Ministry of Economic Development

Assessment of the Likely Impacts on Selected Sectors of a Domestic Emissions Trading Regime

29 July, 2001

PA

Ministry of Economic Development

Assessment of the Likely Impacts on Selected Sectors of a Domestic Emissions Trading Regime

29 July, 2001

Client Confidential

PA Consulting Group
PO Box 1659
142 Lambton Quay
Wellington
Tel: +64 4 499 9053
Fax: +64 4 473 1630
www.paconsulting.com

Version: 1.0

EXECUTIVE SUMMARY

Introduction

This report describes the result of an initial investigation into the impact of the introduction of a tradable emissions permit regime for greenhouse gases.

The investigation is focused on the areas considered most susceptible to the impact of an emissions trading regime, namely;

- *Coal, Gas and Geothermal energy* - encompassing energy suppliers and users (including electricity generators)
- *Oil (including Transport)* - ie oil-based fuel suppliers and transport fuel users
- *Industries that give rise to* CO_2 *emissions from non-combustion processes* - notably calcination of lime within the cement industry and reduction of ironsand within the steel industry
- *Industrial Processes that give rise to non-* CO_2 *emissions* – notably, those involved with insulation, refrigeration and switch gear
- *Waste Management* – encompassing solid waste disposal and wastewater treatment (including industrial wastewater)
- *Agriculture* – including both dairy and other pastoral farming
- *Forestry* – encompassing both harvesting obligations and implications of sink credits[1]

The investigation was carried out and written up over the Month of May 2001. It is based on a particular characterisation of the emissions permit regime current at the time of writing. Core parameters of the regime include;

- Initial allocation is by competitive tender;
- Permits are internationally tradable; and
- The value of the permits in 2008 is $20.00 per tonne of CO_2 equivalent*;*

In a number of cases, the impact of varying the specification of these core parameters is considered.

The report describes the expected impact of the carbon emissions price impost on the structure and conduct and performance of the sectors examined. While the time allowed for the preparation of this report has restricted the depth to which each of the sectors could be examined, some interesting findings have emerged. Key results are summarised below.

[1] Sink credits are a means of rewarding foresters for the carbon removed from the atmosphere and "locked up" in forest biomass.

Coal, Gas and Geothermal energy

The introduction of a tradable emissions permit regime will have a discernible impact on the coal, gas and geothermal industries, as well the closely associated electricity sector. The effects of emission permits will be seen in both prices and a technology shift.

We expect an increase in gas, coal and electricity prices. For a permit price of $20.00 per tonne of CO_2 equivalent, we expect to see price changes in the order of those given in the table below.

	Gas	Coal	Electricity
Wholesale	30%	60%	16%
Industrial	20%	38%	10%
Commercial	10%	16%	9%
Residential	6%	15%	8%

We anticipate that this will result in wind and hydro generation becoming economic. This will be especially true of small wind installations and mini-hydro generators that are embedded in the distribution network.

We expect to see some pressure on the price of gas from electricity generators to keep new gas-fired plant economic. In general, however, we do not expect a significant reduction in the use of gas for electricity production.

Electricity generators who rely heavily on hydro and geothermal generation are likely to gain significantly from a permit regime. The higher price of gas is pushing up the electricity price benefits generators with low cost fuels – especially those low cost producers of electricity from renewable sources.

Coal is expected to become more expensive. There will be pressure on coalmines that are of marginal value to shut, particularly those supplying for domestic consumption. Were the point of obligation to be on the mines, the coking coal export industry would struggle to survive against its non-Annex 1 competitors.

With all fuels more expensive, we expect to see a demand-side response that will encourage fuel conservation. However, at a $20.00 per tonne permit price, this response is not expected to be more than 3-6% without other supporting conservation measures.

Oil (including Transport)

The other major energy source affected by the introduction of a permit regime is oil. The imposition of a tradable emissions permit regime will add a small premium to existing fuel prices (in the order of 4 cents per litre at an emission permit price of $20.00 per tonne).

