Projected balance of emissions units during the first commitment period of the Kyoto Protocol

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Acknowledgements

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Executive summary

This report updates New Zealand's projected quantity of emissions and removals of greenhouse gases during the first commitment period (2008-2012) of the Kyoto Protocol. The report is known as the "net position" report. The projected quantity of emissions and removals is a core component of New Zealand's projected financial surplus or deficit over the first commitment period of the Kyoto Protocol. The other components are the international price of emissions units and the exchange rate between the New Zealand and United States currencies.

The report is a compilation of sectoral projections from across Government. Agricultural and forest sink projections are provided by the Ministry of Agriculture and Forestry, energy and industrial processes projections are from the Ministry of Economic Development and waste projections are from the Ministry for the Environment. The Ministry for the Environment combines the sectoral projections to create the projected balance of units.

This report includes the effects of refinements in modelling process and updated assumptions on variables such as economic growth, population growth and oil prices as at May 2006. The projections use the latest information from the national inventory of greenhouse gas emissions and removals submitted to the United Nations Framework Convention on Climate Change Secretariat on 13 April 2006 (MfE 2006 *in press*).

The projections reported in this document reflect the Government's decision not to proceed with the previously announced carbon tax in December 2005, but do not reflect any impact from the new work programmes being considered by the Government at the time of publication. The projections therefore reflect the climate change policy settings in place at the end of 2005.

The net position report provides a projection of greenhouse gas emissions for 2008-2012 relative to total emissions in the base year of 1990. In comparison, the national inventory of greenhouse gas emissions and removals provides a record of New Zealand's actual greenhouse gas emissions and removals from 1990-2004. A key difference is that the net position report is based around Kyoto Protocol accounting rules for land use, land-use change and forestry, whereas the national inventory adheres to the reporting requirements for inventories under the United Nations Framework Convention on Climate Change.

2006 Results

As at May 2006, New Zealand's net position is projected to be a deficit of 41.2 million units[1] over the first commitment period of the Kyoto Protocol. The net position is projected to range between a surplus of 1.4 million units under a lower emissions scenario and a deficit of 76.1 million units under a higher emissions scenario.

The May 2006 projection shows a change from previous projections. In May 2005, the most likely estimate for the projected net position was a deficit of 36.2 million units with a high scenario of a deficit of 62.6 million units and a low scenario of a deficit of 11.3 million units. This was updated to a deficit of 64.0 million units in the Crown Accounts in December 2005. The December 2005 interim update reflected the Government's decision not to proceed with the carbon tax (an addition of 13.1 million units) and updated information about landowners deforestation intentions (an addition of 14.7 million units). The improvement to 41.2 million

[1] One emissions unit is equivalent to one tonne of greenhouse gas emissions converted to carbon dioxide equivalents by the global warming potential.

units in the May 2006 projection is caused largely by a significant decrease in projected energy emissions since the December 2005 update due to:

- Emissions from energy (including transport) plus industrial processes are projected to be lower than reported in December 2005 by 14.5 million tonnes carbon dioxide equivalent during the first commitment period. This reduction in emissions is largely due to increases in expected energy costs. For example, the projected international oil price has been increased from around US$30.00 per barrel in 2005 to US$60.00 per barrel in the 2006 net position report. This increase has caused a significant reduction in emissions projections for transport.

- There have also been some reductions from modelling refinements following a review carried out by AEA Technology and emissions from industry growth is not as strong as in previous projections. These have also lowered energy sector emissions projections.

Table ES1 compares the net position from May 2005, the interim update to the net position reported in the Crown Financial Statements since December 2005, and the current May 2006 net position.

Table ES1: Reconciliation of December 2005 projection of the most likely balance of emissions units (million tonnes carbon dioxide equivalent)

		May 2006	December Change	2005	Change	May 2005
Projected Emissions						
a. Projected aggregate emissions		**398.5**	**-16.3**	**414.8**	**13.1**	**401.7**
Energy (excluding transport)		91.3				
Transport		78.8				
Industrial processes		22.9				
Energy (including transport) and industrial processes		**193.0**	**-14.5**	**207.5**	**13.1**	**194.4**
Solvent and other product use		0.3	0.3	0.0		0.0
Agriculture		198.8	-3.2	202.0		202.0
Waste		6.5	1.2	5.3		5.3
b. Assigned Amount Units	**AAUs**	**307.6**	**0.0**	**307.6**		**307.6**
c. Emissions to be covered (b-a)		-90.9	16.3	-107.2	-13.1	-94.1
Projection of Removal Units						
d. Removals via forests		78.2	1.0	77.2		77.2
e. Deforestation emissions		21.0	0.0	21.0	14.7	6.3
f. Net Removals via forests (d-e)	**RMUs**	**57.2**	**1.0**	**56.2**	**-14.7**	**70.9**
g. Balance (f-c)		-33.7	17.3	-51.0		-23.2
h. AAUs allocated to Projects to Reduce Emissions		7.5		7.5		7.5
Statistical discrepancy		0.0	5.5	-5.5		-5.5
Balance of units (g-h)		**-41.2**	**22.8**	**-64.0**	**27.8**	**-36.2**

Note: One emissions unit is equivalent to one tonne of greenhouse gas emissions converted to carbon dioxide equivalents by the global warming potential.
Note: Net removals via forests offset emissions and reduce the deficit on the net position.

The Ministry of Agriculture and Forestry has provided a most likely scenario for deforestation of 21.0 million tonnes carbon dioxide. This scenario is based on the Government's current policy to cap the Crown's deforestation liability for pre-1990 forests at 21.0 million tonnes carbon dioxide. A deforestation survey undertaken in late 2005 indicated that deforestation is likely to exceed the 21.0 million tonne cap in the absence of policy interventions if the current market conditions prevail. The high deforestation scenario of 38.5 million tonnes carbon dioxide is based on the 2005 deforestation intentions survey. If the upper deforestation emissions value is assumed, the projected net position deficit increases by 17.5 million units to a deficit of 58.7 million units with a higher value for the deficit of 93.6 million units and a lower value of 16.1 million units. This report presents both values.

Uncertainty

There is still a great deal of uncertainty as to what the final balance of units or net position will be during the first commitment period. The Government's Climate Change policy is continuing to develop following the conclusion of the 2005 review. It will not be until 2015 when the national greenhouse gas inventory covering the first commitment period of the Kyoto Protocol is submitted to the United Nations Framework Convention for Climate Change, when we will actually know the true value of the net position. The uncertainty range in this report is large, with an upper projection of a deficit of 76.1 million units and a lower projection of a surplus of 1.4 million units. The most significant source of uncertainty is attributable to the values used for forest sinks and this will continue to be the case until the New Zealand Carbon Accounting System becomes operational.

Three scenarios are used to quantitatively assess uncertainty about the projection (Table 1 and Chart 1). The variables used in the scenarios represent the best available knowledge as at the time of projection. The most likely scenario represents what is considered the most likely outcome of projected emissions, reductions from fully implemented policies and removals via forest sinks. An upper scenario comprises all upper projection outcomes, ie, high emissions from all sectors and low reductions from all policies and low removals from sinks. Conversely, the lower scenario shows a combination of all lower projection values. It is highly unlikely that all upper or all lower situations will occur together. A repeated sampling technique (also known as a Monte Carlo simulation method) is used to quantify the uncertainty about the most likely outcome.

There is a range of 77.5 million units between the lower and upper emissions scenarios. This uncertainty reflects the difficulty in modelling the complex relationships of the New Zealand energy sector, projecting agricultural markets and animal productivity, and projecting removals from forest sinks prior to the New Zealand Carbon Accounting System becoming operational. The projected value of the net position will continue to change as projection models are further refined, assumptions are updated and the interpretation of the Kyoto accounting rules are applied in practice.

Review of net position

Following the 2005 net position report the Ministry for the Environment commissioned a UK firm AEA Technology to review the report and assess the reasonableness of the assumptions and methodologies underpinning the projections. The review team's key finding was that **"the methodologies employed to project emissions and sinks across the different sectors [are] generally sound and reasonable in their approach"**.

The 2005 report was also reviewed by Audit New Zealand as part of their annual audit of the Ministry for the Environments financial accounts.

1 Introduction

The Kyoto Protocol commits Annex I[2] Parties that ratified the Protocol to limit or to take responsibility for their greenhouse gas emissions. Annex I Parties in Annex B of the Protocol (UNFCCC 1998) must put in place domestic policies and measures to address emissions or take responsibility for emissions in excess of their commitment. The individual emissions targets of Annex I Parties were intended to equate to a total reduction in greenhouse gas emissions of at least 5 percent from 1990 emissions levels in the first commitment period from 2008 to 2012[3]. Emissions may also be offset by increasing the amount of greenhouse gases removed by carbon "sinks," eg, forests planted since 1990. New Zealand has committed to reducing its average net emissions of greenhouse gases over the first commitment period to 1990 levels or to take responsibility for the difference. New Zealand can meet its commitment through emissions reductions and use of the Kyoto Protocol flexibility mechanisms such as carbon trading, Joint Implementation, the Clean Development Mechanism, and offsetting increased emissions against carbon dioxide removed by forests.

This report projects New Zealand's emissions and removals of greenhouse gases during the first commitment period of the Kyoto Protocol. The projection follows New Zealand's annual inventory to the United Nations Framework Convention on Climate Change and considers emissions and removals of the gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Global warming potentials are used to convert each of the gases to a carbon-dioxide equivalent (CO_2-e). The global warming potential values used in this report are from the *IPCC Second Assessment Report* (IPCC 1995) as per the UNFCCC reporting guidelines.

The report is a compilation of sectoral projections from across Government. Agricultural and forest sink projections are provided by the Ministry of Agriculture and Forestry (MAF), energy and industrial processes projections are from the Ministry of Economic Development (MED) and waste projections are from the Ministry for the Environment (MfE). The Ministry for the Environment combines the sectoral projections to create the projected balance of units over the first commitment period of the Kyoto Protocol.

[2] Annex I Parties are industrialised countries that have signed and ratified the United Nations Framework Convention on Climate Change and are listed in Annex I of that document.

[3] Note that the calculation of 5 percent includes the USA and Australia, which have not ratified the Kyoto Protocol.

2 Projected balance of units over the first commitment period of the Kyoto Protocol

The projected balance of units over the first commitment period of the Kyoto Protocol (2008-2012) is based on projected emissions, estimates of New Zealand's assigned amount units, the projected removal units generated from forest sinks and any emissions units allocated to projects such as those awarded under the Projects to Reduce Emissions programme. In the following sections of this report, additional detail is provided on each of these components. The Kyoto compliance equation is summarised in Section 2.1.

2.1 Kyoto compliance equation

The maximum amount of emissions (measured as the equivalent in carbon dioxide) that an Annex I Party may emit over the commitment period in order to comply with its emissions target is known as a Party's "assigned amount".

Parties may offset their emissions by increasing the amount of greenhouse gases removed from the atmosphere by so-called carbon "sinks" in the land use, land-use change and forestry (LULUCF) sector. However, only certain activities in this sector are eligible. These are afforestation, reforestation and deforestation since 1990 (Kyoto Protocol Article 3.3) and forest management, cropland management, grazing land management and revegetation (added to the list of eligible activities by the Marrakech Accords). The removal of greenhouse gases from the atmosphere through eligible sink activities minus any deforestation emissions generate credits known as removal units (RMUs).

An Annex I Party to the Kyoto Protocol must hold sufficient assigned amount units (AAUs) during the first commitment period of the Kyoto Protocol to cover its total emissions during the first commitment period. The Party may offset any excess emissions through RMUs. If the Party's emissions exceed its assigned amount plus RMUs, it must take responsibility for its emissions through the trading mechanisms under the Kyoto Protocol's flexibility provisions or face a 130 percent penalty for non-compliance during the second commitment period. The Kyoto compliance equation may be simplified as described in Box 1.

Box 1: Kyoto compliance equation

Sum of all emissions from 2008 to 2012 from:

1. energy (including transport)

2. industrial processes

3. solvents and other product use

4. agriculture

5. waste

≤

5 times the emissions in 1990 (known as the assigned amount or AAUs)

Plus

Net removals of carbon dioxide via forest sinks (RMUs)

New Zealand awarded assigned amount units[4] to projects which are projected to reduce emissions under its climate change programme "Projects to Reduce Emissions". New Zealand's net position accounts for this by subtracting these units from the Assigned Amount. The projected impacts of the Projects to Reduce Emissions programme are incorporated in the emissions projections from the energy sector. However, the actual numbers of assigned amount units (or emission reduction units) awarded to these projects will depend on the actual emission reductions delivered from 2008 to 2012.

2.2 Projected balance of units

As at May 2006, New Zealand's net position is projected to be in deficit by 41.2 million units over the first commitment period of the Kyoto Protocol (Table 1). The balance of units is projected to range between a surplus of 1.4 million units under a lower emissions scenario and a deficit of 76.1 million units under an upper emissions scenario.

Three scenarios are used to quantitatively assess uncertainty about the projection. The variables used in the scenarios represent the best available knowledge as at the time of projection. The most likely scenario represents what is considered the most likely outcome of projected emissions, reductions from fully implemented policies and removals via forest sinks. An upper scenario comprises all upper projection outcomes, ie, high emissions from all sectors and low reductions from all policies and low removals from sinks. Conversely, the lower scenario shows a combination of low emissions, high policy reductions and high removals from sinks.

It is highly unlikely that all upper or all lower situations will occur together. The uncertainty around the projected balance of units is modelled using repeated sampling. The 95 percent confidence interval around the most likely value is used to represent likely bounds to the upper and lower scenarios (Table 1 and Chart 1). Triangular probability distributions for each sector's emissions outcome are used to transform the lower and upper values into probabilities.

The Ministry of Agriculture and Forestry has provided a most likely scenario for deforestation of 21.0 million tonnes carbon dioxide. This scenario is based on the Government's current policy to cap the Crown's deforestation liability for pre-1990 forests at 21.0 million tonnes carbon dioxide. A deforestation survey undertaken in late 2005 indicated that deforestation is likely to exceed the 21.0 million tonne cap in the absence of policy interventions if the current market conditions prevail. The upper deforestation scenario of 38.5 million tonnes carbon dioxide is based on the 2005 deforestation intentions survey.

If the upper deforestation scenario of 38.5 million tonnes carbon dioxide is used in determining the deficit on the Crown's accounts the deficit will be 58.7 million units with a upper projection for the deficit of 93.6 million units and an lower projection for the deficit of 16.1 million units.

[4] Project participants have the option to request Emission Reduction Units (ERUs) in place of assigned amount units in accordance with the Kyoto Protocol's joint implementation mechanism.

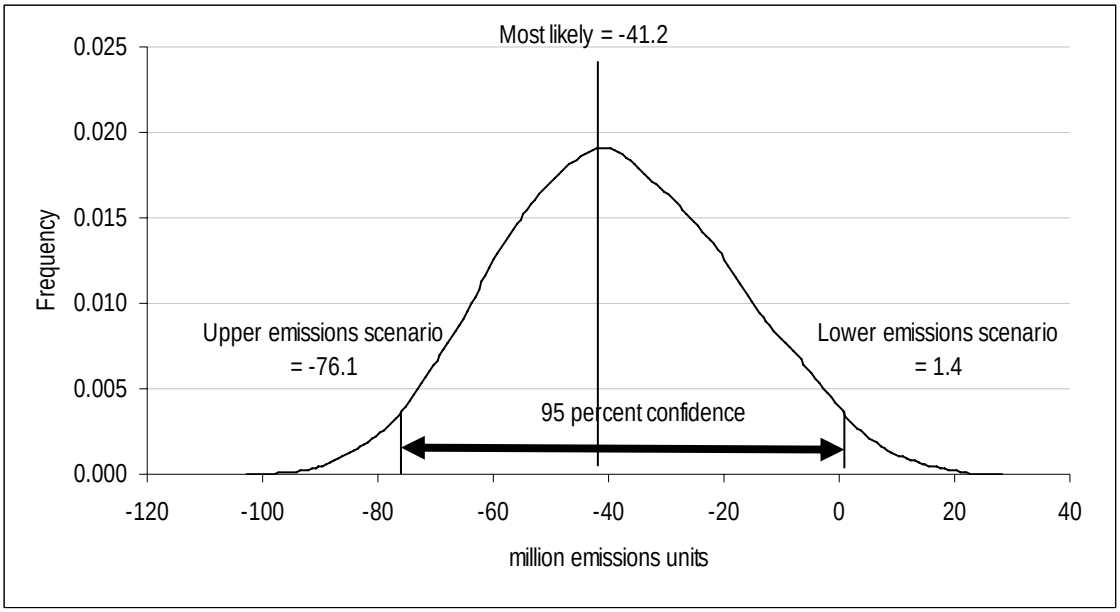
Table 1: Projected balance of emissions units over the first commitment period (Million emissions units)

		Upper scenario	Most likely scenario	Lower scenario
Projected Emissions				
Projected aggregate emissions		**420.3**	**398.5**	**382.7**
Energy (excluding transport)		102.1	91.3	83.7
Transport		85.1	78.8	72.5
Industrial processes		23.0	22.9	22.2
Solvent and other product use		0.3	0.3	0.2
Agriculture		222.2	198.8	180.3
Waste		6.6	6.5	6.4
b. Projected Assigned Amount Units	**AAUs**	**307.6**	**307.6**	**307.6**
c. Emissions to be covered (b-a)			-90.9	
Projection of Removal Units				
d. Removals via forests		-60.4	-78.2	-114.5
e. Deforestation emissions		38.5	21.0	6.3
f. Net Removals via forests (d+e)	**RMUs**	**-21.9**	**-57.2**	**-108.2**
g. Balance (c-f)			-33.7	
h. AAUs allocated to Projects to Reduce Emissions		7.5	7.5	7.5
Balance of units (g-h)			**-41.2**	
Likely balance of units from repeated sampling (95 per cent confidence interval)		-76.1		1.4
2005 'net position'		*-62.6*	*-36.2*	*-11.3*

Note: One emissions unit is equivalent to one tonne of greenhouse gas emissions converted to carbon dioxide equivalents by the global warming potential.
Note: Totals for the upper and lower scenarios will not add because of the repeated sampling technique used to derive these.

