New Zealand Review of Kyoto Protocol Units

New Zealand Ministry for the Environment

28 January 2010

Review of the Projected Balance of Kyoto Protocol Units

Review of Units During the First Commitment Period

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Prepared for

New Zealand Ministry for the Environment

by

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Table of Contents

Executive summary

The New Zealand Government prepares projections on an annual basis to track its expected future level of emissions, particularly in relation to whether it will meet its Kyoto Protocol target. AECOM was selected to review these projections (Review of the Projected Balance of Kyoto Protocol Units) and assess whether they were a reasonable estimate, as well as provide advice about improvements that could be made to the New Zealand Government's process of preparing emission projections.

AECOM assessed the projections as presented in the *Projected Balance of Kyoto Protocol Units (2009)* and, while noting that there are always uncertainties about projecting future trends in human activities and resulting emissions, determined that the 'best' projection was a reasonable estimate of future emissions.

The review team also determined that the process for preparing the emissions projection was sensible and well constructed. New Zealand has developed a practical system for estimating future levels of emissions that is reflective of its national circumstances.

The review team did note, however, several areas where revisions to approaches would provide more consistent results and help stakeholders in better understanding the projections process.

This included treatment of a number of technical issues within each sector. While these were typically minor and specific to individual sectors, there was a lack of clarity around the treatment of scenarios and sensitivity to particular assumptions.

The review team also noted a number of cross-sectoral issues. These primarily related to consistency of treatment and clarity in explanation for preparation of high and low estimates and uncertainty. It would therefore be beneficial if a common template was prepared to categorise and highlight assumptions used in each sector. Addressing these issues would provide greater confidence in high and low projection estimates but would not alter the 'best' estimate.

The review team also found a number of areas of improvement for addressing over the longer term. These include ensuring the projections were based on more than one model, or at the very least, that there was some form of cross-check using a different approach. The review team also noted issues with documentation and ensuring the underpinning processes for preparing the projections were explained well. Although it may take several years to fully address these issues, improvements in these areas would lead to better transparency and the capacity to more easily assess future projections of emissions: they would not change the projections themselves.

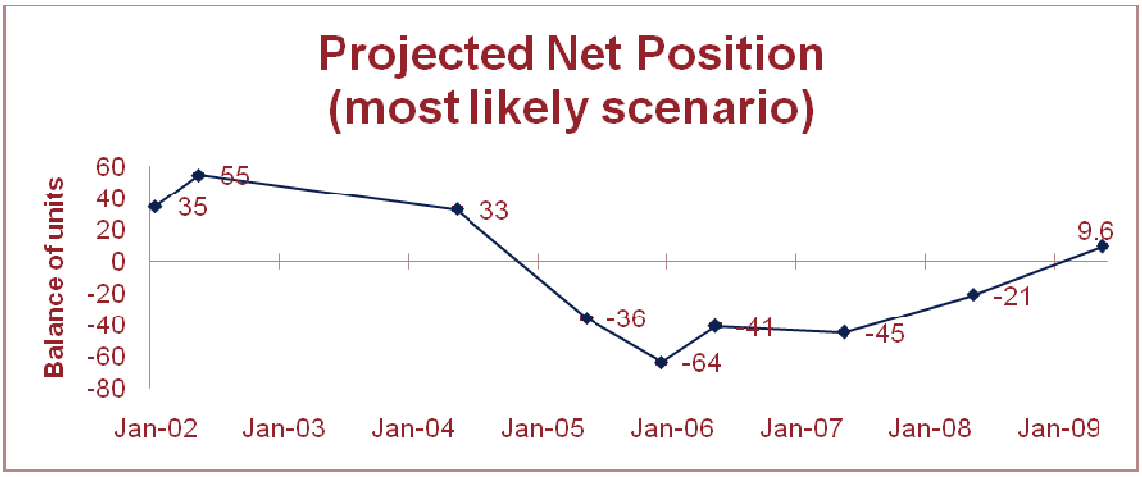
1.0 Introduction

1.1 The Kyoto Protocol and background to the Net Position Report

The New Zealand Government's ratification of the Kyoto Protocol required it to limit its average emissions over the first commitment period (2008 to 2012) to 100 per cent of 1990 emissions. The implications of not meeting the target through domestic policies and measures would be significant. New Zealand may be found in non-compliance with the Treaty and subject to penalty provisions. Alternatively, emissions credits may need to be purchased offshore at potentially great cost. New Zealand, therefore, has faced the difficult task of both assessing how it has been tracking towards its target and in determining which policies and measures would be necessary to meet those targets.

It has been particularly challenging for the New Zealand Government in this regard. Prior to ratification of the Kyoto Protocol, the New Zealand Government assessed that it would readily meet its Kyoto Protocol target. Several years later this assessment was reversed, and the New Zealand Government found that its emissions profile was markedly different than first estimated. Additional changes in forestry shifted New Zealand's outlook again. Consequently, the New Zealand Government has focused on improving its inventory and projections capacity to ensure it is better able to quantify the risk associated with meeting emissions targets. Reviewing emissions projections and the process by which these are made, also increases confidence among the public and policy makers in their robustness.

Figure 1 **Changes in New Zealand's estimate of its net position for the first Kyoto Protocol Commitment Period, shown in time series for the points in time when the predictions were made. A balance of units (net position) greater than zero indicates that New Zealand is expected to meet its obligations. A negative balance would indicate that New Zealand might have to buy units offshore to meet its Kyoto target.**



1.2 Overview of the Net Position Report

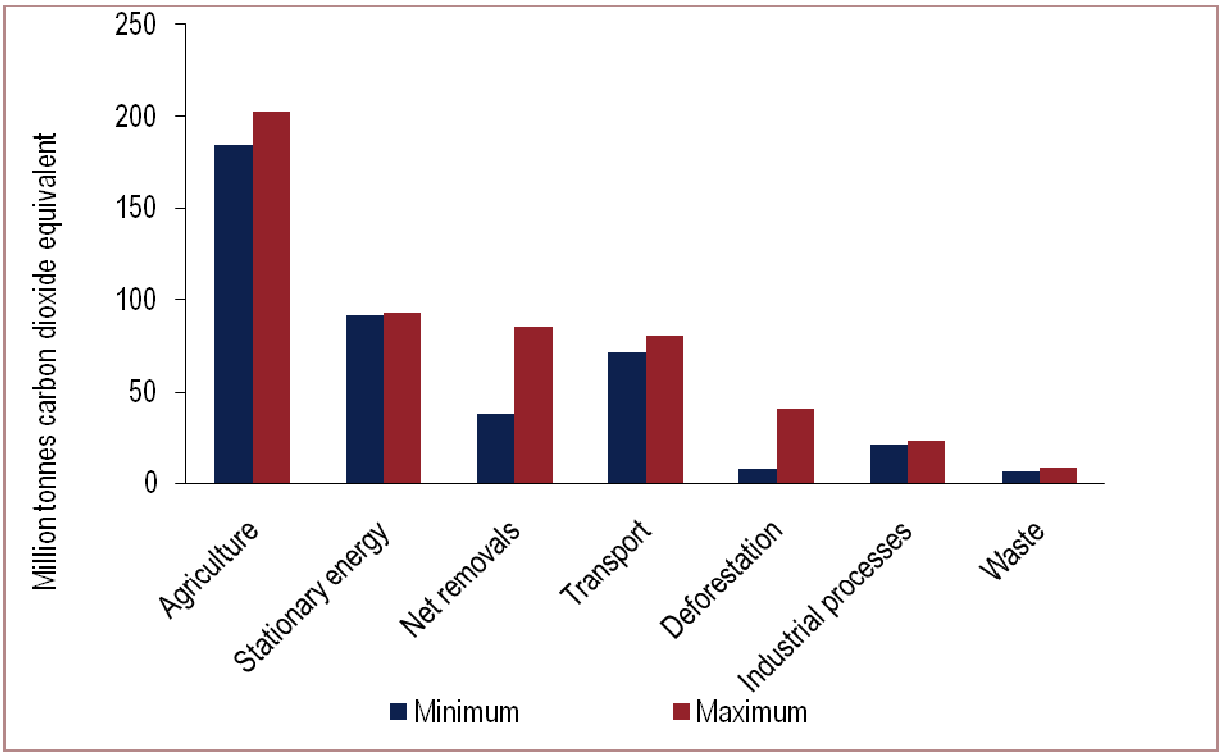
In April 2009, the New Zealand Government released its most recent Net Position Report. This report indicated New Zealand was projected to have a net surplus of 9.6 million Assigned Amount Units (AAUs – equivalent to one tonne of CO_2 each) during the first commitment period.

