energy efficient buildings.

Non-price measures are expected to be an important influence on the scale and speed at which households become more energy efficient. In addition, low to modest income households can be expected to lag behind in their investment in energy efficient building retrofits, and other energy efficiency measures/behaviours, unless specifically assisted and encouraged to undertake them.

3.2.2. Environmental Effects

This section discusses how the behavioural changes above are likely to influence environmental effects from the consumption of stationary energy services. Direct effects of changes in the way electricity is generated are considered in the previous section on energy supply.

Greenhouse gas emissions

Gross emissions of CO_2 are expected fall somewhat compared to the base case as a result of changes in energy demand from the household, SME and institutional sector. This is expected to be initially due to fuel switching away from coal, with lower growth in energy demand over the period of the study. Increased demand for electricity (and possibly gas) may mean CO_2 emissions from electricity (and possibly gas) rise initially, even though some households reduce overall energy use. Over the longer term an increase in the proportion of electricity from renewable sources, increased direct use of solar energy and ongoing improvements in energy efficiency, will offset this effect.

Local air quality

Reductions in coal use are expected to improve local air quality. Increased direct use of wood as a substitute for electricity, especially in open fires or older wood

burners could possibly increase pressure on air quality in some areas.[42] Stakeholders, including officials, advise that technologies are available to eliminate air quality issues associated with domestic wood burning. Actual air quality impacts are highly localised and require specific assessment.

The *Environment New Zealand* 2007 report identifies airsheds where air quality is already poor. In a few cases (e.g. Christchurch) local authorities have information that could enable them to assess the relative air quality effects of these two forms of fuel-switching. Any shift from gas to electricity would be likely to generally improve indoor air quality, especially if older gas stoves and flueless heaters are scrapped or relegated to reserve capacity only.[43]

Human health

Increases in fuel prices make it more likely that those on low incomes will spend less on heating. Some may resort to open fires from scavenged firewood where this is practical. The ETS is expected to create further pressure in this area from additional fuel price increases.

There is good evidence that there are significant health issues associated with the poor thermal performance of the New Zealand housing stock.[44] Both the direct effect of colder, damper houses as a result of reduced heating and, to a lesser extent, the possible risks to indoor air quality from open fires are expected to increase pressures on human health.

The measures in the NZEECS that address these effects will deliver important positive benefits in relation to human health, however at their present scale they are expected to reach a relatively small proportion of households compared with the price effects. In the base case, the Clean Heat programmes, e.g. in Christchurch and Nelson, target the low-income households that are most likely to be at risk of inadequately heated houses. These will help to reduce the final impact on households in these areas.

[42] Unpublished draft report for Ministry for the Environment by Endpoint Consulting Partners.
[43] Carbon monoxide from incomplete gas combustion is a potentially significant health hazard with unflued gas heaters and older gas stoves.
[44] See for example Howden-Chapman et al (2007).

Biodiversity, Landscape and Natural Character

There is a possible risk of firewood scavenging and poaching encroaching on a range of indigenous woody ecosystems. The extent of this is difficult to estimate but could be locally significant, given the evidence that scavenging is already a significant source of wood fuel in Auckland.

Some stakeholders have suggested that clearance of marginal land for firewood may be encouraged. To the extent this occurs, it is likely to be highly sensitive to the extent such land is captured by the ETS provisions relating to deforestation.

Scavenging and firewood harvesting are general effects of increased energy prices; it is possible the ETS will add to pressure in this area, especially if pre-1990 indigenous forests are excluded from liability under the ETS.

3.3. Transport

3.3.1. Behavioural Changes

Introduction

Transport is often segmented into land (road and rail), sea and air modes but for the purpose of this exercise it is better categorised by *functional activity* (e.g. urban access and mobility, logistics and location, long-distance passenger travel). The responsiveness of different functional activities to fuel price changes varies widely, depending on the nature of demand and the availability of alternatives.

Some examples may help illustrate this point. Demand for road freight from profitable and expanding economic activities located in an area where no alternative freight services exist is likely to show little response to small price changes. Commuter journeys are more likely to be influenced by price movements where commuters have access to a high quality public transport system. Demand for domestic air travel may be much more price sensitive for personal travel than for business travel.[45]

The factors affecting transport demand, in particular the effects of price on urban travel demand, have received much attention internationally, but relatively little specific attention in New Zealand. It is commonly thought that because of our

[45] See for example comments by Annable (2007) in relation to this for British travellers.

patterns of work and daily life, road transport use is relatively unaffected by price (i.e. the demand for fuel is "inelastic"[46]).

A recent review of global literature in relation to the demand response to fuel price changes (and a range of other factors) concluded as follows:

> *Although every situation is different, on average the long run effects of a 10% change in fuel price (for example) will be a change in traffic volume of about 3%, and of fuel consumption of about 7%.*[47]

Recent New Zealand research commissioned by Land Transport New Zealand on petrol price elasticities, although not directly comparable, suggests a somewhat similar value for traffic volume and a somewhat lower value for fuel consumption should be used for domestic land transport planning purposes[48]. This study also suggests that the price effects on fuel use and traffic volume, while modest in absolute terms, are quite rapid.

Price effects of the ETS

International factors are expected to be the dominant influence on both domestic prices and supply security for petrol and diesel in the short to medium term. The possibility of a global peak in conventional oil supply (sometimes known as "Peak Oil") in the near future is regularly discussed in the sectoral media[49]. This study does not take a view on the imminence or otherwise of "peak oil"[50]. Clearly, were a peak to occur in the study period, there would be significant upward pressure on the price of mineral oil and diesel. This would be expected to dominate any influences due to the ETS.

The main initial impact of the ETS-plus on transport will be through the cost of carbon being reflected in increased petrol and diesel prices from the start of 2009,

[46] See ETS framework document, 2007, p 106.
[47] Professor Phil Goodwin, "*How easy is it to change behavioiur?*", p49 of ECMT(2003). The difference between traffic volume and fuel consumption arises because changes in vehicles and driving habits mean people can alter fuel consumption through a range of behaviour changes (e.g. different driving styles, more efficient vehicles etc) that change fuel use per vehicle-kilometre, as well as changing total vehicle kilometres driven.
[48] LTNZ (2007), Executive Summary. There are, however, a number of caveats on this conclusion and suggestions for further research. No particular significance should be attached to the divergence between the global averages based on panel data and the New Zealand values from a single study. Variations between individual studies are common, and can reflect noise in data as much as fundamental differences.
[49] For example, NZ Energy and Environment Business Week has run two reports already this year (on the 23rd of January and 6th of February 2008) where different views about the likelihood of Peak Oil in the near future have been aired.
[50] This is not a reflection on the potential importance of the issue. Peak Oil is not an effect of the ETS, rather it is a matter in the base case that requires prudent planning based on the best available information.

when liquid fossil fuels enter the scheme. Overall, it is likely that as fuel prices rise in response to the ETS price, there will be a small relative decrease in total GHG (mainly CO_2) emissions from the transport sector, linked to a small decrease in total road and air kilometres travelled.

International aviation and marine fuels are not covered by the Kyoto framework or the ETS-plus. Any future introduction of international aviation and marine fuels into international or domestic emissions reductions programmes would have significant implications for New Zealand, because of our economic dependence on long-distance international trade (predominantly sea freight) and international tourism (predominantly air travel)[51].

There are many uncertainties in the size of fuel price increases driven by the ETS and the Biofuel Sales Obligation, as well as in individuals' and organisations' response to this price increase and other measures in the ETS-plus. The ETS will affect the relative price of petrol and diesel differently: diesel is not subject to Petrol Excise, and the ETS is initially likely to reduce the price per litre differential between petrol and diesel and hence the incentive to switch to diesel.

Diesel vehicles are however subject to Road User Charges and when these are taken into account the overall percentage change in price per kilometre for diesel and petrol vehicles is likely to be similar. The relative fuel efficiency of diesel and petrol vehicles will also influence consumers' vehicle choices as the relative prices of petrol and diesel change in response to the ETS. Some stakeholders believe that fuel switching from petrol to diesel is likely in the short term, in response to relative price signals, while others expect little change. None of the factors affecting these decisions can be expected to stay constant throughout the period 2009-2020.

Diesel also has significant off-road uses and the increased price of diesel will have some impact on a range of non-transport activities (e.g. on farm-use (see section 3.5), electricity from diesel generators will become more expensive, affecting isolated households, recreation activities, etc).

[51] See for example Smith and Rodger (2007) and Saunders et al (2006). The latter study, of comparative energy and emissions performance of New Zealand's agriculture industry, while it highlighted the relative energy efficiency of New Zealand agriculture compared to EU performance, showed that the sea freight component of total CO2 emissions ranged from 18% (dairy) to 67% (apples and onions). See also section 3.10.

If the world price of emissions rises significantly over the study period, ETS-driven-demand reductions would become more significant additions to demand reductions driven by world market fuel price increases or other factors.

The Biofuel Sales Obligation

Additional response issues arise with the Biofuel Sales Obligation. At present, industry sources advise that bioethanol is domestically produced by Fonterra for Gull petroleum[52] and biodiesel is sourced from tallow and post-consumer oil wastes. Tallow and ethanol from whey have a range of uses besides fuel. The domestic supply of post-consumer oil waste for transport is currently limited as most of the half to two-thirds of the waste stream recovered is supplied to one major industrial processor (Ministry for the Environment 2007[53]).

Industry sources indicate that the biofuel obligation is not likely to be met from existing domestic production processes in the short term. They also note that the international price of biodiesel relative to bioethanol has risen recently. This is affecting earlier expectations that the biofuel obligation would be met largely through domestic biodiesel supply.

Present expectations are that a relatively even balance of imported biodiesel and imported bioethanol will meet the obligation, and this will moderate any domestic environmental effects of biofuel production (see section 3.5). In general, stakeholders suggest that the price effects of the Biofuel Sales Obligation are not expected to be significant in the short term. As with mineral diesel and petrol, the factors affecting the cost and supply of domestic and international biofuels are expected to vary significantly over the study period.[54]

The potential use of imported biofuels raises questions in relation to their role in reducing greenhouse gas emissions, because imported biofuels might have been produced using emissions-intensive processes[55] and their production may have

[52] Refer www.gull.co.nz for a brief discussion of this process.
[53] Page 126.
[54] Note added in press: For example, the Scion CRI reports that there are major opportunities for the production of "second-generation" bioethanol in New Zealand. Refer "Transport Fuels From New Zealand Biomass A Reality": Press Release by Scion, 03 Mar 2008.
[55] For a fuller discussion of these issues refer Zah et al (2007). This research suggests that there is little cause for concern from the current domestic sources of biofuel.

created significant adverse effects.[56] The global sustainability of biofuel production has received significant publicity in the last few months.

In response to these issues, the proposed legislation for the biofuels obligation would give the government the ability to impose a sustainability requirement in relation to fuels used to meet the obligation. Industry sources have suggested that any such requirement needs a high-degree of specificity – for example similar to that provided by the UK's Renewable Fuels Agency[57] - if it is to encourage sustainable domestic production of biofuels.

The precise nature of any sustainability requirements in the biofuel obligation is likely to influence whether there is increased demand for arable land for biofuel production within New Zealand.[58] Based on recent research[59], in the medium to long term it is likely that so-called second-generation biofuels, notably bioethanol from wood waste/residues, will add a further element to the demand for wood residues. The range of factors to be considered in assessing the sustainability of biofuel production is wide, as illustrated by the Appendix in SKM (2008).

Other measures

Behavioural change leading to emissions reductions may also be driven by other ETS-plus measures, particularly the Energywise Transport measures in the NZEECS, e.g. fuel economy labelling and standards, education for fuel-efficient driving styles. In the near future (based on relatively low prices on greenhouse emissions), these initiatives are likely to be at least as significant as price signals from the ETS. For example, commercial fleet driver training alone is expected to deliver reductions in excess of the carbon price signal initially[60].

The effects of fuel economy standards and prices rises are likely to be mutually reinforcing. This contrasts with experiences over the last two decades: some commentators (e.g. Schipper, 2007) have suggested that, in this period, significant gains in fuel economy have been more than absorbed through increases in travel and vehicle size, leading to an overall increase in fuel use. In effect, fuel

[56] See for example Commons (2008) for a full discussion of potential impacts.
[57] Refer http://www.dft.gov.uk/rfa/reportsandpublications/carbonandsustainabilityguidance.cfm for details
[58] The extent to which sustainability obligations exclude subsidised, unsustainably produced imported biofuels will be one of the factors influencing the amount of land used to grow biofuels in New Zealand. See section 3.5 for further discussion.
[59] Refer note 54
[60] It has been suggested that a targeted driver training programme for heavy vehicle drivers could deliver energy savings of at least 10% of current heavy vehicle fleet use (ETS Framework Document, p. 81)

efficiency improvements only reduced the price per kilometre travelled, not the total amount of fuel consumed. It is now recognised that technical and behavioural measures need to be introduced in tandem to minimise this form of take-back. In an environment of rising fuel prices, and climate change awareness, it is much more likely that fuel economy standards will reduce overall fuel use, as well as fuel use per vehicle-kilometre.

Behaviour change in the medium term

The range of possible medium-term behavioural changes in response to the ETS-plus is substantial but similar to those that can be expected as a result of rising fuel prices and changes in public awareness. These include:

- generally greater efficiency of transport use
- more cycling and walking and public transport use
- demand for improved public transport facilities
- less work-related commuting and an increase in people working from home
- increased video-conferencing to replace business travel
- fewer single occupant car trips
- changes in the logistics industry including moves from road to rail and shipping for long-haul freight distribution, and increased pressure for larger heavy road freight vehicles to be permitted
- more fuel-efficient vehicles
- increased demand for electric and hybrid vehicles
- reduction in car usage
- less discretionary travel for holidays and business.
- increased or more intensive use of particular transport corridors
- a reduction in peri-urban lifestyle subdivision requiring long commuting distances.

The likelihood and magnitude of all these changes in transport patterns are very hard to assess because of the complexity of factors influencing people's transport decisions and the dominant role of factors beyond ETS-plus.

The actual rate and extent of change in transportation patterns associated with the ETS and Energywise Transport measures in the NZEECS (as individual or business responses to either rising prices, or generally greater awareness of transport energy demand issues) will depend on the extent to which general

transport policy settings and initiatives support the direction of behaviour change signalled by the ETS.

In particular, there is a need for consistent and mutually supporting price signals, regulation, availability of more fuel-efficient and alternative vehicles, public funding (including infrastructure investment decisions), education and social marketing, and land use planning. At present there is considerable scope to increase the alignment of these factors, deliver a range of benefits and benefits and help to future-proof and manage risks associated with the transport system.

Environmental Effects

This section discusses how the behavioural changes above are likely to influence environmental effects from the demand for and supply of transport. Most effects have similar drivers.

3.3.2. Greenhouse gas emissions

The initial ETS-driven changes in activity and consequent changes in transport GHG emissions from transport are expected to be very small. Officials estimate that, as a result of the ETS, transport sector emissions will reduce by less than 1% relative to business as usual over the medium to long term, with an emissions price in the range of $15-25/t CO2-e; (ETS Framework description, Sept 2007, Table 7.1). As discussed above, other measures in the ETS-plus - notably fuel economy standards and driver training - are expected to result in further reductions in emissions relative to the base case.

Overall, the most likely effect on emissions in the short term is a slight decrease in the rate of emissions growth. It is possible that any emission reduction driven by the ETS-related price signal could be completely offset by efficiency gains or overtaken by population and economic growth. However, this situation would still represent a reduction compared to the base case, under which growth would have been even higher.

If the cost of emissions rises significantly towards the end of the period 2009-2020, the additional reductions from the ETS price signal are expected to become more significant. Trends in emission levels over the medium to long term will also depend on the development of biofuels, other technological developments and

emergence of alternatives to current patterns of urban mobility and freight movement.

3.3.3. Local water quality

Reduced road vehicle usage results in reduced local water pollution from road runoff. Significantly reduced road vehicle usage, to the point that the total number of vehicles declines or projected road construction is not required, generally results in locally improved water quality, because of reduced sedimentation and pollution from road construction and end-of-life disposal of cars, tyres or oil. A further potential positive effect is that biodiesel blends will lessen the aquatic pollution caused by fuel spills. Biodiesel is biodegradable and even small proportions in a fuel mix will speed the breakdown of fuel spills (EECA 2005).

These positive effects may be experienced locally even if road vehicle usage does not decrease nationally but its pattern changes (e.g. growth is concentrated in fewer transport corridors). Conversely, pollution effects in these corridor zones are likely to be greater. Also there is a likely to be a lag in pollution reduction from a reduced total number of vehicles. This is because New Zealand's car fleet is relatively old, and its average age has increased in recent years (Ministry for the Environment 2008). If vehicle prices increase as a result of higher fuel efficiency and pollution standards, there could be a tendency for owners to retain their cars longer than would be the case currently.

3.3.4. Local air quality

In urban areas, transport is a major source of PM_{10} particulates and the main source of oxides of nitrogen and carbon monoxide (MfE, 2007). Particulates from diesel motor vehicles[61] are of particular concern in Auckland.

Increased diesel prices could be expected to reduce diesel use and hence particulate emissions. However the direct price effects on diesel use are expected to be small initially and there is debate about the overall effect of the ETS on the relative attractiveness of diesel versus petrol.

Any increased use of biodiesel, which leads to noticeably lower particulate and sulphate emissions than mineral diesel alone even when blended in small

[61] According to the Ministry of Transport standard emissions model diesel particulate emissions outweigh petrol particulate emissions by a factor of 25:1.

quantities (Biofuels Taskforce, 2007), is expected to reduce particulate emissions from diesel engines. Biodiesel substitution would further enhance the air quality effects of any overall diesel reduction due to price changes.

The evidence in relation to bioethanol/petrol blends is less clear. Some studies suggest that increased use of bioethanol in fuel mixes can increase emissions of oxides of nitrogen[62] and emissions of particulates[63]. According to this study, particulate emissions from a petrol engine running on a 10% ethanol blend may be up to 40% higher than one running on mineral petrol alone. These studies suggest that a significant trend of fuel switching to diesel, and/or increased use of a bioethanol/petrol blend, could possibly lead to decreased air quality in some areas of higher traffic intensity.

The use of biodiesel (as opposed to bioethanol) to meet the biofuel obligation is now likely to be less than initially expected. The effect of the ETS-plus on air quality is therefore difficult to assess with certainty in the short-term, because of the different possible sources of biofuels and the complexity of the factors affecting the relative demand for transport fuels as a whole, diesel and biofuels.

Many factors discussed above are subject to change in the future, and the research information around biofuels is growing rapidly. These facts only reinforce the difficulty of reaching definitive conclusions in a scoping study.

Along with the questions about global sustainability of biofuels, the uncertainties associated with the domestic production and use of biofuels have led the authors to propose further study of biofuels (see Chapter 6).

In the longer term, if there is significantly less diesel used overall, the positive air quality effects of the ETS-plus would be less ambiguous. Reduced road vehicle usage and vehicle numbers could also be expected to decrease local air pollution due to vehicle emissions[64]. An ancillary benefit of this would be reduced air

[62] The domestic effect of the increase in oxides of nitrogen is unclear (there is little New Zealand research according to an unpublished study by Enpoint Consulting Partners for Ministry for the Environment) though an unpublished draft technical report for Auckland Regional Council (contact Gerda Kuschel, ARC, for further information) suggests it could be minor.
[63] Unpublished draft technical report for Auckland Regional Council - contact Gerda Kuschel (ARC) for further information. These figures are accepted as indicative by the Australian Biofuels Taskforce (Biofuels Taskforce (2005)).
[64] Government has recently introduced a land transport rule that specifies minimum emissions performance for newly registered vehicles (http://www.landtransport.govt.nz/rules/vehicle-exhaust-emissions-

pollution from end-of-life disposal of cars, tyres or oil. The extent of these benefits will depend on the way in which transport patterns respond to the ETS-plus.

3.3.5. Human health

Reduced local air pollution resulting from lower emissions would have public health benefits, especially in urban areas. As noted under air quality, the net effect of the ETS-plus on this in the short-term are unclear. The longer-term benefits are relatively unambiguous.

In addition, any increased use of active modes (walking and cycling) will bring clear health benefits through increased exercise. Some concern has been expressed about increased exposure of pedestrians and cyclists to risk of vehicle injury. It will be important to ensure that general policy and funding settings (e.g. through the New Zealand Transport Strategy and Financial Assistance Rates[65] used by Land Transport New Zealand) support an expansion of safe routes for walking and cycling. A number of international studies (eg LEED, 2006; BMA, 1997) suggest that overall an increase in walking and cycling delivers clear public health benefits, even considering possible crash risk and exposure to air pollution.

Possible safety concerns have been raised in relation to proposals to increase the size and dimensions of heavy trucks on New Zealand roads (in order to maximise the energy efficiency of freight movement). To the extent that the ETS-plus increases pressure for this, it can be considered a potential environmental effect of the scheme.

3.3.6. Land use and landscape

It is possible that significant land use-related environmental effects resulting from changes in transport patterns will occur, as discussed in the section above. Changes may be either positive or negative. For example, better urban form could result from less or changed urban road transport required, e.g. less space required for roads and car parks. Similarly changes in land use in response to transport price increases could result in less pressure for peri-urban subdivision, but more pressure from other peri-urban uses such as local food production.

2006.html). This is likely to reduce emissions per vehicle over the next 20 years or so. Any effects of the ETS will be superimposed on this trend.

Stakeholders suggested a range of changed or greater pressures on land, including new transport corridors, changed retail patterns, new infrastructure requirements for alternative fuels, transport methods or routes, or a requirement for more local warehousing. There are likely to be landscape or visual effects from such changes, but predicting the scope or scale of such changes is not possible at this stage.

3.4. Land Use - Agriculture[66]

3.4.1. Behaviour changes

The extent of land use change and on-farm management change as a result of the ETS-plus will depend on a number of factors which are likely to come to bear during the time before agriculture enters the ETS in 2013. For example, change will depend on:

- product prices and profitability within each agriculture sector
- what other countries are doing about the carbon price
- the degree to which the ETS-plus affects forestry land use
- where the point of obligation is for agriculture and how strong the price signal is for land managers/owners
- the availability and uptake of farm management practices and technologies that will reduce emissions, and
- the degree of consumer and public pressure on the sector to reduce its effects on the environment.

Before 2013

The 2007 deforestation intentions survey (Manley, 2008) has highlighted two significant issues for agriculture in the period before it enters the ETS:

- Deforestation was higher in 2007 than forecast in 2006 (19,000 ha c.f. 13,000 ha)
- Deforestation over the period 2008-2011 is lower under all scenarios than forecast in 2006.

[65] The FAR is the share of central government contribution towards the cost of a particular activity (so a FAR of 60%, for example, means the Government meets 60% of the cost of the activity).

[66] This section addresses dairy, sheep and beef, arable and where appropriate horticulture. Note that the biggest effect on horticulture from the ETS-plus is an increase in the price of fuel, which is likely to result in rationalization of horticulture, fuel switching or a reduction in horticulture, resulting in reductions in CO_2 emissions. No stakeholders from the horticulture sector participated in the workshop. Their expertise was subsequently sought for inclusion in this full scoping report.

Manley reports that under the ETS policy scenario[67], deforestation intentions total 10,700 ha: 24% (2700 ha) intend to convert to dairy, 45% (4900 ha) to sheep and beef and 28% (3100 ha) to lifestyle farms. Manley also considered an "amended scenario" allowing forest owners greater flexibility than the ETS policy including the continuation of conversion projects at some cost to the land owner. This scenario generated intentions totalling 47,000 ha deforestation, with 63% converting to dairy (29,600 ha), 29% (13600 ha) to sheep and beef, and 7% (3300 ha) to lifestyle. This amended scenario is presented because the ETS-plus policy is not yet designed in detail and the full implications for the environment will need to be considered if amendments to the ETS-plus considered for this scoping report are made.