The range of 77.5 million units between the lower and upper scenarios reflects the difficulty in modelling the complex relationships of the New Zealand energy sector, projecting agricultural markets and animal productivity, and forecasting removals from forest sinks prior to the New Zealand Carbon Accounting System being operational.

Chart 1: Distribution of projected balance of emissions units over the first commitment period of the Kyoto Protocol (million emissions units)



3 Assigned amount units

The projected volume of assigned amount units for New Zealand is calculated from actual emissions reported in the most recent national inventory of greenhouse gas emissions and removals (MfE 2006 *in press*). The number of assigned amount units is equal to five times the emissions reported for New Zealand's base year of 1990. In the 2006 submission of the inventory for 2004, the emissions in 1990 were 61.5 million tonnes carbon dioxide equivalent (rounded to one decimal place). Each emissions unit is equal to one tonne of greenhouse gas emissions, converted to carbon dioxide equivalents using the global warming potential for each greenhouse gas (IPCC Second Assessment Report 1995). This equates to 307.6 million assigned amount units (rounded to one decimal place) over the first commitment period.

The projected volume of assigned amount units has not changed noticeably since the 2005 estimate despite the effect of recalculations in the national inventory. Recalculations are improvements in data, emission factors or methodologies that are back-dated from the current inventory to 1990. Recalculations are a recognised aspect of the Intergovernmental Panel on Climate Change's good practice guidance for inventory preparation.

New Zealand's 2004 national inventory of greenhouse gas emissions and removals was submitted to the United Nations Framework Convention on Climate Change on 13 April 2006 and is currently undergoing publication (MfE 2006 *in press*). Under the rules of the Kyoto Protocol, the inventory submitted with the Kyoto Protocol initial report will set the final volume for the assigned amount. New Zealand is exercising its option of resubmitting an inventory with its initial report on 1 September 2006. In future net position reports, the assigned amount will be the value set out in the upcoming initial report. Therefore, the value reported here may be subject to change.

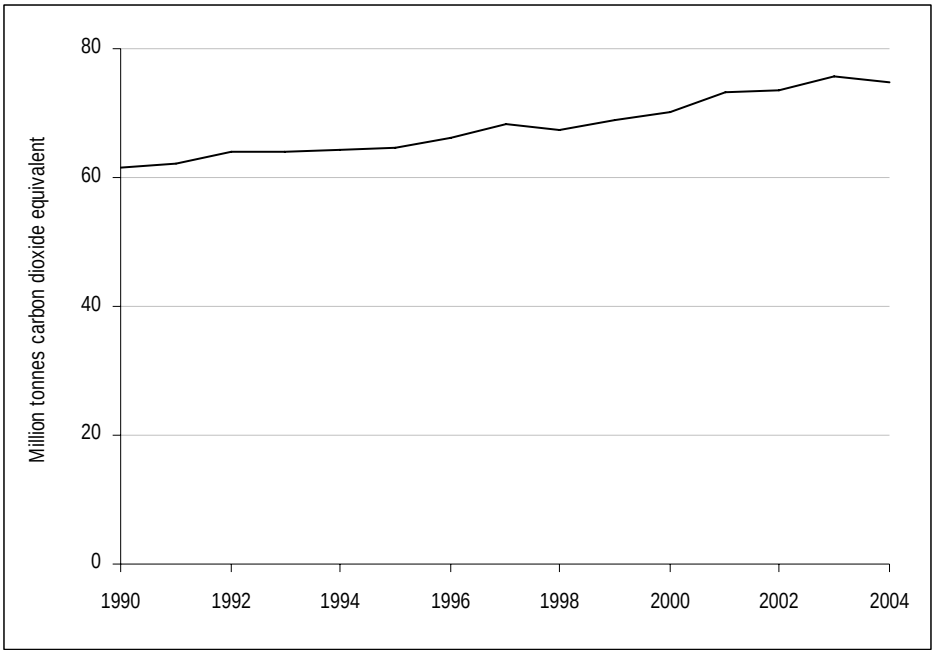
3.1 National trends in New Zealand's emissions

In 1990, New Zealand's total greenhouse gas emissions (excluding the land use, land-use change and forestry sector) were equivalent to 61.5 million tonnes carbon dioxide. In 2004, total greenhouse gas emissions were equivalent to 74.6 million tonnes carbon dioxide. This equates to a 13.1 million tonnes carbon dioxide equivalent (21.2 percent)[5] rise in greenhouse gas emissions since 1990 (Chart 2) from the five sources of emissions shown in Table 2.

The decrease in emissions from 2003 to 2004 visible in Chart 2 is due to emissions in 2003 growing exceptionally fast due to low rainfall and an increased reliance on fossil fuel thermal generation. There was less fossil fuel thermal generation required and consequently less emissions from energy generation in 2004.

[5] In the national greenhouse gas inventory total emissions are sometimes reported as increasing by 21.3 percent. This is due to small quantities of emissions (approximately 0.08 Mt CO_2-e) of nitrous oxide and methane in the land use land-use change and forestry sector being included in total emissions and calculated as total emissions by gas rather than total emissions by sector.

Chart 2: New Zealand's total greenhouse gas emissions 1990-2004, excluding the land use, land-use change and forestry sector (Million tonnes carbon dioxide equivalent)



Source: Ministry for the Environment (2006 *in press*)

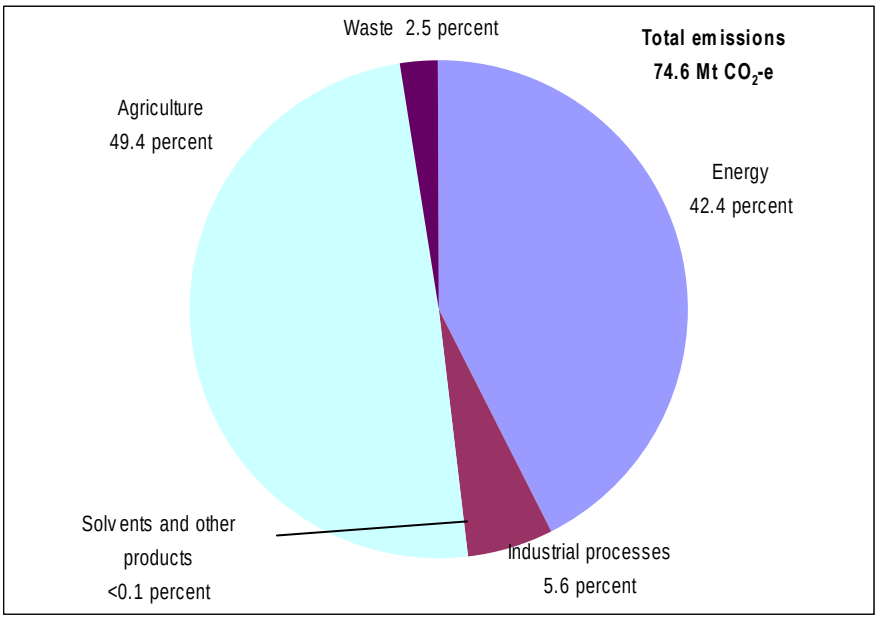
There have been changes in the relative amounts of the different greenhouse gases emitted since 1990. Whereas methane and carbon dioxide contributed equally to New Zealand's emissions in 1990, carbon dioxide is now the major greenhouse gas in New Zealand's emissions profile. This is caused by higher growth in the energy sector compared to the agriculture sector.

New Zealand is unusual amongst developed nations with a large proportion (49.4 percent) of emissions total emissions in 2004 being produced by the agriculture sector (Chart 3). By comparison, emissions from agriculture typically make up 12 percent of total greenhouse gas emissions across Annex I Parties. The agricultural emissions are predominantly methane emissions from ruminant farm animals, and nitrous oxide emissions from animal excreta and nitrogenous fertiliser use. The current level of emissions from the agriculture sector is 4.8 million tonnes carbon dioxide equivalent (14.8 percent) above the 1990 level (Table 2).

The energy sector is the other large component of New Zealand's emissions profile, comprising 42.4 percent of total emissions in 2004. Emissions from the energy sector are now 8.0 million tonnes carbon dioxide equivalent (33.8 percent) above the 1990 level (Table 2). The growth in energy emissions since 1990 is primarily from road transport (an increase of 4.9 million tonnes carbon dioxide equivalent or 62.7 percent) and electricity generation (an increase of 2.6 million tonnes carbon dioxide equivalent or 73.6 percent). Emissions from fossil fuel thermal electricity generation vary from year to year depending on the water resources available for hydro generation. In 'dry' years there is a greater reliance on thermal electricity generation.

Emissions from the industrial processes and waste sectors are a much smaller component of New Zealand's emissions profile, comprising 5.6 percent and 2.5 percent respectively of all greenhouse gas emissions in 2004. Emissions from the waste sector are now 25.9 percent below the 1990 baseline with the majority of the reduction occurring from improvements in management of solid waste disposal. New Zealand's relatively small manufacturing base means that solvent use is lower than in many other countries.

Chart 3: New Zealand's sectoral emissions in 2004



Source: Ministry for the Environment (2006 *in press*)

Table 2: Annual sectoral emissions of greenhouse gases in 1990 and 2004 (Million tonnes carbon dioxide equivalent)

Sector	1990	2004	Change from 1990 2004	Change from 1990 (percent) 2004
Energy	23.7	31.6	8.0	33.8
Industrial processes	3.2	4.2	1.0	30.7
Solvent and other product use	0.0	0.0	0.0	16.4
Agriculture	32.1	36.9	4.8	14.8
Waste	2.5	1.8	-0.6	-25.9
Total emissions	**61.5**	**74.6**	**13.1**	**21.2**

Source: Ministry for the Environment (2006 *in press*)
Note: One emissions unit is equivalent to one tonne of greenhouse gas emissions converted to carbon dioxide equivalents by the global warming potential.
Note: Total excludes small emissions of nitrous oxide and methane from the land use, land-use change and forestry sector.

4 Projected emissions over the first commitment period of the Kyoto Protocol

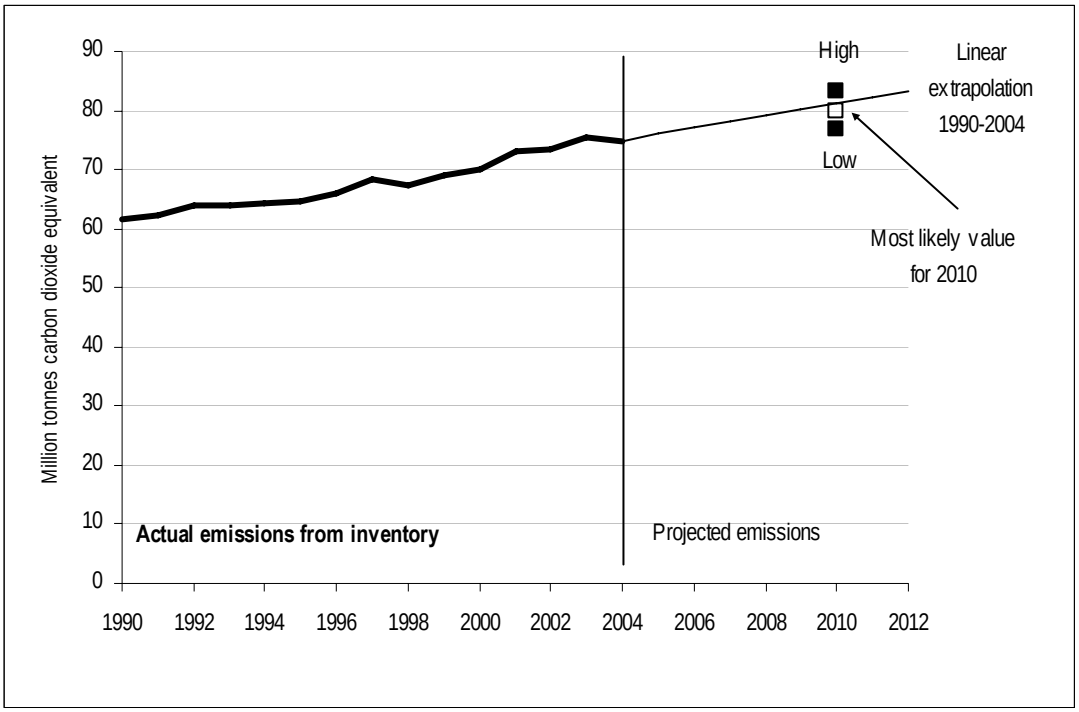
Total emissions of greenhouse gases for the first commitment period are projected to lie between 420.3 Mt CO_2-e and 382.7 Mt CO_2-e (95 percent confidence interval), with a most likely value of 398.5 Mt CO_2-e (Table 3). The total over the first commitment period equates to a range in average annual emissions, excluding emissions from deforestation, between 76.5 Mt CO_2-e and 84.1 Mt CO_2-e with a most likely value of 79.7 Mt CO_2-e (Chart 4).

These projections reflect the Government's decision not to proceed with the previously announced carbon tax in December 2005, but do not reflect any impact from the new work programmes being considered by the Government at the time of publication. The projections therefore reflect the climate change policy settings in place at the end of 2005.

Total emissions over the first commitment period of the Kyoto Protocol are a combination of emissions from the energy, industrial processes, solvents, agriculture and the waste sectors as specified in Annex A and Article 3.1 of the Kyoto Protocol (refer Box 2). Emissions are projected for the mid-point of the first commitment period (2010). Three scenarios – an upper, a most likely, and a lower scenario – are used to assess uncertainty in the projection.

The most likely value of total emissions (excluding deforestation emissions) for 2010 is 79.7 Mt CO_2-e and this coincides closely with what would be expected from a linear extrapolation of the trend in emissions from 1990-2004 of 81.1 Mt CO_2-e (Chart 4).

Chart 4: Projected emissions for 2010, total emissions reported in the national inventory from 1990-2004 and a linear extrapolation of previous emissions (Million tonnes carbon dioxide equivalent)



Note: Excludes emissions from deforestation.

Box 2: Kyoto Protocol Article 3.1

The Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A [to the Kyoto Protocol, refer below] do not exceed their assigned amounts, calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B [to the Kyoto Protocol, refer below] and in accordance with the provisions of this Article, with a view to reducing their overall emissions of such gases by at least 5 percent below 1990 levels in the commitment period 2008 to 2012.

Annex A To the Kyoto Protocol

Greenhouse gases	Sectors/source categories	Sub sectors
Carbon dioxide (CO_2)	Energy	**Fuel combustion**
Methane (CH_4)		Energy industries
Nitrous oxide (N_2O)		Manufacturing industries and construction
Hydrofluorocarbons (HFCs)		Transport
Perfluorocarbons (PFCs)		Other sectors
Sulphur hexafluoride (SF_6)		Other
		Fugitive emissions from fuels
		Solid fuels
		Oil and natural gas
		Other
	Industrial processes	Mineral products
		Chemical industry
		Metal production
		Other production
		Production of halocarbons and sulphur hexafluoride
		Consumption of halocarbons and sulphur hexafluoride
		Other
	Solvent and other product use	
	Agriculture	Enteric fermentation
		Manure management
		Rice cultivation
		Agricultural soils
		Prescribed burning of savannas
		Field burning of agricultural residues
		Other
	Waste	Solid waste disposal on land
		Wastewater handling
		Waste incineration
		Other

Annex B To the Kyoto Protocol (New Zealand Only)

Party	quantified emission limitation or reduction commitment (percentage of base year or period)
New Zealand	100

Table 3: **Projected emissions of gases and sources listed in Annex A of the Kyoto Protocol over the first commitment period** (Million tonnes carbon dioxide equivalent)

	Upper scenario	Most likely scenario	Lower scenario
Projected aggregate emissions	**420.4**	**398.5**	**382.7**
Energy (excluding transport)	102.1	91.3	83.7
Transport	85.1	78.8	72.5
Industrial processes	23.0	22.9	22.2
Solvent and other product use	0.3	0.3	0.2
Agriculture	222.2	198.8	180.3
Waste	6.6	6.5	6.4

Note: Projected lower and upper emission scenarios may not necessarily add to projected aggregate emissions because of the repeated sampling technique used to aggregate emissions.
Note: 1 million tonnes is equivalent to 1,000 gigagrams.