This report compares favourably with the previous Net Position Report, which was released in May 2008 and indicated a projected deficit of 21.7 million AAUs (refer to Figure 1 for estimates made at various times since 2002). The change from the previous projection is due to reduced emissions in the agricultural sector and increased net removals from planted forests. The change in agricultural emissions is largely a result of the 2007/2008 New Zealand-wide drought. The change in the forestry emissions relates to development of a more accurate methodology, which indicated more carbon was being removed by forests, and updated information on intentions of New Zealanders to clear forested land.

As Figure 2 below shows, historically the most significant overall changes in the net position occurred because of changes in the land sectors (agriculture and forestry). Accordingly, this review had a particular focus on the forestry sectors. Changes in projections can be caused by technical faults, changes in the methodology used or

changes in circumstances. New Zealand has experienced all of these inputs and, as illustrated below in Figure 2, the land sectors, particularly forestry, are the most susceptible to dramatic change.[1]

Figure 2 Range in projections by sector as presented in Net Position Reports (2006–2009)



1.3 Purpose of the review of the Net Position Report

To ensure New Zealand is able to meet its Kyoto Protocol commitments, it undertakes regular reviews and audits of the projections for national greenhouse gas emissions to ensure the integrity and robustness of reporting. For this reason, the New Zealand Government, under the coordinating efforts of the Ministry for the Environment (MfE), sought advice on whether the projected emissions during the first Kyoto Protocol commitment period were reasonable and whether the processes followed in making these estimates were robust.

AECOM understands there were two separate, but linked, purposes for undertaking this work. The first was to provide Audit New Zealand with an assessment of the reasonableness of the 2009 estimate of New Zealand's total emissions across all sectors. The second component was to provide an independent review of New Zealand's projections to 2012, including comment on the methodologies used and processes followed to identify possible areas for improvement.

1.4 Scope of work

This review is intended to be a high-level assessment of the process and robustness followed in making New Zealand's emissions projections. While the certainty of emissions projections increases as the period being assessed is more immediate, emission projections are dynamic and change as independent variables, particularly those relating to weather and economic outlook, shift over time.

New Zealand's real net position will remain unknown until New Zealand's national greenhouse gas inventories covering the first commitment period have been submitted, reviewed, and the review report noted by the

[1] The reasons for change in projections in the land sector include changed behaviour by forest owners, improvements in methodology, and changed climatic conditions. The New Zealand Government has consistently looked to improve its methodologies over this time and improve the veracity of these projections.

Enforcement Branch of the Compliance Committee of the Kyoto Protocol. New Zealand's Kyoto Protocol compliance over the first commitment period will not be finalised until 2015.

Given these uncertainties, this review is limited to an assessment of whether the processes used in undertaking the emissions projections are credible, and whether the projections themselves are reasonable given current economic, environmental and other factors. While this assessment can provide confidence in the emissions projections, it can in no way guarantee a particular outcome or result.

1.5 Our methodology

The methodology followed for this review broadly parallels the approach taken in the United Nations Framework Convention on Climate Change (UNFCCC) reviews and included the following key stages:

- **project establishment** – the purpose of this activity was to formally commence the project and ensure both AECOM and MfE shared an understanding of the project's deliverables, timing and outcomes. Tasks completed included refining the project plan and finalising contractual arrangements
- **initial review of documentation** – this involved a desktop study of all relevant Ministry publications, including the 2009 Net Position Report, as well as technical papers and methodologies on New Zealand's greenhouse gas inventory and projection processes
- **interviews** – the project team conducted a series of interviews with relevant New Zealand officials from MfE, the Ministry of Agriculture and Forestry (MAF) and the Ministry for Economic Development on 17 and 18 September 2009. The purpose of the interviews was to obtain further clarification of technical issues which emerged during the initial review of documentation
- **report** – the project team then prepared a draft report for consideration by the New Zealand Government. This report will be finalised after technically related comments from relevant ministries have been compiled and considered by the project team.

1.6 Broad-level findings

The review team found the New Zealand Government's 2009 Net Position Report provides a reasonable estimate of how New Zealand is tracking towards meeting its Kyoto Protocol commitment. While there are a number of areas identified for improvement, most notably among the high and low estimates of emissions presented in the Net Position Report, the approach taken is conservative (ie, not unduly optimistic).[2]

The complexity with emissions projections is they are always characterised by questions relating to the approach taken, methodologies used, and assumptions made. Given the possibility of drought or other systemic climatic events, or a major economic transformation that could shift the underlying assumptions markedly, or technical improvements in model development, there always remains uncertainty that cannot be resolved until the future emissions projection becomes an historical inventory of emissions.

[2] New Zealand's emissions profile is markedly different from other Annex I Parties, with a majority of emissions produced from the land sectors. Additionally, the proportion of removals from the LULUCF sector is greater in New Zealand than other Annex I countries. As these sectors are the most technically challenging, the most susceptible to climate variability and the most easily influenced by changes in human activities, New Zealand's emissions projections are more subject to change than other countries. Particularly in the LULUCF sector, with the development of new modelling tools (LUCAS), New Zealand is among the international leaders in developing and implementing new methodological approaches and tools to estimating emissions and preparing emission projections.

2.0 Review of emission projections for agriculture

The 2009 Net Position Report projects that emissions for the first commitment period for New Zealand will total 184 million tonnes of CO_2 equivalent (CO_2-e). This is a reduction of 14.4 million tonnes in 2008 and is primarily caused by the impact of drought on livestock numbers and their performance. The key issues for estimating New Zealand's agricultural emissions are livestock numbers, their intake of types of food and the use of fertiliser.

While New Zealand's approach to agricultural emissions can be fine-tuned particularly with sensitivity analysis for high and low estimates, the review team found the approach taken to preparing the most likely estimate of projected emissions was reasonable and appropriately conservative.

2.1 Description of modelling approach

Emissions from agriculture were estimated using three models which are described in the following sections:

- Pastoral Supply Response Model (PSRM)
- 'Tier 2' enteric methane model
- Nitrogen fertiliser model.

2.1.1 Pastoral Supply Response Model

The PSRM is used to project animal numbers and performance data. Two key sets of exogenous variables include:

- farm-gate prices and soil moisture deficit
- farm returns for agriculture and returns on land for forestry.