The ETS policy intervention leads to substantially lower levels of deforestation than were planned without the intervention (11,000ha). Of deforestation planned by large-scale owners during 2008 to 2020, 46% (5000 ha) is forecast to take place in the Central North Island, with Northland, Otago/Southland and Canterbury/West Coast being the next highest areas.[68]

With this as context, a number of factors will start driving change before 2013 and build the platform for the behaviour changes expected to affect nitrous oxide and methane emissions after 2013, when farm management mitigation practices and technologies are expected to be better developed and able to be taken up. Significant drivers of change will include:

- the government's sustainable land management and climate change initiatives[69] (these initiatives are part of the base case for this report),
- the slowing of conversion of exotic forestry land to dairying from 2008, due to deforestation liabilities,
- the carbon price signal on liquid fossil fuels from 2009 and electricity from 2010,
- the requirement for the agricultural sector to report its emissions at entity level by 2011[70],
- the expectation of non-CO_2 emissions pricing from 2013,

[67] ETS policy, Amended ETS with more flexibility and No policy scenarios were assessed
[68] It should be noted that these deforestation intentions were collected during a time of policy change and as forecasts they are subject to change.
[69] As set out in the SLM and Climate Change Plan of Action September 2007, Figure 2, page 18
[70] The Government has signalled it will require sector emissions monitoring and reporting two years ahead of agriculture's entry to the ETS, i.e. in 2011. See Question 5, Agriculture in the New Zealand Emissions Trading Scheme (MAF, 2007a).

- the quantum of free allocation of emission units to the sector and how and to whom the units are distributed, and
- the early signalling (by late 2008) of the point of obligation for the agriculture sector entry to the ETS.

According to sector participants in the workshop and the arable and horticulture sector contacts, energy price increases are already being factored into decisions on the farm. For example, the area of land cultivated on an arable farm in any one year has reduced and more cost-effective and energy-efficient cultivation and planting systems are being adopted, including some no-tillage systems where appropriate. This is expected to continue as the price increases from the ETS are passed through to the farmer and are likely to improve the efficiency of water, fertiliser and energy use.

In the greenhouse horticulture sector, there are likely to be growers whose businesses become uneconomic due to increased energy costs, where fuel cannot be switched nor efficiency gains made and where growers compete with Australia for market share. The effect of Australia ratifying the Kyoto Protocol on the relative economics is uncertain at this point. These impacts are economic and social. Some growers, however, are likely to look for new renewable energy sources such as small scale wind and solar where they can be managed within the growing system.

Direct climate change liabilities will be drawn to the attention of the sector with the measurement of industry liabilities in 2011. This increased awareness is likely to lead farmers to increase their carbon-use efficiency.

In addition to rising energy costs, public and market pressure on climate change, water management and about "clean green New Zealand", are currently significant influences on the behaviour and rising awareness of the industry. The responses to date include greater environmental research investment through the PGGRC[71], energy efficiency improvements[72] and environmental agreements on growers for better waterway and riparian management (e.g. Clean Streams Accord, see MFE, 2008).

[71] Pastoral Greenhouse Gas Research Consortium – see their Strategic Plan (PGGRC, 2007).
[72] Industry initiatives and through EECA's SME programme for small and medium enterprises.

Despite these initiatives there is not expected to be much change in behaviour at the farm level up to 2013, especially in the dairy sector, until the price on all emissions is felt at the farm and the technologies for the reduction of non-CO_2 GHGs have been either disseminated (farm management practices that are known now to reduce emissions) or new practices/technologies successfully developed and made available. The stronger influences on industry behaviour before 2013 however, will be other factors, such as the exchange rate, relative prices for different agriculture products, changes in overseas markets and the effects of extreme weather-droughts and storms.

The response by the extensive sheep and beef farmers is likely to be slow up to 2013 for methane, since the mitigation technologies and their delivery mechanisms are still 10-15 years away e.g. ruminant methane reduction technologies, breeding and forage additives. While nitrification inhibitors are available and cost effective now in some areas, they are not yet being taken up in a widespread way, in part due to the need for successful demonstration across the full range of soils and climate conditions and better understanding of their full environmental effects (Suter et al, 2006). The base case initiatives in the SLM and Climate Plan of Action are designed to support such demonstration over the period up to 2013. The effectiveness of these measures, however, will be less for sheep and beef farming than for dairying, due to the practical difficulties of implementing new technologies on extensive farming systems.

Overall, the extensive pastoral sector is likely to be influenced more by the price signal in the ETS-plus than the dairy sector, due to its low current profitability. This is likely to result in more dairy conversions from sheep and beef and some of the remaining farms becoming more intensive, the less intensive farms reverting to regenerating indigenous vegetation and some areas established as exotic forest. The likely mix of land uses is uncertain.

It is expected that between 2008 and 2013 the dairy sector will continue to intensify and move into areas not previously in dairy, while at the same time becoming more efficient, so long as the world prices for dairy products stay relatively high. It is expected that conversions will occur where the benefits are sufficient to meet all the costs involved, including the relevant deforestation liability.[73] This is because the conversions are influenced more by other market drivers and because energy prices are a relatively small proportion of the cost

structure of dairy farming. They range from about 5% for electricity as a proportion of total on-farm costs up to about 20% for the large-scale irrigated dairy farms. Liquid fuels are a smaller proportion. Electricity costs are rising less quickly compared to other on-farm costs like stainless steel dairy equipment and irrigators[74].

The extensive pastoral sector will be directly influenced by what is going on in the dairy sector as a result of the high current prices affecting behaviour and because they are competing for the same land in some areas of New Zealand. The intensive arable and horticulture sector will make decisions on irrigation equipment, for example, based on price, market information and availability of the most efficient equipment. The degree to which regional councils require efficiency ratings for irrigators will also drive behaviour change up to a 10% efficiency gain[75].

OVERSEER is a critical tool that is expected to drive behaviour change on livestock farms. It is a computerised decision-making tool that can assist dairy, sheep and beef farmers to manage nutrient inputs and explore changes to farm management systems. The rate and extent of uptake will depend on industry leadership, the base case initiatives to fine tune it, success of technology demonstrations and whether the price signal to energy use is large enough to leverage some behaviour change that flows over to non-CO_2 GHGs.

In the absence of a price signal to reduce emissions before 2013, strong leadership from the sector will be needed to drive the widespread adoption of OVERSEER for active emissions measurement and monitoring, according to some industry contacts.

For sheep and beef farming it is also expected that there will be spill-over effects from changes in farming structures. These could include a greater proportion of production coming from a smaller number of farm businesses which could influence behavioural responses to the ETS-plus. Note that recent changes in dairy farm ownership have seen owners with different drivers from those of the traditional New Zealand dairy farmer, with respect to scale and management. How changes in ownership patterns will play out is uncertain.

[73] MAF, 2007, Questions and Answers: Forestry in the ETS.
[74] Malcolm Souness, Energy and Technical Services, pers .comm.
[75] Nick Pyke, FAR, pers. comm..

There is likely to be increased arable cropping to supply the expanded dairy sector up to 2013, although this is likely to be muted by increases in energy costs from 2009.

After 2013

After 2013 it is expected that the ETS, along with the outcomes of the SLM and Climate Change Plan of Action, could either reduce dairy production from business as usual forecasts in key dairy regions (industry predictions) or increase dairy production built off a lower carbon (offsets[76] and mitigation) high profit scenario. The likely outcome is uncertain at this stage.

The ETS-plus however, is expected to increase the rate of uptake of mitigation technologies and slow intensification and expansion into new areas. Mitigation technologies are likely to include greater use of nitrification inhibitors, feed additives, biochar, herd homes, feedpads, riparian management, less use of nitrogenous fertiliser and greater use of farm wastes for biogas as the price of energy increases.

The likely responses from regional and district councils to the land-use changes expected under the ETS-plus are uncertain. Some may respond by restricting forestry or dairying, by protecting indigenous biodiversity and through water management tools. Others may actively encourage land use change. Such actions could enhance or detract from the purpose of the ETS-plus. Alignment of national and local government policies are likely to be necessary if the full benefits of the ETS-plus are to be realised.

By 2013 the base case initiatives are likely to start reducing nutrient leakage, reduce GHGs and encourage more efficient use of water and the ETS-plus are expected to reinforce these behaviour changes.

Extensive farming is likely to become less competitive compared with both forestry and dairy farming, unless there is a significant change in recent product price trends that have favoured dairy farming. As a result it is expected that some sheep and beef farms could: (i) become more intensive; or (ii) become less intensive and revert to indigenous vegetation or (iii) convert to dairying, some to forestry and biofuel cropping. The efficiency initiatives, however, are not expected

[76] In this context planting as a result of the AGS on farms where emission reduction mitigation tools are not yet viable for methane reduction.

to be available immediately, as they are based on animal genetics, nutrition or forage plant breeding and transfer. These will all take many years to become robust technologies for use on the farm.

After 2013 the key tool that is expected to bring a change in farmer management practice is the shift in use of OVERSEER from nutrient budgeting, to measurement and monitoring of greenhouse gas emissions. Refinements to OVERSEER will have been completed and trialled and demonstrated actively on farms. Use of OVERSEER is expected to become best practice.

The degree to which expanded feedstock cropping and biofuel planting will be affected by the ETS-plus is currently uncertain (See section on Energy Supply on renewables). Ensuring that any biofuel that is domestically produced is from sustainable sources would be consistent with New Zealand's sustainability objectives.

3.4.2. Environmental effects

Before 2013

Prior to 2013, the most significant determinant of agricultural emissions is the extent of deforestation and conversion to dairy farming. The effects of deforestation on agricultural emissions are twofold - an immediate increase prior to the ETS announcement over 2007, followed by immediate slowing in the intended rate of conversion of forest land to pasture resulting from the forestry sector entry to the ETS from 2008. This has a double benefit from the avoided emissions from deforestation and avoided increase in non-CO_2 emissions in the order of 21 million tonnes of CO_2e over the period 2008-2012.[77] (See Forestry section 3.5).

However, these slower rates of conversion to intensive pastoral farming are reductions off the large increase in 2007. The result will be that dairy is expected to continue to grow up to 2013 under business as usual, resulting in some increase in adverse environmental effects. There are likely to be reduced effects as a result of some reduction in sheep and beef farming, some uptake of energy efficiency measures on the farm, and some limited use of nitrification inhibitors up to 2013.

[77] Calculated using the deforestation intentions survey (Manley, 2007) and the Projected Balance of Emissions Units During the First Commitment Period of the Kyoto Protocol (MfE, 2007b) and assuming 5t CO_2e/ha for sheep and beef farms and 9t CO_2e/ha for dairy farms to give an order of magnitude figure.

Not introducing agriculture sector non-CO2 emissions into the ETS until 2013 may embed some growth in dairying and the associated adverse environmental effects. This is likely to put some of the benefits of the ETS-plus at risk because of the sunk costs of the investments involved and the lack of mitigation options available for methane in particular. In other words, once land has been converted to dairy farming, it is not likely to revert to less intensive uses. This will constrain the ability of the ETS to reduce New Zealand's net emissions from BAU and to lower New Zealand's emission trajectory.

The report *Environment New Zealand 2007* (MFE, 2007a, pp.232-233) sets out the effects of intensive land use (higher stocking rates and stocking densities) in New Zealand over the last two decades. It also identifies the increased inputs of fertiliser and irrigation, both of which have increased the environmental pressures on waterways and groundwater. The energy inputs to the average dairy farm over the past 20 years have doubled, mostly as a result of the increase in use of nitrogenous fertiliser (PCE, 2004). In addition, an increase in arable cropping land to supply the expanding dairy sector and the increased irrigation associated for crops and dairy pasture is expected to increase energy demand and thus increase GHG emissions further.

The change to more intensive farming has in some areas resulted in

> *"further reduction of freshwater quality in lowland rivers and waterways" and "changes in soil health and increases in some GHG emissions for example methane"* (MFE, 2007a).

The adverse environmental effects of the growth in dairying and some irrigated sheep and beef farming up to 2013 are expected to include increased GHG emissions, nutrient leakage, loss of in-stream values, soil compaction with associated soil carbon reduction and structural changes, and landscape changes in some areas where intensive farming has never been undertaken e.g. North Otago and Benmore irrigation schemes and potential for Hunter Downs and McKenzie Irrigation schemes.[78] If all schemes have management plans, water is efficiently used and all farmers have management plans that are audited annually (as proposed in the schemes), then the effects are likely to be reduced, but by how much is uncertain.

At the same time, productivity gains across the industry are expected to continue[79], with some further energy efficiency gains. The degree of uptake of energy efficiency will be largely influenced by the price of energy- a higher price is likely to result in uptake of energy efficiency measures. Initiatives to lower the price of energy on the farm, e.g. night rates, are likely to dampen the uptake of energy efficiency up to around 20c per kilowatt hour.[80]

After 2013

After 2013, if technologies to reduce agriculture GHG emissions have been developed and demonstrated sufficiently on-farm, the ETS-plus is expected to reduce emissions from business as usual, especially for nitrous oxide and for nutrient leakage to waterways and ground water. The degree to which this will produce positive effects on the quality of the environment will depend on how soon changes in behaviour take place. This would suggest that measures to effect change early would have a high priority given the significance of the impacts of intensive agriculture on the environment.

There is expected to be a decline in dairy, sheep and beef farming profitability after 2013, due to the ETS price signal, which is likely to affect land use, its intensity and location. However, by how much and at what rate is uncertain, and depends in particular on the point of obligation and how the price signal is transmitted to farmers.

The base case initiatives[81] will have the effect of slowing the increase in nutrient leakage, degradation of water quality in-stream and groundwater, GHGs, landscape changes and encouraging more efficient use of water. However, these relative improvements in environmental outcomes are likely to be modified by some loss of indigenous biodiversity in some areas due to expansion of either dairying or forestry. Of particular concern would be some areas of indigenous ecosystem types with high biodiversity values, such as post-1990 regenerating forest, scrubland and tussock grassland, that is eligible to be cleared and afforested to gain forestry sink credits.

[78] Otago Daily Times 12 January 2008 pp 19.
[79] Dairy Industry Strategy for Sustainable Environmental Management, March 2006
[80] Malcolm Souness, Energy and Technical Services, pers. comm.
[81] As set out in the SLM and Climate Change Plan of Action September 2007, Figure 2, page 18.

NIWA[82] and work undertaken for the PGGRC (Suter et al, 2006) have identified that there could be secondary environmental effects on waterways from the mitigation technologies, e.g. nitrification inhibitors, which warrant further investigation. Many of the experiments conducted to date in New Zealand on N-inhibitors have been conducted under relatively ideal conditions and using manual measurements techniques, rather than continuous measurement, and thus miss peak N_2O events that can be orders of magnitude larger than baseline emissions and thus contribute significantly to annual emissions.

Suter et al note that little is understood about the impact of nitrification inhibitors on nitrogen cycling, on loss pathways and on soil microbial populations and animals. Similarly, little is known about what happens to nitrogen in the runoff after application of N inhibitors, especially in hill country catchments that support stream networks and wetlands. It is possible that wetlands affected by inputs of nitrification inhibitor may cease to return nitrogen to the atmosphere via denitrification, and could act as conduits for nitrogen from land to waterways, with eutrophication as a consequence.

Nitrification inhibitors are the most significant GHG emissions mitigation technology currently available to the agriculture sector. These uncertainties should therefore be addressed as a matter of some urgency. It is understood that some work has just started on these issues for completion in 2008 and 2009, but that the analysis will then need to look at the potential impacts of nitrification inhibitor use over large catchments on downstream ecosystems, especially lakes and wetlands (refer Chapter 6).

The overall effect on net GHG emissions and nutrient leakage is uncertain. The effects on biodiversity in some areas are not entirely clear since they have not been adequately identified. (See also the Forestry section).

There is likely to be competition for different environmental objectives. For example, feedpads and herd homes minimise soil waste and compaction during winter, but enable an increase in stocking rates that, during other times of the year, could increase emissions overall. The high energy feed model that is emerging for dairying in New Zealand is likely to increase the economic viability of biogas production, thus potentially reducing GHG emissions, although by how much and which gases is still uncertain.

[82] Bob Wilcock and Clive Howard-Williams pers. comm..

In the longer term, emissions could be mitigated through the use of methane-reducing food additives, if this technology becomes available and is taken up. There is some use of imported palm kernel for feed already. Such imports allow greater intensification, which is likely to increase the total pollution load in New Zealand, due to increased animal waste to be dealt with.[83]

Landscape changes that occur before 2013, including further expansion of dairying in the North Otago and Benmore areas and onto previously forested land in the central North Island, are expected to slow post 2013 at rates related to the price of carbon.

Any short rotation arable biofuel cropping that does occur, could result in greater soil disturbance, compared to biodiversity and landscape benefits from longer rotation species, although the environmental effects are less than from dairying or hill country pasture. Recent changes to crop management by the arable sector in response to energy price rises are likely to have benefits for managing these effects. Growing, management and harvest of non-arable crops for biofuel are likely to have less overall effect on the environment (Zah et al., 2007).

Some stakeholders have suggested that the ETS-plus is likely to encourage farmers to remove some kinds of indigenous vegetation from their properties. For example, regenerating indigenous shrublands and scrub (including kanuka and manuka and other woody plant species), which have regenerated since 1990, as well as non-forest ecosystem types (e.g. tussock grassland areas).

In both these situations, affected areas may have medium to high biodiversity and landscape values, but are not "forest" by definition under Kyoto rules, and are therefore eligible for clearance and afforestation. Unless their values are clearly identified and decisions taken to protect them, their biodiversity and associated carbon stocks are at risk (see Forestry section for further discussion).

[83] Dr.Gerald Rys Ministry of Agriculture and Forestry, pers. comm. and from the Australia/New Zealand Workshop on GHG Mitigation Options for Livestock Emissions Management, 2 November 2007 (in draft).

3.5. Land use - Forestry

3.5.1. Interactions between forestry incentive programmes

Forestry is the first sector to enter the ETS (1 January 2008). The ETS-Plus package includes an Afforestation Grants Scheme (AGS) for planting of new forest on previously unplanted land. The base case scenario includes several forestry-related policies e.g. the Permanent Forest Sink Initiative (PFSI), the East Coast Forestry Project (ECFP) and the Sustainable Land Management (Hill Country Erosion) Programme.

The PFSI (operational since December 2007) was established to encourage permanent sequestration of carbon in continuous canopy forests; the AGS has wider objectives and is still being developed. The ECFP (in full operation for some years) was introduced for erosion control purposes. The SLM is a more recent hill country erosion policy introduced following the 2002 and 2004 central North Island floods and is currently being further developed. While these latter two programmes are targeted at a range of wider environmental outcomes, they will also result in carbon sequestration and thus have emission reduction benefits. However, they have different criteria and will interact with the ETS in ways that have a high level of uncertainty, unless there is some alignment of their criteria with respect to biodiversity values. The key features of these forestry initiatives are described below; more detail can be found in Appendix 2.

The Afforestation Grant Scheme

The AGS relates to land that that is not in the ETS, the PFSI or the ECFP. It will be available for Kyoto-compliant land (unforested at 31 December 1989) under two categories: exotic forests; and planted indigenous forests and assisted indigenous reversion. It is expected to be more attractive than the ETS for owners of small forests because it provides simple financial grants rather than emission units and associated harvest liabilities. A key objective of the scheme is to sequester significant amounts of carbon. Grant funding will be weighted to recognise co-benefits including soil conservation, improved water quality, downstream flood protection, improved biodiversity and protection of infrastructure.

There are two areas of uncertainty with the AGS from an environmental effects perspective. The first is the 10 year term of the AGS contract, which creates uncertainty about what happens after year 10, particularly since it has been

proposed that landowners will not be held liable for deforestation after 10 years. While it is expected that such assisted forest establishment will complete a full rotation, monitoring of this outcome will be necessary, over the medium to long term, to ensure that any environmental effects can be managed.

The second is that the "assisted indigenous reversion" category in the AGS could include the establishment of exotic trees to be used as a nurse crop to assist in the transition to indigenous forest over the medium to long term. Given that exotic species grow more vigorously than natives, exotic vegetation could remain the dominant species, thus losing an opportunity for indigenous biodiversity regeneration. In addition, the planting or protection of existing indigenous nursery vegetation or forest trees other than those listed in Appendix 2 of the AGS Guidelines appear to be outside the scope of the scheme. This suggests that, given that the purpose of the AGS is wider than the ETS price signal (least cost carbon sequestration), there is room to consider a wider set of vegetation types to protect and enhance indigenous biodiversity.

The Permanent Forests Sinks Initiative

The PFSI operates separately from the ETS, and is considered part of the base scenario and not ETS-plus. It will enable landowners to earn Kyoto Protocol assigned amount units (AAUs, as distinct from the New Zealand Units (NZUs) that will be issued in the ETS) for establishing permanent forests, and require them to take on deforestation liabilities. There are restrictions on harvesting and a permanent covenant is entered into between the Crown and the landowner. PFSI participants can switch within 18 months of the ETS legislation being passed, to the ETS and give up the right to AAUs and take on obligations under the ETS.

Participating land must be for permanent forests on land un-forested at 1989 and be directly human-induced through planting, seeding and/or the human-induced promotion of natural seed sources. This means that some form of active management will be required in establishing the forest. Limited harvesting of the forests established under this initiative is allowed on a continuous canopy cover basis.

It is unclear the extent to which the PFSI will be taken up, where and on what sort of land. It is likely that some land eligible for both the PFSI and the AGS has high biodiversity values that are currently unprotected (see below).

Increasing the uncertainty will be land use changes taking place in the pastoral farming sectors up to 2013 before agriculture enters the ETS. These changes are likely to interact with the forestry price signal. For example, dairy expansions onto sheep and beef farming areas which will be competing for forestry land that is incentivise under the ETS-plus.

3.5.2. Behaviour changes

The 2007 deforestation intentions survey (Manley 2008) has highlighted two significant issues:

- Deforestation was higher in 2007 than forecast in 2006 (19,000 ha c.f. 13,000 ha)
- Deforestation in the period 2008-2012 is lower under all scenarios than forecast in 2006

(See detail in 3.4.1 Agriculture)

The most significant immediate effect of the ETS-plus on behaviour is expected to be a reduction in deforestation and land use change to intensive agriculture, albeit after a significant increase in 2007.

The projection of deforestation emissions (including avoided deforestation and avoided methane and nitrous oxide emissions) over the same period (2008-2012) was 21 million tonnes of CO_2-equivalent emissions.

The ETS-plus is likely to increase the amount of land afforested, including some post-1989 regeneration of indigenous vegetation. It is uncertain what will happen to the value of eligible land. For most pre-1990 forests the ETS-plus is likely to cause land value to decline but, according to a number of industry stakeholders, not enough to significantly impact on harvesting and replanting behaviour.

There are expected to be consequent changes in land use and, on post-1989 forest land and changes in the way forests are managed in order to increase carbon stocks. For example, industry participants at the workshop suggested that this may alter the production of post-1989 forests grown for pulp relative to processed wood for post-1989 forests, depending on processing options available. The ETS may also change harvesting decisions to minimise obligations to surrender units under the ETS, e.g. corporate owners may have longer or shorter time horizons for their investment in forests depending on shareholder needs.

The ETS-plus is expected to incentivise afforestation on farm land where current and expected future profitability of its current use has declined, due to changing world markets, and the cost of emissions e.g. sheep and beef areas. These areas will include some marginal land which has begun to revert to indigenous vegetation since 1990. The strength of these effects will depend on a range of factors, such as timber prices, and the value of alternative land uses, as well as the ETS.