New Zealand's oil (and associated transport) industries are characterised by considerable competitive pressures with low margins amongst transport operators. The demand for transport services is very inelastic. Price increases generally only result in small shifts in demand.

The competitive nature of the industry, coupled with the inelastic demand, means that virtually all of these costs can be expected to be passed through to the consumer of fuels and to the end-consumer of transport services.

This increase is significant enough to be noticed but relatively insignificant when compared to fluctuations seen recently as a result of changing crude prices and exchange rate fluctuations.

In the short term, this (small) structural shift in the price of transport fuels may reinforce interest in public transport alternatives and increase pressures for rationalisation in the low margin commercial transportation industry.

In the longer term, it may add impetus (however small) to the introduction of new alternative technologies (including fuel cells and "hybrid" cars)

In general, however, the size of the increase is not considered large enough to have any significant impact on transport mode or fuel choice.

Industries that give rise to CO_2 emissions from non-combustion processes

A small number of industries in New Zealand emit CO_2 as a direct consequence of the manufacturing processes they employ. These emissions are over and above any that might result from the consumption of energy.

The most notable examples are the metal production industries (iron and steel making and aluminium smelting) and specific mineral processing industries (cement manufacture and lime processing).

These industries have quite distinct characteristics and cannot be considered a homogeneous sector. Each will be affected by the introduction of an emissions permit regime in a slightly different manner.

We consider that the Steel Industry would be most seriously affected, to the point that it could undermine the viability of the primary processing operations within the industry.

The Aluminium Industry could also be seriously affected – depending on the extent to which the impact of increased electricity costs is passed through in its electricity contracts.

The Cement and Lime Processing industries appear to be in a better position to pass on additional costs to customers, due to the lack of readily available imported substitute products.

Allocating the credits (free of charge) on the basis of 1990 emission levels would have the effect of lowering the impact on the steel industry and cement / lime industries and would reward the aluminium industry for the improvements in its processes since 1990.

The projected impact as a percentage of turnover for the industries concerned is summarised in the table below:

Industry	% OF TURNOVER	
	Emission permits @ 20/tonne (1999 production levels)	Emission permits @ 20/tonne (1999 less 1990 production levels)
Iron & Steel	6.22%	0.74%
Aluminium	1.53%	0.22%
Cement	2.61%	0.77%

TABLE 1

Industrial Processes that give rise to non-CO_2 emissions

In addition to the industries emitting CO_2 gases, some industrial processes within New Zealand give rise to emissions of non-CO_2 greenhouse gases. Most notable in this respect are the industries involved in insulation and refrigeration (which lead to the release of HCF 123) and the electricity transmission and distribution industry (which give rise to the release of SF_6).

HCF 123 is used both as a foaming agent in the manufacture of insulation and as a refrigerant. SF_6 is used as an insulator in electrical switchgear.

The introduction of a tradable emissions permit regime would add to the cost of manufacture of a domestic or commercial refrigeration unit by around 1-2% of the total cost of the unit. There are alternative refrigerants and foaming agents available at much the same cost as HCF 123. However, the cost of switching production lines to these alternatives is not insignificant. The refrigeration industry is highly competitive, with many of New Zealand's competitors located in non-Annex 1 countries.

Interestingly, the allocation of permits free of charge, in proportion to 1990 emission levels, would do little to alleviate the impact on the industry. It is only in the last decade that the industry has switched to using HCF 123, prompted in the main by a desire to eliminate ozone-depleting CFCs.

With respect to the use of SF_6, the introduction of an emissions permit regime would increase the capital and operational costs in the electricity transmission and distribution slightly. However, the advantages offered by SF_6, namely, reduced maintenance costs with respect to non-SF6 switchgear and the lowered capital costs with respect to the land required for the installation, mean that its use is likely to continue should the emission permits regime be introduced.

Waste Management

The introduction of a domestic emissions trading regime has the potential to affect both the wastewater management industry and the disposal of solid waste.

Our assessment is that it would have very little impact on the wastewater management industry. The additional costs imposed on the industry would be too small to induce behavioural changes for either the treatment providers or wastewater producers.