For the first time, the projected net position has included a projection for greenhouse gas emissions from the solvent and other product use sector. This sector as shown in Chart 3 produces less than 0.1 percent of New Zealand's greenhouse gas emissions; however, a simple extrapolation of greenhouse gas emissions was included for this sector for completeness.

4.1 Assumptions

In August 2005, the Ministry for the Environment commissioned AEA Technology (based in the UK) to carry out a review of its May 2005 emission projections, with a focus on the reasonableness of the assumptions and methodologies underpinning the projections. AEA Technology was selected because it is an independent, international consulting firm with experience in conducting a number of similar reviews for other countries. The Ministry for the Environment coordinated the review process, with input from the Treasury, Ministry of Economic Development, Ministry of Agriculture and Forestry, and Ministry of Transport.

AEA Technology recommended that a cross-government team be established to oversee the development of projections and to ensure that the projections were based on a common set of assumptions. This recommendation was adopted when preparing the May 2006 projections. Common assumptions driving the May 2006 projections that apply to model-based projections for more than one sector are shown below in Table 4. Economic growth and population projections are taken from Treasury's Half Yearly Economic and Fiscal Update published in December 2005. Some assumptions are unique to one sector only and are discussed alongside the description of the results for that sector.

Table 4: **Key assumptions for the most likely scenario**

March year ending	Economic growth (GDP)	Exchange rate	Population	Oil prices
	per cent per annum	NZ$/US$	('000)	$US/bbl
2005	3.8	0.69	4,093	60
2006	2.9	0.60	4,130	60
2007	1.7	0.60	4,166	60
2008	2.5	0.56	4,204	60
2009	3.8	0.55	4,240	60
2010	3.1	0.55	4,275	60
2011	2.5	0.55	4,312	60
2012	2.5	0.55	4,350	60

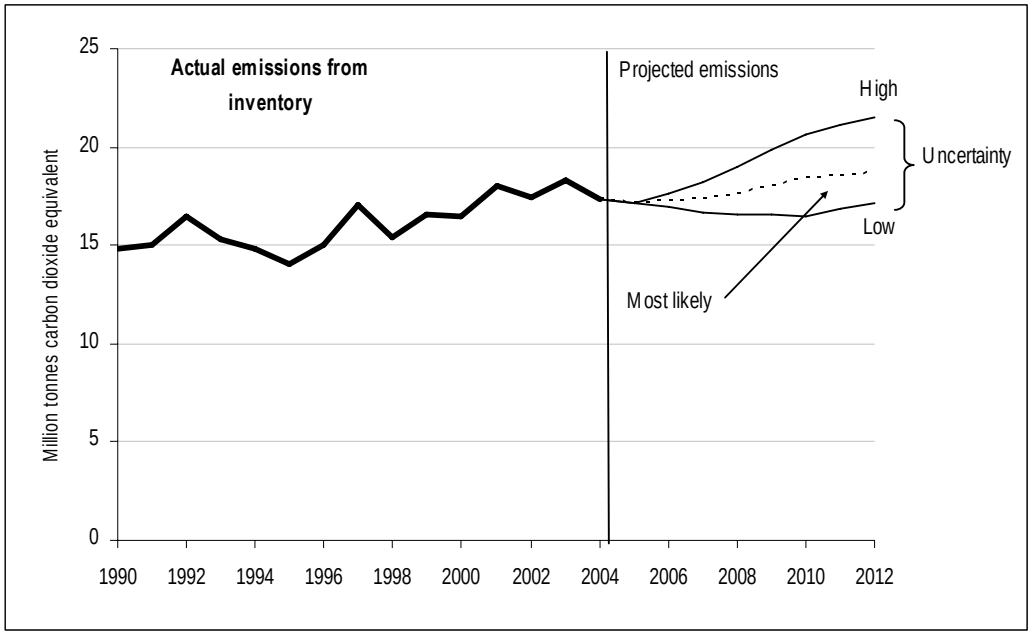
Source: Treasury, Ministry of Economic Development.

4.2 Projected emissions from the energy and industrial processes sectors

Projections of emissions from transport, energy (excluding transport) and industrial processes are provided separately for the May 2006 net position report. This is an improvement on earlier net position reports where these three projections have been included as one single projection. In future it will be possible to reconcile changes in the net position against changes to the projected emissions from transport, energy (excluding transport) and industrial processes.

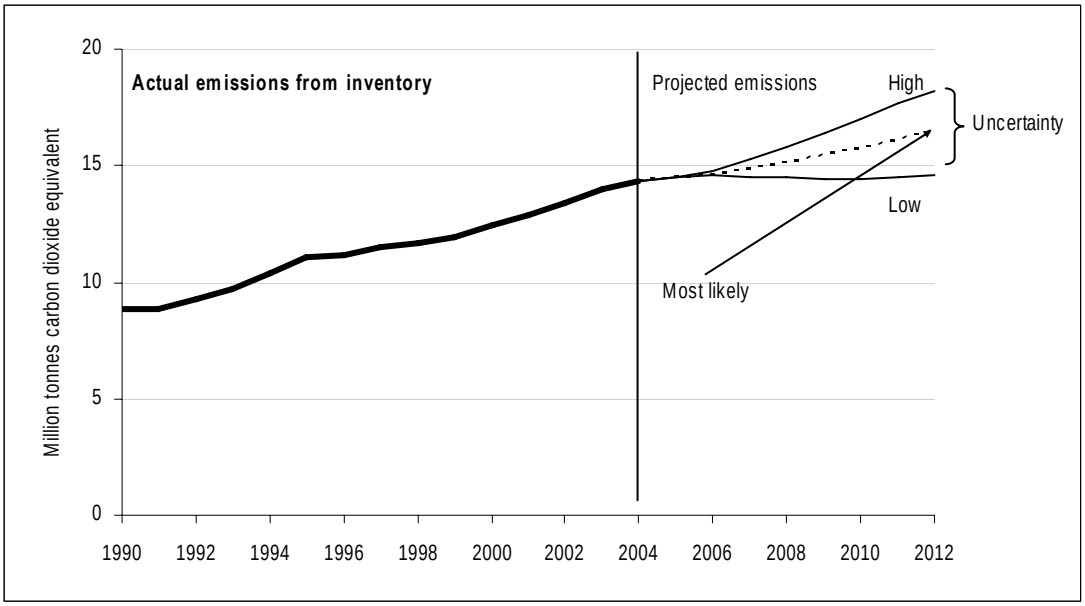
Historical and projected emissions from the energy sector excluding transport, the transport sector and industrial processes sector are shown in Chart 5, Chart 6 and Chart 7, respectively.

Chart 5: Projected annual emissions from the energy (excluding transport) sector (Million tonnes carbon dioxide equivalent)



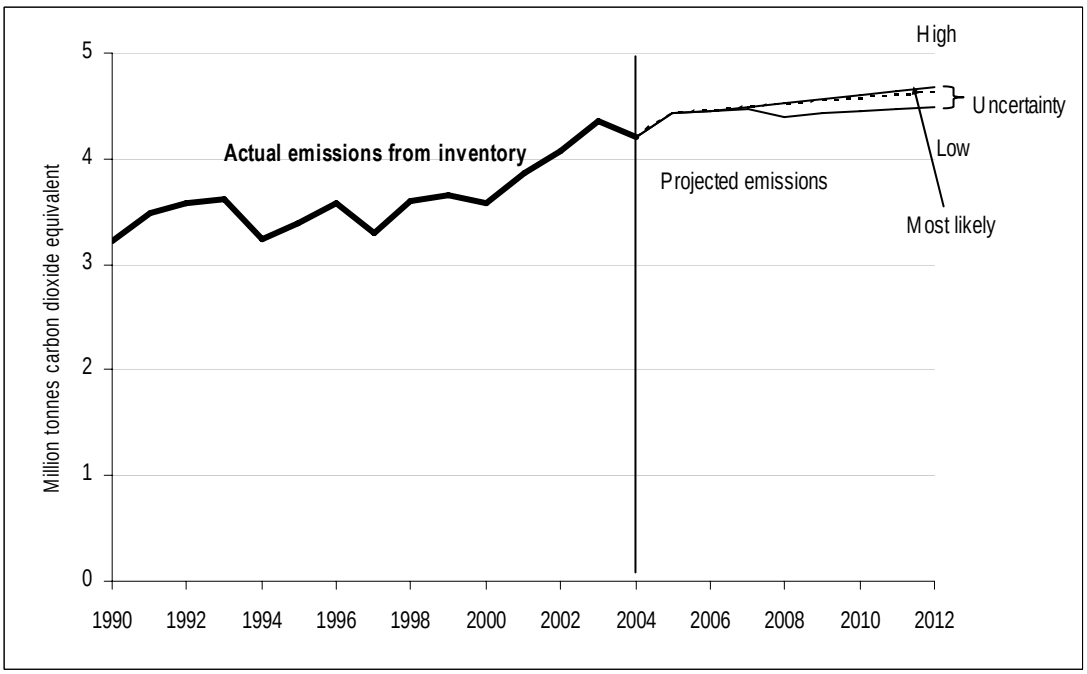
Source: Ministry of Economic Development 2006.

Chart 6: Projected annual emissions from the transport sector (Million tonnes carbon dioxide equivalent)



Source: Ministry of Economic Development, 2006.

Chart 7: Projected annual emissions from the industrial processes sector (Million tonnes carbon dioxide equivalent)



Source: Ministry of Economic Development 2006.
Note: Ministry for the Environment has adjusted the projection by adding 22.0 percent to account for noncarbon dioxide gases from industrial processes.

4.2.1 The Supply and Demand Equilibrium Model (SADEM) projections

This section provides a brief overview of the key assumptions used in the Supply and Demand Energy Model (SADEM). The Ministry of Economic Development's energy modelling team provided updated projections of carbon dioxide emissions from fuel combustion in the energy sector and carbon dioxide emissions from chemical reactions in the industrial processes sector. For the 2006 projections, the SADEM was refined to include increased detail on transport. The SADEM input assumptions for economic growth and population growth were agreed cross-government assumptions used for all sectors (as applicable) and were taken from Treasury's Half Yearly Economic and Fiscal Update. The Ministry of Economic Development is concurrently preparing the 2006 *Energy Outlook* and have undertaken significant model development. More detail of the model structure and new developments will be documented in the 2006 *Energy Outlook.*

Key energy assumptions

Economic growth, population, exchange rate and oil price assumptions for the May 2006 net position used in SADEM for energy (including transport) and industrial processes are shown in Table 4 earlier. Table 5 below shows the specific energy assumptions necessary for the SADEM projections and compares these assumptions with those used last year. The price of oil and coal is significantly higher this year compared with the 2005 projections, and this will result in lower emissions growth being projected in 2006. Average rainfall patterns have been assumed over the first commitment period. The AEA Technology review recommended these rainfall assumptions be reviewed because they have a significant impact on emissions from electricity generation. A review of the rainfall patterns was undertaken by NIWA, which found the assumptions were appropriate.

Coal and oil price assumptions, along with economic growth and population were varied to produce the upper and lower emissions scenarios. The high emissions scenario also assumes lower than average rainfall while the low emissions scenario assumes above average rainfall resulting in higher fossil fuel thermal generation.

Table 5: Energy price and gas discovery assumptions for 2005 and 2006

	2005	2006	Unit
Oil	32.50	60.00	$US/Barrel
Coal	3.75	4.20	$NZ/GJ
Natural gas (delivered to power generators)	6.50	6.50	$NZ/GJ
LNG	7.80	7.80	$NZ/GJ
Gas discovery	60.00	60.00	PJ/Year

Major demand sectors

Three major energy demand sectors are modelled - residential, industrial and commercial – as well as transport (Table 6). Each sector has a number of models underlying it. Approximately two thirds of the total energy is modelled using a sophisticated multi-variate approach. About a fifth of the total energy is modelled based on forecasts, an analysis of the outlook for the specific industries concerned. The remaining portion is modelled using simple ordinary least square linear regression.

The Ministry of Economic Development has updated its projections of heavy industry energy demand (including steel, aluminium, petrochemicals, oil refining, forest products and dairy) in SADEM, having commissioned Covec to re-estimate future energy demand.

The AEA Technology review recommended that New Zealand explore the disaggregation of subsectors in the other industrial and commercial sector, possibly at the 1-digit Australia New Zealand Standard Industrial Classification level. The Ministry of Economic Development has reviewed the data necessary to disaggregate to this level but found that adequate data were not available. The Ministry of Economic Development was, however, able to disaggregate the subsector dairy from the industrial and commercial sector. Further and as recommended by the AEA Technology review, the dairy assumptions used in SADEM were calibrated to the dairy projections provided by the Ministry of Agriculture and Forestry for this report.

Table 6: Energy demand sectors and modelling techniques

Major demand sector	Sub-sector	Model	Net energy (PJ, 2010)	Percentage
Residential demand	Residential	Multivariate, GDP, price, heating and cooling degree days, lagged demand	63.9	12.3
Industrial and commercial demand	Forestry	MAF forecasts	45.7	8.8
	Petrochemicals and refining	Company forecasts	17.3	3.3
	Metals	Industry specific forecasts	39.9	7.7
	Dairy	MAF forecasts	25.7	5.0
	Other industrial and commercial	Multivariate, GDP, price, heating and cooling degree days, lagged demand	84.3	16.3
Transport demand	Petrol (land)	Multivariate, GDP, price, lagged demand	105.5	20.4
	Diesel (land)	Multivariate, GDP, price, lagged demand	100.5	19.4
	Aviation	Ordinary least squares	19.6	3.8
	Sea	Ordinary least squares	14.0	2.7
	Other	Ordinary least squares	1.2	0.2
TOTAL			**517.6**	**100.0**

Source: Ministry of Economic Development

Projects to Reduce Emissions

The Projects to Reduce Emissions programme was a key part of the Government's pre-2005 climate change policy package. The programme also contributes to achieving the outcomes of

the National Energy Efficiency and Conservation Strategy (NEECS) including capacity building in renewable energy. It provides an incentive, in the form of Kyoto Protocol emission units, for projects that reduce emissions below business as usual during the first commitment period of the Kyoto Protocol.

The method used to model the Projects to Reduce Emissions covers only electricity generation projects, which are the vast majority of all projects funded. Projects to Reduce Emissions units are modelled as an effective discount on the capital costs for new generation projects at the margin of viability. Since there is no guarantee that all projects that received PRE project agreements will proceed, it is also assumed that some projects are not fully installed.

Energy efficiency assumptions

Energy efficiency policies that have been fully implemented include energy efficiency improvements that will be driven by the National Energy Efficiency and Conservation Strategy, local Government initiatives, and the energy-intensive business programme. In the May 2005 net position report, the impact of these polices was modelled separately and deducted from the SADEM energy emissions projection. The 2006 net position report adopts the recommendation of the review of the 2005 net position report by AEA Technologies and models the energy efficiency within the SADEM energy projection. Residential energy efficiency improvements were estimated to provide 1.70 PJ of energy savings per year and other industrial and commercial sectors were estimated to achieve 2.34 PJ of energy savings per year during the first commitment period. The estimated energy savings were used in the SADEM projections.

Energy Outlook 2006

The Ministry of Economic Development is preparing to release the 2006 *Energy Outlook* around mid-2006. Further information on the energy modelling methodology will be available in that report.

4.3 Projected emissions from the agriculture sector

Projections of emissions from the agricultural sector are based on modelling by the Ministry of Agriculture and Forestry. Projections are calculated from total animal numbers, species balance changes, increasing animal performance (liveweight and productivity) and future application rates of nitrogenous fertilisers. Details of the methodology and assumptions are included in Appendix A.

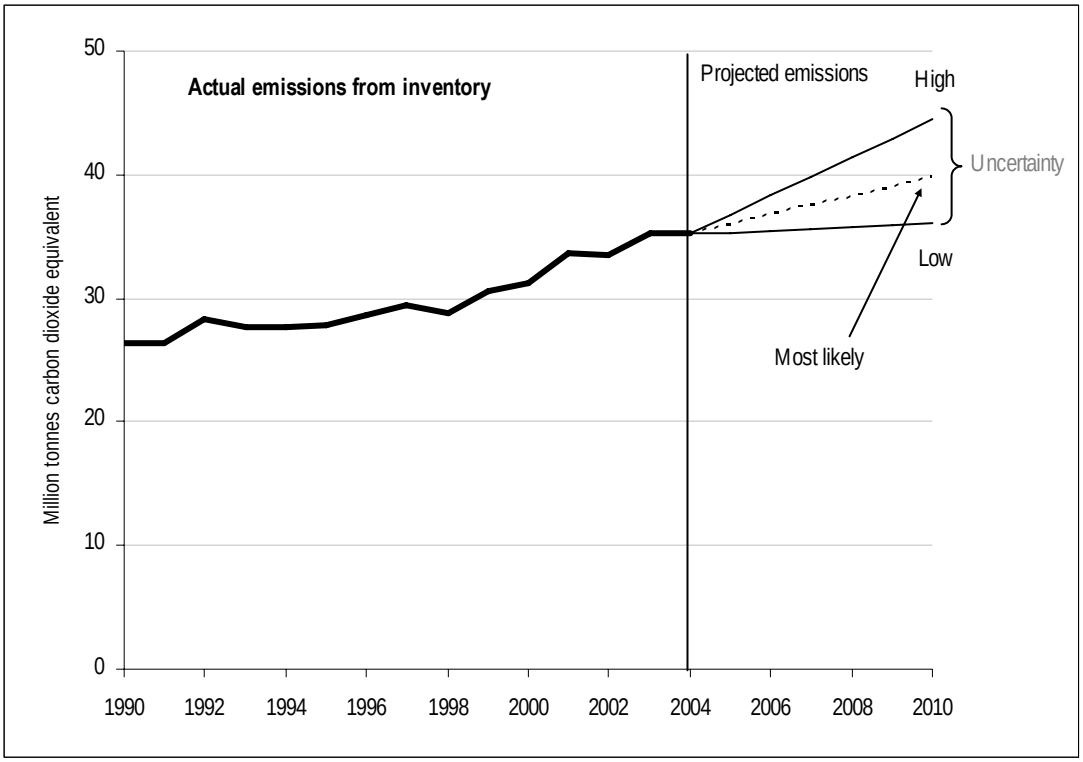
Emissions from the agriculture sector are projected to range between 180.3 Mt CO_2-e and 222.2 Mt CO_2-e over the first commitment period. The most likely value is projected to be 198.8 Mt CO_2-e. Average annual emissions over the first commitment period are projected to range between 36.1 Mt CO_2-e and 44.4 Mt CO_2-e with a most likely value of 39.8 Mt CO_2-e (Chart 8).