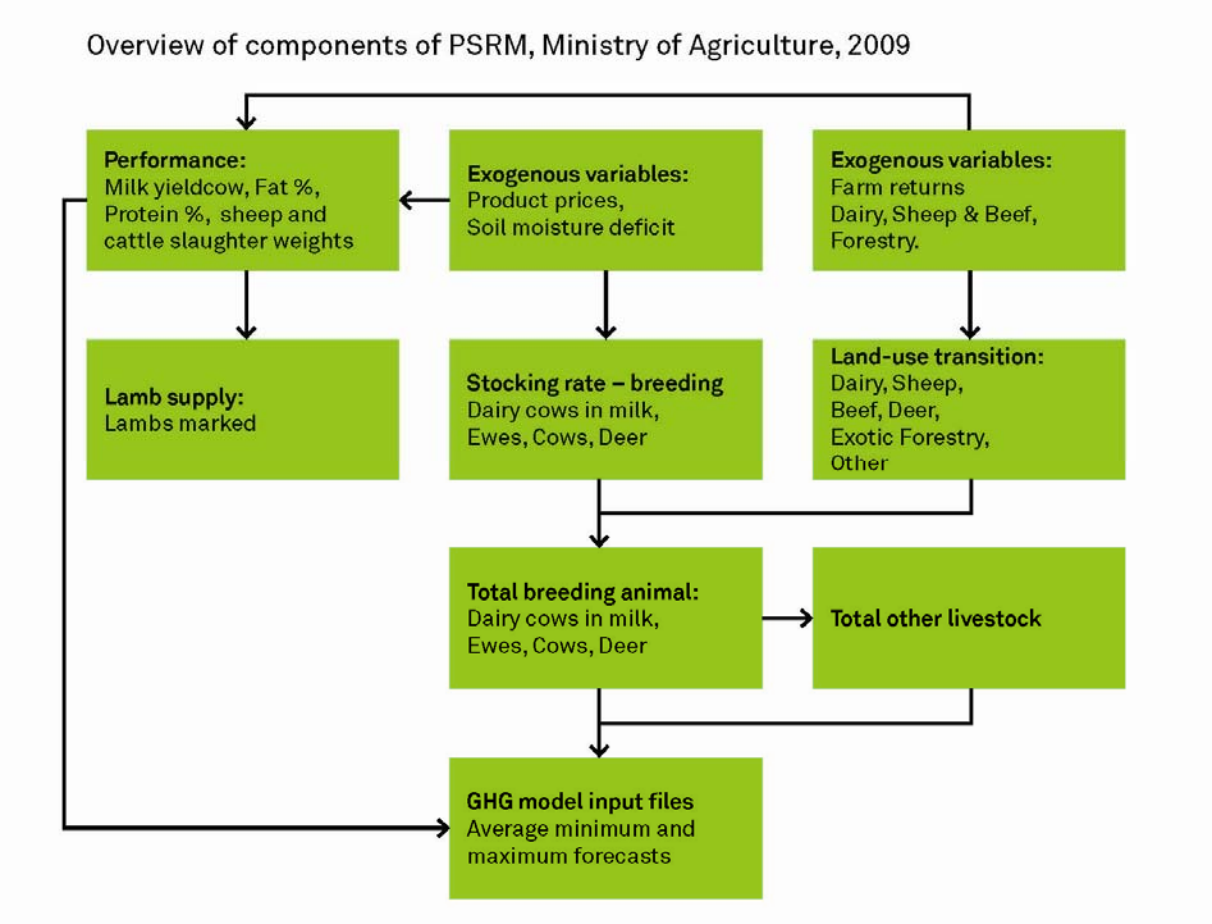
Farm-gate prices for wool, lamb, milk solids, prime beef and urea are positively related to animal performance and stocking rates, whereas soil moisture deficit has a negative relationship with animal performance. For example, in time of drought (with a high soil moisture deficit), the performance per animal decreases and stocking rates generally decline as fewer animals can be supported by the same land area. Higher farm-gate prices have a positive impact on animal performance. Returns on agricultural land use relative to forestry are used to project land-use changes. The higher the return for agriculture relative to forestry, the more land will be used for agriculture.

The exogenous inputs are used to derive animal performance, stocking rates and land-use changes. As a next step, land-use changes (the area of land used for agriculture) and stocking rates (number of animals per hectare) are combined to derive the total animal numbers. The outputs of the PSRM are animal numbers and performance data for sheep, dairy, beef and deer. Figure 3 provides an overview of the structure of the PSRM.

Data sources for exogenous variables in the PSRM vary. Internal analysts develop price projections based on industry expert knowledge. The New Zealand Treasury provides exchange rates and projections for other key economic indicators. Other variables such as soil moisture deficit are derived from historic trends sourced from the National Institute of Water and Atmospheric Research (NIWA). Most of the key assumptions are implicit in the model as it uses relationships between variables in the past to project the future. It is assumed that animal productivity increases steadily, in line with an historic trend, on the basis that productivity can still be markedly improved as evidenced by the higher productivity of sheep, beef and dairy in Europe and the US. Specifically, animal production is estimated as a linear trend of past performance, days of soil moisture deficit and farm-gate price.

It should be noted the model is also used to forecast growth in the agricultural sector as an input to export revenue forecast. This is, in turn, used as advice into Treasury's Economic Outlook.

Figure 3 Overview of components of PSRM, Ministry of Agriculture, 2009



2.1.2 Tier 2 inventory model

The Tier 2 inventory model uses animal population and dry matter intake to estimate emissions per animal. These emissions include methane from enteric fermentation and manure management and nitrous oxide from manure management and agricultural soils. Enteric methane emissions are significant as in 2007 they were the single largest source of emissions. The four main agricultural sub-sectors (sheep, beef, dairy and deer) use a common set of animal population data, derived from PSRM, which, in turn, is informed by an annual animal production survey taken by Statistics New Zealand in June each year. Provisional data from this survey, reported in February of each year, is used in the PSRM.

Dry Matter Intake (DMI) is calculated by the 'Tier 2' inventory model for each classification of animal from performance data forecasted by the PSRM and the energy balance of feed required for maintenance and to achieve the level of performance. Calculations are resolved on a monthly basis. Methane emissions are then calculated for each animal classification according to its DMI, using a known relationship between methane produced per unit of dry matter intake from New Zealand-derived research.

2.1.3 Nitrogen fertiliser model

The nitrogen fertiliser model projects use of nitrogen fertiliser for agricultural purposes. The model uses the price of nitrogen fertiliser and farm-gate output prices to project nitrogen fertiliser use. Future prices for nitrogen fertiliser are obtained from the World Bank. This is considered to be a reasonable approach.

Both the Tier 2 inventory model and nitrogen fertiliser models are appropriate for emission projections.

2.2 Advantages and disadvantages

There are three key advantages of the current modelling approach:

1) Modelling results are animal specific and therefore changes in specific animal types (eg, dairy cattle) can be tracked.
2) The level of disaggregation allows for substitution from one animal type to another to be taken into account.
3) Stocking rates, as well as land-use changes, are taken into account which minimises the need for averaging.

It should be noted that the current approach has recently been improved as it incorporates recent information on animal performance. Once information is available for seven or eight months of the year, it is incorporated into the current approach. Additionally, the current approach for projections uses the same model that is used for the inventory which is reviewed through the annual UNFCCC-ERT process.

The key disadvantages of the current modelling approach are:

- the results may strongly depend on a small number of exogenous variables. As farm product prices are one of the key inputs into both animal performance, stocking rates and nitrogen fertiliser use, it is likely robustness of results depends strongly on the robustness of the farm product price forecasts
- the bottom-up modelling approach is not cross-checked against other methods (eg, a top-down approach). To verify results, a second source of forecasts could be used. A top-down approach for the agricultural sector could involve macroeconomic modelling of demand for agricultural outputs.