The likely impacts for landfills, however, are a little less clear cut. Industry wide, the additional costs would have minimal impact on the amount of waste being disposed of in landfills. The impacts will be felt in terms of the resulting distribution of waste volume disposals to the various landfills.

This impact would arise from the additional costs being applied unevenly across landfills. Landfills with gas collection systems would not be required to purchase as many permits per volume of waste than other landfills. Depending on the degree to which individual landfills apply user-pays pricing principles, the introduction of emissions permits could see a slight diversion of waste towards the landfills that control their gas emissions. At worst, the permits regime could force the closure of a small number of landfills (which are already under pressure to close as a result of environmental requirements). This will reinforce the current trend in the industry towards the market being serviced by fewer, but larger landfills.

Agriculture

The introduction of a greenhouse gas tradable emissions permit regime is likely to have a significant impact on the agricultural sector. It is estimated that, if permits are sold to the sector, the requirement to hold permits will increase the cost of production of agricultural products by between 5.5% (for dairy) and 21.5% (for venison).

In some circumstances, these costs may be passed on to consumers but it is likely that the farmers will bear the bulk of the burden of the permit price.

The effect is least pronounced for dairy and beef farmers and we would expect it to have little impact on their industry. The cost increase is small and there is a greater possibility of passing the cost impost on to consumers.

The impact is much greater on sheep farming. In this subsector, it is unlikely that all the increased costs can be passed to consumers. Cost increases above 10% will have a major effect on farm profitability.

Deer farmers also face a considerable problem. While venison and velvet are niche markets, it is debatable whether they can carry a price rise of the order suggested in this report. Either there will need to be a change in deer farming regimes, or the industry is likely to face substantial restructuring and possibly decline.

Placing the point of obligation at processors will see permit prices linked to animals and products processed. This is easy to administer. If sector boards assume point of obligation responsibilities, the cost of the permits may be allocated according to herd/flock size. This will be much more difficult to monitor and administer.

If permits are allocated rather than purchased, the sheep industry will incur no cost. In fact, it will enjoy a windfall gain as a result of the reducing size of the national flock. Beef and dairy will face some cost in buying permits to meet their shortfall. The deer industry will have to buy nearly all the permits they require. This will tend to move farmers from deer farming to sheep and cattle farming.

Forestry

The forestry industry is unique amongst the sectors considered, in that it has the ability to benefit from the introduction of a tradable emissions regime through the creation of credits corresponding to the amount of carbon that is “fixed” in the forest resource.

In the first instance, this has the potential to reward new investors in forestry through the creation of an additional revenue stream (in the form of permits to the value of the carbon sequestered). However (at least under the regime as it is currently framed) the return is only temporary in nature. The forest owners will be required to surrender all of their newly acquired permits at the time of harvest leaving them no better off. As a result, we do not expect any significant increases in new plantings as a result of the introduction of the tradable emissions permit regime.

Furthermore, the owners of forests planted prior to 1990 stand to become worse off under the regime if they choose not to replant their forests at the time of harvest. The barrier this creates to the exiting industry constitutes a real cost to the large established players in the industry. Generally, the regime creates a complex set of incentives for the large established players which may see them investing or harvesting sub-optimally (from an economic efficiency point of view). In addition, the large energy component of the forest processing industry is likely to make investment in forest processing more attractive in non-Annex 1 competitor countries (which do not have the cost of emission permits built into the price of energy).

On balance, we do not consider that the introduction of a tradable emissions permit regime will favour the forestry sector.

Conclusions

The introduction of a tradable emissions permit regime has the potential to affect all of the sectors canvassed in this study – to varying degrees. Most will be required to make some form of adjustment.

The impact is likely to be felt most seriously in the metal processing industries (particularly the production of steel), the coal industry, and the agriculture sector (particularly deer and sheep).

It is also likely to lead to rationalisation within the commercial transportation industry and (perhaps) the operation of landfills.

The impact on the forestry sector will to an extent depend on the precise specification of the permit regime and on how forest owners choose to manage any newly acquired carbon credits. But, on balance, it does not look to be favourable.