The potential of technologies to reduce emissions, particularly in the agriculture sector, has not been quantified in the May 2006 update. There are new products currently entering the market aimed at reducing nitrous oxide emissions from fertiliser, but for this report the impacts are too uncertain to be quantified. Future updates may include an estimate as more quantitative data are produced on the impacts and industry uptake of technologies. There is also the potential for

upward movement in emissions due to the implementation of agricultural industry growth strategies.

As recommended by the AEA Technology review of the 2005 net position report, lower and upper emissions scenarios for agriculture are now based on livestock projections formed by varying the potential changes in prices in the Pastoral Supply Response Model.

Chart 8: Agricultural emissions projected for 2010 and emissions from the agriculture sector as reported in the national inventory (Million tonnes carbon dioxide equivalent)



Ministry of Agriculture and Forestry 2006.
Note: Agriculture emission projections are provided for 2010 only, the mid-point of the years 2008-2012. For the net position calculation this was multiplied by five as 2010 is considered representative of average annual emissions between 2008 and 2012. The projections from 2004 to 2010 were interpolated for presentational purposes only.

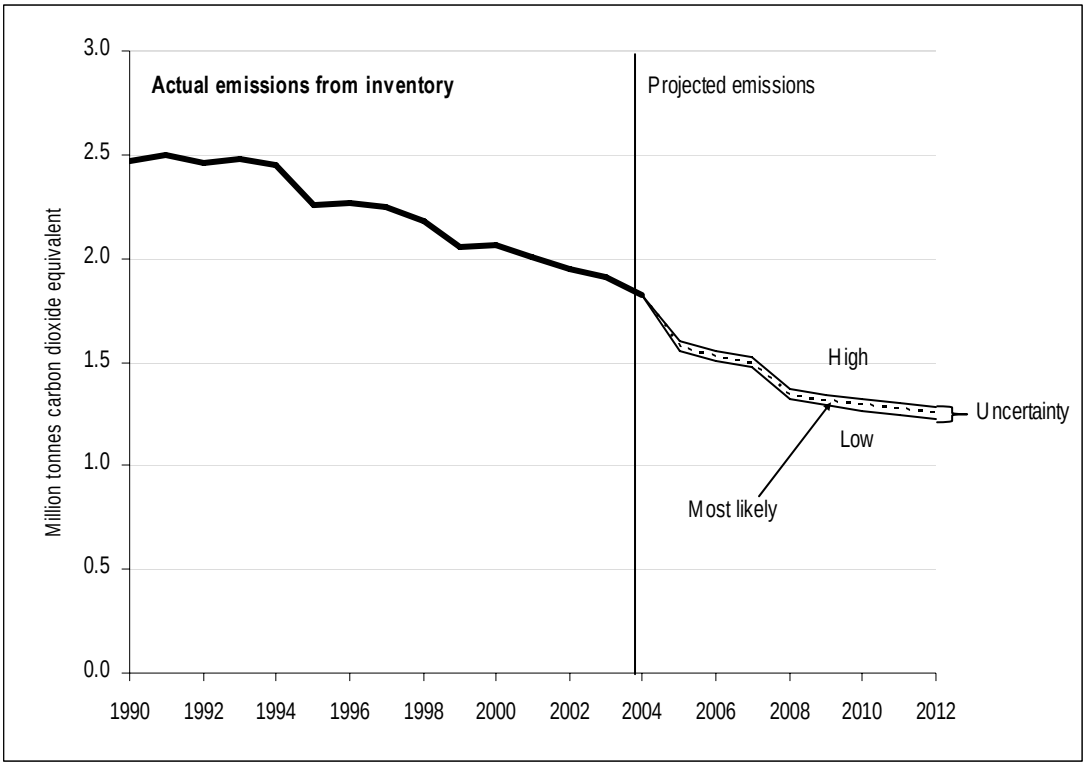
4.4 Projected emissions from the waste sector

Projected emissions from the waste sector include emissions from solid waste disposal sites and wastewater treatment plants. The effects of the New Zealand waste strategy and the national environmental standard for landfill gas collection are included in the total emissions reported from the waste sector.

Emissions from the waste sector over the first commitment period are expected to range between 6.4 Mt CO_2-e and 6.6 Mt CO_2-e with a most likely value of 6.5 Mt CO_2-e. Projected annual emissions for 2010 are expected to lie between 1.2 Mt CO_2-e and 1.3 Mt CO_2-e per annum with a most likely value of 1.2 Mt CO_2-e (Chart 9).

Chart 9 shows that since 1990, there has been a large percentage decrease in emissions due to decreased waste volumes and less organic matter entering landfills. The impacts of the New Zealand waste strategy (MfE 2002) and national environmental standard for landfill gas collection and destruction are projected to further decrease emissions from waste.

Chart 9: Waste sector emissions projected for 2010 and the inventory time series of emissions from the waste sector (Million tonnes carbon dioxide equivalent)



Ministry for the Environment 2006

4.4.1 Waste sector methodology

Solid waste disposal

Emissions from solid waste disposal sites comprise 85 percent of the emissions from the waste sector. The emissions from solid waste disposal are projected using the methodology and variables used in New Zealand's latest national inventory of greenhouse gas emissions and removals (MfE 2006 *in press*). The methodology uses data specific to New Zealand on waste generation rates, waste composition, the percentage of waste disposed to landfills and landfill gas extraction and combustion.

Population projections are taken from Treasury's Half Yearly Economic and Fiscal Update. The medium fertility, mortality and a net migration of 5,000 people are used as the most likely input assumptions. Other variables remain constant at the values reported in the latest national inventory (MfE 2006 *in press*). Projected effects of the New Zealand waste strategy are deducted from the modelled emissions. The effects of the national environmental standard for landfill gas collection were modelled separately and deducted from the gross emissions (Waste Management 2005).

The New Zealand Waste Strategy

The New Zealand Waste Strategy was launched in March 2002 with the objective of moving towards zero waste by 2010. The strategy extends to all waste streams including landfill waste, mine and quarrying waste, and sewage. In the initial estimate of emissions over the first commitment period (Tonkin and Taylor 2002), the New Zealand Waste Strategy was projected to deliver an estimated reduction of 2.4 Mt CO_2-e, or 13.5 percent, against gross emissions from solid waste disposal sites during the first commitment period of the Kyoto Protocol. This projected proportion is retained as the lower value for the May 2006 projection. The most likely estimate is that 90 percent of the reduction occurs, with an upper value assuming 75 percent of the reduction.

The national environmental standard for landfill gas collection

A national environmental standard for landfill gas collection and destruction was introduced under Sections 43 and 44 of the Resource Management Act and applied to landfills that will accept over one million tonnes of refuse throughout their design life (MfE 2004). There is a transitional period to 2007.

Landfill gas collection estimates and projections were updated in 2005. It was projected that 7.4 Mt CO_2-e, or 55 percent, of gross emissions from solid waste disposal sites would be collected by landfill gas systems over the first commitment period. These estimates did not include the effects of the New Zealand Waste Strategy on gross emissions. Consequently, the landfill gas collection estimates were reduced by the same proportion used to reduce gross waste emissions. The most likely scenario now holds that landfill gas collections systems will reduce gross emissions by 6.5 Mt CO_2-e from 2008 to 2012.

Wastewater treatment

Emissions from wastewater treatment produce 15 percent of emissions from waste. The projected emissions for 2010 were estimated using a linear projection of emissions from 1990 to 2004 ($r^2 = 0.96$). Emissions are projected to be 0.33 Mt CO_2-e for 2010.

5 Projected removal units from forest sinks

Removals of carbon dioxide via forest sinks is a key component in how Parties can meet their commitments under the Kyoto Protocol. New Zealand is in a relatively unique situation having planted a substantial area of forest since 1990. It is estimated that between 1990 and 2005 675,000 hectares of new plantation forest have been established as a result of afforestation and reforestation activities.

Projected removals from the land use, land-use change and forestry sector are based on data and assumptions from the Ministry of Agriculture and Forestry and the Ministry for the Environment. The forest carbon modelling was undertaken by Ensis (formerly Forest Research). The underpinning science incorporated in the forest carbon models used in these projections, along with scientific assumptions, come from work carried out by Ensis and Landcare Research.

Forecasting is a challenging task. Forecasts are greatly influenced by prevailing conditions and those that have existed over the last one to two years. As described below the economic and policy environment in which New Zealand forest owners have been operating has been changeable. This makes forecasting the future less certain than when a stable operating environment prevails.

These forest sink projections cover the likely range of the major contributing factors to land use, land-use change and forestry sector removals and emissions (forest sinks) based on the current economic environment, policy settings and the state of scientific knowledge.

5.1 Forest sector operating environment

The New Zealand forest growing sector has seen difficult trading conditions over the last three to four years. A high exchange rate, increasing costs, particularly shipping costs, along with competitive and changing international markets have adversely affected forest growing profitability in New Zealand. In addition there has been the largest number of forest sales since state forest privatisation in the late 1980s. There is now a greater separation between forest ownership and land ownership than has been the case historically. Land owners are looking to maximise value from the land by realising some of the increased land value through forest land sales. Livestock farmers are currently prepared to pay higher land prices than commercial forest owners. The net result of these changes and a somewhat uncertain future has led to:

- A significant decline in the rate of afforestation. Afforestation has fallen from a 30-year annual average (1974 to 2004) of 43,000 hectares to just 6,000 hectares in the year to December 2005.

- The new phenomenon of deforestation where plantation forest land is converted to alternative land uses, particularly pastoral grazing. In the year ended March 2005, an estimated 7,000 hectares of deforestation occurred. Historically there has been little plantation deforestation.

A climate change policy review was undertaken by the Government in the second half of 2005. While policy changes have been signalled, at this point climate change policy development is still underway. These projections do not account for future changes to climate change policy settings and are based largely on prevailing policy.

5.2 Forest model description

Projected forest sink removals were calculated using a simulation model of the Kyoto forest estate. The model was based on a carbon yield table which describes the per-hectare carbon stock at each age for a typical Kyoto forest stand. To calculate the carbon stock in a given year, values in the yield table are multiplied by the net stocked forest area at the corresponding age, and then summed. The distribution of areas by age class is defined by the new planting rate – the simulation advances these areas through annual time periods (1990 to 2012). Net carbon uptake is calculated as the stock change in the first commitment period.

5.3 Scenarios and results

Most likely, upper and lower scenarios have been used to quantify the likely range of carbon dioxide removals by forests and carbon dioxide emissions from deforestation during the first commitment period.

Table 7 represents current efforts to quantify the likely range of the major contributing factors to estimating LULUCF sector removals and emissions. The scenarios attempt to anticipate the results from when the New Zealand Carbon Accounting System (NZCAS) is in operation. The progressive implementation of the NZCAS will replace and likely revise all values reported in Table 7.

Table 7: Calculation of projected removal units during the first commitment period

Projected removal units	Mt CO_2-e		
	Upper	Base	Lower
Total removals from simulations combined in model	**60.4**	**78.2**	**114.5**
Projected deforestation emissions	38.5	21.0	6.3
Net removals (RMUs)	**21.9**	**57.2**	**108.2**
Effects of different input assumptions			
Total sequestration under different planting rates (0, 5k, 20k ha/yr)	95.4	96.6	98.0
Factor adjustments to total sequestration (see assumptions below for details)			
Kyoto forest growth rates	-9.7	0.0	29.5
Soil carbon change with afforestation	-9.5	-3.0	0.0
Planted forest not meeting the Kyoto Forest definition (Ineligible Kyoto Protocol planting)	-20.3	-15.5	-7.7

Note: Factor adjustments to total sequestration do not add to total removals because assumptions have been combined in the model to account for the interrelationships between the assumptions. For further details see Appendix B.

A large source of uncertainty for carbon removals by forest sinks is due to uncertainty around the value to apply for growth rates (of Kyoto Forests). The uncertainty range suggests some scope for higher carbon sequestration due to higher forest growth rates than currently assumed in the most likely scenario. The current most likely scenario uses data on growth rates from older (non-Kyoto) forests. Post-1990 forests may be more productive than older (non-Kyoto) forest due to improved knowledge of forest management, more fertile soils and improved genetic stock. The true growth rate for post-1990 forest will be better known once the New Zealand Carbon Accounting System is fully operational, and permanent plots have been installed and measured in the Kyoto forests.

Another key source of uncertainty is the value used for soil carbon losses from afforestation. Current research is showing that when a new forest is planted there is a loss of soil carbon. The lower case is there is no loss of soil carbon, however there is downside potential for soil carbon losses due to afforestation that has to be accounted for in the treatment of uncertainty. The range around soil carbon losses from afforestation represents a source of uncertainty in these projected carbon removals.

Any new forest planted from 2005 onwards will only have a small impact on total carbon removals during the period 2008 to 2012 because newly planted forest will not absorb as much carbon as forests that are a few more years into their life cycle. Hence the results are not particularly sensitive to varying the planting rate assumptions for new forests.

5.4 Forestry assumptions

Further details on these assumptions are contained in Appendix B of this report.

Kyoto forest growth rates

The most likely scenario uses a national carbon yield table developed from the National Exotic Forest Description (NEFD) yield table database.

The NEFD yield tables better represent the growth of forests on traditional forestry sites. The generally held view is that post-1990 plantation stands have higher growth rates than earlier plantings.

Analysis of forest growth data suggests that fully stocked stands planted after 1990 show a 15-35 percent improvement in productivity over stands currently being harvested, as a result of genetic improvement, better site quality and improved forest management. The upper end of this range was used to develop the lower scenario, which is based on a growth model projection for pruned radiata pine growing on an ex-pasture site. Compared with the NEFD-based yield table, the high yield table has:

- higher volume at maturity
- lower carbon for a given volume (trees on fertile ex-pasture sites have lower wood density and therefore carbon content)
- higher rate of growth in the second half of the rotation.

The upper scenario yield table was set at 10 percent lower than the NEFD yield table. This assumed:

- no increase in volume productivity over stands currently harvested
- no reduction in wood density (and therefore carbon) due to ex-pasture sites
- same pattern of growth as assumed by the NEFD derived yield table.

The growth rate scenarios are broadly indicative only. Accurate modelling of forest carbon removals requires representative sampling of the post-1990 forests. This will not be available until a representative plot network has been established and measured in New Zealand's Kyoto Forests.

Planting rate

The most likely estimate in the May 2005 projection report was based on a planting rate of 10,000 hectares per year. It is provisionally estimated that 6,000 hectares were planted in 2005. The assumptions for planting rates used in this projection are shown in Table 8. The average planting rate over the last thirty years has been 43,000 hectares per year. A future afforestation rate of 5,000 hectares per year is low in the historical context.

Table 8: Afforestation rate assumptions (hectares)

Calendar year	Upper	Base	Lower
2005(p)	6,000	6,000	6,000
2006	0	5,000	5,000
2007	0	5,000	10,000
2008	0	5,000	15,000
2009	0	5,000	20,000
2010	0	5,000	25,000
2011	0	5,000	30,000
2012	0	5,000	35,000
Average	**0**	**5,000**	**20,000**

P Provisional estimate for 2005

Soil carbon

A loss of 3.0 Mt CO_2 (range 0 to -9.5 Mt CO_2) is included for a loss of soil carbon through the afforestation of "grassland". This is based on research by Landcare Research. Landcare Research was commissioned to review the loss of soil carbon and this value has been revised from last year's most likely estimate of -2.2 Mt CO_2. The most likely scenario assumes a loss of soil carbon following afforestation of 4.7 tonnes carbon per hectare over a 20-year period.