The location of new exotic forest establishment and managed reversion of indigenous forest will be affected by a number of factors including land suitability for forestry compared with other land uses, proximity to ports and processing facilities, and availability of seedlings and labour for planting and silviculture. Some permanent forests are likely to be planted in areas where harvesting is uneconomic and where there are sustainable land management benefits. Owners of these forests may want to participate in the PFSI and take advantage of the marketing opportunity for environmental credentials.

Participants of current private carbon credit schemes like EBEX21 will be eligible for the PFSI and the ETS. It is unclear what the environmental effect will be on land already registered under these schemes, when they shift to the ETS or PFSI since they have ecosystems services as well as carbon sequestration benefits and may not be completely aligned with the PFSI, for example.

Maori land and forest owners may also respond differently with respect to pre and post-1989 forests. It is possible that Maori will respond more vigorously than non-Maori owners to the value opportunities offered by the ETS-plus on post-1989 forest, since Maori have a higher proportion of land that is marginal for current land uses, especially in Northland and the east coast of the North Island (Insley and Meade, 2007). On the other hand, multiple ownership of Maori land could make it more difficult for Maori to take advantage of these opportunities. The environmental effects of this different behaviour are uncertain but could have implications for indigenous biodiversity.

The ETS-plus is likely to stimulate a range of responses, but the overall objective of the ETS-plus and the base case initiatives in the forestry sector is to increase carbon sequestration. If these initiatives focus on the short term then they are likely to favour exotic over indigenous species, because of the initially higher growth rates of the former. While exotic plantations can have valuable

biodiversity, concern has been raised by stakeholders that this outcome could affect indigenous biodiversity and landscape values in some areas.

While the international rules under the UNFCCC[84], which are reflected in the ETS, were not designed specifically to protect New Zealand's biodiversity and landscape, Article 4.1(d) of the UNFCCC states that "*all Parties shall promote and cooperate in the conservation and enhancement of sinks and reservoirs including biomass forests … and other terrestrial … ecosystems*." Thus the protection and enhancement of biodiversity is envisaged in this context.

The Afforestation Grant Scheme (AGS), while part of the ETS-plus as defined for this scoping report, provides a grant for the establishment of new forests on previously unforested land. It also aims to provide other environmental benefits such as reduction in erosion, and flood peaks and biodiversity. Afforestation may be undertaken through both exotic and indigenous species or assisted regeneration. This will promote and enhance biodiversity, especially if a long term perspective is taken.

Government proposals envisage devolving part of the administration of the AGS to local government with guidance from central government. Sufficient resources for this devolved management and for the identification of areas of high biodiversity and landscape value, before the schemes are up and running, are essential to avoid any unintended consequences from the ETS-plus and the base case initiatives. This would enable some specific weighting for biodiversity and landscape outcomes in the AGS and the PFSI to be effected. If this is not practical from a timing perspective then the AGS agreements would need to take account of possible new areas of high biodiversity being identified and dealt with subsequently.

Current local government practice in protecting biodiversity is inconsistent across the country depending on whether communities favour afforestation or whether they wish to manage its environmental effects (Walker et al, 2005; Ministry for the Environment 2004). This is likely to lead to a regionally variable pattern of carbon sequestration and both positive and negative environmental effects associated with forestry.

[84] United Nations Framework Convention on Climate Change

3.5.3. Environmental Effects

Greenhouse Gas Emissions

The direct environmental effect of the ETS-plus on GHGs, compared with the base case, will be to reduce net emissions in three ways:

(i) increased sequestration of carbon through increased forest establishment due to the price signal;
(ii) avoided deforestation; and
(iii) fewer conversions of forested land to pastoral farming.

The last two points give a double benefit of the avoided emissions from deforestation and avoided increase in non-CO_2 agricultural emissions. This is expected to be in the order of 21 million tonnes of CO_2-equivalent emissions over the period 2008-2012.[85]

To the extent that there is a switch from sheep and beef farming to forestry, there will be a double benefit to the environment compared with the base case - carbon sequestration and reduction in non-CO_2 GHG emissions.

Freshwater Quality and Quantity

The ETS-plus, through an increase in afforestation, is likely to generally improve stream water quality and biodiversity by reducing inputs of contaminants such as sediment (as long as harvesting is managed sustainably – see below), nutrients, pathogens and agrichemicals. Afforestation – both exotic and indigenous – also restores stream habitat conditions to conditions more similar to its original indigenous forest cover (Elliott et al, in press).

Another positive environmental effect will be reduced erosion and peak river flows for low to medium flood events under a wide variety of situations and reduction in sediment yield with in-stream benefits. The magnitude and environmental significance of these positive effects are highly dependent on the intensity and pattern of afforestation.

On the other hand, afforestation in dry districts can result in reduced base or low flows, reducing water availability for downstream uses in dry seasons (Blaschke et

[85] Calculated using the Manley 2006 Deforestation Intentions Survey and the Projected Balance of Emissions Units During the First Commitment Period of the Kyoto Protocol MfE 2007 and assuming 5t CO_2e/ha for sheep and beef farms and 9t CO_2e/ha for dairy farms to give an order of magnitude figure.

al, 2007, draft in progress), although this is likely to be significant only at a local scale.

Sedimentation of streams, riparian damage and adverse effects on freshwater organisms and water quality are likely to periodically increase at times of forest harvesting activities. However the overall sedimentation load and riparian damage are lower under forestry than agriculture in most regions (Elliot et al, in press). If post-1990 forest owners move to longer rotations as a result of the ETS-plus, this would reduce the impact of harvesting overall and have further positive effects on water quality in the longer term.

Biodiversity, Landscape and Natural Character

In areas that are afforested, there will be both positive and negative effects on indigenous biodiversity. Positive effects will occur when exotic forest plantations, especially those in hill country, contain pockets of indigenous vegetation in gullies or other areas which are not planted out. Older exotic plantation forests often contain indigenous vegetation in their under-storey and offer habitat for a range of indigenous animal species (Brockerhoff et al, 2001). The afforestation of areas adjacent to protected natural areas can also help to buffer these areas from disturbances, while afforestation which results in a reduction in sediment loads also benefits freshwater and coastal biodiversity.

The exact form and location of forest development will have a significant influence on how environmental pressures change. For example, managed reversion of marginal land to indigenous forest and exotic afforestation of erosion-prone pasture have very different consequences from clearance of regenerating vegetation for exotic plantations or the creation of new exotic plantations on tussock grasslands.

The ETS-plus, in combination with the PFSI in the base case, provides incentives to establish exotic or indigenous forests. It does not distinguish or provide differential incentives to establish those forests on any particular areas, although by definition species that sequester more carbon more quickly will be favoured, since that is the purpose of the ETS-plus. Therefore there is some risk that these programmes could result in the establishment of exotic forestry on some areas of regenerating indigenous vegetation, e.g. shrublands dominated by kanuka and manuka, and other woody species, that are on Kyoto-compliant land but do not meet the definition of pre-1990 forest, because of the age of the vegetation

succession occurring on them.[86] This risk also applies to some types of non-forest indigenous vegetation that may be suitable for afforestation, e.g. indigenous tussock grasslands, sand dunes and some types of wetlands. Some of these types are rare or threatened ecosystem types in New Zealand.[87] This is expected to result in further biodiversity loss in some regions. The location and extent of this effect is largely unknown at this point. For the environmental effects of the ETS to be adequately managed urgent attention is needed to identify biodiversity at risk.

There are three significant issues:

(i) a base map of "land use at 1990" being prepared by MfE has not yet been completed, so owners cannot currently see whether or not their land is Kyoto forest or non-forest;

(ii) the base map is not expected to be accurate enough for landowners to identify which areas of post-1990 regenerating scrub forest are Kyoto forest or non-forest (or for Crown agencies to prove compliance if such vegetation was bought into the deforestation provisions of the ETS); and

(iii) biodiversity and landscape values are not mapped consistently or across the whole country.

If these three issues were addressed it would help resolve some of the uncertainties associated with biodiversity effects of the ETS-plus.

The concerns raised by workshop participants about the potential loss of biodiversity values as a result of the ETS-plus, stem from the fact that the loss of indigenous biodiversity across New Zealand has increased significantly as a result of land use change over the last 10 years. For example, exotic afforestation contributed to about 66% of indigenous cover loss from 1996/97 and 2001/02 while clearance for low-production pasture was a secondary cause of indigenous cover loss and conversion to intensive pasture was relatively minor (Walker et al, 2006). Of the increase in exotic afforestation in this period (136,000 ha) at least 8.3% involved clearance of indigenous cover. Nationally, the RMA has not halted or slowed these losses on private land. Walker et al suggest that:

[86] They were not tall or well-developed enough to qualify as forest in 1990, but do so in 2008 or are non-forest ecosystems.
[87] See for example Green and Clarkson, 2005; Walker et al, 2006; Williams et al, 2007; Ministry for the Environment, 2007.

> *"… public awareness and education, voluntary protection, RMA provisions and formal legal protection of remaining indigenous biodiversity have not halted the clearance of vulnerable indigenous biodiversity in much reduced and poorly protected ecosystems and habitats."*

A Ministry for the Environment report (MFE, 2004) concluded that regional and district councils spend a considerable amount of money on biodiversity protection efforts and generally have land clearance rules. The report however, concluded that, a significant proportion of councils do not have criteria for determining the significance of biodiversity when landowners submit applications to clear vegetation, or have not identified significant biodiversity values and thus do not require applications for clearance.

The recently released Clean Streams Accord Monitoring Report (MFE, 2008) identified that in the regions where councils have defined and identified regionally significant wetlands, for example, the 2007 Accord target was met. Only four of the 13 regional councils have defined and identified "regionally significant wetlands".

There is a great variety of approaches used to protect indigenous biodiversity at the local government, from regulatory to voluntary measures. Where councils have rules, the frequency and type of enforcement action varies considerably.

Two critical issues raised in the report with respect to councils' ability to manage indigenous biodiversity were capacity issues and the lack of good information on biodiversity across the country.

It should be noted that many exotic tree species will sequester carbon more rapidly than most indigenous species. However indigenous forests, as long as they are protected from deforestation and well managed (e.g. intact canopy), generally have greater permanence compared with exotic species, and a much greater capacity for total carbon sequestration in an unharvested stand over a long time scale.[88] However, it should be noted that some exotic species like Douglas fir and

[88] The ETS addresses permanence by requiring post-1989 participants to account for all carbon stock changes in their forests. So a non-harvest indigenous forest that stores carbon is equivalent to a exotic forest where the emissions from harvest are offset by purchase of other units. So from a net emissions perspective the harvest emissions are offset and from a climate change perspective this is equivalent to a non-harvest forest.

redwoods can be grown on a much longer rotation and that silviculture of a variety of exotic species including radiata pine on a continuous cover basis is promoted by some parts of the forestry sector. Continuous cover harvesting is a condition of inclusion into the PFSI.

Landscape changes are expected from increased planting rates. In some areas there is a potential for significant adverse effects on landscape and amenity values - for example pine plantations on tussock grasslands and on valued natural and pastoral landscapes around the country. There is however, uncertainty about the extent to which this will happen. Such pressures are already apparent on some South Island land that was previously held under Crown Pastoral Lease.

The experience with past forest establishment is that there will be an increased wilding tree problem as a result of increased exotic afforestation to meet the sequestration objectives of the ETS-plus. (See section 4.6 of this report.) Establishment of new exotic forests is expected to result in some adverse perceptions in certain landscapes that are currently treeless e.g. the high country in the North and South Islands. The degree to which these become a problem will depend on how adequately local government policies and plans deal with them.

The main cross-sectoral benefits from forestry, as incentivised through the ETS-plus, include some recreational benefits of plantings (depending on access arrangements), the use of wood for renewable energy for households and industry with associated reductions in GHG emissions, potential small scale (1 MW) distributed energy systems based on wood waste on farms and indigenous forest restoration for increased biodiversity as encouraged by the AGS.

3.6. Manufacturing Industries

3.6.1. Policy drivers and behavioural change

For New Zealand's major manufacturing industries (including cement, steel, aluminium, fertiliser, agricultural and forestry processing, and other smaller industries), emissions arise from the use of energy (both purchased electricity and fossil fuels used on site) and from industrial processes involving the conversion of certain raw materials, e.g. in cement production. The ETS-plus will drive behavioural change primarily via the cost of emissions associated with ETS obligations. Of particular importance in determining behavioural change in the

manufacturing sector will be the cost of emissions relative to the carbon price (or lack thereof) faced by competitors in other countries, along with the amount of free allocation of emission units received by the New Zealand companies.

The proposed preference for renewable electricity could also influence production decisions in industries that rely on electricity as an energy source, because of a perception that it could create uncertainty regarding security of supply and hence cause price instability. If this occurs, it would deter long-term investment and re-investment in manufacturing plant and equipment. However, the biggest industrial user of electricity, New Zealand Aluminium Smelters, in October 2007 signed an agreement with Meridian Energy that guarantees a continuous supply until 2030, so it is unlikely to be affected by any supply uncertainty during the period covered by this report.

For the agricultural and forest processing industries, potentially even more important than the direct ETS price signal is the impact of the ETS on land use and the supply of raw material for the processing plants. Conversely, if processing capacity declines due to a lack of competitiveness, the lack of value-added processing could have financial implications for land users. The forestry sector has had some difficulty attracting investment in processing even prior to the ETS announcement – it is not clear whether the ETS-plus measures will increase the attractiveness of such investment, due to the expected increase in forest plantings, or decrease it due to the impact of the ETS on energy costs.

The timing of any output effects will largely be determined by when manufacturing plant and equipment needs to be updated or replaced. A forest industry representative indicated at the workshop that the industry is collecting this information for members' plants.

Although the forestry industry has already taken advantage of some of its waste by-products to produce energy, it is expected that more of this will take place within both forestry and agricultural processing, leading to a reduction in GHG emissions from the supply of industrial process heat in these sectors compared to the base case scenario during the period 2008 to 2020.

3.6.2. GHG emissions

There has been no detailed assessment of New Zealand industries' likely GHG emissions reductions in response to the ETS. Two recent modelling analyses

estimated small reductions in output relative to business as usual for some major manufacturing industries and small increases for others (ABARE 2007, see scenario 2; Infometrics, 2007, Table 2), but the behavioural assumptions behind the models were not clear. A report prepared for the Ministry of Economic Development noted:

> "… some energy intensive businesses may already be operating at near best practice in efficiency so there may be limited opportunities to make further improvements in the short term" (Covec, 2006, p. 17).

However, that statement did not consider the influence of a price mechanism such as the ETS. Another report (MED 2007, p.5-2) noted that heavy industry accounts for about one-half of the non-electricity demand for coal, the fuel for which emissions pricing will have the greatest effect at the wholesale level. The report, while assuming no demand response to price, commented "In reality, there are going to be opportunities for these industries to improve energy efficiency in response to emissions pricing" (ibid., p.3-2). The Regulatory Impact Statement for the Bill before Parliament says:

> "Direct emission reductions from New Zealand industry over the next 10-15 years under an ETS will be somewhat constrained by the nature of the existing facilities, although there are still promising opportunities to reduce emissions. … Over the longer term, there are many new technologies that could allow for dramatic improvements in industrial energy efficiency and emission reductions. However, in large, to take advantage of these new technologies new plant would need to be built" (Cabinet Policy Committee, 2007).

Given the free allocation proposed for industries that are trade-exposed, it is likely that at least companies some will invest in new, lower-emission process technologies, including conversion of waste to energy. As a consequence, it is likely that GHG emissions will decline per unit of output as the carbon price increases, though this is likely to occur gradually rather than rapidly.

For some industries, output is likely to decline relative to the base case scenario – the magnitude will depend on a range of factors: the price of carbon, exchange rates, international market demand, the amount of free allocation a company receives in any given year and what policies other countries implement, as well as

the availability of low-emissions technologies. In the worst case, i.e. if low emission technologies are not available at reasonable cost and if competitors do not face a comparable price of carbon, some plants will close as the free allocation of emission units declines. This would lead to emissions leakage and possibly a net increase in global emissions, due to less efficient production and/or increased transportation emissions, as well as adverse social effects on provincial areas.

A different dynamic could arise if the added carbon cost in steel, aluminium and cement causes users to substitute renewable materials such as wood. This could also lead to a reduction in output, but in this case rather than leakage it leads to overall reductions in global emissions as well as domestic emissions.

The timing of significant energy efficiency gains and any output effects will largely be determined by when manufacturing plant and equipment needs to be updated or replaced. There is no publicly available information on this for manufacturing sector.

3.6.3. Other Environmental Effects

Any decline in output is expected to lead to a decrease in associated environmental impacts from these industries – mostly air emissions (e.g. particulates) but also reduced waste (e.g. used cathodes) and discharges to water. These are expected to be relatively minor changes in a national sense but could be locally significant at the site of a major industrial plant. If output shifts overseas, there would also be a shift of these other environmental effects ("leakage") to the overseas production locations. Conversely, if there is production substitution to wood, any reductions in environmental effects would be a clear gain globally as well as domestically.

There are some cross-sectoral linkages that could be important. It is possible that a higher price for energy, due to the ETS, will make recycling (e.g. of glass and paper) less financially viable, leading to either more waste to landfill or increased transport to reprocessing facilities in other countries, again with the possibility of leakage.

Secondly, output levels of some industries will depend upon New Zealand demand. For the fertiliser industry, for example, if use of biochar grows as partial substitute for fertiliser, possibly driven by the ETS obligations imposed on agriculture, then fertiliser production in New Zealand would be expected to decline. If fertiliser production falls because it is less competitive with imports,

there could be fertiliser quality issues for the agricultural sector, although the environmental implications of this are unclear.

3.7. Mining, including oil and gas exploration[89]

In the mining industry, the ETS-plus will drive behavioural change primarily via the cost of emissions associated with electricity generation and liquid fuels, as mining typically uses a significant amount of diesel fuel in machinery and equipment, and electricity for processing and other activities. In addition, manufacturing and processing plants are likely to use less coal, which, compared to the base case scenario, is likely to lead to less mining of coal that is not export-grade.

Gold mining is among the activities expected to decrease relative to the base case as a result of the ETS price signal, with a corresponding reduction in associated environmental effects – waste, discharges to water, landscape effects and site remediation. It is likely that the ETS price signal, by raising the cost of energy, will generate new interest in re-processing waste materials, incentivising development of more energy-efficient technologies to extract minerals from tailings and post-consumer waste streams.

3.7.1. GHG emissions

It is not possible to predict with any confidence the magnitude of changes in GHG emissions from mining activities due to the operation of the ETS-plus. In principle, emissions should decline gradually over time *relative to the base case*, though not necessarily in absolute terms. If declines in GHG emissions are the result of a reduction in output, this is likely to cause some emissions leakage to overseas mining operations.

3.7.2. Other Environmental Effects

Any reduction in mining activity is expected to be accompanied by an associated decline in adverse impacts on water, air, biodiversity and landscapes. These are expected to be relatively minor changes in a national sense but could be locally significant at particular mining sites.

[89] No stakeholders from the mining sector were present at the workshop, although some participants had previous experience in the sector.

3.8. Fishing and aquaculture[90]

Of the elements in the ETS-plus policy scenario, the ETS price signal applied to transport fuels is expected to be the primary driver of behavioural change within the fishing industry. The industry has already initiated an energy-efficiency programme in response to recent fuel price increases; these efforts are likely to continue and expand due to the ETS.

The biofuels sales obligation could help to accelerate the introduction of bio-diesel as an alternative energy source. While biodiesel might not cost any less than non-renewable diesel, it would at least help to anticipate potential consumer concerns about the high energy requirements for fishing.

For aquaculture, increases in fuel costs driven by the ETS are expected to generate increased interest in aquaculture as a source of fish protein to meet growing world demand, as aquaculture tends to be less energy-intensive than wild capture fisheries. Finfish farming requires fish to be fed, so unless food can be produced locally there are also transport and other energy issues for this activity, and hence corresponding issues of total carbon footprint relative to wild capture fisheries.

3.8.1. Behavioural change

The ETS-plus is not likely to affect the overall amount of fishing – quota prices are likely to fall somewhat but most of the fish (in terms of total allowable catch) will probably still be harvested. The emphasis will be on reducing catching costs, by using more efficient methods and gear and through greater use of cooperative or collective harvest strategies. Some of the less efficient vessels are likely to exit the fleet.

3.8.2. GHG emissions and other environmental effects

GHG emissions are likely to decline over time as more efficient technologies and methods are developed and deployed.

There is a risk of localised depletion of in-shore fish stocks if vessels reduce trip distances and stay closer to port, while other more distant stocks could re-build if they are subjected to less fishing pressure.

[90] No stakeholders from the seafood sector or the Ministry of Fisheries were present at the workshop, but an industry representative subsequently provided input to this analysis.

Trawling is one of the most energy-intensive fishing methods, so is likely to decline with corresponding reductions in benthic disturbance. However, new fishing techniques could cause either more or less environmental effects (e.g. seabird bycatch) than existing methods, although any significant increase in adverse effects could trigger a regulatory response.

Interest in aquaculture is expected to increase, which would increase the demand for coastal space, the allocation of which has been largely stalled for several years. It is expected, therefore, that interest in deepwater aquaculture and possibly land-based aquaculture will grow – environmental effects of these activities are not fully known but are likely to be less than near-shore aquaculture, due to greater dispersion, fewer competing activities and reduced biosecurity risk.

In traditional near-shore marine farming areas, the increased importance of aquaculture could also increase the political pressure on land-based sources of marine pollution to reduce their impacts. More farming of filter-feeders (such as mussels, oysters and scallops) would help to ameliorate excess nutrients where these occur, but could deplete phytoplankton in nutrient-poor areas. Finfish farming can have the opposite effects.

3.9. Solid waste management[91]

The solid waste sector is not due to enter the ETS until 2013, but is expected to be subject to a waste levy prior to (and after) that date – the levy is in the base case scenario. From 2009, the sector will experience increased haulage costs – in principle this should increase the cost of waste disposal and reduce waste generation, but how much is unclear. Otherwise, the ETS-plus is not expected to have any direct effect on the sector until 2013, and after that date the impact will depend on the magnitude of the emissions cost relative to other costs of waste disposal, including the waste levy. There is roughly a 1.0:0.6 correlation between a tonne of solid waste and a tonne of CO_2-equivalent emissions.[92] Thus, if emission units are selling for \$25/tonne CO_2e, this would add \$15/tonne to the cost of solid waste disposal to landfill, i.e. more than the \$10/tonne default for the waste levy. For landfills without methane gas collection, the emissions ratio is around 1:1 and the corresponding cost would be even higher at \$25/tonne.

[91] No stakeholders from the waste sector were present at the workshop, although some participants had some familiarity with issues facing the solid waste sector.
[92] Scott Gulliver, Ministry for the Environment, pers. comm.

At such prices, the ETS-plus is expected to lead to more separation of organic waste at source, provided the lower emissions content of non-organic waste can be reflected in waste-pricing regimes. There is also expected to be more interest in use of waste streams as an energy source (see also the Industry sections of this report); this has the potential to increase air pollution although, in the case of municipal waste, national air quality standards prevent the use of incineration technology currently available in New Zealand. At some emissions price, however, it would presumably become economically feasible to import more sophisticated incineration technology that would meet air quality standards and reduce disposal to landfill and the associated emissions.

From 2010, when stationary energy enters the ETS, the reprocessing of recycled materials (e.g. paper and glass) is likely to become less attractive, due to ETS-driven energy price increases, relative to importing virgin product from countries without emissions obligations (leading to emissions leakage). Collection and transport of recyclables will also become more costly starting in 2009, putting more financial pressure on these operations, which could result in more recyclables ending up in landfills.