Interestingly, the option of “grandfathering” the allocation of permits would have quite different impacts across the different sectors. For example, it would aid considerably the position of metal processing industries but do nothing to alleviate the impact on the refrigeration or deer farming industries.

Households will feel the impact of the introduction of the regime principally through rises in the price of energy (electricity and gas) and in transport fuels. However, it is also possible that they will feel the effect of some of the impacts in the agricultural sector - through higher prices for meat and wool in particular. The overall impact is likely to be in the order of a 1% to 2% rise in consumer prices as the repercussions of the regime filter through the economy.

PA

TABLE OF CONTENTS

Appendices

1. INTRODUCTION

PA Consulting Group (PA) has been retained by the Ministry of Economic Development to conduct an investigation into the impact of the introduction of a tradable emissions permit regime for greenhouse gases.

The investigation is focused on the areas most susceptible to the impact of an emissions trading regime, namely;

- *Oil (including Transport)* - ie oil-based fuel suppliers and transport fuel users
- *Coal, Gas and Geothermal energy* - encompassing energy suppliers and users (including electricity generators)
- *Industries that give rise to* CO_2 *emissions from non-combustion processes* - notably calcination of lime within the cement industry and reduction of ironsand within the steel industry)
- *Industrial Processes that give rise to non-* CO_2 *emissions* – notably, those involved with insulation, refrigeration and switch gear
- *Waste Management* – encompassing solid waste disposal and wastewater treatment (including industrial wastewater)
- *Agriculture* – including both dairy and other pastoral farming
- *Forestry* – encompassing both harvesting obligations and implications of sink credits[2].

The investigation was carried out and written up over the Month of May 2001. It is based on a characterisation of the emissions permit regime provided by the Ministry. As such, it represents the best estimate of the specification of the regime available at the time of writing. Should the design of the regime evolve to the extent that it varies significantly from that evaluated in this document, it is possible that the impacts postulated in this report may need to be revisited.

The report is organised as follows:

- *Chapter 2* - provides an overview of the approach taken to the investigation. It covers the methodology employed, the data and data sources referred to and the way in which the presentation of the material dealing with each of the sectors is organised.
- *Chapter 3* - details the characteristics of the tradable permits regime that is to be evaluated. By way of preamble to the specification of the regime, we also include some background information on emission reduction targets set for New Zealand as part of the international negotiation process, New Zealand's recent historical record of greenhouse gas emissions, and the broad policy context within which the specification of the regime is being developed.
- *Chapters 4 to 10* - contains our views on the likely impact of the introduction of the tradable emission permits regime on each of the key sectors identified above.

The appendices provide additional baseline data, along with the information sources used in generating the report.

[2] Sink credits are a means of rewarding foresters for the carbon removed from the atmosphere and "locked up" in forest biomass.

2. STUDY APPROACH AND METHODOLOGY

2.1 INTRODUCTION

It is vital that an investigation of this type be conducted within a consistent and robust analytical framework. This will ensure all relevant elements of the possible impacts of emission permits are captured and that the reader can have confidence that the analysis and presentation of results is based on a rigorous foundation.

In this chapter, we outline the methodology employed in this investigation, the sources of our information and the way in which the analysis is presented.

2.2 METHODOLOGY

The Industrial Organisation (IO) branch of economics provides us with a ready-made methodology for an analysis of this type. IO is particularly suited to situations where a detailed understanding is required of the impacts of significant policy changes on the functioning of the various sectors within an economy.

The most commonly used IO methodology is the Structure-Conduct-Performance Model developed at Harvard during the middle of the twentieth century. This is the model we adopt as the primary framework for the evaluation.

However, more recently Price Theory Models have also been used as analytical tools in the Industrial Organisation field. Price Theory models also have the potential to inform the analysis of the economic impact of the introduction of tradable emission permits. The fundamentals of both models are explained below.

2.2.1 Structure-Conduct-Performance Model

The Structure-Conduct-Performance Model analyses an industry's **performance** (ie its success in producing benefits for the end user) as a function of the **conduct** (or behaviour) of firms, which in turn depends on the market **structure** (factors that determine the competitiveness of a market).