Ineligible Kyoto Protocol planting

A loss of 15.5 Mt CO_2-e is included for plantation forests planted into existing forest. Field studies and a national analysis in a geographic information system have suggested that a proportion of existing planted forests, estimated at up to 16 percent nationally, were planted in scrub that could meet the definition of forest in the Kyoto Protocol, ie, the planting was not onto "grassland". There is anecdotal evidence that the ineligible Kyoto Protocol planting estimates may be too high; however, in the absence of better quantitative evidence the more conservative estimate has been retained. Better estimates will not be known until the NZCAS is in operation. The upper and lower estimates use estimates of 21 percent and 8 percent of forests being planted in existing forest as well as new forest planted from 2006 onwards.

Deforestation

At the time of these projections, the deforestation cap is Government policy. Based on this the cap of 21.0 Mt CO_2 has been used for the base scenario. The upper scenario assumes an emission liability of 38.5 Mt CO_2. This is based on a deforestation intentions survey completed in December 2005. The results from this survey indicated that under current conditions, forest owners intended to deforest about 47,000 hectares during the first commitment period (2008-12). This scenario allows for the removal of the deforestation cap and for current market

conditions to prevail. The calculation of 38.5 Mt CO_2 is based on all deforestation being mature forest and all emissions being instantly emitted.

The projections include a lower scenario of 6.3 Mt CO_2 to show the effect of changes in either forest policy or improved forest growing profitability. In absence of any better figure the lower scenario is based on 1,500 hectares of deforestation each year, slightly higher than the historical deforestation rate.

No allowance has been made for deforestation of indigenous forest or shrub land that meets New Zealand's adopted Kyoto forest definition. Under current legislation (eg, Resource Management Act 1990, Forests Act 1949 amended 1993) and/or codes of practice (eg, The New Zealand Forest Accord), any significant deforestation of indigenous forest is, in practice, difficult to do.

Other assumptions

These projections assume an average harvest age of 28 years. Harvesting forest stands younger than 22 years old prior to 2012 would result in harvesting emissions during the first commitment period. These have not been accounted for in these projections.

5.5 Impact of the Permanent Forest Sinks Initiative

The Permanent Forest Sink Initiative (PFSI) provides an opportunity for landowners to establish permanent forest sinks and obtain tradable Kyoto Protocol compliant emission units in proportion to the carbon sequestered in their forests.

At the time of writing this report the Climate Change Response Amendment Bill had passed its first reading in Parliament and had been reported back from Select Committee. If the Bill proceeds through its final Parliamentary stages, regulations will need to be developed for the PFSI to become operational.

There is potential for some of the existing Kyoto-compliant forests to enter the Permanent Forest Sink Initiative. Any switching of these forests to the Permanent Forest Sink Initiative will result in the devolution of those credits and their removal from the Crown's balance of units. However, given the various risks and uncertainties associated with the initiative that existing forest owners will need to consider, it is not possible to provide an estimate of the area of existing forest that might switch to the Permanent Forest Sink Initiative at this stage.

5.6 Current data limitations

There are acknowledged weaknesses in some of the data used in these LULUCF sector projections due to information gaps and scientific uncertainty.

The National Exotic Forest Description database and Land Cover Database continue to be used for projecting forest sink carbon dioxide removals until the NZCAS becomes operational. The NEFD database was designed to forecast future wood supply, not for forest carbon accounting purposes. Much of the information required for carbon accounting purposes is currently unavailable. The NEFD describes the pre-1990 forests, where the ownership is dominated by

larger forest growers' forests well. NEFD information on the plantation forests established since 1992 by a large number of smaller-scale forest owners is of poorer quality.

With funding confirmed for the further development of the NZCAS in August 2005, the Ministry of the Environment commenced implementing the NZCAS during the 2005/06 year. The NZCAS is being designed to provide robust land use, land-use change and forestry sector inventory data specifically for Kyoto carbon accounting purposes. This is a long-term, large-scale project that will take some years before being fully operational. In protest over Government's climate change policies, forest owners currently have a ban on the installation of forest carbon inventory plots in their forests. This has delayed the implementation of some NZCAS work streams. Delays in implementing the NZCAS will mean that it will take longer to reduce the uncertainty of some elements of estimating and projecting land use, land-use change and forestry carbon dioxide removals and emissions.

There is still scant information on forest carbon stocks and fluxes in New Zealand's 6.5 million hectares of indigenous forest and 2.6 million hectares of shrubland.

5.7 Accounting for Article 3.4 forest management

Under Article 3.4 of the Kyoto Protocol, New Zealand has until 2007 to elect which additional Article 3.4 land use, land-use change and forestry activities, if any, it wishes to account for in the first commitment period. The election of these activities is voluntary for Annex I parties. Forest management is one such activity and would include accounting for emissions and removals from forests not eligible under Article 3.3 over the first commitment period. The Government has agreed in principle not to account for these activities in the first commitment period. However, a final decision will not be made until closer to 2007, when further information is available.

At present, there is considerable uncertainty in the data on carbon stocks and carbon stock changes for forest land. The available data suggest that carbon stocks are likely to be in a steady state or a slight decline. An assessment of the significance to New Zealand of Article 3.4 forest management activities concluded that the balance lay somewhere between -92 Mt CO_2-e to 11 Mt CO_2-e over the first commitment period. New Zealand is also subject to a cap of 1.0 million tonnes carbon (equivalent to 3.67 million tonnes carbon dioxide equivalent) for Article 3.4 forest management activities during the first commitment period.

Whether New Zealand will be obliged to account for such activities in subsequent commitment periods is a matter for future international negotiations. If New Zealand is obliged to account for pre-1990 forests and these forests are in fact losing carbon, then this would add to New Zealand's emissions liabilities.

6 Reconciliation with the 2005 projection

Table 9 compares the net position from May 2005, the interim update to the net position reported in the Crown Financial Statements since December 2005, and the current May 2006 net position.

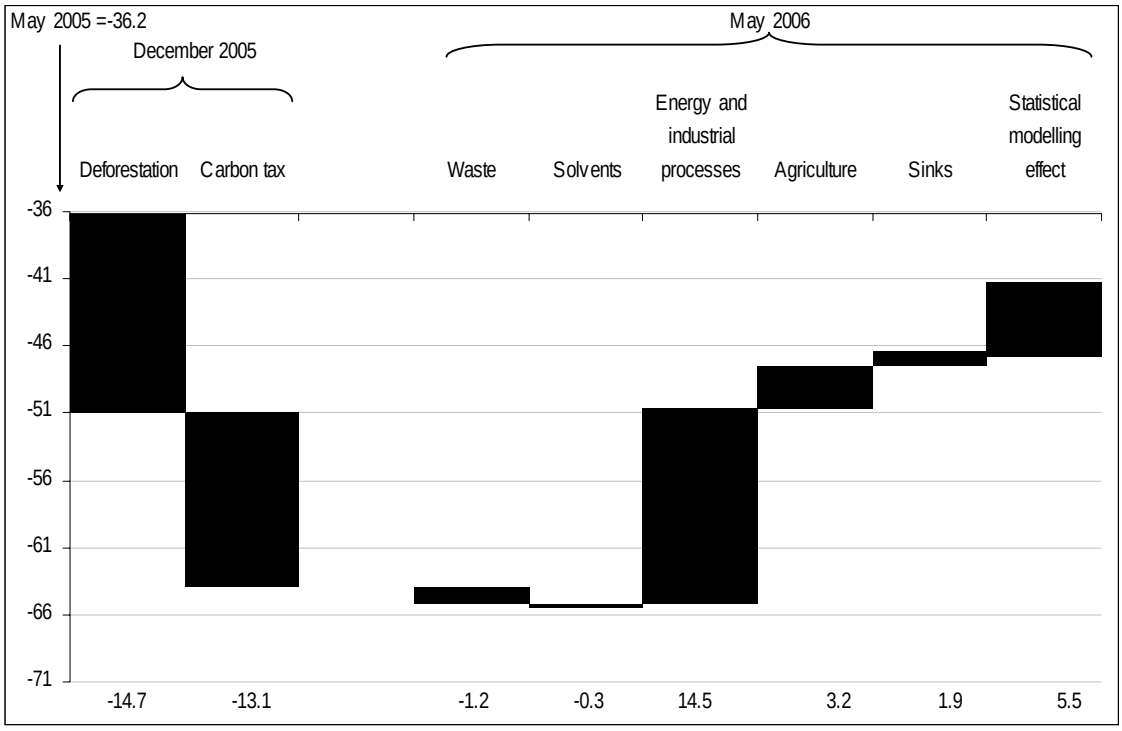
Table 9: Reconciliation of previous projections of the most likely balance of emissions units (Million tonnes carbon dioxide equivalent)

		May 2006	December Change	December 2005	Change	May 2005
Projected Emissions						
a. Projected aggregate emissions		**398.5**	**-16.3**	**414.8**	**13.1**	**401.7**
Energy (excluding transport)		91.3				
Transport		78.8				
Industrial processes		22.9				
Energy (including transport) and industrial processes		**193.0**	**-14.5**	**207.5**	**13.1**	**194.4**
Solvent and other product use		0.3	0.3	0.0		0.0
Agriculture		198.8	-3.2	202.0		202.0
Waste		6.5	1.2	5.3		5.3
b. Assigned Amount Units	**AAUs**	**307.6**	**0.0**	**307.6**		**307.6**
c. Emissions to be covered (b-a)		-90.9	16.3	-107.2	-13.1	-94.1
Projection of Removal Units						
d. Removals via forests		78.2	1.0	77.2		77.2
e. Deforestation emissions		21.0	0.0	21.0	14.7	6.3
f. Net Removals via forests (d-e)	**RMUs**	**57.2**	**1.0**	**56.2**	**-14.7**	**70.9**
g. Balance (f-c)		-33.7	17.3	-51.0		-23.2
h. AAUs allocated to Projects to Reduce Emissions		7.5		7.5		7.5
Statistical discrepancy		0.0	5.5	-5.5		-5.5
Balance of units (g-h)		**-41.2**	**22.8**	**-64.0**	**27.8**	**-36.2**

Note: One emissions unit is equivalent to one tonne of greenhouse gas emissions converted to carbon dioxide equivalents by the global warming potential.
Note: Net removals via forests offset emissions and reduce the deficit on the net position.

Emissions projections in some sectors are higher while other sectors are lower; however the net effect is that emissions are projected to be lower during the first commitment period than reported in the Crown Financial Statements since December 2005. Chart 10 tracks the changes to the net position by component and shows how changes in each component have impacted on the final net position value since the May 2005 net position report. Chart 10 also shows the change to the net position made in the December 2005 interim update in the Crown Financial Statements, and shows how the net position has changed through to the May 2006 net position report.

Chart 10: Changes to the net position by sector (Million tonnes carbon dioxide equivalent)



6.1 December 2005 net position

Deforestation emissions

For the May 2005 net position report the historic rate of deforestation of 6.3 Mt CO_2-e was used for the most likely scenario. A structured survey of forestry companies' deforestation intentions was completed in late 2005 which projected emissions during the first commitment period could be as high as 38.5 Mt CO_2-e. In December 2005, the Crown Financial Statements were updated to reflect the capped value of the Crown's liability of 21 Mt CO_2-e. This increased emissions relative to the May 2005 net position report by 14.7 Mt CO_2-e. For the 2006 projection of the net position the deforestation cap value of 21.0 Mt CO_2-e is retained.

Carbon tax

The decision not to proceed with the proposed carbon tax added approximately 13.1 million units to the net position and was based on SADEM model results from the Ministry for Economic Development. The Crown Financial Statements were updated in December 2005 when the Government announced it would no longer proceed with implementing a carbon tax.

6.2 May 2006 net position

Energy and industrial processes

As discussed in section 4.2, emissions projections for energy, transport and industrial processes were only provided as an aggregate result for these emissions projections in May 2005. The 2006 net position report provides separate projections for energy (excluding transport), transport and industrial processes for the first time. This will enable future net position reports to provide more disaggregated explanations of year-on-year changes in emissions projections.

Emissions from energy (including transport) plus industrial processes are projected to be lower than reported in December 2005 by 14.5 million tonnes carbon dioxide equivalent during the first commitment period. The reduction in emissions from the energy and industrial processes sectors is largely attributable to:

- higher energy prices, even without the carbon tax
- refined energy modelling with SADEM.

For the May 2005 net position report a $15 per tonne carbon tax was assumed to apply to carbon dioxide emissions from fossil fuel combustion from 2007. Coal and oil price assumptions were significantly lower in the May 2005 net position report compared with this report. Oil prices were assumed to be around $US35.00 per barrel and coal prices were assumed to be around $NZ3.75 per gigajoule over the projection period. Expectations of higher energy prices have been assumed for the May 2006 net position report. Oil prices are now assumed to be $US60.00 per barrel and coal prices $NZ4.20 per gigajoule during the first commitment period. This is equivalent to a price increase for carbon dioxide emissions due to higher oil and coal prices of roughly $NZ150.00 and $NZ7.00 per tonne of carbon dioxide, respectively, compared to the price assumptions in the May 2005 net position report. Overall energy prices to end users are assumed to be significantly higher in 2006, compared to 2005 even without the carbon tax being applied.

The Ministry of Economic Development has also undertaken significant refinement of its SADEM model for the 2006 Energy Outlook due in mid-2006, such as refining the estimated demand for energy by heavy industry. This will impact on the projections of emissions from energy, transport and industrial processes during the first commitment period, however the effects of all these refinements cannot be quantified.

Agriculture

Emissions from agriculture are projected to be lower in 2006 compared to 2005 projections by 3.2 million tonnes carbon dioxide equivalent. In line with IPCC good practice and new research the emissions factor for nitrous oxide from agricultural soil was revised from 1.25 percent to 1.00 percent. Previous projections of nitrogen fertiliser application were based on a simple average of industry expectations and a linear extrapolation. The projection methodology for nitrogen fertiliser has been refined and nitrogen application projections are now linked to Ministry of Agriculture and Forestry's livestock projections. This change in methodology resulted in projected nitrogen application decreasing from 421,000 tonnes nitrogen to 403,709 tonnes. As a result the combined effect of these changes was that emissions of nitrous oxide from soils are lower compared to projections included in the May 2005 net position report.

There have been small changes in the projected numbers of livestock and the emissions methodology has been improved for livestock excreta, however, the impact on the net position has been small.

Solvents and other products use

For this year a projection for this sector was included for completeness. This sector contributes less than 0.1 percent of total emissions; however, a simple projection for this sector was included and contributed an additional 0.3 million tonnes carbon dioxide equivalent to New Zealand's projected emissions during the first commitment period.

Waste

Waste emissions are projected to be higher than previously projected by 1.2 Mt CO_2-e due to a number of model refinements, revisions to assumptions and recalculations. Some of the improvements this year include:

- revisions to projections of municipal solid waste per person per day and this increased emissions marginally because more solid waste is going to landfill
- population projections were revised to be consistent with projections used in other sectors as recommended by the AEA Technology review of the 2005 net position report
- the methodology for projecting methane recovery was recalculated
- the forecast impact of the waste strategy was recalculated.

Removals by sinks

Removals of carbon dioxide by forest sinks are approximately 1.0 million tonnes higher this year compared with the 2005 net position report because of changes to assumptions and the use of the latest information from the National Exotic Forest Description.

Statistical discrepancy

For the 2005 net position report, the mean of the distribution of results was used as the final estimate of the net position. The mean of the results from the repeated sampling was higher than the simple summation of the most likely estimate of emissions and removals. The use of the repeated sampling and the reporting of the mean has caused some confusion among readers. The 2006 net position report now calculates the most likely estimate as the simple summation of each most likely projection by sector. The repeated sampling was still used, however, to provide the 95 percent confidence interval for the upper and lower scenario. The use of the mean of the repeated sampling as opposed to the simple summation of most likely projection in each sector decreases the deficit by 5.5 million units relative to the 2005 net position. The repeated sampling in 2005 increased the net position by 5.5 million units relative to a simple summation of all the most likely estimates because there was more uncertainty in the upper range than lower range. If this method were applied for the 2006 report to obtain the most likely estimate of the net position it would likely reduce the deficit on the net position because there is more uncertainty in the lower range.