This report has not considered possible effects of the ETS-plus on synthetic gases such as hydroflourocarbons (HFCs). HFCs are used as refrigerants and propellants and can escape to the atmosphere when products containing them are sent to landfills. HFCs are substitutes for the ozone depleting chemicals HCFCs, the use of which is required to be phased out by 2015. ETS pricing, by increasing the cost of HFCs, could create an incentive for users to delay phasing out HCFC use until the 2015 deadline when they might otherwise have phased them out earlier. This risk has been noted by government departments working on Montreal Protocol issues and administering the licensing regime for HCFC imports (Scott Gulliver, pers. comm.).

3.9.1. GHG emissions and other environmental effects

The entry of the waste sector into the ETS in 2013 is expected to lead to gradual reductions in GHG emissions from landfills.

Increased air emissions are possible from increased conversion of waste to energy. Recycling and re-processing programmes will face higher costs; it is possible that

this will result in more recyclables going to landfill. There is a possibility of increased illegal dumping of waste if price gets too high.

Overall, the change in demand for landfill space is difficult to predict, but relative to the base case scenario it is likely to decline, with associated landscape and amenity benefits and reduced GHG emissions.

3.10. Tourism and other service industries

3.10.1. Assumptions and Uncertainties

This section addresses the tourism sector specifically but is also relevant to other service industries such as accommodation, retail, hospitality and entertainment. Tourists' travel is by far the greatest contributor to GHG emissions in New Zealand from tourism (Patterson and McDonald 2003; Forer 2006, Becken and Hay 2007), and a large component of GHG emissions from other service industries. Therefore, much of the discussion in the Transport section of this chapter also applies to this section.

The tourism sector is estimated to contribute around 6% of national energy use. Transport and accommodation services together account for about 85% of the sector's total energy use (Becken 2002).

The biggest uncertainty in assessing any emissions programme for the tourism sector is the possible entry of international aviation fuels into the international emissions framework after 2012. Any exposure of international air travel to a carbon price is expected to have major significance for the whole tourism sector. A further uncertainty related to international tourism is that the wide range of drivers and behaviours of international tourists in New Zealand are often different to those of New Zealanders.

3.10.2. Behavioural Changes

The main drivers of behavioural change are expected to be fuel, energy and waste disposal price increases as a result of the ETS. Further drivers will be increased awareness of energy and travel costs involved in tourism by tourists, operators and sector leaders. Such awareness and the responses to it by tourists and operators will be highly variable. However the sector as a whole has shown significant

awareness of climate change issues. The 2007 *New Zealand Tourism Strategy 2015* states:

> *"International concern about climate change is increasing, particularly in our key markets in the United Kingdom and Europe. This may start to affect visitor arrivals to New Zealand if people start flying less as a result…New Zealand's response to these concerns will be fundamental to the future success of the tourism sector. We need to respond to our visitors' concerns and provide them with options for reducing or mitigating their carbon emissions."*

Arguably, the existence of the ETS will add to the environmental credibility of New Zealand as an international tourism destination. Responses by the sector will be influenced to some extent by the leadership shown by tourism sector leaders in working towards the environmental goals in the *New Zealand Tourism Strategy 2015.*

Rising fuel, waste disposal and energy costs will lead to higher costs for travel, accommodation and many other services consumed by tourists. Micro-economic static models of tourism's accommodation division (Moriarty 2007) suggest that short-term impacts of energy taxes contained in the proposed ETS would lower values of Financial Yield (FY) for accommodation businesses by between 3% and 14% per annum.

Higher costs and greater awareness of these costs could lead to reduction of tourism travel emissions through more efficient fuel use and/or less travel within New Zealand. Tourism travel demand is generally seen as more elastic than other types of travel because it is discretionary, i.e. tourism travel could be more affected by price changes than other types of travel. However, because of the relatively low effect of the ETS on travel costs, there is likely to be very little impact on net tourism emission levels in the short term. This is a similar situation to that for transport in general, accentuated by two factors:

- less behavioural change by overseas tourists, most of whom have travelled a long way to New Zealand and who are less likely to change their travel plans in response to slightly higher prices; and
- reduced travel by some international or domestic tourists being at least balanced by more domestic holiday travel by New Zealanders who choose not to travel overseas.

It is more likely that the *pattern* of internal tourism travel will change, rather than the total amount significantly decrease. For example, tourists may choose to avoid travelling to remote destinations within New Zealand, and instead, stay closer to the main tourist travel routes. It is also possible that more tourists will choose to travel in groups on tour buses rather than "free and independent" travellers with their own hired or purchased cars or campervans. Given that one of New Zealand's attractions to many groups of international tourists is the ease of free and independent travel, any such change is likely to be insignificant unless the price signal becomes very large. Stakeholders have suggested a number of alternative tourism and recreation travel scenarios resulting in either positive or adverse environmental effects, but it is very difficult to predict the magnitude or even direction of these impacts at this stage.

The ETS may promote further moves towards more sustainable tourism, as signalled in the New Zealand Tourism Strategy 2015. For example, awareness of the emissions involved in tourism travel could stimulate interest in offset programmes and other mitigation measures. Whether any such offsets result in reductions in New Zealand or global emissions depends on where they are generated and, if within New Zealand, how the accounting for them interacts with the ETS.

3.10.3. Environmental Effects

The main impacts of the ETS on tourism and services are likely to be economic effects, resulting from reduced or changed patterns of tourism travel, in particular if tourists were less willing to travel to remote destinations. Economic effects are beyond the scope of this study, except for spillover effects on the ability of the tourism sector to support conservation or environmental management (see below).

Greenhouse gas emissions

As discussed in the Energy supply and Transport sections above, the ETS-plus is expected to have only a weak effect on gross CO_2 emissions from the tourism sector in the short to medium term, the most likely trend being a decrease in the expected rate of emissions growth.

Biodiversity and conservation

Tourism has become an important catalyst for conservation in some regions. In some cases tourism businesses offer direct support or sponsorship for public or private conservation management. A decline in tourism levels or profitability may lead to less willingness or ability to support conservation management or other environmental management initiatives by tourism businesses.

A changed pattern of tourism resulting from higher travel costs would lead to different impacts on natural resources e.g. tracks, wildlife, flora. Some impacts would be positive and some adverse (e.g. those in districts in the main travel routes). For example, some well-known nature-based tourism "hotspots", where there are concerns about the effects of visitors on natural resources, are in relatively remote areas, such as Aoraki/Mt Cook, Milford and Doubtful Sounds, Punakaiki Rocks. It is possible that visits to such areas could decrease, while other areas closer to the main tourism routes or urban centres see an increase. As for other environmental effects, it is very difficult to predict the magnitude or even direction of these impacts at this stage.

Landscape

A changed pattern of tourism resulting from higher travel costs would lead to different impacts on landscape, for example a shift from road to air travel between Queenstown and Milford Sound would affect amenity values experienced by visitors to Milford. Some impacts would be positive and some adverse (e.g. those in districts in the main travel routes). Tourists' perceptions of landscape could also change as a result of land use or energy supply changes driven by the ETS, for example an increase in forestry plantations. Such perceptions would depend entirely on the scale and location of changes. It would be difficult to predict the magnitude or even direction of these impacts until at least several years' operation of the ETS.

4. EFFECTS BY ENVIRONMENTAL RESOURCE

4.1. Introduction

Chapter 3 examined the changes in behaviour that could arise from ETS-plus across sectors of the economy and identified the environmental effects that could result. This chapter summarises these environmental effects by environmental resource and comments on their significance. (Please note: references provided in Chapter 3 for statements about behavioural change and environmental effects are not repeated in this chapter.)

The terms of reference for this study call for an assessment of the domestic environmental effects of the ETS and closely-related measures, i.e. the ETS-plus policy package. The domestic environmental effects, and assessment thereof, fall into two distinct categories.

As discussed in Section 2.1.2, the domestic environmental effects of the ETS-plus, and our assessment of those effects, fall into two distinct categories:

(i) effects on GHGs, both relative to the base case and in absolute terms, and

(ii) effects on New Zealand's environment as a result of behavioural change of households, businesses, government and non-government organisations.

The tables in Appendix 4 provide a comprehensive compilation of all identified environmental effects of the ETS-Plus scenario by environmental resource. The tables indicate whether the potential environmental effects are positive or negative, when they are expected to commence, the expected extent and duration of change, and the overall significance, including where this is uncertain.

This chapter summarises and discusses the most significant effects identified in Chapter 3 and Appendix 4, and those where the significance is uncertain. Many of these effects can be adequately addressed by existing measures in place under the Resource Management Act and other legislation, whereas some might require new or additional policy responses. Chapter 5 will consider the adequacy of existing measures and propose possible response measures where these are considered appropriate.

4.2. Greenhouse gases

The ETS aims to reduce net emissions below business-as-usual. The net approach with the ETS encompasses reducing gross emissions of GHGs, avoiding deforestation and increasing removals of atmospheric CO_2.

4.2.1. Avoided Deforestation

The anticipated introduction of the proposed ETS, which would place obligations on the forestry sector as of 1 January 2008, has resulted in two significant effects. Actual deforestation was higher in 2007 than forecast in 2006 (19,000 ha c.f. 13,000 ha, Manley, 2008) and the 2007 deforestation survey indicates that deforestation will be lower over the study period than forecast in 2006.

In the short term, this delivers an absolute increase in emissions, due to recently cleared land being added to pastoral production. However, further additions to New Zealand's emissions will then decline rapidly through both avoided deforestation and avoided methane and nitrous oxide emissions from intensification of pastoral farming conversions. This is expected to be the largest effect of the proposed ETS-plus on net emissions, at least in the short to medium term.

4.2.2. Afforestation

Afforestation is also encouraged by the ETS-plus. New forest establishment is expected to be significantly ahead of the base case over the study period, resulting in increased carbon sequestration, especially in new exotic forests.

4.2.3. Gross Emissions (Outside the Forestry Sector)

CO_2

Over the study period, a reduction in domestic gross emissions of CO2 compared with the base case is expected. Gross domestic emissions are likely to continue to rise in absolute terms, largely due to growth in transport emissions.

The direct price effect of the ETS-plus will reduce energy demand and alter the way energy (especially electricity and industrial, commercial and domestic heat) is supplied. The initial effect of ETS-related price changes is expected to be small in the transport sector, and other components of ETS-plus are expected to achieve greater reductions in transport emissions in the early part of the study period.

Methane and Nitrous Oxide

Methane emissions are likely to rise in absolute terms, though they are expected to be lower than in the base case. Any reduction in methane is expected to be initially associated with reduction in stock numbers or improvements in animal efficiency and relatively small, while larger reductions are likely to only occur once mitigation technologies are available and used widely by farmers. This is expected to be beyond the study period.

Nitrous oxide emissions are also likely to be reduced compared with the base case by the end of the study period, although the speed and extent of this is expected to depend heavily on the use of nitrification inhibitors being taken up at the farm.

4.2.4. Overall effects on GHGs

Overall, net emissions are expected to be below base case levels over the study period. The extent of this reduction will depend on the global price of carbon, which will affect both domestic gross emissions and domestic removals.

Domestic gross GHG emissions are expected to increase above present levels over the study period despite the presence of the ETS and closely-related measures[93]. This is largely as a result of emissions from the energy sector (in particular from the use of liquid fuels in transport), along with growth in intensive pastoral agriculture, in particular dairying.

From a global environmental perspective, the best evidence to date suggests that very large cuts in global emissions will be necessary to stabilise the climate. Prudent environmental management suggests that complementary measures should be strengthened in order to achieve a more significant reduction in gross domestic emissions over the study period and beyond.

4.3. Land and soil

The ETS-plus policy package is expected to have a range of environmental effects, positive and negative, on land and soil health including changes in erosion and sedimentation, soil structure and soil carbon content.

[93] Although the impact on domestic emissions is expected to be limited during the first commitment period (2008-2012), the ETS will contribute to Kyoto compliance through the purchase of international emission units that would otherwise be used for emissions in other countries.

The environmental effects of dairying are expected to be reduced relative to the base case as a result of the ETS-plus. Soil compaction and associated changes in structure and soil carbon will have increased up to 2013 before agriculture comes into the ETS. At this stage it is uncertain whether these effects will be reversible through a reduction in stock numbers or the use of on-farm management practices such as concrete pads for winter feeding. Research is underway to establish the sustainable limits[94] of intensive farming on soils in New Zealand, the results of which are needed with some urgency.

In terms of the biofuels obligation and the possible increase in short rotation biofuels crops, the effects on the land and soil are likely to be negative but of low policy significance. The effect on soil from the cultivation of crops for biofuels or for stock feed for dairy growth[95] will depend on the extent to which crop management practices reduce soil disturbance. The signs to date are that such practices are increasingly driven by the price of energy inputs. The ETS effect on energy prices will be evident in 2009 and 2010 and is expected to help counteract any extension of the land area in crops that involves a higher degree of soil disturbance.

Landscape effects of increased afforestation and any associated wilding tree problems are expected to be an issue in those areas of New Zealand where forestry is not currently a prominent land use and in some areas where exotic forestry is in proximity to indigenous vegetation of high landscape value (particularly in the South Island high country). These effects are expected to start emerging as soon as the ETS-plus is in operation and to continue for the life of the forest, although public perceptions of landscapes could change over time.

The increased forest area as a result of the ETS-plus is likely to increase the pressure at time of harvest on land and soil with periodic and temporary increases in sediment yield in some localities, although this could be moderated to some extent by increased rotation times.

The overall net effect of the ETS-plus on land and soil could be positive or negative depending on the scheme design and the extent to which the

[94] The Sustainable Land Use Research Initiative a FRST funded programme

[95] A move to stock crop feed regimes on dairy farms has increased with dairy expansion and intensification and likely to continue while world dairy prices are high. The ETS-plus is not likely to influence this greatly unless the price of carbon is high (pers. comm. Nick Pyke, FAR).

environmental effects are considered in its implementation. A reduction in erosion and sediment yield is likely as a result of the ETS-plus, especially the AGS. Once agriculture enters the ETS in 2013, reductions in soil compaction are also likely, although whether this will result in improved soil health is still uncertain. Uncertainty about the effects of the ETS-plus on biodiversity is discussed in section 4.5 Biodiversity.

4.4. Freshwater

The ETS-plus policy package is expected to have a range of environmental effects, both positive and negative, on freshwater flows and levels and on freshwater quality and ecosystem health. The full list of potential effects is provided in Appendix 4.

In terms of freshwater flows and levels, the environmental effects of the ETS-plus are expected to be mixed. The increased demand for renewable energy driven by the ETS-plus is expected to put significant additional pressure on freshwater systems as energy companies look for new sources of renewable energy to meet New Zealand's anticipated demand growth. Increased afforestation is likely to reduce water yields, but this is likely to be significant only at a local scale. On the positive side, the ETS price signal is also expected to cause a reduction, compared to the base case, in the demand for irrigation, due to an increased price of electricity for pumping and to the cost of emissions from livestock production.

The negative effects of additional hydro-electric power generation are likely to be concentrated on particular river systems, whereas the positive effects of less irrigation pressure are likely to be more widely dispersed across regions where irrigated dairy farming is prevalent and where water is in short supply during the summer months. Both the positive and negative effects are likely to continue until at least 2020, and could increase over time especially if the price of emissions increases.

In terms of freshwater quality and ecosystem health, the ETS-plus is likely to have mostly positive environmental effects. These stem from the behavioural change in the forestry sector, including avoided deforestation as well as new forest establishment, and in intensive farming, which is likely to ease back on inputs, and therefore non-point source discharges to water, at least somewhat relative to the base case. The extent to which this occurs will depend on a complex mix of factors discussed in the land use section of Chapter 3 – if sheep and beef farming

exits in some regions in favour of dairying, there could be an adverse effect on water quality.

There is likely to be an increase in periodic effects on water quality and ecosystem health due to increased forest harvesting activities as forests incentivised by ETS-plus mature, although that is likely to be 25-30 years in the future. Where post-1990 regenerating scrub or indigenous bush is cleared to establish pine trees, this is likely to have an adverse effect on local freshwater quality at forest establishment.

Overall, the effect of the ETS-plus on freshwater quality is likely to be positive, but this is subject to uncertainty due to the difficulty of predicting land use change.

4.5. Biodiversity

The ETS-plus package is likely to have potentially significant effects on biodiversity, which could be both positive and negative.

In general, policies that result in an increase in forest area are positive for indigenous biodiversity values. This statement would apply to regeneration and indigenous afforestation under most circumstances[96]. In the case of exotic plantation forests, there are some important caveats to this statement. Afforestation on marginal hill country has positive effects for biodiversity (especially freshwater biodiversity) because it reduces erosion and sedimentation, adds additional habitat for some indigenous species, can increase buffering of existing remnants of indigenous forest, and in the longer term increases indigenous riparian and under-storey vegetation.

However, exotic afforestation replacing regenerating indigenous scrub, or in indigenous non-forest habitats such as tussock grasslands and sand dunes etc, are expected to have negative biodiversity impacts on such habitats, some of which are recognised as threatened or priority vegetation. To the extent that ETS-plus measures allow or encourage afforestation of such habitats, this is likely to have negative impacts on biodiversity values where these habitats are not adequately protected through local or regional RMA measures policies.

[96] An exception would be attempts to establish a type of indigenous forest cover where it is not the original natural vegetation cover, e.g. a kauri plantation replacing 'natural' indigenous scrub in areas south of kauri's natural distribution. Currently, this is a hypothetical situation but may not necessarily remain so in the future.

Based on the experience of past forest establishment, there will be an increased wilding tree problem in some parts of the country as a result of increased exotic afforestation to meet the sequestration objectives of the ETS-plus. Wilding trees have become significant weeds affecting biodiversity values in a number of New Zealand regions (DOC, 2001). The longer control is deferred, the greater are the impacts and costs of control.

Increased electricity generation from renewable sources, particularly expanded hydro generation, is another potentially significant effect on biodiversity. Hydroelectric generation can have significant adverse effects on freshwater and riparian biodiversity, unless sufficient environmental flows remain in exploited waterways. These effects are ongoing and essentially non-reversible. Biodiversity effects of other renewable energy, such as geothermal or wind power, have been noted but are generally minor and localised, as long as construction effects are minimised by good management through the RMA. It should be noted that wind power can co-exist with other land uses that have positive biodiversity effects, such as regenerating indigenous bush in hill country, with wind turbines and access roads confined to ridge systems.

Potential ETS-plus effects on biodiversity via changes in the agricultural sector are much more difficult to predict. The biofuels obligation could have the same adverse impact on threatened habitats as described for forestry, but this would be entirely dependent on which biofuel species is planted in which habitats. Dairy conversions could also have the same effects if they occur on the same land. By decreasing the incentive for dairy conversions, especially as 2013 approaches, the ETS-plus is likely to have a positive effect on biodiversity.

4.6. Landscape and natural character

In general, potentially significant landscape and natural character effects of the ETS are similar to those summarised above for biodiversity, with the most significant relating to exotic afforestation and renewable energy sources. To the extent that the ETS-plus package increases either, it is expected to have adverse effects on landscape and natural character in some areas where these land uses have not existed before and where landscape and natural character values are deemed to be high.

Exotic afforestation reduces natural character, and is perceived by many to have negative effects on landscape values compared to the landscapes which it replaces (Fairweather *et al.* 2003). Perceived adverse landscape effects generally decrease over the rotation time of the exotic crop, and increase sharply at the time of harvesting and replanting when bare land surfaces are visible. Wilding conifers in regenerating indigenous scrub and tussock grassland habitats are often perceived to have an adverse impact on natural landscapes, as well as on indigenous biodiversity.

Energy generation generally reduces natural character and can have adverse effects on the landscape. Adverse effects related to energy generation and transmission are generally permanent except for the rare cases when infrastructure is dismantled. The effects of wind generation and transmission lines on landscape values have been a particularly controversial management issue under the RMA in recent years in some locations. Some proposed wind projects have had their generation capacity reduced on appeal. On the other hand, a number of other wind projects have been supported by communities and erected within months.

4.7. Coastal and marine

The effects of the ETS-plus on coastal and marine environments are of three main types: effects on coastal ecology due to changes in sedimentation from land use, effects on marine ecology due to changes in fishing, and effects on natural character and amenity values due to the possibility of energy developments.

Afforestation due to the ETS-plus is expected to reduce sedimentation of coastal environments, but not until newly established forests achieve canopy closure (about eight years after planting) and the existing bedload of sediment is flushed out of river systems.

Changes in environmental effects due to fishing are likely to be relatively minor and mixed, as the main behavioural response is expected to be a redistribution of fishing pressure to reduce fuel costs. To the extent that energy-intensive trawling is reduced in favour of other methods, the ETS-plus is expected to have a positive effect on benthic environments.

The possibility of new methods of electricity generation from the marine environment could result in as-yet unknown environmental pressures in the marine

environment. Investigation of potential marine generation technologies is at a very early stage, so it is not within the scope of this report to speculate on possible environmental effects, but these could be a matter for future investigation.

4.8. Air quality

Overall, the ETS is likely to result in fewer discharges of pollutants to air from the use of fossil fuels for stationary energy, space heating and transport. The medium to long-term effects of the ETS on air quality are therefore expected to be positive. However, there are also likely to be localised increases in discharges, especially in the short-term, primarily from changes in fuel for household heating. As the effect of discharges on air quality depends very much on the location of the discharges, the effects of the ETS on air quality in the short-term are ambiguous.

Moves away from coal use and unflued gas heaters are expected to reduce pressure on interior and ambient air quality. Increased pressures are expected in some areas due to the increased use of wood in older solid fuel heaters and fireplaces in place of electricity. It is possible that increased direct use of scavenged wood has already been a part of household responses to increased electricity prices. Open fireplaces and older woodburners are a significant cause of local air quality problems and so any increased pressure in this area is potentially of concern.

The impact of biofuels on air quality is complex and requires further investigation. Use of liquid biofuels, especially biodiesel, generally results in fewer emissions than fossil diesel and petrol. There are, however, potentially significant exceptions to this conclusion. In particular, there is some evidence that petrol/bioethanol blends may lead to higher emissions of some pollutants than mineral petrol alone.[97]

Over the longer term, ETS-plus is likely to reduce the level of transport emissions and change their spatial distribution. A reduction in emissions is unambiguously positive for air quality, while changed distribution implies a mix of localised increases and decreases in pressure on ambient air quality.

[97] References can be found in section 3.3.1.

4.9. Human Health

Human health effects flow from changes in air quality and also from the direct effect of increases in fuel prices, in particular due to reductions in ambient heat in dwellings.

4.9.1. Air quality related health effects

The effects of poor air quality on health are now well understood and national air quality data has improved. In the short-term the ETS-plus is not expected to be the major driver of air quality effects on human health. It is possible ETS-plus will have significant local health impacts (due to increased use of firewood in older space heaters and open fires in the short term, and changes in transport patterns in the medium term). The overall effects of ETS-plus will become more important in the longer-term. These longer-term effects on air quality are generally expected to be positive.

4.9.2. Direct effects of increased fuel prices

To the extent that increases in liquid fuel prices due to ETS-plus encourage increased walking and cycling, this is expected to provide benefits to human health.

Another direct effect of the ETS on human health will be through its impact on 'fuel poverty' and associated health problems. There is good evidence that health problems associated with cold, damp houses are significant in New Zealand, and ETS-plus is expected to add to pressure in this area.

5. POSSIBLE RESPONSE MECHANISMS

5.1. Introduction

A major issue in considering the information from Chapters 3 and 4 is the extent to which each possible effect and/or issue requires an immediate policy response. In some case, it will be more appropriate to study a possible effect in more detail or to monitor more closely, or to take no further action at all. The framework used to decide between these courses of action for each effect is set out in section 5.2.