Figure 1[3] below shows the nature of the relationships between structure, conduct and performance, and importantly how industry conditions and government policy interact. In this particular assignment, the task becomes one of postulating the likely impact on the structure; conduct and performance of the sectors chosen given the "policy shock" of a tradable emissions permit regime.

The list of factors relevant to this assessment (identified in Figure 1) suggests that impacts of policy shocks are often multi-dimensional (affecting aspects of structure, conduct and performance) and that their determination is not a trivial task.

In order to capture the subtleties of these multi-dimensional impacts, and to avoid conveying an impression of precision where it does not exist, we have (mostly) steered away from any attempts to quantify the impacts. Rather, we have focussed on using

---

[3] Taken from Carlton and Perloff *"Modern Industrial Organisation"* Second Edition, 1994

qualitative descriptors as a means of describing what we might expect to occur in each of the sectors under examination.

The one exception to the above is the electricity sector where we have made use of our mathematical model of the New Zealand wholesale electricity market (WEMSIM) – which has been developed and refined over a number of years. WEMSIM allows us to model quantitatively the impact on the electricity sector (including market clearing price and dispatch) of changes in the price of input fuels. However, even with the insights provided by this sophisticated modelling capability, the uncertainties and complicating factors mean that the quantitative results produced by WEMSIM need to be accompanied by an extensive qualitative commentary.