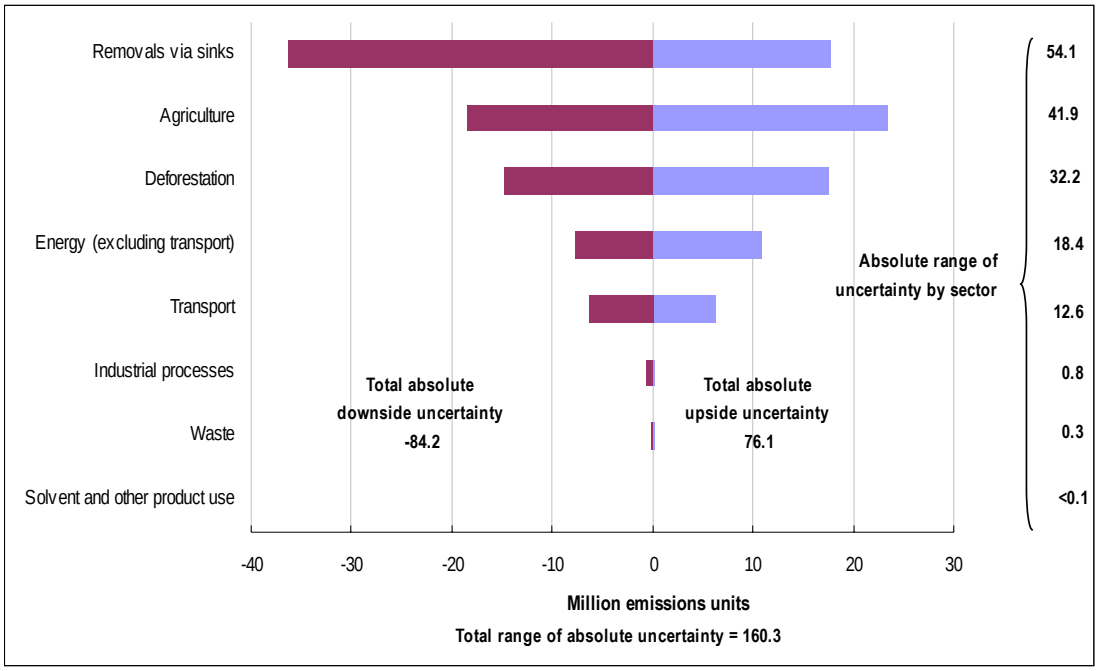
6.3 Accounting for uncertainty

Chart 11 shows the relative contribution of each component of the net position makes to the total level of uncertainty in the net position. The contribution to total uncertainty by each component is related to the overall magnitude of the component in the calculation of the net position as well as the level of variability considered in the projection. Small sources of emissions such as industrial processes do not make a significant impact on overall uncertainty around the net position. The negative range of values indicate more downside uncertainty (optimism) on the deficit of the net position than upside uncertainty (pessimism).

If all upper and lower scenarios were combined without the repeated sampling technique the absolute uncertainty range would be 160.3 million tonnes carbon dioxide equivalent compared to the current range from the repeated sampling technique of 77.5 million tonnes. Uncertainty due to net removals of greenhouse gas emissions by sinks is the greatest, with a range between the upper and lower scenarios of 54.1 million tonnes carbon dioxide.

If all the upper and lower results were simply summed the range of uncertainty would be implausibly high. The method of simulating the range of uncertainty by the repeated sampling technique provides a more plausible confidence interval around the most likely value of the net position.

Chart 11: Uncertainty ranges for impact on net position by component (Million tonnes carbon dioxide equivalent relative to the most likely scenarios)

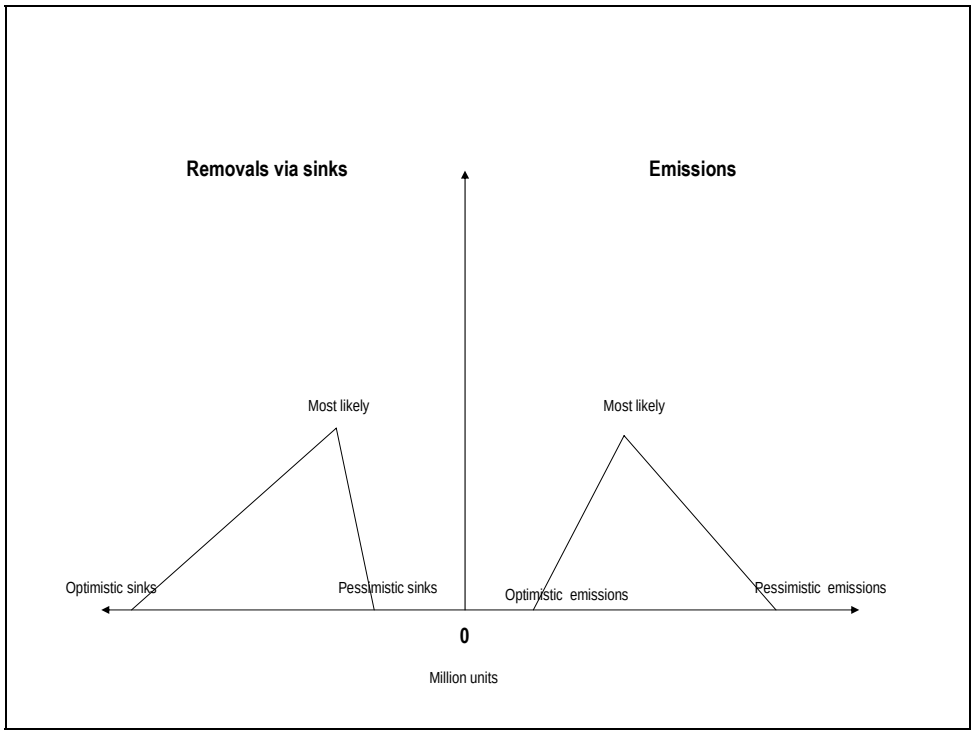


Explanation of the repeated sampling technique

Figure 1 has been provided to help explain how the repeated sampling technique works. A triangular distribution is used to approximate the distribution of possible results for emissions by each sector and removals of emissions via forest sinks. The base of the triangular distribution is set at the lower and upper results and the mode of the triangular distribution (the peak of the triangle) is set at the most likely value of the projection result. Repeated samples (50,000) are drawn from each distribution and the net position is calculated each time. With so

many samples drawn and the net position calculated so many times an approximate normal distribution curve (bell shaped curve such as Chart 1) is obtained. From this distribution the 95 percent confidence interval for the upper and lower range is obtained.

Figure 1: Representative fitting of triangular distributions



7 Conclusions

This report has updated New Zealand's projected quantity of emissions and removals of greenhouse gases during the first commitment period (2008-2012) of the Kyoto Protocol for 2006. The net position report provides New Zealanders with an indication, using best available information at the time of projection, on how New Zealand is heading towards meeting its responsibilities under the Kyoto Protocol.

The net position is now projected to be a deficit of 41.2 million units during the first commitment period of the Kyoto Protocol (2008-2012). This compares with a projected deficit reported in May 2005 of 36.2 million units and a deficit of 64.0 million units reported on the Crown Financial Statements since December 2005.

The projections reported in this document reflect the Government's decision not to proceed with the previously announced carbon tax in December 2005, but do not reflect any impact from the new work programmes being considered by the Government at the time of publication. The projections therefore reflect the climate change policy settings in place at the end of 2005.

The report was compiled using sectoral projections from across Government. Agricultural and forest sink projections are provided by the Ministry of Agriculture and Forestry, energy and industrial processes projections are from the Ministry of Economic Development and waste projections are from the Ministry for the Environment. The Ministry for the Environment combines the sectoral projections to create the projected balance of units over the first commitment period of the Kyoto Protocol.

Key sources of change in the net position since May 2005 have been due to:

- The recent phenomenon of deforesting plantation forest, where plantation forest land has been converted to alternative land uses, particularly pastoral grazing. Historically there has been little plantation deforestation. This has increased the projected deficit on the net position.

- The decision not to proceed with the carbon tax which was reported in the Crown Financial Statements (December 2005) as an increase in the deficit on the net position based on an estimate of the impact of the carbon tax. In 2006 higher energy price assumptions (particularly for oil) has reduced the projected deficit on the net position.

- The revision of the methodology for calculating nitrous oxide emissions following IPCC good practice guidelines. Application of nitrogenous fertiliser has been a growing source of emissions and this revision to the methodology for calculating emissions coupled with a change in the projection methodology for nitrogen fertiliser application has reduced projected agriculture emissions and therefore the projected deficit on the net position.

There is still a great deal of uncertainty as to what the final balance of units or net position will be during the first commitment period. The Government's climate change policy is continuing to develop following the conclusion of the 2005 review. It will not be until 2015 when the national greenhouse gas inventory covering the first commitment period of the Kyoto Protocol is submitted to the United Nations Framework Convention for Climate Change, when we will actually know the true value of the net position. The uncertainty range in this report is large, with an upper deficit of 77.5 million units and a lower projection of a surplus of 1.4 million units. The most significant source of uncertainty is attributable to the values used for forest

sinks; this will continue to be the case until the New Zealand Carbon Accounting System becomes operational.

The update was based on current information as well as updated assumptions regarding economic growth, population growth and oil prices as at May 2006. Officials from across Government will continue to monitor New Zealand's progress toward meeting its Kyoto Protocol responsibilities. The projected net position is likely to be revised as new knowledge becomes available, there are material changes in assumptions used (such as oil prices), new policies are implemented and the situation of the nation evolves over time.

Officials from across Government will continue to work towards improving the robustness of the projections methodology and anticipate that the next net position report to the Minister Responsible for Climate Change Issues will be delivered in May 2007.

8 References

AEA Technology, 2005, *Review of New Zealand's Net Position*, Final Report to the Ministry for the Environment, October 2005, London.

Clark, H.; Brookes, I. and Walcroft, A. 2003, *Enteric Methane Emissions for New Zealand Ruminants 1990-2001 Calculated using an IPCC Tier Two Approach.* Report prepared for the Ministry of Agriculture and Forestry by AgResearch Ltd.

Ensis, 2006, *Net Carbon Uptake Projections (2008-12) Land Use, Land-Use Change and Forestry,* Wakelin, S., Paul, T., Beets, P., and Kimberley, M., Client report for Ministry of Agriculture and Forestry, Rotorua.

IPCC, 1995, C*limate Change 1995: The Science of Climate Change. Contribution of Working Group I to the Second Assessment of the Intergovernmental Panel on Climate Change*. JT Houghton, LG Meira Filho, BA Callender, N Harris, A Kattenberg and K Maskell (Eds). Cambridge University Press, UK. pp 572.

IPCC, 2000, *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. J Penman, D Kruger, I Galbally, T Hiraishi, B Nines, S Emmanul, L Buendia, R Hoppaus, T Martinsen, J Meijer, K Miwa and K Tanabe (Eds) IPCC National Greenhouse Gas Inventories Programme. Published for the IPCC by the Institute for Global Environmental Strategies, Japan.

Ministry of Agriculture and Forestry, 2006, *Briefing on Methodology for Forecasting Livestock Numbers and Nitrogen Fertiliser* Use. 8pp.

MfE, 2002. *The New Zealand Waste Strategy: Towards zero waste and a sustainable New Zealand.* Ministry for the Environment ISBN: 0-478-24051-1, ME number: 422. This document is available on the Ministry for the Environment's website: www.mfe.govt.nz.

MfE, 2004. *Proposed National Environmental Standard to Control Greenhouse Gas Emissions from Landfills Resource Management Act Section 32*. Ministry for the Environment. ISBN: 0-478-18936-2 ME number: 515. This document is available on the Ministry for the Environment's website: www.mfe.govt.nz.

MfE, 2006. *National inventory of greenhouse gas emissions and removals (in press). Submitted to the United Nations Framework Convention on Climate Change* 13 April 2006. Ministry for the Environment, Wellington.

NZIER, 2005, *Clover Root Weevil, Economic Impact Assessment,* Report to Biosecurity New Zealand, Ministry of Agriculture and Forestry, Wellington.

Tonkin and Taylor, 2002, *Assessment of Greenhouse Gas Emissions from Waste Disposal as a Result of Implementation of the Proposed New Zealand Waste Strategy*; Report to Ministry for the Environment.

UNFCCC, 1998, *Kyoto Protocol to the United Nations Framework Convention for Climate Change*, UN, Bonn.

Waste Management 2005, *Landfill Methane Recovery Estimate for Updating the National Greenhouse Gas Inventory from the Waste Sector – Solid Waste Disposal Site*s, Report to the Ministry for the Environment, June 2005, Wellington.

Appendix A: Methodology report for agriculture projections as provided by the Ministry of Agriculture and Forestry

Projected emissions from the agriculture sector over the first commitment period (2008-2012)

Table A1: Summary of emission projection scenarios

	1990		2010	
	Baseline	Lower scenario	Most likely	Upper scenario
	*Mt CO_2-e	Mt CO_2-e	Mt CO_2-e	Mt CO_2-e
Total projected emissions	32.117	36.059	39.756	44.447
Projected emissions above 1990		3.942	7.639	12.331
Percent change from 1990		12.3	23.8	38.4
Methane total	22.159	23.694	25.971	28.798
Nitrous Oxide total	9.958	12.365	13.785	15.649

Figures based on 2004 national greenhouse gas inventory methodology
*Million tonnes carbon dioxide equivalents

a. Summary

Emissions from the agriculture sector are projected to range from 180.29 Mt CO_2-e to 222.24 Mt CO_2-e over the first commitment period (2008-2012) with a most likely value of 198.78 Mt CO_2-e. Average annual emissions over the first commitment period are projected to range from 36.06 Mt CO_2-e to 44.45 Mt CO_2-e with a most likely value of 39.76 Mt CO_2-e.

The most likely value for annual emissions at 2010 is 0.64 Mt CO_2-e lower than projected in 2005. This small decrease is attributed to a decrease in the emission factor for nitrogen fertiliser. There has also been a significant increase in the range between the upper and lower projection scenarios. The difference is now 8.4 Mt CO_2-e compared to 3.5 Mt CO_2-e in the 2005 estimate. This is due to the use of a new methodology for calculating the uncertainty in projected animal numbers and the use of a new econometric model to project future nitrogen fertiliser use.

b. Introduction

These projections are based on the methodology used in the New Zealand national greenhouse gas inventory submitted to the United Nations Framework Convention on Climate Change (UNFCCC) annually and on econometric models developed by the Ministry of Agriculture and Forestry (MAF). The inventory methodology conforms to the Good Practice Guidance methodologies developed by the Intergovernmental Panel on Climate Change and adopted by the UNFCCC.

Projections are driven by future estimates of:

- animal numbers by species: dairy cattle, beef cattle, sheep and deer in 2010 using the MAF Pastoral Supply Response Model (PSRM)
- enteric methane emissions per animal based on changes in past emissions per animal between 1990 and 2004
- nitrogen output per animal based on changes in past nitrogen output per animal between 1990 and 2004
- nitrogen fertiliser use based on an econometric model projecting future use using projected animal numbers.

Two further scenarios of projected emissions in 2010 have also been produced. These represent emission estimates using the upper and lower bounds of methane and nitrous oxide emission factors and animal numbers.

c. Changes in methodology since last year's assessment

Changes in the methodology have been instigated to take into account new approaches and information obtained since the last update in May 2005.

Changes were implemented in four areas:

- no post-model adjustments of land area change were incorporated into the projected animal numbers that were derived from the PSRM model
- a new methodology was implemented for upper and lower scenario values for animal numbers
- the projections of nitrogen fertiliser usage in 2010 was based on a new methodology developed by MAF
- updating of the national greenhouse gas inventory methodology in keeping with UNFCCC requirements for maintaining "good practice".

The national greenhouse gas inventory implemented two changes in the agricultural sector inventory in 2006, reporting on the 2004 emission levels. These were:

- decreasing the emission factor for nitrous oxide of nitrogen fertiliser applied to agricultural soils from 1.25 percent to 1 percent, and
- implementing a new "Tier 2" system for accounting for methane emissions from waste produced by ruminant animals.

The above changes have resulted in an increase in the difference between the upper and lower scenarios.

d. Development of the most likely scenario

i. Projection of most likely animal population in 2010

The PSRM is used to project animal numbers. The PSRM is currently used for livestock projections that contribute to the Treasury's economic and fiscal updates twice yearly. It is a system of equations that capture the biological and market behaviours of the New Zealand pastoral sectors (dairy, beef, sheep, and deer). Changes in livestock inventory are derived from exogenous shocks to the model that includes real farm-gate prices and weather.

Baseline scenario

The MAF livestock forecasts provide farm-gate price forecasts out to 2014. These forecasts take into account the macro-economic assumptions (eg, economic growth, exchange rate, inflation) provided by Treasury's Half Yearly Economic and Fiscal Update in December 2005 and the international supply and demand factors which subsequently affect international commodity prices.

The weather variable in the PSRM uses the Daily Soil Moisture Deficit (DSMD) series supplied by National Institute of Water and Atmospheric Research. For the forecast period (2006-2020), DSMD uses the average value over the 1973-2005 period.

The price assumptions are exogenous in the PSRM. Information from experts in the forestry sector suggests that land conversion only marginally impacts the pastoral sectors. Therefore, any land use changes in the forecast period are assumed to be captured by the residuals (errors) of the forecasts.