Overall, the modelling approach for the agricultural sector is sound. The approach has a sufficient level of disaggregation to appropriately account for a range of factors from animal population to soil moisture content.

2.3 Comment on appropriateness of approach and alternate approaches

The approach used to project future emissions from this sector appears reasonable and sensitive to changes in economic indicators that influence the overall emissions performance of the sector. In particular, the use of a single characterisation of livestock populations and feed intake across all sub-sectors is robust.

More could be learned with the current modelling approach by carrying out sensitivity analysis to determine the scale of impact from variation in key parameters such as farm incomes, soil moisture and performance. It is acknowledged it may not be possible to prepare sensitivity tests for the projection report due to time constraints. However, sensitivity tests could still be prepared at a later stage to confirm results.

2.4 Assumptions – emissions factor

A major assumption used in the inventory (and projections) for agriculture is the assumption of the fraction of nitrogen from livestock that escapes to atmosphere. This is known as FracGASM. This year's projections have used a new peer-reviewed value of FracGASM of 0.1. The previous value was 0.2, which resulted in a reduction in the estimate of N_2O emissions from agriculture. This is a valuable improvement as there is strong evidence to support the contention that this better reflects New Zealand conditions. It is fully in line with IPCC good practice.

2.5 Activity data and emissions factors

The climate is obviously a large determinant in the emissions of greenhouse gases (GHGs) from the sector as evidenced by the effect of the nationwide drought in later years of the inventory. Weather has been included as a key factor in the current projections; however the description of how this is achieved is limited and could be expanded.

2.6 Proposals for improvements

While the modelling approach is considered sound, there are three areas that could be improved. Recommendations for additional steps to improve projections for agriculture include:

- improve transparency of reporting, particularly with reference to:
  - exogenous price inputs
  - uncertainty
  - weather and drought treatment

- conduct sensitivity analysis to determine the best way to predict upper and lower bounds to the projections
- undertake independent checks to confirm confidence in results.

Firstly, the projections for prices for wool, lamb, milk solids, prime beef and urea are currently determined using industry expert knowledge. However, considering Figure A1 in Appendix A of the Net Position Report, the price projections are very specific. Additionally, farm-gate prices are likely to have a strong influence on the results. Using the current approach, it is not transparent how future price movements have been derived. As prices are an important exogenous input to the modelling, it is recommended to improve the transparency of price projections. A methodology for deriving prices that is repeatable and verifiable should be used as this ensures maximum transparency. It is acknowledged a purely quantitative approach also has drawbacks as it cannot take into account one-off events (eg, the melamine scandal in China). However, a repeatable and verifiable process that takes into account quantitative and qualitative information has the advantage of increasing transparency of changes in projections between two years. For example, to increase robustness of projections even further, price projections could be compared with forward prices as traded, such as on the Chicago Mercantile Exchange.

Secondly, the treatment of uncertainty in the agricultural sector needs to be articulated appropriately. Appendix A of the Net Position Report implies that the upper and lower 95 per cent confidence intervals for a number of variables were combined to derive the upper and lower overall emissions estimate. Importantly, combining the 95 per cent confidence interval of a number of input variables (with independent probability functions) cannot be used to derive the 95 per cent confidence interval of the endogenous variable. The text leaves some doubt as to whether the method of using the 95 per cent confidence interval was applied correctly. After clarification from the Ministry of Agriculture, it is clear that the correct method was used to determine the overall upper and lower emissions estimate. It is therefore recommended to carefully revise the wording on uncertainty to ensure that no doubts about the application of confidence interval remain.

Thirdly, weather and droughts should be treated consistently.

There is currently no evidence that sensitivity analysis has been undertaken. While an upper and lower estimate is provided for total emissions, it is unclear whether emissions in the agricultural sector are particularly dependant on prices, soil moisture or other factors. To improve the general understanding of the factors that influence agricultural emissions, sensitivity testing could provide a beneficial tool in determining the key factor that influences emissions in agriculture.

Good practice would suggest that New Zealand develop an independent check of future emission projections to strengthen confidence around the projection. One independent check for modelling emissions from enteric fermentation, which does have some limitations, is to attempt to use data on available Dry Matter Intake to calculate the methane emissions from each classification of animal. This would provide a cross-check on the current approach, which uses performance data. The challenge with this approach is New Zealand's agricultural system makes extensive use of pasture and grazing, particularly in the key areas of dairy, beef and sheep production. This complicates the assessment of dry matter intake. It is acknowledged some work has already started on pasture growth forecasts that will be used as a cross-check.

3.0 Review of emissions projections for land use, land-use change and forestry

Under the Kyoto Protocol, unless Parties include additional activities described in Articles 3.4 or trigger Article 3.7 – which New Zealand has not – activities covered in the Land Use, Land-use Change and Forestry (LULUCF) sector include emissions from deforestation and removals from afforestation and reforestation.

In the 2009 Net Position Report, the New Zealand Government reported that as a result of new information of Kyoto-relevant planted forests and revised estimates of deforestation, net removals by planted forests are projected to be 85 million tonnes during the commitment period.

The review of the projections contained in the Net Position Report found that the processes followed in estimating the future level were robust and assumptions were conservative. The review team is of the view that the emission projections for the LULUCF sector are robust, noting that the projected emissions have changed markedly since 2008 as a result of external factors.

3.1 Description of modelling approach

Time series afforestation and reforestation statistics have been derived from annual forest owners and related surveys. Data from the National Exotic Forest Description (NEFD) is used, as well as other forest surveys including an annual survey of nurseries to provide timely estimates of afforestation. The NEFD survey has been in operation since 1982. This annual survey covers forest owners with more than 1000 hectares of forest. There are approximately 100 of these large forest owners. The data from these owners is of good quality and the survey achieves close to a 100 per cent response rate. These owners manage the majority of the forests planted prior to 1990. Every second year a comprehensive census of all owners with more than 40 hectares of forest is conducted. While this survey still has a high response rate, around 85 per cent, the quality of the information received is more variable. In addition, it has been challenging to maintain an up-to-date survey frame, thus areas from owners with less than 40 hectares are estimated. There is no evidence of systematic bias in response, although this should be confirmed with every new emissions projection.

Grants to replant forests that are prone to erosion are a driver for afforestation that feeds directly into the projections. Relatively small areas are planted under these grants and they are currently oversubscribed. The areas planted under these grants have been included in the 2009 Net Position Report but are not separately identified.

Capacity for land to become available is also taken into account by using a net present value curve. Previous work by international forestry experts has been considered, however economic modelling of land-use changes in forestry remains an area for future improvement. In its discussions with the review team, the Ministry of Agriculture and Forestry noted that previous econometric work to forecast land-use change, while helpful in assisting understanding of the drivers of land-use change, has not resulted in robust forecasts. The forecasts would, therefore, likely require considerable work before an approach based on economic drivers could provide useable estimates of future land-use change.

Deforestation intentions are estimated on the basis of annual deforestation surveys. In 2005, a review of methodology options to forecast future deforestation was undertaken (Manley 2005). The review examined the use of surveys, econometric models and land-use economics to estimate future deforestation of planted forests. The review recommended a structured survey of major forest owners on the basis that:

- the New Zealand planted forest estate is well understood in terms of ownership, land tenure and age class
- the majority of area that will be harvested over the next 10 to 15 years (and hence most likely to be deforested in CP1) is owned by relatively few owners
- information from other sources is available to corroborate stated intentions.