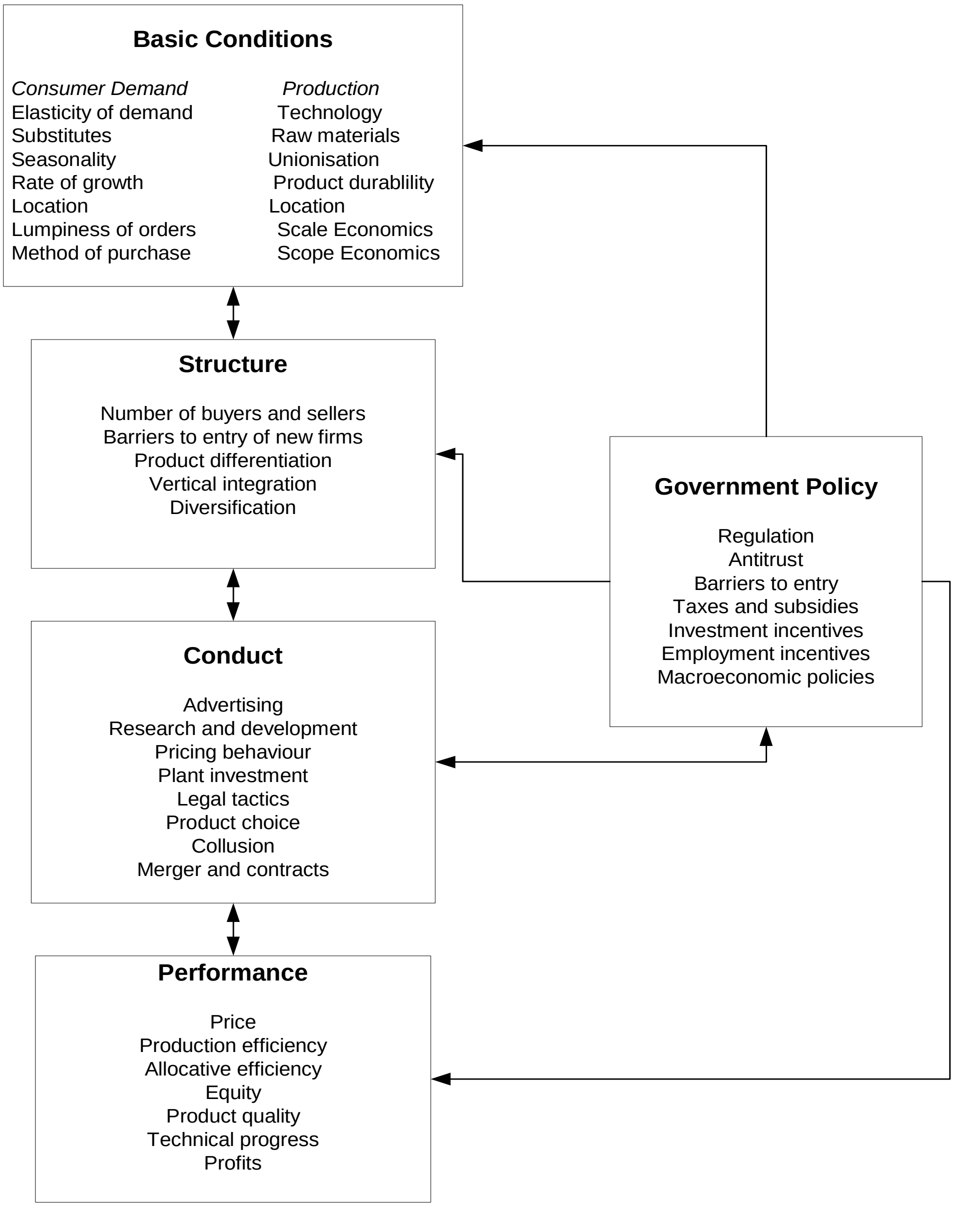


FIGURE 1: RELATIONSHIPS AMONG STRUCTURE-CONDUCT-PERFORMANCE, AND INTERACTION BETWEEN GOVERNMENT POLICY AND BASIC

2.2.2 Price Theory

Price theory models have the potential to complement the insights provided by the Structure-Conduct-Performance analytical framework.

Essentially, price theory models focus on the micro-economic incentives facing individuals and firms as a means of explaining market phenomena. In recent years, three theoretical applications of price theory have been used extensively; transaction cost analysis, game theory and contestable market analysis.

The **Transaction costs** approach uses differences in transaction costs to explain why structure, conduct and performance varies across industries. In brief, it involves identifying a set of environmental and human factors, which explain internal firm and industrial organisation. The main environmental factors are *uncertainty* and the *number of firms*, while the key human factors are *bounded rationality* and *opportunism*.

Game theory uses formal models to describe how firms form their strategies and how these strategies shape profits. This approach provides insights into situations in which there are relatively few firms. We have found this approach (Cournot gaming models in particular) to be useful in explaining behaviour in the wholesale electricity market.

Contestable Market Analysis focuses on the barriers to entry (or exit) as a means of explaining market phenomena. Markets in which many firms can enter rapidly, if prices exceed costs, or can exit rapidly if prices drop below costs are called contestable. Where sectors are characterised by few firms and entry or exit are difficult, the market is not contestable, and the strategic behaviour analysed in game theory becomes more relevant. If the number of firms is few, but entry and exit is easy, strategic behaviour becomes less of an issue. This suggests for example that the liquidity of the market for emission permits is going to be something to consider in this assignment.

As can be seen from the above, Price Theory provides a valuable set of analytical tools when it comes to understanding how the introduction of a tradable emission permits regime might impact on the structure, conduct and performance of the sectors under consideration. We have used these analytical tools in undertaking the investigation.

2.3 DATA SOURCES

The timeframe provided for this study has meant that we have relied as much as possible on existing sources of information. In particular, with respect to emissions data, we have drawn heavily on New Zealand's National Inventory Report of greenhouse gases published by the Ministry for the Environment and the report on Energy Greenhouse Gas Emissions published by the Ministry of Economic Development.

In the electricity sector, as indicated above, we have been able to draw on existing models of the wholesale electricity market running them under different scenarios with respect to the cost of carbon.

In most of the other sectors, however, we have relied on discussions with industry groups as a means of complementing what existing information there is available. A list of individuals and organisations consulted during the course of this assignment is contained in Appendix A.