Table A2: Projected most likely animal numbers in 2010

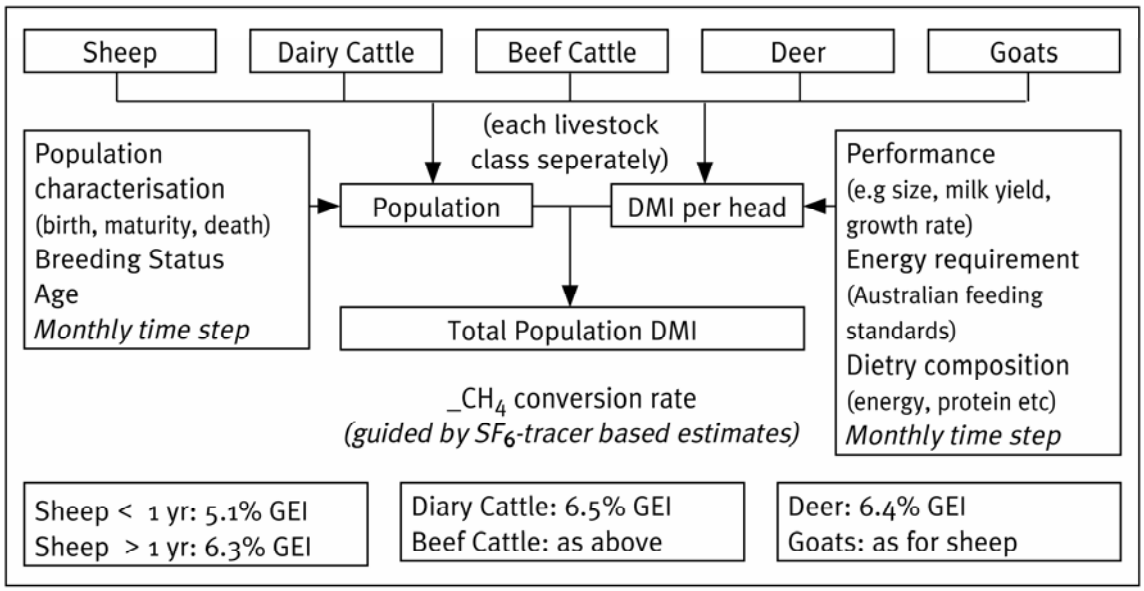
	1990 baseline (000)	2010 most likely scenario (000)
Dairy cattle	3,391	5,526
Beef cattle	4,597	4,076
Sheep	57,861	39,736
Deer	1,036	1,448

ii. Projections of enteric methane emissions

Projections of methane emissions per animal in 2010 are derived from linear trends of the methane emissions per animal using data in the national greenhouse gas inventory from per animal emissions from 1990 to 2004 extrapolated to 2010.

These per-animal emissions have been derived from the model developed by Clark *et al* (2003) that is used to estimate methane emissions in the national inventory (Figure A1).

Figure A1: Model for deriving methane emissions (Clark *et al*, 2003)



The model determines animal feed intakes in monthly time steps for age classes of each animal species based on the mean national animal performance derived from national statistics relevant to each species. For example, dairy cattle inputs include: animal liveweight, total milk production and milk fat and protein percentages. For each animal species, an empirical relationship has been derived for the amount of enteric methane produced per unit of feed intake. These relationships have been developed in New Zealand for: deer, beef and dairy cattle, and sheep guided by the SF_6 technique that enables assessment of methane emissions in the field. The estimated annual methane emissions per animal take into account changes in animal performance over time.

The estimated methane emission factors for each of the species in 1990, 2010 and the correlations of the trend over time from 1990 to 2004 used to derive the projected value are presented below.

Table A3: Projected most likely methane emission per animal in 2010

	1990 (kg/methane/head/annum)	**2010 Projected** (kg/methane/head/annum)	**Correlation (r)** 1990 to 2004
Dairy cattle	70.8	83.4	0.963
Beef cattle	51.0	58.9	0.929
Sheep	8.9	11.6	0.996
Deer	21.0	23.4	0.864

iii. Methane from ruminant animal waste

Methane emissions also arise from faecal material deposited on pasture and, in the case of lactating dairy cows, from animal waste management systems (effluent ponds).

Table A4: Projected most likely methane emissions from animal waste in 2010

	1990 (kg/methane/head/annum)	2010 Projected (kg/methane/head/annum)	Correlation 1990 to 2004
Dairy cattle	2.93	3.47	0.977
Beef cattle	0.65	0.75	0.925
Sheep	0.09	0.12	0.997
Deer	0.20	0.22	0.865

iv. Projections of nitrous oxide emissions

Nitrous oxide emissions are derived from animal nitrogen output. This is a function of animal feed intake and nitrogen content of the pasture eaten minus any nitrogen stored in animal product. Models developed by Clark *et al* (2003) for methane emissions also estimate nitrogen output per animal. Projections of nitrogen output per animal in 2010 are derived from linear trends of nitrogen outputs per animal using data in the national inventory for the period 1990 to 2004. Nitrous oxide emissions are then calculated using the methodology used for the national inventory.

Table A5: Projections of most likely nitrogen output per animal in 2010

	1990 (kg/N/head/annum)	2010 Projected (kg/N/head/annum)	Correlation 1990 – 2004
Dairy cattle	106.2	122.1	0.955
Beef cattle	65.2	76.1	0.927
Sheep	12.2	15.9	0.995
Deer	27.4	30.6	0.871

v. Projections of nitrogen fertiliser use

A new method of projecting nitrogen fertiliser use was developed for this round of projections. In order to select the best-practice model for forecasting nitrogen fertiliser use, the consistency between the forecast for nitrogen fertiliser and livestock number forecasts was considered. In the empirical nitrogen model, the nitrogen use series was inserted into the PSRM model and livestock forecasts used to derive the nitrogen use forecast.

Empirical model

After investigating the impact of many different variables on nitrogen usage, the main drivers of nitrogen usage were found to be the number of dairy animals. Information from industry supports this conclusion. In 2005 average nitrogen fertilizer application on dairy farms was

140kg/ha whereas on sheep and beef farms, an average of 12kg/ha was used. Also, from the 2004 Agricultural Production Survey, 66 percent of urea was applied to farms defined as solely dairy.

The projected most likely value for nitrogen usage in 2010 was **403,709** tonnes.

vi. Other animal species and greenhouse gas sources

No projections were derived for the emissions of minor animal species present in the national inventory, ie, horses, goats, pigs, and poultry. This was also the case for nitrous oxide emissions from crop stubble burning, savannah burning and nitrogen fixing crops. These emission sources make up less that 4 percent of the agricultural sector emissions. There was no basis to assume that any of these emission sources would be significantly different from the present levels. The impact of even large changes in any of these small emission sources on total national emissions would be small and so 2004 inventory emission levels were used for 2010 projections.

e. Development of lower and upper scenarios

Two further scenarios were developed: an upper and lower scenario. The upper scenario combined the upper 95 percent confidence interval values for animal numbers, methane emission per head, nitrogen output per head and nitrogen fertiliser use. The lower scenario combined the lower 95 percent confidence interval values for animal numbers, methane emission per head, nitrogen output per head and nitrogen fertiliser use. These two scenarios give an estimate of the upper and lower bounds of future projected emissions.

i. Animal numbers

To derive livestock forecasts for different scenarios, exogenous price uncertainty is introduced into the PRSM model. Price uncertainty is introduced into the simulation through specifying the possible movements in commodity prices for the forecast period. Variation of prices (or standard deviation of the 95 percent confidence interval) during the last ten-year period for each price series is used. This gave estimations for the upper and lower bounds of the stochastic forecasts that could be considered as upper and lower scenarios due to the movement in prices.

Table A6: Lower and upper scenarios of animal number projections in 2010

	Lower 2010 (000)	Most Likely 2010 (000)	Upper 2010 (000)
Dairy cattle	5,281	5,526	5,813
Beef cattle	3,502	4,076	4,761
Sheep	37,349	39,736	43,106
Deer	1,095	1,448	1,871

ii. Methane emissions

Upper and lower estimates of methane emissions per animal were obtained from the 95 percent confidence interval for the linear regression of emissions from 1990 to 2004. This gave an upper and lower bound for projected methane emissions per head in 2010.

Table A7: Lower and upper scenarios of per-animal methane projections to 2010

	Lower 2010 ($kgCH_4$/head/annum)	Most Likely 2010 ($kgCH_4$/head/annum)	Upper 2010 ($kgCH_4$/head/annum)
Dairy cattle	82.0	83.4	84.8
Beef cattle	57.7	58.9	60.0
Sheep	11.5	11.6	11.7
Deer	22.7	23.4	24.2

iii. Nitrogen output

Upper and lower estimates of nitrogen output per animal were obtained from the 95 percent confidence interval for the linear regression of emissions from 1990 to 2004. This provided an upper and lower bound for projected methane emission per head in 2010.

Table A8: Lower and upper scenarios of per-animal nitrogen output projections to 2010

	Lower 2010 (kgN/head/annum)	Most Likely 2010 (kgN/head/annum)	Upper 2010 (kgN/head/annum)
Dairy cattle	120.1	122.1	124.0
Beef cattle	74.6	76.1	77.6
Sheep	15.8	15.9	16.1
Deer	29.5	30.6	31.5

iv. Nitrogen Fertiliser

Upper and Lower scenarios for future nitrogen fertiliser use were obtained from the upper and lower projections of dairy animal numbers derived within the PSRM model.

Table A9: Lower and upper bounds of projected nitrogen fertiliser use in 2010

Lower 2010 Tonnes N per annum	Most likely 2010 Tonnes N per annum	Upper 2010 Tonnes N per annum
299,659	403,709	541,707

f. Overall assumptions and limitations of projections

The projections need to be assessed within the uncertainties of biological systems and economic circumstances of the agricultural industry, which is largely driven by overseas markets. For example, an assumption implicit in the projections is that the rate of increase in productivity per animal over the next 6 years will not be dissimilar to the rate of increase in animal performance over the past 14 years, and therefore a linear extrapolation of methane emissions per animal is appropriate. It is possible that the rate of increase in animal performance may decline over time and to test this other non-linear relationships were looked at; however, no improvement in relationship was gained.

Mitigation technologies that reduce emissions at an individual animal level may emerge over the next six years. These include products such as Monensin, a bloat control agent that has been show to reduce methane emissions, or the widespread adoption of the nitrification inhibitor, DCD that has also been shown to reduce nitrous oxide emissions. None of these mitigation technologies has been factored into the projections as it is believed that they may be counter balanced by improvement in animal productivity growth. Industry strategy plans, particularly the dairy industry, are seeking productivity that is, however, higher than that achieved over the last 14 years ie, since 1990. There is also considerable uncertainty around the level of adoption of potential mitigation technologies.

In terms of nitrogen fertiliser usage, future changes such as limitations on nitrogen use in some catchments, ie, Lake Taupo and Lake Rotorua, the continuing conversion of pastoral land to forestry, the Dairying Clean Streams Accord, Regional Council initiatives, industry policies on good fertiliser practice, are likely to limit the steep upward trend in fertiliser nitrogen use apparent in recent years.

On the other hand, a pest found in New Zealand in 1996 has been reducing the nitrogen fixation in clover, New Zealand's main source of nitrogen for pasture. The response of affected farmers has been to increase the use of nitrogen fertiliser and increase feed supplements. An economic impact assessment (NZIER, 2005) determined that under a medium-impact scenario, the clover root weevil increased greenhouse gas emissions by 0.92 Mt CO_2-e during the first commitment period. With the revised emission factor for nitrogen fertiliser, clover root weevil is expected to increase total emissions from nitrogen fertiliser by 0.74 Mt CO_2-e.

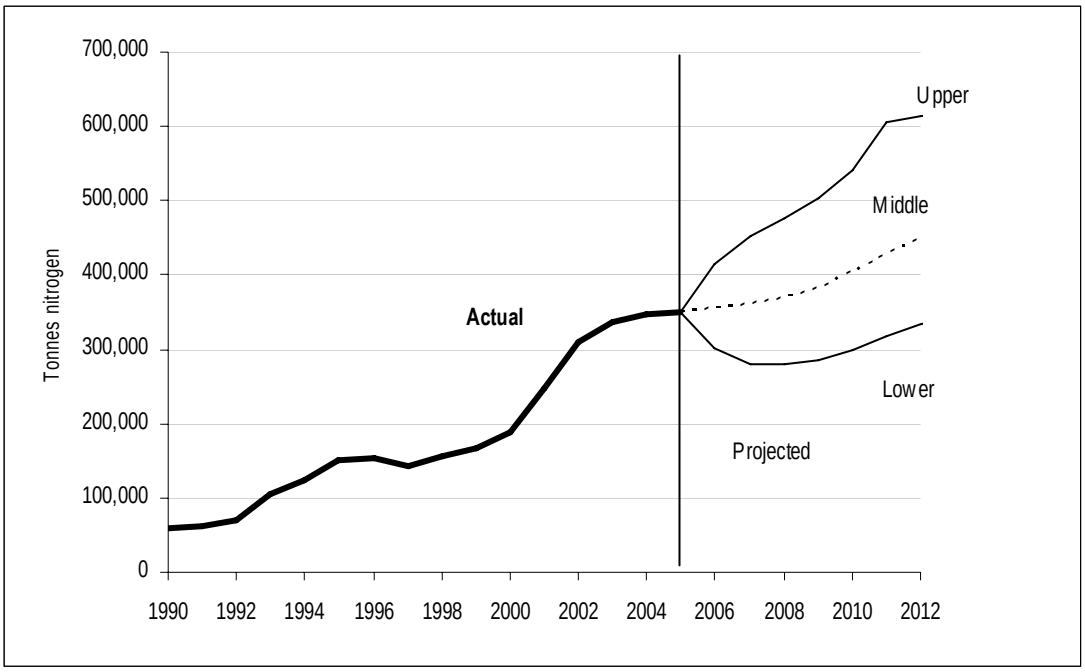
g. References

Clark, H.; Brookes, I. and Walcroft, A. 2003, Enteric methane emissions for New Zealand Ruminants 1990-2001 calculated using an IPCC Tier Two approach. Report prepared for the Ministry of Agriculture and Forestry by AgResearch Ltd.

Ministry of Agriculture and Forestry, 2006, Briefing on Methodology for Forecasting Livestock Numbers and Nitrogen Fertiliser Use. 8pp.

NZIER, 2005, Clover Root Weevil: Economic Impact Assessment. For Biosecurity New Zealand, Ministry of Agriculture and Forestry.

Figure two: Nitrogen use projections



Appendix B: Methodology report for forest sink projections as provided by the Ministry of Agriculture and Forestry

Projected removals from the land use, land-use change and forestry sector (2008-2012)

a. Introduction

This appendix provides forecast projections of carbon dioxide removals and emissions from New Zealand's land use, land-use change and forestry (LULUCF) sector. These projections are based on data and models used in the latest greenhouse gas (GHG) inventory submitted to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat on 13 April 2006.

The UNFCCC GHG inventory estimates New Zealand's GHG emissions and removals for the period 1990 to 2004. This report provides scenario-based forecasts (projections) of removals and emissions for the LULUCF sector for the period 2008 to 2012. The projections are based on the best available information as at May 2006.

Projected removals from the LULUCF sector are based on data and assumptions from the Ministry of Agriculture and Forestry (MAF) and the Ministry for the Environment (MfE). The carbon modelling was undertaken by Ensis (formerly Forest Research). The underpinning science incorporated in the forest carbon models used in these projections, along with scientific assumptions, come from work carried out by New Zealand's Crown Research Institutes, predominantly Ensis Research and Landcare Research.

Forecasting is a challenging task. Forecasts are greatly influenced by prevailing conditions and those that have existed over the last one to two years. As described below the economic and policy environment in which New Zealand forest owners have been operating has been changeable. This makes forecasting the future more uncertain than when a stable operating environment prevails.

In order to incorporate scientific uncertainty, knowledge gaps and the range of possible future outcomes (particularly for afforestation and deforestation), a scenario-based approach has been used. The scenarios presented are upper, base and lower. These scenarios are today's best attempt to cover the likely range of the major contributing factors to estimating LULUCF sector removals and emissions based on the current economic environment, policy settings, knowledge of land-use patterns, and the state of scientific knowledge.

b. Operating environment

The last three to four years have been difficult for the New Zealand forest-growing sector. A high exchange rate, increasing costs, particularly shipping costs, along with competitive and changing international markets have adversely affected forest growing profitability in New Zealand.

There has been the largest volume of forest sales since state forest privatisation in the late 1980s. New Zealand's two largest corporate forestry companies (Fletcher Challenge and Carter Holt Harvey) have both sold forests. In the case of Fletcher Challenge all forests were sold. The pattern of forest ownership is changing. With Weyerhaeuser announcing the sale of its Joint Venture Nelson forests and the recent sale of Carter Holt Harvey to the Rank Group, further changes are anticipated. Superannuation funds and timber investment management

organisations (TIMOs) have purchased large areas of plantation forests in New Zealand. TIMOs now own around 20 percent of the total planted forest area in New Zealand.

There is now greater separation between forest ownership and land ownership than has been the case historically. Land owners are looking to realise some of the increased land value through forest land sales. In some locations pastoral farmers are currently willing to pay higher prices for land than commercial forest owners.

The net result of all of these changes along with an uncertain future has led to:

- A major decline in the rate of afforestation. Afforestation has fallen from a 30-year annual average (1974 to 2004) of 43,000 ha to just 6,000 ha in the year to December 2005.
- The new phenomenon of deforestation where plantation forest land is converted to alternative land uses, particularly pastoral grazing. In the year ended March 2005, an estimated 7,000 hectares of deforestation occurred. This was predominantly in the Central North Island and Canterbury regions. Historically, little plantation deforestation has occurred.

On the policy side there has been strong opposition from the forest industry towards Government's climate change and forest policies. This is likely to have had both real and perceived impacts on forest growing investment decisions.