Sections 5.3 through 5.10 discuss the more significant environmental effects that are expected to arise in each sector as a result of the ETS-plus, and propose response measures to address these effects.

In some cases possible responses are similar enough across sectors to constitute a set of generic actions to support the ETS-plus. Section 5.11 proposes generic response measures that are common to all or most of the effects and will help an emissions trading scheme to operate effectively.

5.2. Determining appropriate response mechanisms

5.2.1. Prioritising Effects

The assessment undertaken for this report suggests that the ETS-plus will deliver significant environmental benefits in some areas compared with the base case. The assessment also suggests that there is some risk of unintended adverse effects. These may arise as a result of the scheme and the incentives it creates, or as a result of the way the scheme interacts with already existing policies and programmes.

The extent and degree of uncertainty regarding the potential environmental effects of the ETS-plus, and therefore the need for a policy response and/or further investigation of those effects, can be divided into four categories, as follows:

First, for some sectors and/or environmental resources, it is expected that there are ***not likely to be any significant adverse environmental effects, and any positive effects are not at risk***. For these, no policy response is recommended, and further environmental assessment is not a priority.

Second, for some sectors and/or environmental resources, it is likely that there will be some adverse environmental effects, and these ***effects are likely to be relatively minor or localised and can be adequately managed within existing policies and measures***. Any positive effects are not at significant risk. In this situation, any recommended response is likely to involve either enhancements to existing measures, or monitoring, and further environmental assessment is not a priority.

Third, for some sectors and/or environmental resources, it is likely that there is ***significant potential for major adverse environmental effects, and/or risk to potential positive effects***. While the magnitude, timing and/or location of these effects might not be known with certainty, further environmental assessment will not always be the most appropriate policy response, not least because the answers will often depend on factors that cannot be discovered by further study – the future price of emission units, the availability and nature of new technology, and the future policies of other countries.

Rather, where there exists significant potential for major adverse environmental effects, this report recommends implementing policies as part of, or in conjunction with, the ETS so that the potential for adverse effects is avoided or at least minimised. In these cases, effort is generally better applied to policy design than more empirical research.

In some cases, however, a concurrent further investigation might also be appropriate or, more likely, monitoring for effects will be recommended in conjunction with new or enhanced policy responses, to evaluate the need for and adequacy of those responses.

Finally, there are some sectors and/or environmental resources where there exists a possibility of significant adverse effects that existing policies and measures might not be adequate to address, but where there is a ***large degree of uncertainty around either the likelihood or the magnitude of the effects*** (possibly even the direction of the effects), and/or concerning the adequacy of existing policies and measures. In such cases, further assessment of environmental effects is recommended where such assessment is deemed to have the potential to deliver policy-relevant information, in particular to enable the issue to be re-categorised into one of the other problem types outlined above.

5.2.2. Monitoring

Where there is a possibility of significant adverse effects but more in-depth environmental assessment seems unlikely to yield policy-relevant information, the appropriate response is to monitor the situation closely so that any problems can be detected early and a policy response devised as quickly as possible. Problems can and do arise unexpectedly, and if good monitoring data is not available, valuable time can be lost while parties debate the significance of limited and/or anecdotal evidence of a wider problem.

New Zealand should have an environmental monitoring network that is capable of identifying emerging environmental problems before they become serious. As the OECD Environmental Performance Review of New Zealand (2007) made clear, this is not currently the case. The recent report *Environment New Zealand 2007* (Ministry for the Environment 2007) provides a welcome start to a more systematic environmental monitoring system.

Many of the response measures identified in this report will assist in creating the information necessary for monitoring. However, development of a detailed approach to monitoring the environmental effects of ETS-plus is beyond the scope of this report. At a high level the following conclusions can be drawn:

- Monitoring needs to be integrated with the ETS timetable
- Monitoring needs to be transparent and credible.
- The effects identified in this report (and subsequent investigation) help to identify many elements for which monitoring is required.

In addition to monitoring, New Zealand needs to improve its modelling capability so that monitoring data can be utilised to forecast future trends, e.g. in land use change and associated environmental impacts. Particular examples of this are cited in the discussion in the next chapter on information needs.

Associated with monitoring is the need for better information on land use change and soil integrity and the degree to which changes that are expected to occur before 2013, when agriculture enters the ETS-plus, are reversible.

The remainder of this chapter describes proposed possible policy responses to address the potential environmental effects identified in Chapters 3 and 4, starting

with generic measures that would help to address possible effects across a range of sectors and environmental resources. Chapter 6 then describes where more detailed investigations and environmental assessment of particular issues would be most useful.

5.3. Energy supply and demand

5.3.1. Response measures for GHG emissions

Strengthen measures to enhance energy efficiency and demand side management in the energy sector, especially but not exclusively in relation to electricity.

Demand management and more efficient use of energy have the potential to reduce significantly the environmental pressures arising from increasing the supply of energy sources. This is true for renewable sources as well as for fossil fuels.

Energy efficiency and demand-side management are thus important in the short-term as a CO_2 mitigation measure and in the longer term as means of reducing pressure on the environment from renewable energy supply. The existing and proposed measures in the NZEECS represent a positive and significant start. There is a strong environmental case for substantially greater levels of activity in the longer term as well as during the transition to lower carbon energy sources.

5.3.2. Response measures for freshwater, biodiversity, landscape and natural character

Introduction

The ETS-plus is expected to lead to increased demand for renewable sources of energy, especially for electricity generation. These changes are expected to increase pressures across different aspects of the environment including water quality and quantity, biodiversity and conservation values, landscape and amenity values and natural character.

The extent of increased pressure from large-scale projects depends on the pattern and rate of growth in demand, and hence on levels of demand side management, energy efficiency and smaller-scale distributed generation. The exact nature of

potential impacts depends on the type of renewable energy, the scale of the project and the proposed location.

In broad terms, response measures can be divided into three categories:

a) Reducing the pressure arising from growth in demand for electricity

b) Considering the relative importance of further hydroelectric development in meeting New Zealand's growing demand for energy

c) Ensuring that a coherent policy framework exists to consider proposed developments.

As has already been noted under the section on GHGs, increased attention to energy efficiency and demand-side management are important in the long run to reduce pressure from renewables and transmission infrastructure, as well as in the short-term to reduce GHGs.

> *Consider undertaking a strategic environmental assessment of the role of further hydroelectric generation in a sustainable energy system.*

Hydroelectric development in particular has the potential to create significant irreversible effects, especially compared with generation options of a smaller physical scale. Some stakeholders have suggested giving priority to augmentation of existing power stations and prioritising low-impact developments on rivers that are already substantially modified. While the first suggestion appears straightforward, the second depends on the environmental values still associated with the river in question. Other stakeholders have suggested a complete ban on further hydroelectric development, while still others see it as an essential component of a sustainable energy system.

Along with biofuels, the future of hydroelectric development is an area where a more comprehensive strategic environmental assessment might be undertaken. Possible terms of reference for such a study are discussed further in the next chapter.

Enhancing the existing policy framework: Additional water use for hydro generation

Provide guidance on the potential use of freshwater resources for hydroelectric generation via the Sustainable Water Programme of Action

Hydro generation affects both water quality and water quantity. Any additional hydro generation will compete with other river uses such as irrigation, recreation, assimilation of discharges, and cultural and amenity needs, as well as the requirements for a base environmental flow for the river to maintain ecological health. All river systems, regardless of whether currently exploited for power or not, require robust allocation systems to enable efficient use while ensuring that minimum ecological health requirements are met.

The current Sustainable Water Programme of Action (SWPOA) provides a suitable RMA process as work is currently underway on scoping and drafting a National Policy Statement on managing increasing demands for water and pressures on water quality, together with a national environmental standard on setting environmental flows and levels. These instruments should ensure not only that minimum requirements are met, but also provide guidance to regional councils and other decision-makers on how to assess competing demands between hydroelectric development and users that prefer unmodified flow regimes.

Ensure that areas of high biodiversity value are identified across New Zealand as a matter of urgency.

This is discussed in relation to forestry but it is also important in relation to hydroelectric generation.

Enhancing the existing policy framework: Forward planning for wind farms

Address forward planning for wind energy through generic and cross-sectoral measures.

Wind energy development is well-suited to the type of central leadership coupled with local dialogues advocated under cross-sectoral measures. As already noted the Parliamentary Commissioner for the Environment has suggested a similar approach to resource landscape, amenity and natural character conflicts in relation to wind. This approach may help reduce pressures on areas of particular sensitivity and provide a useful complement to the planning process.

Enhancing the existing policy framework: National Instruments under the RMA relevant to renewables

Expand the scope of the proposed NPS on renewable energy.

Officials have advised the authors that a renewable energy National Policy Statement under the RMA is likely to be released within 12 months. We have been given to understand that it will primarily focus on the benefits of renewable energy. In light of the findings of this study, the content might need to be broader, as this is likely to be the first significant public initiative on the environmental effects of renewables.

Such an NPS needs to provide a framework that recognises the adverse effects of renewable generation as well. Biodiversity impacts may be local, for example, but biodiversity is a recognised issue at national and international level.

An NPS should also address mechanisms for forward planning as well as consent - level considerations. It could for example help establish a framework for initiating some of the cross-sectoral measures discussed at the end of this chapter.

Develop a national instrument to guide identification, recording and protection of high value landscapes.

This is discussed in relation to forestry but is also clearly relevant to wind and hydro development. Such an instrument would provide a methodology and clear timeframe (e.g. via a National Environmental Standard) for identifying high value landscapes. This work should be undertaken in parallel with the national mapping project described in Chapter 6.

Address wind and marine energy development in the review of the New Zealand Coastal Policy Statement.

Marine energy is likely to emerge as a competing use of coastal and marine space over the next decade. The review of the Coastal Policy Statement needs to consider this. There is also potential for wind farm development in the coastal marine area, and on land close to the coast.

5.3.3. Response measures for air quality and human health

Address air quality issues associated with domestic heating through improved co-ordination between central and local government.

Air quality is a key area where support and partnership between local and central government will help ensure that responses deliver the best long-term outcomes. A local response needs to incorporate the full range of considerations - for example impacts on energy demand (and hence other environmental impacts) of a switch from open fires to heat pumps. The appropriate technological and policy solution may vary from region to region and area to area. In locations where air quality is not under severe pressure, improving the efficiency of wood combustion may be appropriate. In locations where air quality pressures are acute, accelerated installation of heat-pump technology could be preferred.

Provide assistance to low-income households to minimise the effect of the ETS in exacerbating New Zealand's "cold home" problem.

Further pressure on fuel prices from ETS-plus will exacerbate pressures on human health arising from the increased cost of home heating. The Government has already announced that it will provide some assistance for lower income households. Details of this are not available at the time of writing.

There is a strong case to be made for ensuring that health effects are addressed without removing the carbon price signal in fuel. There also appear to be real limits to the speed at which household energy efficiency retrofits can occur, and it is likely that the price of carbon will be reflected in energy costs before the bulk of the housing stock has been retrofitted.

One possible approach would be to provide direct financial assistance, in some form, to lower income households. However the direct health effects arise from colder and damper houses, and it is not clear how financial assistance will affect decisions by households faced with higher power costs and limited budgets. This is especially so if energy efficiency actions are to some extent supply-constrained and the assistance is not clearly and transparently related to energy costs. As already noted, fuel switching to wood from electricity, for example, may adversely affect indoor and outdoor air quality.

Response measures need to be well integrated with the overall ETS package so as to avoid any unintended consequences. Government may wish to consider measures such as progressive pricing, e.g. providing a limited quantum of electricity at a reduced price, possibly via financial assistance to eligible households, and avoiding incentives to switch to wood fuel where doing so would cause undue health impacts.

An additional interaction between fuel cost and health is the possibility that significant increases in fuel costs will directly affect the public health sector, which currently uses a significant amount of coal. Transitional funding for less emission-intensive forms of heating is a possible response, and would have additional health benefits in the form of improved local air quality.

5.4. Transport

Because of the significance of the transport sector in New Zealand's emissions profile, the complexity of factors affecting transport decisions, and the relative inelasticity of transport demand, addressing GHG emissions and other environmental effects of the ETS-plus requires an exceptional degree of integration between technical and policy responses. A 1998 Select Committee inquiry into the environmental effects of road transport made some relevant comments on this issue:

> *"A conceptual hierarchy underlies most thinking on reducing the environmental effects of road transport. This hierarchy can be summarised as:*
>
> - *Reducing the need to travel*
> - *Choosing a low impact means of travel*
> - *Choosing a low impact propulsion system*
> - *Improving the efficiency of propulsion*
>
> *"In general, the higher up this hierarchy one moves, the more broadly effects are addressed by a given measure. Travel reduction addresses land use, pollution and safety concerns. Low impact fuels and fuel efficient driving tend to address pollution from individual vehicles. These levels also have a different time dimension. Changes in a vehicle's tuning can happen very quickly while changes in land use tend to occur over decades, though they can be surprisingly rapid.*

> *"Successful approaches seek to use these levels in harmony and harness market forces to provide mutually supportive improvements. This points to a degree of caution over technical solutions to environmental problems. The OECD recently concluded that technical innovation will be most effective when located within a context of reducing travel demand. By contrast, a focus on reducing per vehicle emissions while increasing the need for vehicle use can mean most or all of the environmental gains are lost."*

Maximum benefits are achieved by working through this hierarchy in a systematic way and ensuring that actions at different levels are mutually reinforcing. Reductions in CO_2 emissions from transport will require integration between price signals, regulation, public funding (including infrastructure investment decisions), education and social marketing, development and distribution of alternative technologies, and land-use planning. At present there is considerable scope to increase the alignment of these factors, and considerable evidence that this would deliver a range of medium to long-term benefits additional to reduced CO_2 emissions.

In the transport sector, the ETS-plus has the potential to improve air quality over time relative to the base case as transport users respond to the ETS price signal. To capture significant potential benefits to air quality, however, will require making sure that users have an appropriate mix of low-emission transport choices available, and are aware of the significance of their decisions.

In light of this, the following response measures are proposed:

1. Increase the focus on demand-side management activity and the provision of a wider range of transport choices as a means of reducing emissions over the medium term.
2. Improve the overall coherence and alignment of existing transport sector policies with emission reduction objectives. In particular, ensure that -
    a. ETS price signals are reinforced by complementary measures relating to vehicle fuel efficiency; and
    b. patterns of land use and infrastructure investment support a move to a lower emissions future rather than locking in higher emissions over the medium term.

Some of the generic cross-sectoral response measures (see 5.11) are relevant for transport. In particular, the positive effects of the ETS-plus with respect to transport can be enhanced through proactive local planning, supported by central and regional leadership, involving more community-based, multi-stakeholder forward planning within the context of Long-Term Council and Community Plans and/or regional transport strategies.

One area in which considerable technology-driven benefits are potentially available for New Zealand is the widespread use of electric or hybrid vehicles (King, 2007). The potential benefits are seen to be greater for New Zealand than for many other countries because of the relatively greater availability of renewable energy. However, if adoption is widespread this would place additional pressure on renewable energy generation, with the potential adverse environmental effects discussed earlier. Recent modelling work by the Electricity Commission[98] indicates that this demand would be considerable, especially if vehicles are not charged during off-peak hours. Disposal issues (especially batteries) and other infrastructure requirements are other environmental effects that would require further examination.[99]

The most appropriate role for electric vehicles needs to be considered within the framework described above. This can help New Zealand avoid the trap of simply replacing GHG emissions with pressure on New Zealand's domestic environment without addressing the overall level of energy use in transport. Issues relating to electric vehicles requiring further study are summarised in chapter 6.

5.5. Agriculture

Before 2013, when agriculture enters the ETS, there is expected to be ongoing growth in non-CO_2 emissions, albeit potentially slower than over the last few years, due to slower deforestation and conversion of that land to dairying. The growth will be driven to a significant extent by the large increase in deforestation during 2007, as that land is brought into pastoral production during the next few years. The growth in intensive pastoral agriculture is likely to result in ongoing environmental pressures on waterways, groundwater, soil health and increased non-CO_2 GHG emissions. The delay in the introduction of agriculture into the ETS until 2013 is likely to put some of the benefits of the ETS-plus at risk. This

[98] See http://www.electricitycommission.govt.nz/opdev/modelling/EVs/index.html
[99] See http://www.mfe.govt.nz/publications/waste/use-disposal-batteries-jul06/index.html

will constrain the ability of the ETS to reduce New Zealand's net emissions from BAU and to lower New Zealand's emissions trajectory. Clarity soon about the agreed point of obligation for agriculture and the means of transmitting that signal to farmers where the mitigation can take place will help incentivise mitigation action, however.

Completion of the work around the base case initiatives, particularly resolution of issues surrounding the effectiveness and environmental effects of nitrification inhibitors and measurement of their effect on emissions, their verification and ability to be counted internationally, will see greater uptake and thus reduction in the non-CO_2 GHG emissions. The requirement, signalled by government, for entity-level measurement and reporting of GHG emissions in agriculture by 2011 will drive this work. The further development of OVERSEER as an emissions measurement and monitoring tool is also urgent in this context.

The full environmental effects of the use of nitrification inhibitors have yet to be determined, in particular their effects on the nitrogen cycle and on water quality, including on wetland functioning. It is important that the parallel work being funded by government on these issues is comprehensive and fills the gaps in knowledge, before nitrogen inhibitors are widely used

Adequate resourcing for soil science research is also essential to better understand the effects of land use change on soil integrity in New Zealand and in particular the degree to which change is reversible.

An incentive could be provided for early voluntary action in the agriculture sector, e.g. by rewarding the sector with emission units in 2013 for early reductions in emissions. This would encourage more widespread use of current nitrification inhibitors before 2013.

To address these potential effects, the following response measures should be considered:

1. Investigate the potential long-term effects of nitrification inhibitors on the nitrogen cycle, terrestrial water quality, soil health and wetlands and identify any additional response measures required prior to widespread adoption of nitrification inhibitors.

2. Provide adequate capacity for research programmes aimed at understanding the effects of land use change on soil integrity, to enable assessment of the reversibility of land use changes occurring prior to 2013 so as to capture the full benefits of the ETS-plus.
3. Determine as soon as possible the ETS points of obligation for the agriculture sector, including how the price signal will be passed on to farmers.
4. Investigate the risk that the benefits of the ETS-plus will not be realised due to the delay in agriculture entering the ETS. Determine the extent to which behaviour, emissions and adverse effects are likely to diverge from "optimal", i.e. from a situation in which future policy settings are known with certainty and fully factored into investment decisions, and consider policy options to reduce any such divergence.
5. Improve understanding of the effect of different land ownership structures (e.g. corporate vs. individual vs. multiple Maori) on land use change to better anticipate the environmental effects of ETS-plus.
6. Monitor progress towards reversing biodiversity decline in New Zealand; this will require maintenance and updating of national databases, and measures of ecological processes that sustain indigenous species assemblages and ecosystem functions.
7. Improve the quality of national data on significant vegetation cover, ecosystems and landscapes to enable rapid assessment of land use changes and pressures.
8. Fill information gaps on land use change to enable adequate modelling to be undertaken.
9. Monitor the effect of land use change on soil integrity.
10. Monitor land use change as part of a specific monitoring programme associated with the ETS.
11. An incentive could be provided for early voluntary action in the agriculture sector either by providing credits at 2013 for actions between 2008 and 2013 or forward looking allocation starting in 2013 for earlier action.

5.6. Forestry

The biggest effect of the ETS-plus in the forestry sector is the avoided deforestation which has a combined effect of avoiding GHG emissions from deforestation and also emissions from the dairying that would have gone onto that land. This is a significant positive effect. (Refer to the combined effect with conversion of land to intensive pastoral agriculture in 5.6 above.)

The other positive effect of the ETS-plus is the increased forest establishment of both exotic and indigenous forest from the ETS price signal and the Afforestation Grant Scheme (AGS). However, there is some uncertainty around the extent to which there is an inherent favouring of exotic species, due to their ability generally to sequester carbon more quickly. The spill-over effect of this could be that some areas where indigenous vegetation has regenerated since 1989 and comprises threatened ecosystems or habitats. This biodiversity could be at risk.

There are a number of environmental effects from the ETS-plus that are either likely or uncertain but which require specific attention. The ETS-plus is likely to cause some adverse biodiversity and landscape effects from increased exotic forest establishment. To adequately address this, the comprehensive mapping of areas with high biodiversity and landscape values is an urgent priority. (See also section 3.5.3 for the nature of the mapping needed.)

In 2007, the government issued a statement on national priorities for protecting rare and threatened indigenous biodiversity on private land (MFE & DOC, 2007). That statement provides information that can be used by local and central government agencies and landowners to coordinate their decisions and on the ground actions in relation to biodiversity.

Unfortunately, given the significant decline of some ecosystem types in recent years, the evidence is clear that the response through the RMA is inadequate to protect the remaining areas of high biodiversity. The statement of national priorities remains voluntary, and it is unlikely, by itself, to be sufficient to mitigate the risk to biodiversity values presented by the ETS-plus. Thus, further response measures are required.

To address this problem, the AGS could be modified to protect biodiversity and landscapes at risk, e.g. by making these areas ineligible for grants. Similar provisions could be applied in the ETS. For these measures to be effective at the commencement of the ETS-plus, however, the mapping referred to above must be completed urgently.

In some areas increased afforestation is also likely to reduce water yields, but this is likely to be significant only at a local scale.

Apart from these potential negative environmental effects the overall effects of the ETS on the forestry environment are positive.

If pre-1990 indigenous forests were to be incorporated into the ETS, there is an expectation that they would receive additional allocation of units, though at a lesser rate than exotic forests reflecting the much lower deforestation rates of these forests currently.

If this were to happen, then as a matter of principle, incentives for retention of indigenous forests should be at the same level as disincentives for deforestation of indigenous forests, including regenerating indigenous vegetation.

The basis for allocating credits to pre-1990 indigenous forests, if this were to be done, could reflect a broader range of factors than just deforestation rates (including biodiversity, the benefits of pest management for example), and the value of doing so could be increased if New Zealand was required to use full carbon accounting in the future.

In light of the preceding discussion, the following response measures should be considered:

1. Ensure that areas of high biodiversity value are identified across New Zealand as a matter of urgency.
2. Provide criteria in the AGS to ensure that areas of high biodiversity value e.g. significant post-1989 regeneration, are not planted in exotic forestry
3. Include in the ETS legislation provision to ensure that NZUs are not issued for planting of exotic forest on areas of high biodiversity value
4. Link the AGS to the forestry best practice code to reduce environmental effects at establishment and harvesting
5. Provide a methodology and time-frame, e.g. via a national environmental standard under the RMA, to guide local authorities in protecting landscapes of high value
6. Undertake further work to establish how the ETS could be modified if full carbon accounting were required by a future international agreement.
7. Undertake further environmental assessment if pre-1990 indigenous forests are included in the ETS
8. Undertake further environmental assessment if the ETS-plus is amended to create more flexibility for land use change.

5.7. Manufacturing and Mining

No significant unintended environmental consequences of the ETS-plus have been identified from the manufacturing sector, and therefore no policy response measures are proposed. There are likely to be some local improvements in air quality as plants adjust their fuel mix away from coal, and possibly some reductions in other discharges e.g. to water, if plants reduce output, but no additional policy measures are proposed to secure these. In fact, if plants reduce their output or close entirely, there are likely to be unintended adverse economic and social consequences that have a greater priority for policy response.

The same considerations apply to the mining sector, and no policy response measures are proposed.

Further investigation would be necessary if the Government wants quantitative estimates of likely reductions in greenhouse gas emissions from the industrial sector under the ETS-plus. Such a study should focus on the age of plant and equipment, when decisions are likely to be made on major maintenance and/or replacement, the likely effectiveness of free allocation of emission units at reducing leakage, and the cost and availability of lower-emission technology. The wood processing industry is currently collecting information on the first two points and could provide a useful pilot for a larger study.