2.4 STRUCTURE OF SECTORAL CHAPTERS

In order to provide some consistency to the analysis and to the presentation of the findings, we have structured each of the chapters dealing with the analysis of the particular sectors along similar lines. Essentially, they all follow the same broad format as follows:

- *Description of the sector* – in which the sector, subject to the analysis, is described as it exists at the moment. In accordance with the analytical framework laid out above, the sector is described in terms of:
  - Its basic conditions;
  - Its structure;
  - Its conduct; and
  - Its performance.
- *Impact of emission permits* – in which the impact of the introduction of a permits regime is worked through. Again, the findings of this part of the analysis are presented in terms of the same structure-conduct-performance framework; and
- *Conclusions* – in which the key elements of the analysis are drawn together

3. THE TRADABLE EMISSION PERMITS SCENARIO

3.1 INTRODUCTION

In this chapter we specify the design parameters of the tradable emission permits regime that will be the subject of the impact analysis. By way of preamble, the chapter also includes as background an overview of the state of New Zealand's emissions and the domestic and international policy context within which the development of the tradable emissions regime is taking place.

3.2 BACKGROUND

3.2.1 The State of New Zealand's Emissions

A. THE CURRENT SITUATION

New Zealand's total greenhouse gas emissions are small from a global perspective, accounting for around 0.5% of total emissions. However, on a per capita basis, New Zealand's emissions are comparable to most other developed countries.

Where New Zealand is significantly different from the rest of the world, however, is in the composition of its emissions. New Zealand is unique amongst the developed world in having methane as its largest component of greenhouse gases. Methane, along with nitrous oxide emissions, stems largely from the agricultural sector.
Unusually, carbon dioxide is only New Zealand's second most significant greenhouse gas (39%) of which the energy sector accounts for by far the largest proportion (around 90% of New Zealand's gross human-made CO_2 emissions). The remainder comes from industrial processes. The primary sources of CO_2 emissions from within the energy sector are domestic transport (accounting for 43.2% of CO_2 emissions within the energy sector), Industry (21.7%) and Electricity Generation (20.2%). The core elements of New Zealand's greenhouse gas emissions profile is summarised in Figure 2 and Figure 3 below.