A climate change policy review was undertaken by the Government in the second half of 2005. While policy changes have been signalled, at this point climate change policy development is still underway. These forecasts do not account for future changes to climate change and forest policy settings; the projections are based on the prevailing policy settings as of the time of publication.

c. Forest model description

Projected forest sink removals were calculated using a simulation model of the Kyoto Forest estate. The model was based on a carbon yield table which describes the per-hectare carbon stock at each age for a typical Kyoto forest stand. To calculate the carbon stock in a given year, values in the yield table are multiplied by the net stocked forest area at the corresponding age, and then summed. The distribution of areas by age class is defined by the new planting rate – the simulation advances these areas through annual time periods (1990 to 2012). Net carbon uptake is calculated as the stock change in the first commitment period.

d. Projection results

Table 1 provides a breakdown of the major contributing factors on which the removal and emission forecasts are based.

Removals from the LULUCF sector for the period 2008 to 2012 are projected to be in the range of 60.4 Mt CO_2-e to 114.5 Mt CO_2-e. The base scenario is projected to be 78.2 Mt CO_2-e. Emissions from forecast deforestation for the period 2008 to 2012 are projected to be in the range of 6.3 Mt CO_2-e to 38.5 Mt CO_2-e. Current Government policy is to cap its liability for deforestation of pre-1990 forests at 21.0 Mt CO_2-e.

Table 1: LULUCF projected CO_2 removals and emissions (Mt) in CP1 (2008-2012)

Contributing factor	Upper scenario	Base scenario	Lower scenario
Total removals from simulations in combined model [1]	60.4	78.2	114.5
Less deforestation emissions	-38.5	-21.0 (cap)	-6.3
Removals less deforestation emissions	**21.9**	**57.2**	**108.2**
Removals based on afforestation only	**Upper scenario**	**Base scenario**	**Lower scenario**
Kyoto planted forest CO_2 removals (based on existing 675,000 ha)	95.4	95.4	95.4
Future afforestation (2006 to 2012) (0, 5k, 20k ha/yr)	0	1.2	2.7
Adjustment factors (see assumptions below for further details)			
Kyoto forest growth rates	-9.7	0	+29.5
Soil carbon change with afforestation	-9.5	-3.0	0
Ineligible planting	-20.3	-15.5	-7.7
Total removals from simulations in combined model [1]	**60.4**	**78.2**	**114.5**

1. The combined model results account for interrelationships between adjustment factors (growth rates, new planting, soil carbon changes, over planting, and scrub clearance during site preparation). The removals attributed to each factor are not additive, because some factors are correlated. For example, the impact of soil carbon decline due to afforestation is –3.0 Mt CO_2 under the base new planting assumption, but falls to –2.5 Mt CO_2 under the base over-planting scenario, because the area planted is reduced. Three separate simulations were run using all of the upper, base and lower assumptions respectively to produce the combined model results.

e. Assumptions

Future afforestation (plantations)

The average new planting rate over the last 30 years has been 43,000 hectares per year. In the period 1992 to 1998 new planting rates were high; during this period new planting averaged 69,000 hectares per year. Since 1998 new planting has declined. Afforestation in 2005 was 6,000 ha, down from 10,600 ha the year before and the lowest level since 1960.

Fig 1: New forest planting (1920 to 2005)

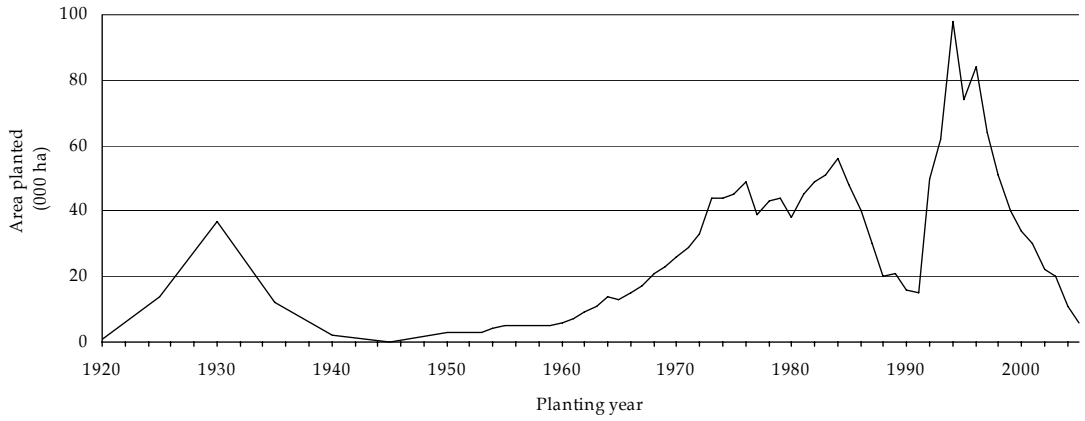


Table 2 below shows the afforestation rates used in the 2006 projections.

Table 2: Future plantation afforestation (hectares)

Calendar year	Upper	Base	Lower
2005(p)	6,000	6,000	6,000
2006	0	5,000	5,000
2007	0	5,000	10,000
2008	0	5,000	15,000
2009	0	5,000	20,000
2010	0	5,000	25,000
2011	0	5,000	30,000
2012	0	5,000	35,000
Average	**0**	**5,000**	**20,000**

P Provisional estimate for 2005

The upper scenario assumes no further afforestation occurs after 2005. The base scenario assumes annual afforestation of 5000 hectares. The lower scenario assumes average afforestation of 20,000 hectares per year between 2006 and 2012.

Growth rates (plantations)

The base scenario uses a national carbon yield table developed from the National Exotic Forest Description (NEFD) yield table database.

The NEFD yield tables better represent the growth of forests on traditional forestry sites. The generally held view is that post-1990 plantation stands have higher growth rates than earlier plantings.

Analysis of forest growth data suggests that fully stocked stands planted after 1990 show a 15-35 percent improvement in productivity over stands currently being harvested, as a result of genetic improvement, better site quality and improved forest management. The upper end of this range was used to develop the lower scenario, which is based on a growth model projection for pruned radiata pine growing on an ex-pasture site. Compared with the NEFD-based yield table, the lower yield table has:

- higher volume at maturity
- lower carbon for a given volume (trees on fertile ex-pasture sites have lower wood density and therefore carbon content)
- a higher rate of growth in the second half of the rotation.

The upper scenario yield table was set at 10 percent lower than the NEFD yield table. This assumed:

- no increase in volume productivity over stands currently harvested
- no reduction in wood density (and therefore carbon) due to ex-pasture sites
- the same pattern of growth as assumed by the NEFD derived yield table.

The growth rate scenarios are broadly indicative only. Accurate modelling of forest carbon removals requires representative sampling of the post-1990 forests. This will not be available until a representative plot network has been established and measured in New Zealand's Kyoto forests.

Soil carbon changes

Soil carbon levels are a function of climate, land use and soil type. Most pasture to radiata pine afforestation occurs on erodible hill country where soil properties are inherently variable, including that of soil carbon. Work is currently underway to improve New Zealand's approach to determining change in soil carbon with afforestation.

At present New Zealand uses two methods to estimate the change in soil carbon with afforestation.

The first estimation method is the New Zealand Soil Carbon Monitoring System (SCMS) – a model that uses historical soil data from the National Soils Database (NSD). These data are coupled with the key factors that influence soil carbon. The SCMS generates estimates of soil carbon change associated with afforestation as well as for a range of other land-use changes and the system has been described in peer-reviewed international journals. Recent scrutiny of the model predictions for localities where most of the pasture to radiata pine land-use change occurs, has led the developers and officials to suspect that the predicted soil carbon reduction associated with afforestation is overstated. The limited number of historic soil data in such localities (erodible hill-country) is the prime reason for these views. It is because of this issue that the estimate produced by the SCMS (a loss of 20±6 tC/ha) is considered to be the most pessimistic estimate of likely soil carbon change with afforestation.

The second means for estimating soil carbon change with afforestation analysis of the soil-paired plot database – a cache of purpose-collected data intended to be used as validation of the SCMS estimates. The difference between the estimate provided by these data (a loss of 4.7±2.9 tC/ha) and that derived from the SCMS provides a strong case for accepting the SCMS value as

the most pessimistic estimate. The specific nature of the data collected in those localities where afforestation takes place leads to the decision to call this estimate (a loss of 4.7± 2.9 tC/ha) the **base** value.

The soil-paired plot database, that provides an estimate of soil carbon loss of 4.7±2.6 tC/ha, contains several outliers, all of which indicate substantial carbon losses. If these outliers are excluded form the calculation of soil carbon change with afforestation the estimate becomes a gain of 0.2±2.5 tC/ha (95 percent confidence). For the purposes of this report, the lower scenario of soil C change with afforestation is accordingly considered to be 0 tC/ha.

Ineligible planting

Initial investigation has indicated that some plantation afforestation since 1990 may have occurred on land that, from a definitional perspective, already met the New Zealand Kyoto adopted forest definition. Under carbon accounting rules, any land planted after 1990 where the land was already "forest land" under the Kyoto forest definition, does not qualify as "Kyoto" forest.

The estimates of the proportion on "ineligible" exotic forests used in the 2005 net position report were 16 percent (base), 8 percent (lower) and 21 percent (upper).

The base and upper figures were based on the use of two national classifications to test the representativeness of a pilot mapping project in Nelson-Marlborough, in terms of post-exotic forest planted into possible forest land. The two sources of data were the 1987 Vegetation Cover Map and the 2001/02 Land Cover Database. Spatial intersection of these indicated the likely area of post-1990 forest planted into possible forest land being: nationally 16 percent; Marlborough region 21 percent; and the Gisborne region 15 percent. Some anecdotal information at the time suggested that the levels could be a low as 8-10 percent, and this was used for the lower figure. These estimates were made at a time when it had not been decided how New Zealand was going to interpret, and map, the Kyoto forest classes as defined in the Marrakech Accords (which defines the Kyoto forest definition).

Table 3: Percentage of existing forest (shrubland) ineligible under the Kyoto Protocol

	Upper	Base	Lower
Percentage of afforestation since 1990 planted onto shrublands that could meet NZ's Kyoto Forest definition	21%	16%	8%

Last year industry commentators expressed the view that the proportion of "ineligible" Kyoto forests was too high. However to date no further quantitative information has become available to provide improved estimates of the area of forest over-planting. In light of this, these projections use the 2005 scenarios again in 2006. Indications from further preliminary analysis suggest that the proportion of ineligible forests may be reduced once further land use mapping for the NZCAS is undertaken and completed.

A closely related issue is the requirement under the Kyoto Protocol to account for emissions from burning and decay of scrub biomass that is cleared for afforestation. That is, if the previous land use does not meet the definition of forest but still contains significant carbon

stocks, the carbon stock change due to afforestation must be accounted for. An allowance has been made for this in the combined model results.

Future deforestation (plantations)

Historically, little plantation forest deforestation occurred in New Zealand. In 2002 the Government's publicly stated deforestation policy was to cap liabilities that it would accept for pre-1990 forests at 21 Mt CO_2 over the first commitment period (2008-12). If deforestation looked likely to occur at levels above expectations the Government would consider its policy options to manage deforestation emissions within the cap.

The relatively new trend of not replanting forest after harvesting, and in some cases converting immature forest to pasture, started on a larger scale in 2004. New Zealand has always had a relatively dynamic landscape so changes in land-use are not unusual. However, historically little conversion of planted production forest land has occurred. The 2005 NEFD survey estimated that 7,000 hectares of forest clear-felled in the year ended March 2005 will not be replanted. This area represents 18 percent of the area harvested, and compares with historical information indicating that only about 2 to 3 percent of the area harvested has not been replanted in the past.

Government is currently reviewing climate change policies, including deforestation policy. Potential alternative deforestation policy options are due to be reported back to Ministers later this year. At the time of these projections, the deforestation cap is Government policy. Based on this the cap 21 Mt CO_2 has been used for the base scenario.

The upper scenario assumes an emission liability of 38.5 Mt CO_2. This scenario is based on a deforestation intentions survey completed for the Ministry of Agriculture and Forestry in December 2005. The results from this survey indicated that under current conditions forest owners intended to deforest about 47,000 hectares during the first commitment period (2008-12). This scenario allows for the removal of the deforestation cap and for current market conditions to prevail... The calculation of 38.5 Mt CO_2 is based on all deforestation being mature forest and all emissions being instantly emitted.

The projections include a lower scenario of -6.3 Mt CO_2 to show the effect of changes for forest policy or a future improvement in forest growing profitability. In absence of any better figure the lower scenario is based on 1550 ha deforestation each year, slightly higher than the historic annual deforestation area.

No allowance has been made for deforestation of indigenous forest or shrub land that meets New Zealand's adopted Kyoto forest definition. Under current legislation (eg Resource Management Act 1990, Forests Act 1949 amended 1993) and/or codes of practice (eg, The NZ Forest Accord) any significant deforestation of indigenous forest is, in practice, difficult to do.

f. Limitations of current data

There are acknowledged weaknesses in some of the data used in the LULUCF sector projections due to a lack of current knowledge and scientific uncertainty. With funding confirmed for the further development of the NZCAS in the August 2005, the Ministry for the Environment commenced implementing the NZCAS during the 2005/06 year. The NZCAS is being designed to provide more robust LULUCF sector inventory data specifically for Kyoto carbon accounting purposes. This is a long-term and large-scale project that will take some years before being fully

operational. In protest at the Government's climate change policies forest owners have banned the installation of forest carbon inventory plots in their forests. This has delayed the implementation of some NZCAS work streams. Delays in implementing the NZCAS may mean it will take longer to reduce the uncertainty of some elements of estimating and projecting LULUCF carbon dioxide removals and emissions.

Because the NZCAS is not yet generating data, existing forest resource information such as the NEFD database and Land Cover Database (LCDB) continue to be used for projecting LULUCF carbon dioxide removals. It is important to note that the NEFD database was designed to forecast future wood supply and is not designed for forest carbon accounting purposes. This means that some of the information required for carbon accounting purposes is currently unavailable. The NEFD describes the pre-1990 forests, where the ownership is dominated by larger forest growers' forests, reasonably well. NEFD information on the plantation forests established since 1992 by a large number of smaller-scale forest owners is of poorer quality. In addition there is relatively scant information on New Zealand's 6.5 million hectares of indigenous forest and 2.6 million hectares of shrubland.

The 2005 projections were subject to a number of reviews last year. The most comprehensive review was undertaken by AEA Technology from the United Kingdom. While the AEA Technology review identified a number of improvements that could be made in producing future projections, most of which have been incorporated in producing this year projections, the overall finding of the review was that "the methodologies employed to project emissions and sinks across the different sectors [are] generally sound and reasonable in their approach". The review noted the uncertainties inherent in all countries' approaches to projecting future greenhouse gas emissions, and that it is "not uncommon" for projections to change on re-analysis. The reviewers provided a number of useful suggestions for improving the accuracy and robustness of future forecasts. They recognise that many of their recommendations build upon improvements already in train. The key conclusions for the AEA Technology LULUCF review were:

- "Methodologies and input assumptions are reasonable and the resulting removal and emission projections are of a good standard;
- A single document should be produced for any future projection estimates that provides a detailed basis and sources for all calculations;
- Four key issues will require further consideration to minimise uncertainty in future projections:
    1. reasons and drivers for the downward trend in new forest planting;
    2. the areas of post-1990 forest planting at a national scale into existing shrublands that meets the Kyoto Protocol definition of forest;
    3. estimation of areas deforested and drivers for this process;
    4. time patterns of loss of carbon soil after afforestation.
- The New Zealand Carbon Accounting System will provide valuable data in assessing removals and emissions for land use land-use change and forestry."

g. Impact of the Permanent Forest Sinks Initiative

The Permanent Forest Sink Initiative (PFSI) provides an opportunity for landowners to establish permanent forest sinks and obtain tradable Kyoto Protocol compliant emission units in proportion to the carbon sequestered in their forests.

At the time of writing this report the Climate Change Response Amendment Bill had passed its first reading in Parliament and had been reported back from Select Committee. If the Bill proceeds through its final Parliamentary stages, regulations will need to be developed for the PFSI to become operational.

There is potential for some of the existing Kyoto-compliant forests to enter the Permanent Forest Sink Initiative. Any switching of these forests to the Permanent Forest Sink Initiative will result in the devolution of those credits and their removal from the Crown's balance of units. However, given the various risks and uncertainties associated with the initiative that existing forest owners will need to consider, it is not possible to provide an estimate of the area of existing forest that might switch to the Permanent Forest Sink Initiative.

h. Accounting for Article 3.4 forest management

Under Article 3.4 of the Kyoto Protocol, New Zealand has until 2007 (when it submits its 'Initial Report' to the UNFCCC) to elect which additional Article 3.4 land use, land-use change and forestry activities, if any, it wishes to account for in the first commitment period. The election of these activities is voluntary. Forest management is one such activity and would include accounting for forests not eligible under Article 3.3 over the first commitment period. The Government has agreed in principle not to account for these activities in the first commitment period.

At present, there is uncertainty in the data on carbon stock and carbon stock changes for New Zealand's indigenous forests. Available data suggest that the carbon stocks are likely to be in a steady state or possibly in slight decline. An assessment of the significance to New Zealand of Article 3.4 forest management activities concluded that the balance lay somewhere between -92 to 11 Mt CO_2-e over the first commitment period. New Zealand is also subject to a cap restricting the maximum amount of carbon dioxide removals it can claim in the first commitment period to 3.7 Mt CO_2 under Article 3.4 forest management but potential emissions are uncapped.