In this survey, major forest and forest landowners are asked about their deforestation intentions under three different policy scenarios. Almost all owners contacted have been willing to provide information. Deforestation intentions for smaller-scale owners are assumption driven. A cross-check with projections in agriculture is also undertaken to ensure that land-use projections are not inconsistent.

3.2 Advantages and disadvantages of current approach

Advantages of the current approach are:

- survey data is likely to be accurate in the short term. As most commercial forestry operations are likely to have a good idea about their activities over the coming year, surveys are likely to generate accurate information on afforestation and deforestation in the short term
- the comparison of land-use changes in forestry and agriculture provides an important cross-check of the overall emissions results. Double-counting is avoided by ensuring the agricultural projections account for land converted from forestry to agriculture.

Disadvantages of the current approach are:

- reliance on survey results for both afforestation and deforestation in the longer term may be misleading. The deforestation survey asked about future land-use changes under three different policy scenarios. It is questionable whether survey respondents were sufficiently informed about policy scenarios to make meaningful statements about their activities in each scenario
- the current approach does not use any economic inputs such as price, exchange rate or world demand for forestry products. While there is considerable difficulty in establishing robust relationships between prices and land-use changes (and the long time lags in forestry complicate the issue further) prices of forestry products should be used as an input to projections. For example, surveys could include statements on deforestation and afforestation under different price scenarios.

3.3 Assumptions – modelling

There are a number of assumptions included in the approach of modelling future emissions from LULUCF. The review team found the assumptions were reasonable, but in several cases they were not transparently explained. Assumptions worthy of note include:

- data estimates focused on planted exotic forests only. The modelling could benefit from an explanation of why this is the case
- the confidence placed in data from large landholders, which underpins much of the modelling. This assumption should be defended;
- in cases where a middle estimate is not used, there needs to be a clear explanation of the rationale for the decision.

3.4 Proposals for improvement

New Zealand has an excellent approach to estimating future emissions from the LULUCF sector and is making progress towards improvements. Areas for improvement include modelling, methodologies and data collection.

3.4.1 Modelling

New Zealand is making strong progress in improving its capacity to estimate and project emissions from the LULUCF sector. New Zealand has used its forest inventory – the National Exotic Forest Description (NEFD), which covers planted forests only – to provide the basis for carbon reporting, accounting and projections. The New Zealand Government has decided to invest in a new capacity, the Land Use and Carbon Analysis System (LUCAS). LUCAS will cover all land uses. When it becomes fully operational, LUCAS will provide New Zealand with world-leading carbon accounting capacity. Very usefully, links between LUCAS and the NEFD will be maintained. While they will have different results – and future Net Position Reports will be different as a result – broad trends are expected to be similar and the use of both systems will provide a check of each other. Confidence with the results will be further enhanced as results from these models are considered alongside results in the agricultural section. It is important to note that LUCAS covers all land uses while the NEFD's scope is solely planted production forests.

One suggestion for further improvement would be to link economic indicators, such as prices for agricultural goods (particularly dairy) and forestry products to a land-use change model. To start this process, details on price drivers could be included in forest surveys. This could also improve the simplicity of surveys as landowners are

more likely to know their response to different market prices than policy scenarios. It would allow an economic model to be created that would enable a cross-check of the intentions focused models used now.

3.4.2 Methodologies

New Zealand appears to have an effective system of considering its emissions methodologies and reviewing those that are nationally significant. As a result of this approach, there was a significant methodological change in the 2009 Net Position Report from the 2008 edition, which focused on emissions from forested land that had been cleared. Upon review, this change is sensible and fully consistent with the IPCC approach of continuous improvements in inventory practice.

The description of the new approach, however, was instantaneous release of CO_2 following land clearing. The review team queried this methodology because on the surface it seemed that New Zealand was moving towards a less sophisticated approach in estimating emission reductions that could expose it to international criticism. Access to additional details outlined new information which showed that emissions following land clearing occur rapidly over a year. In order to prevent the suggestion that New Zealand is selecting its approach to suit its circumstances, it is suggested that the changed methodology be highlighted and further explained in future Net Position Reports, New Zealand's inventory and in the forthcoming Fifth National Communication [since published].

3.4.3 Data collecting

The basis for estimating the rates at which companies will thin forests, as well as the proportion of 'over-planted' forests, is derived from information obtained from forest owners. While an appropriate source of data, it would also be useful to collect information on the drivers of these activities to ensure that progressively an alternative model for estimating the future level of emissions from economic drivers could be prepared. While this alternate model would probably be used only to confirm projections made from survey data, it would help provide increased confidence in projection results.

Other areas for improvement of data collection include:

- improvements to data on Kyoto forest area, as well as the area of forests that are Kyoto ineligible. Given the commitment period has started, it would be timely to invest in an effort to resolve these issues definitively. Data collected from LUCAS is expected to resolve these issues
- improved collection of data on intent of small land holders to either afforest/reforest or clear land
- additional clarity on whether, and how, impacts from policies and measures, particularly afforestation grants, are being included in the projection.

4.0 Review of emissions projection for energy

Projected emissions from the energy and industrial process sector (covered separately in Chapter 5 below) are unchanged from 2008 and remain at 185 million tonnes of CO_2-e. The economic downturn in the last year which reduced emissions has been counterbalanced by removing policies relating to biofuels and renewable energy.

In order to develop emissions projections for the energy sector the following models are used:

- GEM (Generation Expansion Model) which was developed to support the production of generation capacity expansion paths under various future scenarios; and SADEM (Supply and Demand Equilibrium Model) to project emissions from electricity generation
- VFEM (Vehicle Fleet Emissions Model) to project emissions from transport.

SADEM works in conjunction with projections of transportation fuel demand from VFEM and projections of electricity prices, generation fuel use, and generation capacity expansion from GEM. As a result, SADEM provides the link between VFEM and GEM. A detailed review of the energy modelling approach for greenhouse gas emissions was outside of the scope of this review. Accordingly, there is less analysis on the energy sector than other sectors in this review. However, the review team was of the opinion that results from this sector are credible.

4.1 Description – electricity

A full review of the SADEM model was undertaken in 2005 and is therefore not part of the review of the Net Position Report. SADEM is a partial equilibrium model that is used to project demand and supply of different energy sources in New Zealand.

A number of assumptions are used as inputs to SADEM such as economic activity, exchange rate, population and world oil prices. These assumptions are sourced from other government agencies, such as Statistics New Zealand and TheTreasury, and international agencies. Data used as input on the supply side is sourced mainly from surveys of electricity generators.

SADEM estimates how much energy will be generated by different sources to accommodate total demand. The outputs therefore include energy supply by fuel type, energy demand for different fuel types and energy prices.

The 2009 projections use sub-sectoral demand forecasting with GDP estimates as the primary driver. This recent approach has replaced a bottom-up estimate of the impact of policy. The criticism of the previous approach was that it potentially involved double-counting of energy efficiency measures.

SADEM is also used to develop New Zealand's Energy Outlook.