5.8. Fishing and aquaculture

5.8.1. Fishing

There are not expected to be any significant unintended consequences, either positive or negative, of the ETS-plus package as a result of behavioural changes in the fishing industry, although some negative effects are possible and warrant monitoring. Some positive effects are expected, but are likely to be limited in extent and significance.

With regard to negative effects, the Ministry of Fisheries should watch for any significant shifts in fishing behaviour showing a stronger preference for inshore vs. offshore fishing as fishers seek to reduce their fuel costs, and ensure that fisheries management tools are adequate to prevent localised depletion of fisheries. Scientists performing stock assessments should be aware of possible changes in fishing behaviour that might need to be adjusted for in stock models,

e.g. models based on catch per unit effort. Such shifts might already be occurring, of course, since fuel price increases that have occurred in the past two years are much larger than will result from the ETS, at least initially.

Similarly, the government should monitor whether changes in fishing gear or strategies give rise to any change in fisheries interactions with protected species such as seabirds and marine mammals. Current monitoring procedures may well be adequate for this purpose, in which case it is only a matter of checking for any such changes.

On the positive side, given that bottom trawling is among the most energy-intensive of fishing methods, the ETS price signal on fuel is expected to increase the search for and use of other less harmful methods.

Apart from the monitoring noted above, no additional policy measures are proposed for the fishing sector.

5.8.2. Aquaculture

Given the energy-intensity of capture fisheries, there is expected to be an increased interest in aquaculture, especially from the larger fishing companies that are active in both. This could increase the pressure for allocation of coastal space, raising conflict with other coastal stakeholders. The Government is already seeking to resolve the tensions over near-shore space and to facilitate the expansion of aquaculture; no further policy measures have been suggested in that regard except to note the importance of central government leadership to overcome the inertia evident at the regional level.

5.9. Solid waste

The ETS-plus package is not expected to have significant unintended consequences in the solid waste sector, although there are some issues that warrant monitoring.

Increased conversion of waste material to energy could potentially cause increased air pollution, but the national air quality standards and regional plans are expected to be adequate to manage this possibility. This should be monitored and the effects assessed when the ETS is up for it regular review.

As noted in section 3.9, there is also the possibility that the increased cost of electricity could make reprocessing of recycled materials less viable, with the result that more of these materials could end up in landfills. From 2013, when the waste sector enters the ETS, this is likely to be less of an issue, because the emissions cost of landfill disposal is likely to offset the added cost of transporting and reprocessing recyclables.

Prior to 2013, the government should monitor whether a problem with recyclables is emerging. If so, it could consider increasing the waste levy and/or using some of the levy revenues to subsidise recycling, provided this does not increase global emissions.

5.10. Tourism and services

No sector-specific response measures are proposed for the tourism sector or other service industries. To the extent that measures might help to secure positive effects of the ETS-plus in these sectors or mitigate adverse effects, they are addressed in the Energy Demand and Transport sections above.

5.11. Generic and cross-sectoral measures

5.11.1. Introduction

Climate change is a long-term and pervasive new feature of today's world, and the ETS-plus is designed to bring about behavioural shifts that will over time create major changes in our society.

Business and consumer behaviour is determined by non-price factors as well as prices, and is shaped to a considerable extent by infrastructure and socio-cultural norms. As a result, a number of cross-sectoral and generic initiatives are likely to be necessary to help ensure that opportunities for positive environmental outcomes are maximised and negative environmental outcomes reduced. The specific sectoral response measures described previously are critical. But they are not likely to be sufficient in themselves to achieve the objectives of the ETS-plus without adverse environmental effects. The suggested cross-sectoral measures help to address this gap.

In essence, the overall responsiveness, engagement and motivation of individuals, communities and owner-operated businesses will depend in large measure on:

(a) the options people have available, which is influenced strongly by local infrastructure and available technology and management systems; and
(b) how the ETS-plus and associated price changes are perceived and understood; an inability to determine which choices are the "right ones", for example, may well reduce motivation.

The suggested generic measures comprise modifications and enhancements to the overall approach to environmental management that could enhance and focus the way society responds to the emissions price signal arising from the ETS-plus. They would also help ensure the ETS-plus delivers on its goal of environmental integrity, and least-cost transition.

5.11.2. Areas requiring cross-sectoral and generic response measures

Two suggestions have emerged from this scoping study that would assist in addressing these issues:

- enhanced central government guidance on how to plan locally (including but not limited to RMA planning) in relation to the changes that are likely to flow from the ETS and from climate change itself; and
- an enhanced focus on the non-price drivers of the behavioural response to the cost and price changes resulting from the ETS – in particular, the need for social marketing and information to support the price responses and thus guide behaviour.

The following statements are a few examples of stakeholder comments that underpin this second point:

- climate change needs a generic social marketing response as well as a generic economic instrument.
- if all households perceive is rising energy or dairy prices they are much more likely to simply become annoyed about rising prices, and look for someone to blame.
- people will want to see companies “doing their share” if prices have to rise; the credibility of environmental claims will become increasingly important.

5.11.3. Potential cross-sectoral and generic response measures

The following cross-sectoral response is suggested:

Proactive local planning and dialogue, supported by central and regional leadership, to help deal with potential resource conflicts and environmental effects, and engage with communities over the response to climate change.

This would include:

1 *An explicit and structured partnership between central and local government around the use of the Resource Management Act.*

The suggestion here is to establish engagement processes and systems with local government with an explicit focus on the ETS and climate change. This would focus on supporting local government in making decisions that avoid, remedy and mitigate the environmental effects identified in this scoping report, and would extend beyond national instruments, and the existing processes of dialogue. Central government could demonstrate facilitative leadership in assisting local authorities to deal with the longer-term changes that may come about as a result of the ETS-plus.

Examples of the type of issues that could be addressed include:

- guidance material on likely environmental effects of the ETS-plus and how to manage them proactively through RMA, including improved planning for land use change (both urban and rural).
- guidance for sectors on best practice and case studies for local government to manage effects from the ETS-plus and climate change generally
- increased use of national instruments to provide methodologies and frameworks for assessment
- increased national information gathering to assist in decision-making (eg the biodiversity survey and the proposed landscape survey)
- encouraging greater use of existing provisions in RMA by councils to provide greater certainty and clarity and strengthened compliance of existing plan provisions.

2 *More community-based, multi-stakeholder forward planning, within the context of Long-Term Council and Community Plans under the Local Government Act.*

Many stakeholders at the workshop and in discussion afterwards, felt that greater community dialogue and collaborative planning could add value in a range of areas identified in this report. Such approaches at a local level were thought important in creating a 'climate of possibility' in relation to major issues.[100] [101] This cannot be created through a top-down approach alone; it requires an ongoing level of engagement and dialogue at the local level.

In a recent discussion of the effects of commercial-scale wind farms on communities, the Parliamentary Commissioner for the Environment recommended a combination of greater strategic leadership and improved community dialogue (PCE, 2006). The authors of this scoping report have concluded that this general approach could be expected to assist the implementation of the ETS-plus.

Rather than involve consultation on specific issues, this approach envisages a range of topics being considered together on an ongoing basis. Examples could include:

- improving energy efficiency at a local level,
- appropriate scale and siting of renewable electricity generation,
- assessing the extent of concerns over local air quality and the impact of alternative fuels,
- identifying how best to encourage climate-supportive transport choices, and
- expanding the work of local voluntary groups such as Climate Reduction Action Groups.

3 Improve the level of information available to individuals, businesses and others making decisions/choices to reduce the climate impact of their lifestyle, and respond to the price and cost signals arising from the ETS.

Improvements are needed to the information that will enable people to make climate friendly choices that suit their needs. Examples of the type of issues that could be addressed include:

[100] Some discussion of one approach to such dialogues can be found at http://www.ecologic.org.nz/?id=80&page=Conf+presentations under "Collaborative Governance".
[101] The rural sector has experience in such group dialogues to address issues facing farmers e.g. adapting to Climate Change in Eastern New Zealand . Earthwise Consulting Ltd 2005 and through farmer focus groups and field days through which experience is shared.

- national standards on life-cycle analysis to enable consumer protection agencies to have a clearer idea of the merits of green claims,
- better guidance for the advertising industry about the types of initiatives that can legitimately be considered climate-friendly, and
- engaging with business leadership to enable increased business leadership and provide greater clarity about what actually constitutes climate-friendly practices.

6. FURTHER INVESTIGATION OF ENVIRONMENTAL EFFECTS

This chapter summarises key information gaps and identifies where investigations would be useful to further inform government and stakeholders about environmental effects of the ETS-plus, and possible policy mechanisms to address them.

Further investigation of potential effects of the ETS-plus should be prioritised to target issues where a better understanding will be relevant for policy makers.

Further work falls into three categories:

- Investigations
- Monitoring
- Data and information

The studies suggested below should be seen not just in the context of climate change policy, but rather in the context of environmental and sustainability policy more generally. This is particularly true of pastoral agriculture and the transport sector, both of which are major users of natural and physical resources and therefore have significant impacts on the environment. Gaining a better understanding of the likely environmental impacts of the ETS-plus in these sectors is thus part and parcel of better management of these sectors more generally.

6.1. Investigations

6.1.1. Energy

Biofuel production and consumption

There is a considerable amount of uncertainty regarding the potential domestic environmental consequences of increased use of biofuels in the New Zealand transport sector, principally in relation to the sources of biofuels. While the reduction in domestic GHG emissions from transport can be estimated based on the biofuels sales obligation, there are questions regarding the emissions from biofuel production, whether it be in New Zealand or overseas, as well as other environmental consequences of biofuel production and consumption. If, for instance, New Zealand imports biofuels produced via energy-intensive processes,

increased use of biofuels could actually increase global GHG emissions. In such a case, the Government could consider whether to add conditions or complementary measures to the regulatory obligation to increase its effectiveness, in addition to the proposed statutory requirement for environmental sustainability.

A more detailed assessment of the likely environmental effects of biofuel production and consumption is therefore recommended. Box 1 provides an outline of what such a study should encompass.

Box 1. Suggested scope for review of environmental effects of increased domestic production and consumption of biofuels.

Further study of production and consumption of biofuels should include the following:

Undertake a detailed review of:

- The likely effects of increased domestic use of biofuels on CO_2 emissions from liquid fuels, including embodied carbon in imported biofuels
- Pressures on the environment arising from increased domestic production of biofuels from different sources
- Co-benefits of production of biofuels from different sources
- Impacts on human health and air quality of significantly increased use of biofuels, both in isolation and as blends with mineral fuels.

Key outputs:

- Detailed specifications for a sustainability standard for biofuels
- Recommendations including draft measures if required, to manage the adverse effects of increased production and use of biofuels

Renewable electricity supply

This report has identified pressure on rivers for hydroelectric development as a significant effect of the ETS-plus. The extra pressures as a result of ETS-plus are clear and we have proposed general measures to address these in the preceding chapter. However, there may also be value in further investigation in order to provide information to support more detailed response measures and facilitate a more proactive approach.

A strategic environmental investigation of this sort should have a well-defined timeframe and expected outputs, and ought to consider the:

- likely extent of these pressures;
- influences on the pressures; and
- appropriate measures for reducing the pressures.

A key aspect of the study would be to identify the best way to integrate development and issuance of guidance under the RMA and the Sustainable Water Programme of Action with climate change and energy policy. The key outcome should be a set of recommended response measures to deal with pressure on rivers arising from the transition to a carbon-constrained energy system[102].

A comprehensive investigation could facilitate a more proactive approach to this issue. Absent such measures, pressure will grow over time, unless and until a significant and sustainable alternative emerges. There may be value in extending this investigation to other renewables, but hydro-electric development is a priority due to the potential scale, significance and irreversibility of effects.

6.1.2. Transport

The transport sector is characterised by billions of dollars worth of long-lived infrastructural investment, which has a significant effect on people's lifestyle decisions as well as on business investment, and the overall shape of our cities and towns. As a result, demand for transport fuels tends to be insensitive to price changes in the short term but does respond over time, and targeted government policies can assist that response.

Given this, there would be benefits in further developing modelling capacity in two related areas:

1. Improve the capacity to analyse scenarios involving significant changes in urban design, fuel costs, patterns of transport and land-use. Some stakeholders have indicated that current modelling capacity at a regional level is more suited to assessing small changes in existing patterns, and

[102] Consideration should be given to the full range of policy options, including those identified by stakeholders such as enhanced energy management options to reduce the need for such projects; a preference for development on existing facilities and rivers that have already been modified; restrictions on further large-scale hydroelectric development; and accelerated development of non-traditional renewable sources of energy.

that this approach may understate the benefits and overstate the costs of more sustainable patterns of urban transport and settlement.

2. Continue the development of the Vehicle Fleet Fuel and Emissions Model to enable better assessment of local impacts of changes in transport patterns. In particular, develop capacity for assessing changes in emissions of greenhouse gases and local pollutants with greater accuracy.

Further investigation of the factors influencing transport demand will also improve the design of such policies, to advance the objective of reducing New Zealand's net GHG emissions over time.

Box 2 outlines the scope of further investigation for the transport sector.

Box 2. Suggested elements of further study of behavioural change in the transport sector.

- Assess factors influencing the responsiveness of demand in New Zealand to price changes from for various travel modes and functions, and for different groups of users.
- Assess the role of public awareness and responses in influencing transport choices. Research (including reviews of international work) could include:
    - relative role of awareness, monetary incentives, and other factors in changing transport behaviour,
    - identification of different groups within the population in terms of attitudes and responsiveness to change;
    - estimating elasticities for urban, rural, and freight journeys and for petrol and diesel;
    - price threshold points which drive significant behavioural change for different groups and transport functions;
    - influences on behavioural change in the sector (preference for car size, fuel type, fleet composition etc
    - inter-relationships of differing responses of individuals/ organizations/ businesses
- Assess implications of greater prevalence of people working from home including:
    - Factors and trends influencing the choice of workplace
    - Building energy use in the home compared with a workplace
    - Transport use based on the home compared with a workplace
- Assess inter-relationships between urban design, different modes of transport and fuel price increases (modelling)
- Assess implications of changing patterns of transport use. For example, adapting the Tourism Flows Model to other sectors (modelling).

One area seen as having considerable potential is the development of electric vehicles. Considerable work is required to develop this potential, and to consider the range of effects this could have on New Zealand's energy system. Box 3 shows suggested elements of this work.

Box 3. Suggested elements of further study in relation to electric vehicles in New Zealand

- Assess the most appropriate specific roles for electric vehicles in the New Zealand transport sector
- Assess appropriate technology for electric vehicles in New Zealand
- Address barriers to adoption in New Zealand
- Investigate the implications of electric vehicle use for renewable energy demand and infrastructure
- Identify appropriate technology for waste disposal of electric car components

6.1.3. Land use (intensive and extensive agriculture)

Pastoral agriculture dominates the rural landscapes of New Zealand, and how it is managed has major implications for environmental quality across those landscapes. There remains significant uncertainty regarding how the sector will respond to the ETS-plus policy package, and therefore what the corresponding environmental effects will be. In order to target most effectively any policy response measures, the following investigations are suggested:

- Review knowledge of the effects of nitrification inhibitors on the nitrogen cycle, water quality of rivers, lakes and wetlands by locality and develop best practice guidance
- Ensure the research on soil integrity and the effect of land use change on soils is adequately resourced to enable the ETS-plus to deliver positive environmental benefits
- Improve understanding of how different land ownership structures (corporate, individual, multiple Maori) affect land use change so the environmental effects of ETS-plus can be better anticipated.

6.1.4. Forestry

Forestry presents opportunities for significant environmental co-benefits from the ETS-plus, as well as risks of unintended adverse consequences, which were discussed in the previous chapter. Further investigation would enable improved policy design to enhance the co-benefits. In particular, we recommend a study to:

- Complete the base map of "land use at 1990" being prepared by MfE as soon as possible, so owners can see whether or not their land is "Kyoto forest" (post-1989).
- Improve the resolution of the above mapping so that landowners can identify which areas of post-1990 regenerating scrub forest are Kyoto forest or non-forest (or for Crown agencies to prove compliance if such vegetation was bought into the deforestation provisions of the ETS).
- Undertake comprehensive mapping of biodiversity and landscape values across the whole country, but especially of areas of indigenous vegetation that are threatened ecosystems and habitats.
- Assess how small forest owners can coordinate their plantings to enhance environmental co-benefits and achieve more long-term carbon sequestration compared with the current ETS-plus design.
- The suggested investigations in agriculture will be necessary for the ETS-plus to avoid adverse environmental effects from the expected increased forest establishment.

6.1.5. Manufacturing

The forest products industry is conducting a study on when its members' major plants are due for re-investment. This would provide a good indication of when output and associated domestic GHG emissions from that particular industry might decline more significantly depending on how competitiveness issues are addressed in ETS design. Similar studies could be conducted in other industries, and could also examine the availability and feasibility of lower-emission technology. Together with information on the carbon pricing policies of other countries, this would enable an analysis of the reduction of GHG emissions through new technologies and efficiency improvements vs. leakage.

Beyond this, further investigations will not shed much light on these questions except inasmuch as they could generate scenarios based on varying price, policy and technology scenarios. Such studies would have relevance in terms of social

and economic policy, but would not be a priority in terms of evaluating the environmental impacts of the ETS-plus package.

6.1.6. Tourism

For tourism and other service sectors, the main area of uncertainty related to the ETS-plus concerns the amount of GHG reduction that is likely to be achieved. There is also significant uncertainty about other domestic environmental effects that will flow from behavioural changes in the tourism sector (changed transport and accommodation patterns etc), but these largely fall in the category of issues that can be addressed within existing policy frameworks.

To obtain a more accurate picture of likely GHG reductions in the tourism sector, further investigation could focus on the following:

- Investigate the impacts of higher domestic travel costs on tourism demand and travel and accommodation patterns (part of this work could be done using the Tourism Flows Model[103]).
- Investigate effects of future inclusion of aviation fuel in the international climate change framework.

6.1.7. Fishing

The rising price of fuel will drive changes in fishing practices, with the potential for both positive and negative environmental effects. Fisheries management frameworks should be reviewed to:

- Assess potential changes in fishing methods driven by fuel-saving initiatives and whether current fisheries management strategies will prevent localised depletion of fish stocks.

6.2. Monitoring, data and information

As noted in Chapter 5, on-going monitoring of the environment is a critical part of managing the environmental effects of the ETS-plus, which by its very design is meant to reach into virtually every aspect of economic activity and whose flow-on effects cannot be fully anticipated. It should be expected that other unintended

[103] See Hay and Becken, 2007 and http://www.tourismresearch.govt.nz/Research/Tourism+Flows+Model/

consequences, both positive and negative, will arise over time, and that further policy responses will be required.

6.2.1. Terrestrial biodiversity

Specific monitoring and data for managing the possible effects of the ETS-plus on biodiversity are as follows:

- Monitor progress towards reversing biodiversity decline in New Zealand; this will require maintenance and updating of national databases, and measures of ecological processes that sustain indigenous species assemblages and ecosystem functions.
- Improve quality of national data on significant vegetation cover, ecosystems and landscapes and their extent to enable rapid assessment of land use changes and pressures.

6.2.2. Land use modelling and monitoring

In order to better anticipate likely effects of the ETS-plus on land use and land use change, and therefore implement appropriate policy responses, New Zealand should enhance its land use modelling capability. Possible further work could include:

- Improve the ability to predict land use change and its effects on the environment, e.g. by filling data gaps concerning existing land use and how land use practice varies across locations.
- Monitor the effect of land use change on soil integrity
- Monitor land use change as part of a specific monitoring programme associated with the ETS. Deforestation of a small area does not trigger a liability under the ETS and therefore need not be reported, but could in total amount to significant areas of land use change. This could result in an inaccurate measure of the effects of the ETS-plus unless such changes are monitored in other ways.

6.2.3. Energy

There are also some information needs in the energy sector, to enable more effective targeting of measures:

- Further detailed studies of determinants of household energy use (including transport choices) and the factors influencing variation in energy use between households (cf Perkins and Hamnett, 2005)
- Work with regional councils to ensure sufficient information is available to assess the air quality effects of fuel switching, especially in areas where pressure on air quality is already significant

6.2.4. Transport

Stakeholders suggest that there are some gaps in data in relation to transport, in particular in relation to sub-national information. The following is recommended to assist decision-making and planning in respect of transport:

- Significantly improve the quality of data on regional and local travel patterns, freight movements, fuel demand and emissions.
- Develop up-to-date measures of fuel efficiency for various transport functions, locations and modes.

6.2.5. Waste

The Government should monitor the solid waste sector to determine –

- Whether conversion of waste to energy is causing localised air quality problems;
- Whether the increased cost of electricity and transport fuels is making reprocessing of recycled materials non-competitive and forcing more recyclables to landfill; and
- Whether the increased cost of solid waste disposal is causing an increase in illegal tipping of wastes.

7. SUMMARY OF PROPOSED RESPONSE MEASURES

This scoping report aims to identify potential environmental effects of the ETS-plus at a high level, identify possible response measures to address these effects, and develop terms of reference for possible further investigations of particular areas of concern or uncertainty. Further environmental assessment of the ETS-plus will help ensure that the policy package has broad environmental integrity from the start and is broadly consistent with the government's overall sustainability goals.

This chapter is a summary of all of the responses, including further investigations, proposed to address the potential environmental effects of the ETS-plus.

Other conclusions of the report are summarised in the Executive Summary and are therefore not repeated here.

7.1. Response measures for Energy Supply and Demand

Over the period to 2020, the ETS-plus is expected to lead to increased development of renewable sources of energy relative to the base case, and this effect is expected to increase as the cost of carbon rises. However, demand for energy is likely to be inelastic in the short term; even if demand growth is met by renewables, there are likely to be increased pressures on the environment.

Thus, improving energy efficiency and demand-side management are important in both the long and the short-term. In the short term, while thermal electricity is on the margin for peak electricity demand, these measures can make a useful contribution to reducing greenhouse gas emissions. Energy-efficient homes also help to address health concerns from rising electricity prices. In the medium to longer term these measures serve to reduce the pressure on the environment from renewable electricity supply.

1. Strengthen measures to enhance energy efficiency and demand side management in the energy sector, especially but not exclusively in relation to electricity.
2. Consider undertaking a strategic environmental assessment of the role of further hydroelectric generation in a sustainable energy system.

3. Provide guidance on the potential use of freshwater resources for hydroelectric generation via the Sustainable Water Programme of Action
4. Ensure that the areas of high biodiversity value are identified across New Zealand as a matter of urgency
5. Address forward planning for wind energy through the generic and cross-sectoral measures described in section 5.11.
6. Expand the scope of the proposed NPS on renewable energy to address how adverse effects of such projects on the environment are to be avoided, remedied or mitigated.
7. Develop a national instrument to guide identification, recording and protection of high value landscapes.
8. Address wind and marine energy development in the Coastal Policy Statement review.
9. Address air quality and domestic heating through improved co-ordination between central and local government (cf cross-sectoral measures).
10. Provide assistance to low-income households to minimise the effect of the ETS in exacerbating New Zealand's "cold home" problem.

7.2. Response measures for Transport

The transport sector – both the fleet and the nation's transport infrastructure – will have a major influence on how New Zealand meets its emissions targets. In the short-term, complementary measures within ETS-plus are likely to exert as much if not more downward pressure on emissions as the carbon price signal in diesel and petrol prices. Suggestions are made to strengthen aspects of transport modelling and planning in order to maximise the synergy between the price signal and other measures.

1. Investigate the net contribution that biofuels are likely to make to both domestic and global GHG emissions, and consider further the potential for positive and negative environmental effects from increased production of raw material for biofuel production.
2. Strengthen demand management measures and improve the overall coherence and alignment of existing transport sector policies with emission reduction objectives. In particular, using government funding mechanisms, seek to ensure ETS price signals are reinforced by complementary measures relating to vehicle fuel efficiency, and that

patterns of land use investment do not serve to lock in higher emissions over the medium term.

3. Improve capacity to model transport demand in response to significant changes in determinants of transport demand (e.g. urban design, land use, fuel costs), and to assess the impacts of transport on GHGs and other environmental parameters.
4. Investigate the implications of increased introduction of electric vehicles for electricity supply and demand.
5. Significantly improve the quality of data on regional and local travel patterns, freight movements, fuel demand and emissions.
6. Develop up-to-date measures of fuel efficiency for various transport functions, locations and modes.
7. See also the proposed generic and cross-sectoral measures.

7.3. Response measures for Agriculture

Only limited reductions in non-CO_2 emissions can be expected from agriculture in the short term. Under the base case scenario, further intensification of land use is likely prior to the sector's entry to the ETS in 2013. The ETS-plus is expected to slow the existing trend of intensification of land use and the corresponding increase in emissions and environmental effects on soil, water quality, water demand to some extent, although the large investments behind this land use change will make the emissions growth more difficult to reverse despite the ETS price signal that is proposed to apply to agriculture starting in 2013. That is, there is a risk that some of the potential benefits of the ETS-plus will not be realised.

1. Investigate the potential long-term effects of nitrification inhibitors on the nitrogen cycle, terrestrial water quality, soil health and wetlands and identify any additional response measures required prior to widespread adoption of nitrification inhibitors.
2. Provide adequate funding of research programmes aimed at understanding the effects of land use change on soil integrity, to enable assessment of the reversibility of land use changes occurring prior to 2013 so as to capture the full benefits of the ETS-plus.
3. Determine as soon as possible the ETS points of obligation for the agriculture sector, including how the price signal will be passed on to farmers.
4. Investigate the risk that the benefits of the ETS-plus will not be realised due to the delay in agriculture entering the ETS; determine the extent to

which behaviour, emissions and adverse effects are likely to diverge from "optimal" if future policy settings were known with certainty.

5. Improve understanding of the effect of different land ownership structures on land use change to better anticipate the environmental effects of ETS-plus.
6. Monitor progress towards reversing biodiversity decline in New Zealand; this will require maintenance and updating of national databases, and measures of ecological processes that sustain indigenous species assemblages and ecosystem functions.
7. Improve the quality of national data on significant vegetation cover, ecosystems and landscapes to enable rapid assessment of land use changes and pressures.
8. Fill information gaps in the current FRST-funded research on land use change.
9. Monitor the effect of land use change on soil integrity
10. Monitor land use change as part of a specific monitoring programme associated with the ETS.

7.4. Response measures for Forestry

The ETS-plus is expected to lead to a significant reduction in emissions due to avoided deforestation and new afforestation; these will also have other positive environmental effects, especially with respect to soil erosion and water quality. The ETS-plus is also likely to cause some adverse biodiversity and landscape effects from increased exotic forest establishment. To address these risks, several response measures are proposed:

1. Ensure that areas of high biodiversity value are identified across New Zealand as a matter of urgency.
2. Provide criteria in the AGS to ensure that areas of high biodiversity value, e.g. significant post-1989 regeneration of indigenous vegetation, are not planted in exotic forestry.
3. Include in the ETS legislation provision to ensure that NZUs are not issued for planting of exotic forest on areas of high biodiversity value.
4. Link the AGS to the forestry best practice code to reduce environmental effects at establishment and harvesting.

5. Provide a methodology and time-frame, e.g. via a national environmental standard under the RMA, to guide local authorities in protecting landscapes of high value.
6. Undertake further work to establish how the ETS could be modified if full carbon accounting were required by a future international agreement.
7. Undertake further environmental assessment work if pre 1990 indigenous forests are included in the ETS.
8. Undertake further environmental assessment if the ETS-plus is amended to create more flexibility for land use change from forestry to other land uses.

7.5. Response measures for Manufacturing and Mining

No significant unintended environmental consequences of the ETS-plus have been identified from the manufacturing and mining sectors, and therefore no policy response measures are proposed.

7.6. Response measures for fishing and aquaculture

Some positive environmental effects are expected as a result of the ETS-plus in the seafood sectors, but these are expected to be of limited significance. Some negative effects are also possible and warrant monitoring:

1. Monitor for shift in fishing effort towards areas closer to ports and ensure that fisheries management tools are adequate to prevent localised depletion of fisheries.
2. Consider whether stock assessment models, e.g. models based on catch per unit effort, need to be adjusted for changes in fishing behaviour.
3. Monitor whether changes in fishing gear or strategies give rise to any change in fisheries interactions with protected species such as seabirds and marine mammals.

7.7. Response measures for Waste

The ETS-plus package is not expected to have significant unintended consequences in the solid waste sector, although there are some issues that warrant monitoring.

1. Monitor, and assess during review of the ETS, whether air quality standards and plans are sufficient to address the potential for increased air pollution from conversion of waste to energy.
2. Monitor whether increased cost of energy makes recycling less viable financially and, if so, consider adjusting policy settings for the proposed levy on solid waste.
3. Monitor whether the increased cost of solid waste disposal is causing an increase in illegal tipping of wastes.

7.8. Response measures for Tourism

No sector-specific response measures are proposed for the tourism sector or other service industries. To the extent that measures might help to secure positive effects of the ETS-plus in these sectors or mitigate adverse effects, they are addressed in the Energy and Transport sections above and in the Generic and Cross-sectoral measures, below.

To obtain a more accurate picture of likely GHG reductions in the tourism sector, further investigation could focus on the following:

1. Investigate the impacts of higher domestic travel costs on tourism demand and travel and accommodation patterns.
2. Investigate potential effects of future inclusion of aviation fuel in the international climate change framework.

7.9. Generic and cross-sectoral measures

A number of cross-sectoral and generic initiatives are likely to be necessary to help ensure that opportunities for positive environmental outcomes are maximised and negative environmental outcomes reduced. In general, these measures involve proactive local planning and dialogue, supported by central and regional leadership, to help deal with potential resource conflicts and environmental effects, and engage with communities over the response to climate change.

This would include:

1. An explicit and structured partnership between central and local government around the use of the Resource Management Act.

2. More community-based, multi-stakeholder forward planning, within the context of Long-Term Council and Community Plans under the Local Government Act.
3. Improving the level of information available to individuals, businesses and others making decisions/choices to reduce the climate impact of their lifestyle, and respond to the price and cost signals arising from the ETS.

More detail on these generic measures, and the other response measures, can be found in Chapter 5.

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APPENDIX 1: EXCERPT FROM PROJECT BRIEF: SCOPING REPORT FOR AN ENVIRONMENTAL ASSESSMENT OF THE NZ ETS

Scope of proposed work

This project includes two tasks:

- Task 1: Preparing a scoping report for an environmental assessment of the NZ ETS

- Task 2: Conducting an information-gathering workshop with stakeholders and policy experts.

The methodology for each task is discussed below in part 3 of this proposal.

Task 1: Preparing a scoping report for an environmental assessment of the NZ ETS

The scoping report will cover the following three areas:

1. **Environmental Effects**: At a high level, it will identify and analyse any significant domestic environmental sustainability concerns and opportunities in respect of the NZ ETS and closely related aspects of sectoral policies and measures.

2. **Response Mechanisms**: At a high level, it will propose domestic policy mechanisms (enhanced existing and new) by which these can be addressed and indicate the appropriate governance level, taking into account existing governance arrangements, regulations and policies.

3. **Environmental Assessment Terms of Reference**: It will prioritise the environmental impacts and response mechanisms to be analysed in greater depth in the environmental assessment. It will also recommend the terms of reference for the environmental assessment, including the scope, general methodological approach, key assumptions, primary information sources, and anticipated constraints (including uncertainty and lack of information).

Environmental Effects

With regard to the analysis of environmental effects, the scoping report will include the following (at a high level):

(i) The likely significant effects of the NZ ETS (and closely related government policy) on the domestic environment[104], which may include issues such as greenhouse gas emissions, biodiversity (including indigenous flora and fauna), human health, soil, water, air, and landscape.

(ii) Characterisation of these effects, including their relative significance; their spatial location; whether they are temporary, permanent and/or cumulative; whether they are synergistic; and whether they are positive or negative.

(iii) The extent to which such effects are addressed under, consistent with or contrary to existing government regulations and policies, including the RMA, the NZBS, and broader sustainability objectives.

Examples of environmental effects to be assessed include:

- Afforestation pressures on existing and regenerating natural ecosystems and landscapes
- Pressures on land, water and coastal resources from increased use of renewable energy, including pressures on natural rivers from expanded use of hydroelectricity
- Pressures on landscapes and other amenity values from new generation of renewable energy
- Changes in soil carbon as a result of changes in land use and land use practices
- Air quality improvements or deterioration in both rural and urban areas
- Public health co-benefits
- Forest cover and land-use impacts on erosion control in unstable regions as well as catchment water quality/quantity
- Changes in freshwater flows and freshwater quality from change in land use practices, including e.g. changes in fertiliser use patterns
- Changes in biodiversity through changes in land use, e.g. permanent indigenous forest sinks
- Biosecurity benefits or increased risk factors
- Environmental aspects of the use of nitrification inhibitors and other agricultural emission mitigation technologies.

[104] Note that the scope of the report will not include social, economic or cultural impacts of the NZ ETS. These considerations are being addressed through other mechanisms.

Response Mechanisms

Response mechanisms could mitigate negative environmental impacts or enhance opportunities for achieving greater positive environmental benefits. Response mechanisms could be integrated into the NZ ETS design when they are compatible with its objective; otherwise, they could be implemented outside of the NZ ETS as complementary measures, e.g. via RMA mechanisms. Response mechanisms could include options for measuring and monitoring the ongoing environmental effects of the NZ ETS such that they can be considered in the review of the NZ ETS prior to the end of the first Kyoto commitment period and subsequent commitment periods. In proposing response mechanisms relating to the design of the NZ ETS, the report will give regard to their consistency with the objective of the NZ ETS.

Methodology

The project team will utilize its expertise and existing analysis and information to identify the key issues and potential environmental impacts of the NZ ETS. The project team will analyse the environmental issues using a matrix approach, that is, considering the response of each of the main economic sectors to the NZ ETS price signal and also considering how various natural resources could be impacted by changes in human activity prompted by the NZ ETS. The team will also consider different scenarios, based primarily on different prices of emission units and how this will stimulate changes in business and household activity. The project team will then "ground truth" this information in the workshop with officials and key stakeholders, and utilise this feedback to prepare the draft report. A final report will be submitted after feedback from officials and the Climate Change Leadership Forum.

The workshop needs to include local government officials, representatives from environmental NGOs and key business sector interests as well as central government officials. The number of participants is likely to be approximately 30 people (although holding it in late January might result in a lower than desirable response rate). In order to ensure that the workshop is effective with these numbers, the workshop will include small breakout groups of 6-8 people each, facilitated by members of the project team. Each group will discuss one or two issues in depth, including what methodological approach, key information and assumptions would be appropriate for a more detailed environmental assessment of the NZ ETS.

Risks

The timeline and limited budget create some risks that could affect the quality or timing of the report. The limited budget means that issues will only be considered at a high level based on existing knowledge – any modeling or other more in depth analysis would need to be done in the 2nd phase, i.e. the environmental assessment itself.

In addition, the need to submit a draft report by the end of January,[105] and to hold the workshop prior to that, means that in all likelihood some key stakeholders will not be available, and that this will reduce the effectiveness of the workshop. This risk could be mitigated to some extent if officials are able to notify potential participants prior to Christmas.

[105] Note from the authors: This timeline was subsequently altered.

APPENDIX 2: POLICY SCENARIOS

The purpose of this scoping study is to identify potentially significant environmental effects associated with the proposed NZ Emissions Trading Scheme (ETS) and closely related measures, and to identify where the government's policy framework may need to be adapted to address significant environmental concerns and opportunities that are likely to arise in respect of those measures.

Table A2.1 lists the policies included in the "ETS and closely related measures" scenario "ETS-plus", whose environmental effects will be assessed against a base case scenario. The base case consists of all other policies and measures already implemented as at 1 January 2008 unless otherwise specified below. Table A2.2 lists base case policies of particular significance.

Measures that are already established and funded – for example, the Permanent Forest Sinks Initiative – are in the base case scenario and their interaction with the ETS will be assessed in that context.

We have also put new waste management policy in the base case category – we have made the assumption that Parliament will enact the Waste Minimisation (Solids) Bill, and that it is not driven primarily by climate change considerations. And we have excluded policies that have goals or targets but no definitive measures – however, measures to achieve these goals might be identified in this project as new policy responses to address environmental concerns.

Finally, of policies related to agriculture and forestry, only the ETS itself and the proposed Afforestation Grants Scheme are in the ETS-plus scenario (Table A2.1); other measures in the Government's Plan of Action on Sustainable Land Use and Climate Change are in the base case scenario (Table A2.2). Although these are driven mainly by climate change considerations, they have in most cases already been confirmed and will operate to support the ETS and closely related measures.

Table A2.3 lists some key assumptions regarding energy supply.

Table A2.1. Main features of the ETS and closely related measures (ETS-plus) to be assessed against the base case scenario.

Measure	*Main features*	*Comments*
Emissions trading scheme		
Forestry	a. As of 1 Jan 2008, post-1989 forests[106] eligible to claim sink credits. If claimed, must account for any reduction for harvest or deforestation. b. As of 1 Jan 2008, owners of pre-1990 exotic forests will be liable for deforestation emissions; will receive some free allocation. c. Owners of pre-1990 indigenous forests are not included in the ETS, but government has signalled openness to further discussion	Government will allocate 21 Mt for deforestation of pre-1990 exotic forest during CP1, plus 34 Mt thereafter. Distribution mechanism for these units will be determined in allocation plans issued under Order in Council. Deforestation exemptions: Owners of <50ha (must apply) Deforestation of <2ha per 5-year period (automatic) Removal of invading weed trees (up to 1,250 ha)
Liquid fossil fuels	As of 1 January 2009, those who import liquid fossil fuels, or remove them from refinery, are liable for emissions.	Exemption for fuel exported or used in international trips.
Stationary Energy	As at 1 January 2010, importers or producers of fossil fuels[107] for generation of stationary energy (e.g. heat and electricity) liable for emissions.	*Both Stationary Energy & Industrial Processes:* Zero free allocation will be given to fuel suppliers and electricity generators. Eligible trade-exposed industrial firms will receive free allocation equal to 90% of 2005 emissions from stationary energy[108] and industrial processes from 2010 to 2013, with annual allocations declining to zero by 2025.
Industrial Processes	As at 1 January 2010, industrial facilities will be liable for non-energy industrial process emissions.[109]	
Agriculture	As of 1 Jan 2013, the agriculture sector[110] will be liable	Sector will be given free allocation in 2013 equal to 90% of 2005 non-CO_2

[106] Excludes post-1989 land subject to a forest sink covenant under section 67ZD of the Forests Act 1949.
[107] Includes importing or mining coal or natural gas; off-taking geothermal steam; using geothermal fluid for generating electricity or industrial heat; combusting used oil, waste oil, used tyres and waste for generating electricity or industrial heat; and refining petroleum where the refining involves combustion of obligation fuel or obligation jet fuel.
[108] This includes both direct emissions from stationary energy and indirect emissions associated with the consumption of electricity. Note that the basis for allocation for electricity consumption will be one that compensates firms for the cost impact. It therefore is likely to be based on the emissions from marginal generation rather than average generation.
[109] Note that the importation of sulphur hexafluoride (SF_6) will not carry obligations until 1 January 2013.

	for non-CO_2 emissions, though point of obligation yet to be determined.	emissions, with annual allocations declining to zero by 2025. (Energy emissions already covered as of 2010 under "Stationary Energy".)
Waste	As of 1 Jan 2013, solid waste disposal facilities will be liable for non-CO_2 emissions from operations.	(Energy emissions already covered as of 2010 under "Stationary Energy".)
Closely-related Measures		
Preference for renewable electricity generation	10-year ban on construction of new fossil-fueled thermal baseload generation capacity >10 MW, subject to exemptions.	Exemptions apply, subject to application criteria set out in Climate Change (Emissions Trading and Renewable Preference) Bill currently before Parliament
Biofuels sales obligation	From mid-2008, oil companies required to sell biofuels as certain proportion of total fuel energy sold, starting at 0.53% and rising to 3.4% in 2012.	Based on energy content of diesel and petrol (aggregated). Biofuel Bill currently before Parliament. Bioethanol currently has an exemption from petrol excise duty. There is no equivalent exemption for biodiesel; vehicles that use biodiesel are subject to Road User Charges in the same way as vehicles that use petroleum diesel.
NZEECS		
Energywise homes - all actions in 2.1-2.3 (except 2.1.5, 2.2.5, 2.3.2-4), 2.4.1, 2.5.1	• Insulation retrofits and clean-heat installation in private and Housing NZ homes • New minimum energy performance standards, accelerated household appliance retirement (especially fridges) • Building Code changes: increased use of compact fluorescent lighting, higher thermal performance and hot water system standards • solar water heating: financial and other assistance	Some questions remain as to which of these are existing programmes, and what is new for the 2007 NZEECS.
Energywise business -	• Business energy audits and capital grants for energy	Some questions remain as to which of these are existing programmes, and what

[110] In this context, the agriculture sector includes pastoral and arable farming and horticulture.

3.1.1.a&b, 3.1.2.1 and 3.1.2.3, 3.1.3.3,	intensive businesses • Technology transfer for compressed air, electric motors and industrial heat • Capital grants for woody biomass demonstration projects and pilot scheme for school boiler conversion to woody biomass, • Electricity efficiency programme for commercial buildings	is new for the 2007 NZEECS.
Energywise transport - 4.3.1,4.3.2 and 4.3.6 only	• Light vehicle fuel economy labelling introduced by March 2008 • Average fuel economy standards for new and used vehicles entering the fleet (around 7 litres/100km)	Fuel economy standards for light vehicle fleet still being finalised.
Afforestation Grant Scheme		
Afforestation grants	Grants by competitive tender for new afforestation that is not in ETS, PFSI or ECFP. Exotic, planted indigenous and "assisted indigenous reversion" are eligible.	Maximum grant rates to be determined. Level of funding not yet known. Grantees enter 10 year contracts with Crown. No obligations after 10 years.

Table A2.2. Main features of significant policies included in the base case scenario.

Measure	*Main features*	*Comments*
Sustainable land management: ***A. Forestry - Creating carbon sinks and reducing emissions***		
East Coast Forestry Project	Erodible land in Gisborne District eligible for grant to assist afforestation, targeted at most highly erodible land. Grants available for exotic forestry, gully planting and indigenous reversion. Since 1992, 37,000 ha planted.	Proposed that ECFP grant be reduced if grantees opt in to ETS, but only for applications received after ETS announcement in September 2007. Can combine PFSI with ECFP without penalty, but if participant later opts into ETS, must refund difference between full and reduced ECFP grant.
Permanent Forest Sinks Initiative	New forests can earn emission units with permanent covenant and harvesting restrictions.	Proposed that PFSI participants have option of switching to ETS (more ability to harvest, but with associated obligations) within 18 months. Scheme will develop methodology for measuring carbon storage.
Public conservation land carbon storage	Six pilot projects on 40,000ha, in which investors pay DOC to establish forest carbon sinks on specified areas of conservation land. Two options: planting or natural regeneration of land not in forest at 1990; or measured pest control initiatives to increase carbon storage for pre-1990 forest.	Tenders for initial round due on 31 March 2008. Tenders are also invited to sponsor additional conservation activities on public conservation land. Investment term for carbon sink projects is 45 years.
Hill Country Erosion Initiative	$2 million available annually to help hill-country farmers treat erosion-prone land. Covers assistance to farmers for afforestation plus research, training and other support.	Primarily for regional initiatives through regional councils at this stage.
MAF policy on illegal logging	Awareness and action amongst New Zealand producers, suppliers and consumers to reduce illegal logging.	Covers domestic and international illegal logging. MAF researching feasibility and practicality of introducing a regulatory requirement for a supplier's declaration of conformity on all timber and wood products sold in New Zealand.
Forests Act	Provisions for sustainable management of indigenous forest on private land, primarily through Sustainable Management Plans and Permits. Also covers milling and export controls.	

Biofuels R&D	Bioenergy Research & Development (R&D) and other R&D in the Plan of Action related to forestry measurement and management.	Biofuels R&D is part of a larger R&D programme with the wood industry
B: Agriculture		
Government investment initiatives for agriculture emissions mitigation in the Sustainable Land Management and Climate Change Plan of Action	• Adaptation partnerships and community irrigation fund; • Farm level GHG reporting; • GIS infrastructure; • Business partnerships, biochar R&D; • Adaptation, mitigation and inventory R&D fund; • Technology transfer partnerships with industry through SFF and Climate Change funding.	Total investment in the SLM and Climate Change Plan of Action is $175.584 million over 5 years A number of initiatives are partnered with industry and are currently being developed but are progressively being implemented over the next 3 years. *Refer NZ Climate Change Solutions SLM and Climate Change Plan of Action A Partnership Approach September 2007pp 18*
Waste management		
Waste levy	Levy per tonne of waste to landfill. Default rate of $10/tonne of waste, but regulations can vary the rate (higher or lower) and set a different rate for different facilities and in different locations. Levy revenue is split between local authority and central government and must be used for waste minimisation.	Levy proposed in Waste Minimisation (Solids) Bill, and also in Supplementary Order Paper Sept 07. Government indicated support for the Bill when SOP referred to Select Committee.
Product Stewardship Scheme	A product stewardship scheme must be developed and accredited for products declared (by the Minister through Gazette notice) to be "priority products". Other products can apply for voluntary accreditation of schemes,	Extended producer responsibility proposed in Waste Minimisation (Solids) Bill, amended to Product Stewardship Scheme in Supplementary Order Paper September 2007. Government indicated support for the Bill when SOP referred to Select Committee.
Transport		
Existing funding and expenditure policies	National Land Transport Programme 10 year forward programme (including Northern Busway) plus existing commitments for ONTRACK, including Auckland rail electrification and Wellington rail extension. Existing active living programmes maintained and	These are examples of new initiatives. The base case scenario assumes that other aspects of existing transport funding policy are maintained.

	Walking and Cycling strategy implemented	
RMA and other environmental management statutes and policies		
Resource Management Act, Conservation Act, New Zealand Biodiversity Strategy, etc	All existing statutory RMA policies, plans and standards at national and local level, including those that have been formally notified as proposed; all existing Conservation strategies and plans; existing policies, programmes and plans under the Biodiversity Strategy, the Biosecurity Act, the Fisheries Act and other statutes are considered part of the base case scenario.	Any policies, plans, programmes or standards that are currently under development and have NOT been formally notified as proposed are excluded from the base case scenario, but could be identified in this project as new policy responses to address environmental concerns arising from the ETS and closely related measures.

Table A2.3. Assumptions about energy supply and price.

Energy		
For the purposes of this project, we assume:	No major oil and gas finds in New Zealand during the period 2008-2020. International oil & gas prices remain high and rise over the course of the study. Sufficient domestic gas reserves to meet existing commitments.	

APPENDIX 3: ACKNOWLEDGEMENTS

The consultants thank officials from the Emissions Trading Group, especially Catherine Leining and Amy Kearse, for considerable assistance during the course of the project, which went well beyond the normal call of duty.

Below is a list of participants in a workshop held in Wellington on 25 January 2008 to collect information and views on the possible environmental effects of the ETS and closely related measures. (See Chapter 2 of this report for more detail regarding the workshop.). Some of these participants also provided additional material to the consultants after the workshop, for which we are most grateful.