GEM was developed to provide future electricity generation scenarios; that is, forecasts for new electricity generation development over the next 30 years. GEM finds a cost-minimising schedule of new generation capacity to meet energy and incremental peak demand forecasts (Ministry of Economic Development (MED), 2009). The outputs are electricity prices, generation fuel use, generation emissions and generation capacity additions (MED, 2009).[3]

[3] http://www.med.govt.nz/templates/MultipageDocumentPage____39771.aspx?&MSHiC=65001&L=0&W=generation+expansion+model+%22generation+expansion+model%22+&Pre=%3Cb%3E&Post=%3C%2fb%3E

4.2 Description – transport

Emissions from road transport are projected using the VFEM. The VFEM projects vehicle kilometres travelled (VKT) by vehicle type, age and the road type used. In the model, demand for light vehicle VKT depends on population, GDP per capita and the price of travel (including the price of fuel) whereas demand for heavy vehicle travel depends on GDP only.

There are also models for projecting emissions from domestic sea and air transport. These projections are based on historical energy demand and future growth rates linked to GDP. However, these sectors are relatively small when compared to road transport emissions.

Transport modelling includes recent changes to policy settings, including the recent repeal of the *Biofuel Bill 2008*. This change increased emissions estimates by 1.1 million tonnes for the first Kyoto Protocol commitment period.

4.3 Description – industrial activity

Industrial activity is projected separately using reports on particular industries on a bi-annual basis. Due to the high concentration of industry updates on projections of industrial activity, these estimates are prepared separately.

4.3.1 Advantages and disadvantages

Advantages of the current modelling approach include:

- energy generation is modelled coherently as part of one package. As a result, interactions between different fuel types are taken into account and double-counting is avoided
- consistent GDP and other assumptions – using one model for energy demand ensured that assumptions on economic indicators such as GDP and the world oil price were consistent
- specific factors influencing the output projections of industrial processes can be taken into account by estimating emissions from this sector separately.

Disadvantages of the current modelling approach include:

- reliance on energy census results – inputs to the supply side of the SADEM model involves industry surveys. The outputs from the SADEM model are dependent on the accuracy of information provided by energy sector participants which is subject to review over time
- the modelling approach is intended to be used for long-term projections rather than short term. This presents a particular problem with respect to dry years as the long-term model cannot be used to forecast short-term droughts. This problem will become exacerbated over the next few years. A mitigating factor is the replacement of projections with inventory data as the first commitment period draws to a close. This impact should be discussed in terms of both sectoral and overall uncertainty. VFEM does not take into account availability of alternative modes of transport, nor does it distinguish between the potentially different price elasticity for passenger car travel for urban and rural transport. This comment is of particular relevance to areas where there is no public transport service.

4.4 Proposals for improvement

- Energy projections could be improved by running both the bottom-up and top-down approaches for estimating the impact of energy efficiency policies and comparing the two results.
- Transport projections could be improved by reducing the elasticity of transport demand in areas that do not have public transport. It is acknowledged that improvements to price elasticity in the VFEM model are unlikely to have a major impact on overall transport emissions projections.

5.0 Industrial process

Emissions from industrial processes include a number of activities involved in manufacturing that are not from fossil fuel combustion. In the 2009 Net Position Report, emissions from the industrial process sector reduced by nearly 1.3 million tonnes of CO_2-e from 2008. The causes of the decrease were a reallocation of 0.7 million tonnes CO_2-e occurring in urea processing from the industrial process sector and a downward estimate of remaining industrial process emissions.

While there are areas for improvement needed in the industrial process sector, the review team is of the opinion that these will not substantively change the emissions projections for the Kyoto Protocol's first commitment period.

5.1 Description of modelling approach

New Zealand's emissions from the industrial process sector can be divided into two sets. The first set refers to emissions of gases that are a direct by-product of industrial activity and, typically, happen in a consistent ratio between the activity and the emission which, in the main, only varies with technology and the basis of the raw materials used. For example, the production of one tonne of cement leads to emissions of a constant amount of CO_2. In New Zealand, the main industrial processes are: iron and steel production, aluminium production and cement production. The approach to projection of these emissions is directly correlated to estimates of expected energy use. A key component of this projection is discussions with major energy users to determine their plans.

The second set of emissions relates to synthetic greenhouse gases (HFCs, PFCs and SF_6). These gases are used in, and emitted by, the electricity supply industry (SF_6) and are used as replacements for ozone depleting substances (HFCs) in a range of applications, most notably in the refrigeration and air conditioning industries.[4] There is no information on these emissions provided in the Net Position Report or its appendices.

5.2 Comment on appropriateness of approach and alternate approaches

Given the close, and often direct, relationship between energy used and non-synthetic gas industrial process emissions, the approach taken is reasonable. It would be worth ensuring communication with plant owners canvassed the likely changes either in technology or raw material inputs, as these can alter the relationship between energy imported and industrial process emissions. A statement that this has been done and what the aggregated findings are for the sector (to ensure commercial confidences are maintained). would be a helpful addition to future Net Position Reports.

The projections for the non-synthetic greenhouse gas industrial process emissions are calculated every two years. These gases make only a small contribution to New Zealand's net emissions and while the amount of emissions will vary according to output, this is constrained by plant capacity. Further, as it takes more than two years to plan for, obtain approval, construct and start operating any of the type of plants that occur in New Zealand, the two-year revision cycle is appropriate.

However, good practice in emissions projections would suggest that an alternative approach should be implemented to ensure the robustness of the projections. Given, the scale of these emissions and that they will change slowly, conducting a scenario analysis to determine possible high-side risk would provide additional certainty in relation to estimates provided in the Net Position Report.

No information is provided in the Net Position Report on SF_6 and HFC emissions. The review team was informed that HFCs, PFCs and SF_6 are assumed to increase at the same rate as CO_2 industrial process emissions. While this approach is followed on the assumption that emissions of these gases are low (ie, less than 1 per cent of New Zealand's total emissions), the inventory estimates should be verified. The approach taken for these projections assumes a basic trend line based on historic data. However, the inventory data underpinning the projection may not capture the dynamic changes in these industries, particularly as ozone-depleting substances are being phased out and consumer attitudes and purchasing behaviour around air conditioning changes.

[4] PFCs released as a by-product of aluminium production are captured in the first approach to estimating emissions in the industrial process sector.

Given a recent comment during a UNFCCC review of New Zealand's inventory that emissions of synthetic greenhouse gases were markedly lower than any other Annex I Party, this is an area that might warrant effort to support more sophisticated emissions inventory and projections processes.[5]

5.3 Proposals for improvements

Improvements to the emissions projections for the industrial process sector have three key components:

- ensure information on possible changes in technologies and raw materials is collected as part of the emissions projections for the industrial process sector. A statement that this has been done and the main aggregated findings could be included in the Net Position Report
- conduct a sensitivity analysis on the potential high-side emissions from the non-synthetic gas industrial process sector
- review, and if necessary revise, the inventory data collection and emissions projections approach for synthetic greenhouse gases, particularly HFCs used as replacements for ozone-depleting substances.

[5] Refer to UNFCCC document FCCC/ARR/2006/NZL

6.0 Review of emissions projections for waste

Projected emissions from this sector in the 2009 Net Position Report are 8.3 million tonnes CO_2-e for the first commitment period. This is an increase of 1.1 Megatonnes of CO_2-e over the previous projection (MfE, 2008). The 2009 Net Position Report explains the increase has come from improvements to the method used to model emissions from solid waste disposal (refer to page 13). This statement is further explained in the appendices:

> *For the period 2008 to 2012, projected emissions from the waste sector have increased 1.130 Mt CO_2-e (15 per cent) from the 2008 estimates due to several factors:*
>
> - *the IPCC 2006 MS-Excel spreadsheet model used to develop estimates of gross and net methane emissions from landfills required changes to various methodological inputs*
> - *methodological changes in modelling emissions from domestic and commercial wastewater treatment. This factor accounts for nearly 25 per cent of the increase*
> - *not including any effects of waste minimisation policies, strategies or legislation in the projections of emissions in this report. This factor accounts for over 75 per cent of the increase.*

Moving this more detailed explanation of the increase in projected emissions to the main report would significantly improve stakeholders' appreciation of the issues.

6.1 Description of modelling approach

6.1.1 Inventory

The inventory approach used separates the sector into three major sub-categories: solid waste disposal on land, wastewater handling (treatment) and waste incineration. Each sub-category's emissions are calculated using IPCC methods (IPCC 1996 or IPCC 2006). The methods appear to be chosen (and slightly modified) to suit the data situation in each case. The differences from the standard methods are noted in the relevant section of the inventory report (methodological issues).

Activity data generally comes from a variety of surveys, industry provided data and consultants' reports.

A significant data limitation noted in the inventory report is the inability to separate the solid waste data into either municipal or industrial waste. This issue is discussed further below.

6.1.2 Projections

The Net Position Report and associated appendices together provide a thorough description of the principles of the projections approach for the waste sector. Some minor changes and inclusions will improve the explanations significantly. These are detailed in section 6.4, below and are characterised as 'reporting improvements'.

The approach taken to project emissions in this sector is to use the IPCC inventory techniques, apply population increases and assume there is a direct relationship between population growth and the growth of emissions from solid waste and wastewater. Policies and measures are excluded. The appendices refer to three different population scenarios. Population is used to grow the total emissions over the commitment period, against the background trend of improving technical performance for the sector. Projections use Statistics New Zealand's National Population Projections (2006 base, series 1, 5 and 9). It is assumed this data provides growth scenarios.

6.2 Comment on appropriateness of approach and alternative approaches

The modelling approach used in the underlying inventory appears to be sound and consistent with international trends in this area. The availability of representative data remains the most significant factor affecting the accuracy of estimates, however the New Zealand Government has in place appropriate policies to improve the data over the longer term.

The estimation of waste in the inventory has changed over time. The Ministry for the Environment inventory report appropriately explains the way that these changes have impacted on the estimates of waste emissions. Previous

reviews of previous Net Position reports (2005, 2007) noted limitations and made recommendations which have been implemented. For example, in the 2007 review (AEA Energy and Environment, 2007) it was recommended that:

> *Consideration should be given to whether future wastewater emissions could be modelled directly for future years using the inventory methodology, as while the linear projection has an acceptable r_2, it does not take account of the potential for the current upwards trend to plateau. A linear extrapolation is still used for wastewater emissions, but there is an ongoing research project to examine the methodology used to estimate wastewater emissions which is due to report soon. This will use population growth as a driver for emissions.*

It appears that this action has been taken, with the latest projections for wastewater using a combination of IPCC methods and population statistics. This is an improved approach over the previous linear extrapolation and results in a slight increase in emissions for the projection period (0.04 Mt CO_2-e).

6.3 Assumptions – modelling

The modelling relies heavily on assumptions due to the limited availability of data on waste. The major assumptions include:

- that all solid waste is 'municipal' waste (this is of particular note, as the assumption that all solid waste is municipal in origin may lead to a significant overestimate of emissions, due to the lower degradable organic carbon fraction of industrial waste. While this assumption is conservative in nature and transparently applied, a more reasonable yet supportable factor should be sought)
- that solid waste composition is uniform throughout New Zealand and remains unchanged since 2004
- the use of default factors for BOD, capacity factor and scaling factor in the estimation of wastewater handling emissions the use of default composition values for the proportion of fossil fuel-derived carbon in incineration waste
- projections use Statistics New Zealand's National Population Projections (2006 base, series 1, 5 and 9). No description of the process of growing emissions based on these statistics is provided. A brief explanation of the direct relationship between population growth and increasing solid and sewage waste would build a better picture for stakeholders.

6.4 Proposals for improvements

Key areas for improvement in the forecasting of waste emissions include:

- the development of techniques to better characterise solid waste, including techniques to improve assumptions 1 and 2 above
- the development of consistent and transparent scenarios for high and low projections that include a component of technological change (such as landfill and sewage gas management and separation of organics from waste streams).

Key areas for improvement in the reporting of the projections include:

- move the more detailed description of reasons for the increase in projections from the appendices to the main report
- briefly describe the relationship between growth in population and growth in emissions from solid waste and wastewater in the main report.

7.0 General issues and recommendations

The review team noted the very clear intent of officials to provide robust advice in a transparent manner. However, a number of areas were identified where revisions to approaches across sectors would provide more consistent results and help stakeholders better understand the projections process. These issues can be broken down into three categories:

- technical issues including treatment of scenarios, consistency of assumptions, sensitivity, high and low estimates, and uncertainty assessment and inclusion of policies and measures into the projections
- process issues including documentation, transparency and the composition and characteristics of the Net Position Report.

7.1 Overall assessment of projections

The review team is satisfied the 2009 projections report is based on reasonable estimates of the likely sectoral emissions in the estimate period. New Zealand has improved its previous projections for the commitment period by demonstrably improving the underlying data, improving the modelling techniques applied to the data and streamlining and improving its report. The review team is of the view that while these improvements indicate a positive trend, in the interest of continuous improvement, further changes to the projections approach and reporting are recommended.

Recommendations range from suggestions to improve data and technical issues in the manner in which information is reported. A detailed discussion of the issues and potential improvements is presented below.

7.2 Technical issues

7.2.1 Scenarios

The Net Position Report would benefit from having a discrete set of scenarios to test emissions projections for each sector that are defined in detail and included in the report. Currently, where scenarios are used, there is inconsistency in approach. For example, in the energy model an assumption of ‘three drier years’ has been used, whereas the agricultural model uses a one in five drought cycle.

While only a handful of scenarios would likely be included, and these would focus on nationwide events (such as either a climatic event like a drought or economic transformation), the consistency in approach would provide policy makers with a better sense of the threats to New Zealand meeting its Kyoto Protocol emissions target. The results could be presented in the report in a central location, instead of only within each sectoral analysis.

7.2.2 Consistency in assumptions

Projection results are sensitive to assumptions for the values of the parameters and exogenous variables used in models. They are usually based on existing data, analysis, outputs of other models, and expert judgement. In preparing the Net Position Reports, an attempt should be made to seek consistency in the assumptions used in models. These should be reported in the Net Position Report, and the use of alternative assumptions should also be noted there.

7.3 Sensitivity and high and low estimates

Sensitivity refers to the relationship between modelling outcomes according to changes in either assumptions or input data. These shifts in outputs help create a high and low estimate of emissions, and should not be confused with uncertainty.

In order to ensure consistency and robustness of approach in preparing emissions projections, a list of input data and assumptions that are meaningful should be prepared and subject to change as a result of external influences. Combinations of factors from this list should be run through the model in order to determine high and low estimates. The list of factors used for assessing sensitivity and determining high and low estimates should be included in the Net Position Report and cross-sectoral analysis should be undertaken before preparing a high and low estimate for New Zealand as a whole.

7.3.1 Treatment of uncertainty (including combining uncertainties)

Projections of the future are necessarily uncertain. Uncertainty in emissions projections relates to modelling and future conditions in New Zealand and throughout the world. To be clear, the sensitivity analysis and high and low estimates described above cover the doubts about future conditions.