Kevin Hackwell	Royal Forest and Bird of New Zealand
Raewyn Peart	Environmental Defense Society
Joern Scherzer	Ecologic Foundation
Mark Newton	Sustainable Future
Claire Pascoe	Greenpeace
Dairne Poole	WWF
Molly Melhuish	Sustainable Energy Forum
Bryce Johnson	Fish and Game New Zealand
Geoff Keey	Greenpeace
Peter King	Automobile Association
Sarah Berry	Tourism Industry Assn of New Zealand
Paul Nicholas	New Zealand Shipping Federation
Paul van Brakel	NZ Steel
Raechel Cummins	PWC
Maryann Mitchell	Meridian Energy
Carmen Blackler	Contact Energy
Peter Bodeker	Wood Processors Assn
Peter Weir	New Zealand Forest Owners Assn
Con Williams	Meat and Wool New Zealand
Gerda Kuschel	Auckland Regional Council
Wes ten Hove	Masterton District Council
Blair Dickie	Environment Waikato
Maryanne Macleod	Environment Bay of Plenty
Susan Edwards	Local Government New Zealand
Trevor Freeman	Regional Chief Executives' Forum (Gisborne District Council)
Jamie Tuuta	Māori Reference Group Executive (Ngati Mutunga)
Lisa Kanawa	Māori Reference Group Executive (Te Runanga A Iwi O Ngapuhi)
Roger Pikia	Māori Reference Group Executive (Ngati Hikairo)
Murray Poulter	NIWA
David Wratt	NIWA & Climate Change Leadership Group
Leah Murphy	Emissions Trading Group/Ministry of Transport
Caroline Ryder	Ministry of Economic Development
Trecia Smith	Ministry for the Environment
Richard Wallace	Ministry of Agriculture and Forestry
Roger Fairclough	Ministry of Economic Development

Craig Wadsworth	EECA
Jules Williams	Ministry for the Environment
Joseph Arand	Department of Conservation
Andrew Sweet	Emissions Trading Group / Ministry of Agriculture and Forestry
Marina Conway	Ministry of Agriculture and Forestry
Catherine Leining	Emissions Trading Group / Ministry for the Environment
Amy Kearse	Emissions Trading Group / Ministry for the Environment
Jessica Prendergast	Ministry for the Environment (notetaker)
Heather MacKenzie	Ministry for the Environment (notetaker)
Zoe Studd	Ministry for the Environment (notetaker)
Anne Sutton	Ministry of Agriculture and Forestry (notetaker)

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Larry Burrows	Landcare Research
Craig Trotter	Landcare Research
Suzi Kerr	Motu Economic and Public Policy Research
Guy Salmon	Ecologic Foundation
Simon Terry	Sustainability Council of New Zealand
Barry Blackett	BP New Zealand
Scott Gulliver	Ministry for the Environment
Craig Palmer	Solid Energy
Cath Wallace	Environment and Conservation Organisations of New Zealand
Barry Weeber	Environment and Conservation Organisations of New Zealand
Neil Deans	New Zealand Fish & Game Council
Malcolm Souness	Energy and Technical Services, Wellington
Don Houghton	Auckland Regional Council
Peter Sheppard	Ministry of Transport
Bryan Smith	Ministry of Agriculture and Forestry
Peter Gorman	Ministry of Agriculture and Forestry
Peter Lough	Ministry of Agriculture and Forestry
Anne Sutton	Ministry of Agriculture and Forestry
Gerald Rys	Ministry of Agriculture and Forestry
Hilton Furness	FertResearch New Zealand
Chris Ward	Horticulture New Zealand
Joseph Arand	Department of Conservation
Di Buchan	Corydon Consultants Ltd
Nick Pyke	Foundation for Arable Research
Vern Harris	PALMS Ltd

Many other government officials provided useful comments on our draft report, for which we are grateful.

APPENDIX 4: SIGNIFICANCE OF ENVIRONMENTAL EFFECTS BY ENVIRONMENTAL RESOURCE

This Appendix records the range of potential environmental effects that have been identified during this scoping study and summarise the judgement of the authors in relation to them. The sector and pressure information is drawn from the analysis in the first part of Chapter 3. A preliminary qualitative assessment of each change in environmental pressure against three broad categories is noted:

- **Direction** – i.e. is the expected influence on the state of the environmental resource in question increased pressure on the environment, decreased pressure, mixed or uncertain?
- **Onset** – i.e. how soon is the effect expected to become apparent? "Immediate" means within 12 months of commencement of the ETS legislation, "Early" means during the period 2008-2012, "Medium" means during the period 2013-2020, and "Distant" means around or after 2020.
- **Magnitude and Duration** – i.e. how important is the pressure and how is it expected to vary through time?

The final column then records the authors' preliminary assessment of the policy significance of the change in environmental pressure, drawing together the information in the previous columns. Significance is a qualitative judgement based on the above factors, drawing upon information from a range of sources, including information on the existing state of the environment and the relativity of the possible effect to other expected pressures on the resource during the study period.

Policy significance is broken into four broad categories.

LOW - the expected change in environmental pressure is not significant. This judgement should be revisited during any review of the ETS but no additional response or further investigation is proposed at the present time.

MODERATE - the expected change in environmental pressure is of some significance but is likely to be able to be managed through existing mechanisms. However the effectiveness of these existing response measures needs to be assessed and, where necessary, enhanced. Ongoing monitoring of environmental pressure is usually required and further investigation may be proposed.

HIGH - the expected change in environmental pressure is significant. New response measures may be required to ameliorate adverse effects or reinforce positive changes or both. Further investigation may be proposed.

UNCERTAIN - There is insufficient information to assess the significance of the effect. Further investigation will be proposed rather than policy response mechanisms.

It must be stressed that all changes described here are relative to the base case scenario (see Appendix 2). That is, a change is described as a decrease in pressure (and therefore a positive effect) even if the pressure is expected to increase over time, *provided the ETS-plus policies are responsible for reducing the pressure relative to what it would have been otherwise*.

Table A4.1. Schedule of possible environmental effects identified in relation to Greenhouse Gas Emissions.

Sector	Nature of pressure	Expected direction of change	Expected onset of change[111]	Expected extent and duration of change	Preliminary assessment of policy significance
Electricity Supply	Increased share of renewable energy sources in electricity generation capacity	Decreased pressure (CO_2)	Immediate - medium term	Ongoing, effect increasing with emissions price. Initial effects relate to use of existing generation. The impact on new investment is modest initially (renewables prominent in base case as well), increasing relative to base case over the study period. Relative size of absolute emission *reduction* effect declines as renewables start to dominate system and less thermal is displaced.	High Positive
Electricity Demand	Increased demand for electricity due to fuel switching	Increased pressure (CO_2)	Immediate-early	Transitional effect only due to increased operation of carbon-intensive thermal generation at peaks in early years of ETS-plus	Moderate-High Negative
Electricity Demand	Reduced household, farm and small business use of electricity	Decreased pressure (CO_2)	Immediate	Ongoing and increasing over time with emissions price, rate of change heavily affected by non-price measures as well.	Moderate-High Positive
Transport, Agriculture & Service industries	Reduced demand for liquid fuels	Decreased pressure (CO_2)	Early-medium	Ongoing while fossil fuels dominate transport fuels. Initial impacts will come from measures such as fuel efficiency and driver education; emission price effects will only become apparent over other price effects as emission price rises.	High Positive

[111] Indicates when the effects are first likely to appear. "Immediate" means within 12 months of commencement of the ETS legislation, "Early" means during the period 2008-2012, "Medium" means during the period 2013-2020, and "Distant" means around or after 2020.

Sector	Nature of pressure	Expected direction of change	Expected onset of change[111]	Expected extent and duration of change	Preliminary assessment of policy significance
Transport, Agriculture	Fuel switching to biofuels	Uncertain (CO_2)	Early-medium	Small effect initially, rising with increased use of biofuels. Any use of biofuels will reduce recorded domestic emissions relative to base case but global emission reduction depends on fuel source.	Moderate Positive
Agriculture	Reduced conversion from forest to dairy	Decreased pressure (CO_2, Methane, Nitrous oxide)	Immediate-early	Ongoing effect, becoming more significant as emission costs rise. The reduction in land clearance is noted under avoided deforestation. The additional effect noted here is lower methane and nitrous oxide from dairying emissions relative to the base case.	Moderate Positive
Agriculture	Changes in the scale and nature of dairying	Decreased pressure (Methane, Nitrous Oxide)	Early-medium	Ongoing effect, increasing as emission costs rise. The initial effect is likely to be modest until points of obligation are established and emissions measurement takes place. The effect will be pronounced from 2013, with actual rates of change dependent on a range of factors including technology, its uptake and world prices.	Moderate Positive
Agriculture	Reduced extensive pastoral farming	Uncertain (Methane)	Early-medium	This change is likely to be most extensive post 2013, and as a range of alternative land uses including dairying, forestry and biofuel crops are possible. The overall effect on GHGs of these changes is uncertain.	Moderate Uncertain
Agriculture	Reduced extent of arable farming	Uncertain (Nitrous Oxide)	Early-medium	This change is likely to be most extensive post 2013, and as a range of alternative land uses including dairying, forestry and biofuel crops are possible, the overall effect on GHGs of these changes are uncertain	Moderate Uncertain
Forestry	Avoided deforestation,	Decreased	Immediate	Ongoing, and likely to increase as emission price	High

Sector	Nature of pressure	Expected direction of change	Expected onset of change[111]	Expected extent and duration of change	Preliminary assessment of policy significance
	relative to base case	pressure (CO_2)		increases	Positive
Forestry	New afforestation, relative to base case	Decreased pressure (CO_2)	Immediate-Early	Ongoing and likely to increase as emission price rises	High Positive
Forestry	Increased management of forests for carbon storage, relative to base case	Decreased pressure (CO_2)	Early-Medium	Small effect initially, potentially significant for pre-1990 forests, and regenerating indigenous vegetation depending on post-2012 outcomes	Moderate-High Positive
Manufacturing	Reduced use of fossil energy and fossil feedstock	Decreased pressure (CO_2)	Early-Medium	Ongoing and likely to increase as emission price rises. Small effect initially. Potential for significant step changes in domestic emissions but also potential for emissions leakage. Overall rate of change depends on technology as well as emissions price.	Low-moderate Positive
Mining	Reduced fugitive emissions and emissions from energy use	Uncertain - Decrease (CO_2, Methane)	Immediate-Early	Ongoing and likely to increase as emission price rises. Any fall in output will reduce domestic GHG emissions but there is likely to be some emissions leakage to overseas mining operations.	Low Uncertain
Fishing	Reduced fuel use relative to base case	Decreased pressure (CO_2)	Immediate-early	Ongoing and likely to increase as emission price rises.	Low Positive
Waste	Reduced fugitive emissions from landfills	Decreased pressure (Methane)	Early-medium	Ongoing, and likely to increase as emission price rises. Overall effect of ETS-plus is likely to be small before waste enters scheme in 2013. Reduced pressure due to both diversion of organic waste and increased incineration; the latter does of course lead to CO_2 emissions but the net effect is to reduce emissions pressure.	Low Positive

Table A4.2. Schedule of possible environmental effects identified in relation to Land and Soil.

Sector	Nature of pressure	Expected direction of change	Expected onset of change	Expected extent and duration of change	Preliminary assessment of policy significance
Agriculture	Short rotation biofuel cultivation causing soil disturbance, soil carbon reduction and soil structural changes	Increased pressure	Before 2013 for crop feed effects	Effect of ETS price signal will increase as 2013 nears; mixed changes in land use and farming practice expected, overall effect on land and soil likely to be positive	Low Negative
Forestry	Effects on soil erosion and sediment yield	Decreased pressure	Medium	Erosion control benefits increase as trees grow, especially at canopy closure (~8 yrs). Will continue for duration of ETS-plus incentives.	Moderate Positive
Forestry	Land and soil impacts of periodic harvesting	Increased pressure	Distant	Increased forest area but rotations could be longer. New forests not expected to be harvested for 25-30 yrs. Effects can be locally significant.	Low Negative
Mining	Mining of coal for domestic use	Decreased pressure	Early-Medium	Ongoing. International market could offset reduced domestic demand; in medium term depends on the effectiveness of global efforts in reducing world demand for coal and feasibility of carbon capture and storage technology.	Low Positive
Transport	Land use change due to better urban form and more efficient transport systems.	Reduced pressure	Medium to distant	Over time and lasting.	Uncertain/Low Mostly Positive

Table A4.3. Schedule of possible environmental effects identified in relation to Biodiversity, Landscape and Natural Character

Sector	Nature of pressure	Expected direction of change	Expected onset of change	Expected duration and intensity of change	Preliminary assessment of policy significance
Electricity Demand	Increased hydroelectric generation has the potential to adversely affect freshwater biodiversity.	Increased pressure	Early- medium	Waters of local, regional and possibly national significance could be affected: likely to be ongoing and increasing as long as electricity demand rises. Could be exacerbated by likely climate changes.	High Negative
Electricity Demand	More direct use of scavenged firewood may impact local biodiversity	Increased pressure	Early	Impacts local, likely to plateau or decline as resource is depleted (in the absence of response)	Low- Moderate Negative
Forestry	Increased afforestation pressures on indigenous terrestrial biodiversity (eg post 1990 regenerating forest, scrubland, tussock, other rare ecosystems)	Increased pressure	Early-medium	Ongoing. Pressure will be much higher in some districts than others.	High Negative
Forestry	Increased risk of wilding trees spreading to areas of high conservation or landscape value	Increased pressure	Early-medium	Increases as exotic forestry extends to new areas over time. Threat relates mainly to wilding radiata pines but may also arise from other exotic species including those used for erosion control.	Moderate Negative

Sector	Nature of pressure	Expected direction of change	Expected onset of change	Expected duration and intensity of change	Preliminary assessment of policy significance
Energy supply	Increased biosecurity risks from new or expanded renewable energy sources	Increased pressure	Medium – Distant	Risks largely unknown. Probably relate to dispersal of threat organisms. They could apply to expanded hydro (freshwater environments), expanded wind or solar (terrestrial), expanded geothermal (freshwater or soils), new sources of marine energy (marine).	Uncertain
Forestry	Increased afforestation or regeneration reduces pressures on terrestrial and freshwater biodiversity	Decreased pressure	Medium-Distant	Ongoing. Magnitude depends on extent and location of afforestation.	High Positive
Electricity Demand	Increased renewable energy generation (esp. hydro and wind) may adversely affect landscape and natural character values.	Increased pressure	Early- medium	Ongoing. Localised to regions suitable for renewable power generation. Coastal developments (eg wind and wave) will not emerge until technologies become economically viable. Effects are largely perceptual.	Low-High (varies) Negative
Electricity Supply	Increased pressure on landscapes and natural character from transmission investment for reconfiguration of the distribution system to deal with renewables.	Increased pressure	Medium	Ongoing but localised.	Low-Medium Negative
Transport	Changed pressures on	Mixed	Medium-distant	Ongoing, likely to be localised	Uncertain

Sector	Nature of pressure	Expected direction of change	Expected onset of change	Expected duration and intensity of change	Preliminary assessment of policy significance
	landscapes and natural character arising from changes in land use in response to transport price increases				
Forestry	Increased pressures on landscape and natural character arising from increased afforestation	Mixed	Medium	Ongoing, effects will depend on location and nature of afforestation (eg indigenous versus exotic plantation).	Moderate Negative to Uncertain

Table A4.4. Schedule of possible environmental effects identified in relation to Freshwater Flows and Water Quality

Sector	Nature of pressure	Expected direction of change	Expected onset of change	Expected extent and duration of change	Preliminary assessment of policy significance
Energy Supply and Demand	Changing freshwater flows & levels for hydro-electricity generation	Increased pressure	Immediate	Waters of local, regional and possibly national significance could be subject to this pressure; likely to continue until at least 2020.	Moderate-High Negative
Agriculture	Water abstraction for irrigation	Reduced pressure, but some uncertainty	Early-medium	Effect of ETS price signal will increase as 2013 nears; mixed changes in land use and farming practice expected, overall effect on water likely to be positive but small and hard to predict. Biofuels obligation not likely to have significant impact on water demand.	Low-Moderate Positive
Forestry	Afforestation effects on base flows	Increased pressure	Early	Effects can be locally significant in small to medium rivers & aquifers; will continue for duration of ETS-plus incentives.	Low Negative
Transport	Local water pollution from road runoff.	Decreased pressure	Early	Effects likely to be small due to inelasticity of demand for road transport; could be increased pressure in selected transport corridors.	Low Positive
Agriculture	Nutrient and sediment runoff from intensive land use	Decreased pressure	Medium	Effectiveness of ETS-plus expected to increase over time. Significance hard to predict.	Moderate Positive
Forestry	Effects on soil erosion and sediment yield	Decreased pressure	Medium	Erosion control benefits increase as trees grow, especially at canopy closure (~8 yrs). Will continue for duration of ETS-plus incentives.	Moderate Positive
Forestry	Water quality impacts of harvesting	Increased pressure	Distant	New forests not expected to be harvested for 25-30 yrs. Effects can be locally significant.	Low Negative

Table A4.5. Schedule of possible environmental effects identified in relation to Coastal and Marine environments.

Sector	Nature of pressure	Expected direction of change	Expected onset of change	Expected duration and intensity of change	Preliminary assessment of policy significance
Energy Supply	Pressure on coastal landscapes and natural character from wind farms	Increased pressure	Medium	Localised, ongoing. Issue has been very contentious recently	Medium Negative
Energy Supply	Placement of wind, wave or other electricity generation facilities in marine environments.	Increased pressure	Medium-Distant	Pressure will only become real when technologies become economically feasible, then continuing as long as electricity demand rises. Effects are likely to be small and localised and, depending on the technology, more visual than ecological.	Low Negative
Forestry	Afforestation effects on sediment yields to coastal environments	Decreased pressure	Medium	After planting, significant reductions in erosion occur at canopy closure. Existing bed-load of rivers must also be flushed before sedimentation of coastal environment is reduced, but long term effect is significant.	Medium Positive
Fishing	Effects of energy-intensive fishing methods, especially trawling	Decreased pressure	Early	Depends on magnitude of price signal in relation to market price (either domestic or international) for product	Low Positive
Fishing	Localised depletion of fish stocks if vessels reduce trip distances and stay closer to port	Increased pressure	Early-Medium	Localised effects, potentially ongoing	Low-medium Negative

Sector	Nature of pressure	Expected direction of change	Expected onset of change	Expected duration and intensity of change	Preliminary assessment of policy significance
Fishing	Rebuilding of distant fish stocks if fishing pressure reduced because of fuel price increases	Decreased pressure	Early-Medium	Ongoing	Low-medium Positive
Aquaculture	Pressure on coastal space from increased interest in coastal aquaculture	Increased pressure	Medium	Localised. Depends on resumption of allocation of coastal space.	Low Negative
Aquaculture	Pressures on marine environment from increased interest in deepwater aquaculture	Increased pressure	Medium - Distant	Likely to be relatively minor because of greater dispersion, fewer competing activities and reduced biosecurity risk.	Low Negative
Aquaculture	More farming of filter-feeders could deplete phytoplankton in nutrient-poor areas or remove excess nutrient in enriched areas; finfish farming has opposite effects.	Increased pressure in some areas, decreased in others; overall effect uncertain	Medium	Localised, variable and ongoing.	Uncertain

Table A4.6. Schedule of possible environmental effects identified in relation to Air Pollution.

Sector	Nature of pressure	Expected direction of change	Expected onset of change	Expected extent and duration of change	Preliminary assessment of policy significance
Energy Supply and Demand	Reduced direct combustion of fossil fuels	Decreased pressure	Immediate-early	Ongoing effect, becoming more significant as emission costs rise.	Low-moderate Positive
Energy Supply and Demand	Fuel switching to wood from electricity, gas and coal	Uncertain to Decreased pressure	Immediate-Early	Ongoing localised effect; extent will vary depending on location and extent of wood use and extent to which electricity use is displaced; coal to wood improves local air quality; electricity or gas to wood may reduce it, depending on combustion technology.	Moderate Uncertain to Positive
Manufacturing	Reduced activities associated with emissions to air	Decreased pressure	Early-Medium	Ongoing and likely to increase as emission price rises. Small effect initially, extent of change depends on extent of changes in production. Potential for significant reductions in locally significant pollutants but also potential for leakage.	Low Positive
Mining	Reduced activities associated with emissions to air	Decreased Pressure	Immediate - early	Ongoing and possibly increasing as emission price rises. Overall effect likely to be very small but possibility of locally significant changes.	Low Positive
Transport	Reduced use of liquid fossil fuels	Decreased pressure	Medium-term	Ongoing while fossil fuels dominate transport fuels. Initial impacts will come from measures such as fuel efficiency and driver education, emission price effects will only become apparent over other price effects as emission price rises.	Moderate Positive

Sector	Nature of pressure	Expected direction of change	Expected onset of change	Expected extent and duration of change	Preliminary assessment of policy significance
Transport	Changes in transport patterns	Uncertain	Longer-term	ETS-plus measures may lead to changes in transport patterns in specific locations; these are likely to reduce local emissions pressures in some areas and increase them in others.	Low Uncertain
Transport	Increased use of biofuels	Uncertain	Early	Ongoing, determined initially by biofuels sales obligation (BSO). Biodiesel effects on air quality are largely positive while the impact of bioethanol/petrol blends is less obvious. Balance of effects will depend in part on the balance between different biofuel sources used to meet the BSO.	Moderate-High Uncertain
Waste	Air quality effects of increased combustion of waste and landfill gas	Increased pressure	Early-medium	Ongoing effect, possibly becoming more significant as emission costs rise. Overall effect of ETS-plus is likely to be small before waste enters scheme in 2013.	Low Negative

Table A4.7. Schedule of possible environmental effects identified in relation to Human Health.

Sector	Nature of pressure	Expected direction of change	Expected onset of change	Expected extent and duration of change	Preliminary assessment of policy significance
Energy Demand	Health effects arising from household damp and cold	Increased pressure	Immediate	Ongoing and likely to increase as emission prices rises. Offset to some extent by NZEECS measures but price effects felt more broadly.	High Negative
Energy Demand	Health impacts arising from changes in ambient and indoor air quality due to fuel switching to wood	Uncertain to Decreased pressure	Immediate-Early	Health effects follow from effects on air quality (see previous table). Reduced use of flueless gas heaters may improve indoor air quality.	Moderate Uncertain to Positive
Energy Demand, Transport	Health effects arising from changes in local air quality due to reduced use of fossil fuels	Decreased pressure	Immediate-Medium	Ongoing and likely to increase as emission prices rises, though increase tapering off as fossil fuel share of energy use falls	Low-moderate Positive
Transport	Increased use of active modes (walking and cycling)	Decreased pressure	Medium-term	Ongoing and likely to increase as emission price rises, while fossil fuels dominant transport fuels. Initial effects small and possibly further reduced by measures that improve fuel economy.	Low-moderate Positive
Transport	Health impacts of air quality changes due to increased use of biofuels	Uncertain	Early	Ongoing, determined initially by biofuels sales obligation (BSO). Biodiesel effects on air quality are largely positive while the impact of bioethanol/petrol blends is less obvious. Balance of effects will depend in part on the balance between these that is adopted to meet the BSO.	Moderate-High Uncertain

Sector	Nature of pressure	Expected direction of change	Expected onset of change	Expected extent and duration of change	Preliminary assessment of policy significance
Transport	Increased pressure for larger trucks to improve road freight fuel efficiency, raising possible safety issues	Increased pressure	Early-Medium	The effect of ETS-plus on this issue is likely to be very low in the short-term, as other factors are expected to dominate fuel price changes.	Low Negative