Uncertainty in this context relates to statistical uncertainty – including in relation to historical inventory data and the structural composition of models and their predictive abilities. Uncertainty was estimated for the most important sectors for New Zealand. However, the definition of, and processes used in defining, uncertainty were not transparent. The review team was unable to confirm whether a consistent approach was taken to estimate uncertainty, nor was it confident that a single definition of uncertainty was used. As a first step, the review team recommends the Net Position Report contain a discussion and definition of uncertainty, as well as a general description of the process used to estimate it.

7.4 Policies and measures

7.4.1 Treatment of policies and measures

There are three sets of policies and measures that need to be included in the Net Position Report. Each of these would benefit from revisions to how they are treated.

- International linking: New Zealand companies are able to purchase emission credits offshore and bring them in to New Zealand or establish Joint Implementation Projects in New Zealand and export the credits earned. The Net Position Report should contain a section explaining the expected trade of these credits, the basis for that analysis and an assessment of the impact on New Zealand's capacity to meet its Kyoto Protocol target.;
- Economy-wide policies: These include, particularly, the PRE measures and the implementation of an emissions trading scheme. At this point, there is no consistency in how the impact of a trading scheme is being treated in the projections. In the energy sector, two scenarios are used: one with and one without a carbon cost. In estimating deforestation, three policy scenarios are described (each with different costs to the landholder). There needs to be a clear decision about whether prospective policies are included and how these will be included. These results need to be clearly explained in the Net Position Report. In relation to the PRE measures, there needs to be clarity about whether these measures are incorporated into sectoral models (either explicitly or implicitly).
- Sectorally relevant policies: There needs to be a consistent approach, which is explained, that covers both when policies are included and how the results are transmitted. For example, there is an inconsistency between the LULUCF sector in which grants for forest plantings after storms are not included in models versus the energy sector where the impact of repeal of renewable energy and biofuel legislation is included, but the impact of each is described differently.

7.5 Process issues

7.5.1 Transparency and document control

The New Zealand Government should be commended for its efforts in preparing these emissions projections and in making all of its analysis public. The preparation of these estimates is a significant body of work requiring many person-months of effort across many New Zealand government departments.

At present, the results are publicly presented in a challenging manner, with a confusing path of weblinks required to collate all the necessary reading. The review team thinks an annotated bibliography with web links in one central place would help readers to navigate across the sources provided from different agencies. The links should only include those studies relevant to the preparation of a single Net Position Report. In this way, public access to the work underpinning the emissions projections would be facilitated.

Additionally, the review team recommends a template be prepared for all projections used to compile Net Position Reports. The purpose of this template would be to clearly report a number of factors described above such as assumptions, approach to sensitivity analysis and the like. These would be annexes to the Net Position Report and might streamline the documents needed to be included in the appendices.

Lastly, the content of the Net Position Report needs to be considered afresh. There is a necessary balance to be struck between 'telling a story' for policy makers and the public and providing technical details on findings and approach.

The review team recommends that in the future a somewhat longer executive summary be prepared with all of the high-level results. This would be supported by the Net Position Report itself, which would provide more detail on the results and would explain the trends and differences from previous reports. The appendices would consist of the template information, which would clarify the assumptions made, the uncertainties for each sector and other technical details. The detailed technical reports – which would be focused on the process of estimating future emissions rather than the outcomes – could be accessible through the web page.

7.6 Sectoral recommendations

7.6.1 Agriculture

1) A methodology for deriving prices that is best practice should be used; this would have the advantage of increasing transparency of changes in projections between years. In order to increase robustness of projections even further, price projections could be compared with forward prices as traded, for example, on the Chicago Mercantile Exchange.
2) The treatment of uncertainty in the agricultural sector needs to be articulated appropriately.
3) It is unclear whether emissions in the agricultural sector are particularly dependant on prices, soil moisture or other factors. In order to improve the general understanding of the factors that influence agricultural emissions, sensitivity testing could provide a useful tool in determining the key factors that influence emissions in agriculture.[6]
4) New Zealand should develop an alternative method for projecting future emissions to provide an independent check on the traditional approach.

[6] Sensitivity testing would probably not be able to occur on a yearly basis due to time constraints, but could happen every few years.

7.6.2 LULUCF

1) In the long term, development of an approach by which economic factors could be incorporated in the model to cross-check the intentions focus of the models currently in use, is recommended to better understand the drivers of land-use change,.
2) Update the description of emissions from land clearing to highlight that the new methodology is not an instantaneous release assumption, but indicates instead rapid removal of forest residues in changing land use and that it is based on available information.

7.6.3 Energy

1) Energy projections could be improved by running both the bottom-up and top-down approaches for estimating the impact of energy efficiency policies and comparing the two results.
2) Transport projections could be improved by tempering the elasticity of transport demand in areas that do not have public transport.

7.6.4 Industrial process

1) Ensure information on possible changes in technologies and raw materials is collected as part of the emissions projections for the industrial process sector. A statement that this has been done and the main aggregated findings could be included in the Net Position Report.
2) Conduct a sensitivity analysis on the potential high-side emissions from the non-synthetic gas industrial process sector.
3) Review and revise inventory data collection and the emissions projections approach for synthetic greenhouse gases, particularly HFCs used as replacements for ozone-depleting substances.

7.6.5 Waste

Key areas for improvement in the forecasting of waste emissions include:

1) the development of techniques to better characterise solid waste, including techniques to improve assumptions relating to whether all solid waste is ‘municipal waste’ and if solid waste composition is uniform throughout New Zealand and unchanged since 2004
2) the development of consistent and transparent scenarios for high and low projections that include a component of technological change (such as landfill and sewage gas management and separation of organics from waste streams).

Key areas for improvement in the reporting of the waste projections include:

1) moving the more detailed description of reasons for the increase in projections from the appendices to the main report
2) briefly describing the relationship between growth in population and growth in emissions from solid waste and wastewater in the main report.

7.7 General recommendations

1) The Net Position Report would benefit from having a discrete set of scenarios to test emissions projections for each sector that are defined in detail and included in the report.
2) In preparing the Net Position Reports, an attempt should be made to seek consistency in the input data and assumptions used in models and these should be reported transparently in the report. Where there are different, particularly contradictory assumptions, the rationale for their use needs to be explained.
3) There needs to be consistency in how economy-wide and sectoral policies and measures are included and reported in the results. This will need to include a section explaining the expected trade of international credits, the basis for that analysis and an assessment of the impact on New Zealand's capacity to meet its Kyoto Protocol target.
4) Revisions to the structure and content of the Net Position Report should be considered, including:
    - a template for all sectoral projections to clearly and consistently report a number of factors such as assumptions, approach to sensitivity analysis and the like. Additionally, there should be a single, comprehensive discussion of the list of factors used for assessing sensitivity and determining high and low estimates across all sectors
    - an annotated bibliography that provides details on resources used. Online, it would be helpful if there was a website which described and provided links to those studies relevant to the preparation of a single Net Position Report.

8.0 Note on sources

The majority of the sources used in this report were official and working papers prepared by the New Zealand Government. This included the 2009, 2007 and 2005 Net Position Reports, as well as National Inventory Reports and national communications. Additionally, the review team considered a large number of working papers prepared by various New Zealand departments on projection results, methodologies and related issues. These included papers from the Ministries for Environment, Agriculture and Forestry, and Economic Development.

In addition to these sources, the review team consulted material on inventory and emissions projections methodologies and processes prepared by the OECD, the IPCC and the UNFCCC. These sources were consulted for comparative purposes and to ensure it had an up-to-date understanding of best practice. Finally, the review team consulted a number of sectoral reports prepared by the Australian Government. These were consulted to have a direct comparison of alternative approaches.