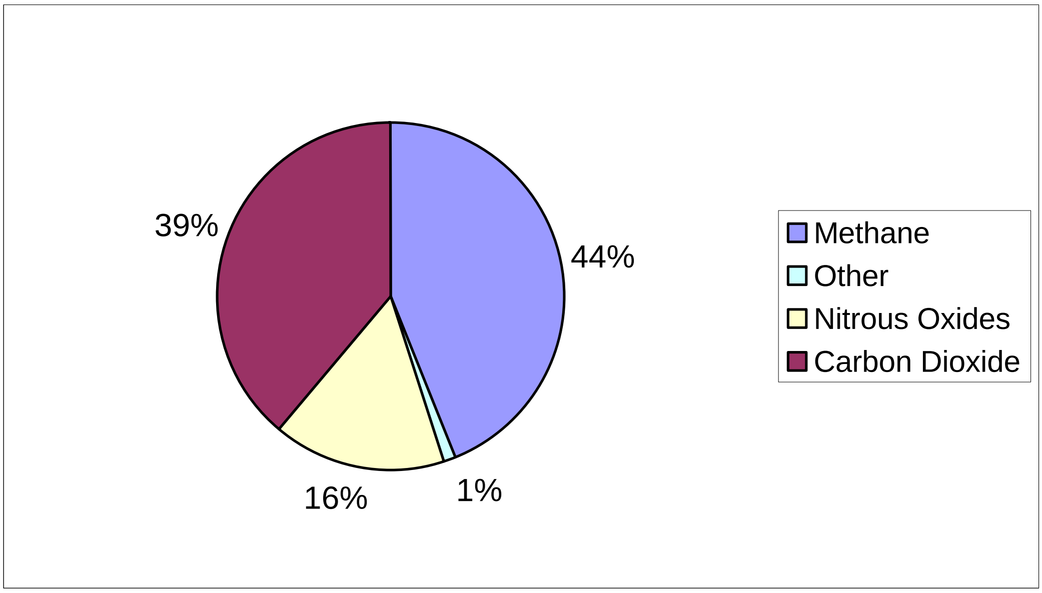


FIGURE 2: NEW ZEALAND'S GREENHOUSE GAS EMISSIONS

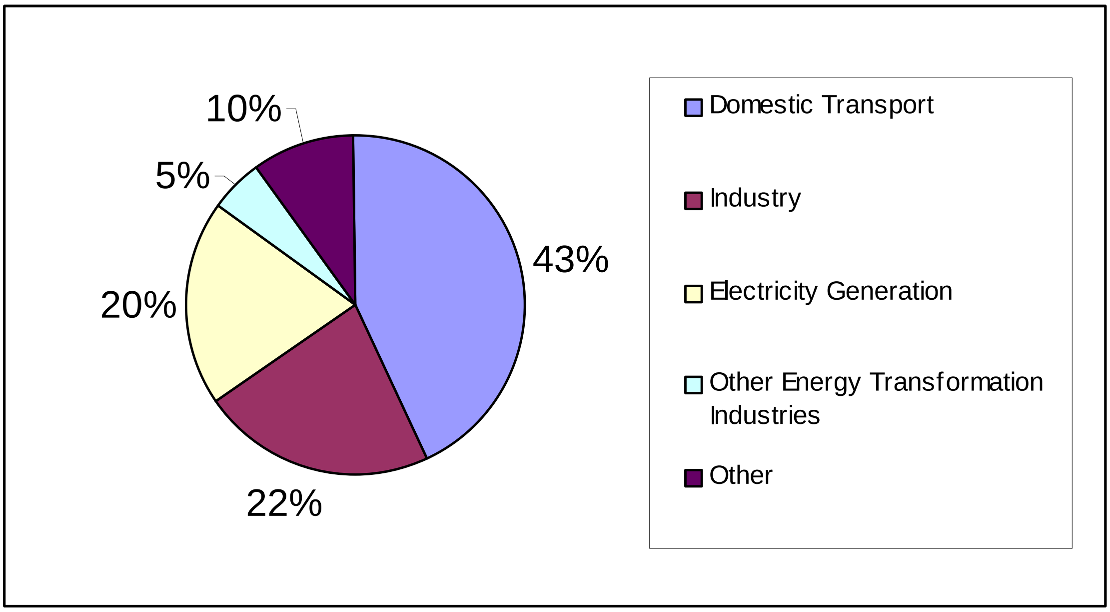


FIGURE 3: CARBON DIOXIDE EMISSIONS FROM THE ENERGY SECTOR

More details on New Zealand's greenhouse gas emissions are contained in Appendix B.

3.2.2 The policy development context

A. THE KYOTO PROTOCOL OBLIGATIONS

As with other developed countries, New Zealand's climate change policy is strongly influenced by The Kyoto Protocol negotiated in 1997 under the auspices of the Framework Convention on Climate Change.

In essence, the Protocol sets national emission obligations for the period 2008-2012 (known as the first commitment period). If ratified, the Protocol would oblige New Zealand to manage its net emissions to 1990 levels (ie 365 (5 x 73) Mt of CO_2 equivalent) during the commitment period. If New Zealand ratifies the Protocol, it must either reduce its emissions to this amount, or account for any excess by purchasing further emission units on the international market.

Other key features of the Kyoto Protocol include:

- Provisions for international emission trading.
- Provisions for forest sinks to be included and traded (post 1990).
- Provisions for "clean development mechanism" initiatives.

B. DEVELOPMENT OF THE DOMESTIC RESPONSE

New Zealand, like most countries, faces a considerable challenge in meeting its Kyoto target. Present forecasts suggest that, under "business as usual" (ie assuming no additional measures are taken to reduce emissions) New Zealand's emissions would exceed its initial assigned amount in the commitment period by 9 -14% (or 34 to 50 Mt CO_2). Even taking into account the potential for abatement, it seems unlikely that New

Zealand's emissions could be brought back to 1990 levels. This means that New Zealand will invariably need to rely on sinks and/or purchases of credits on the international market in order to achieve its Kyoto targets (see Figure 4).

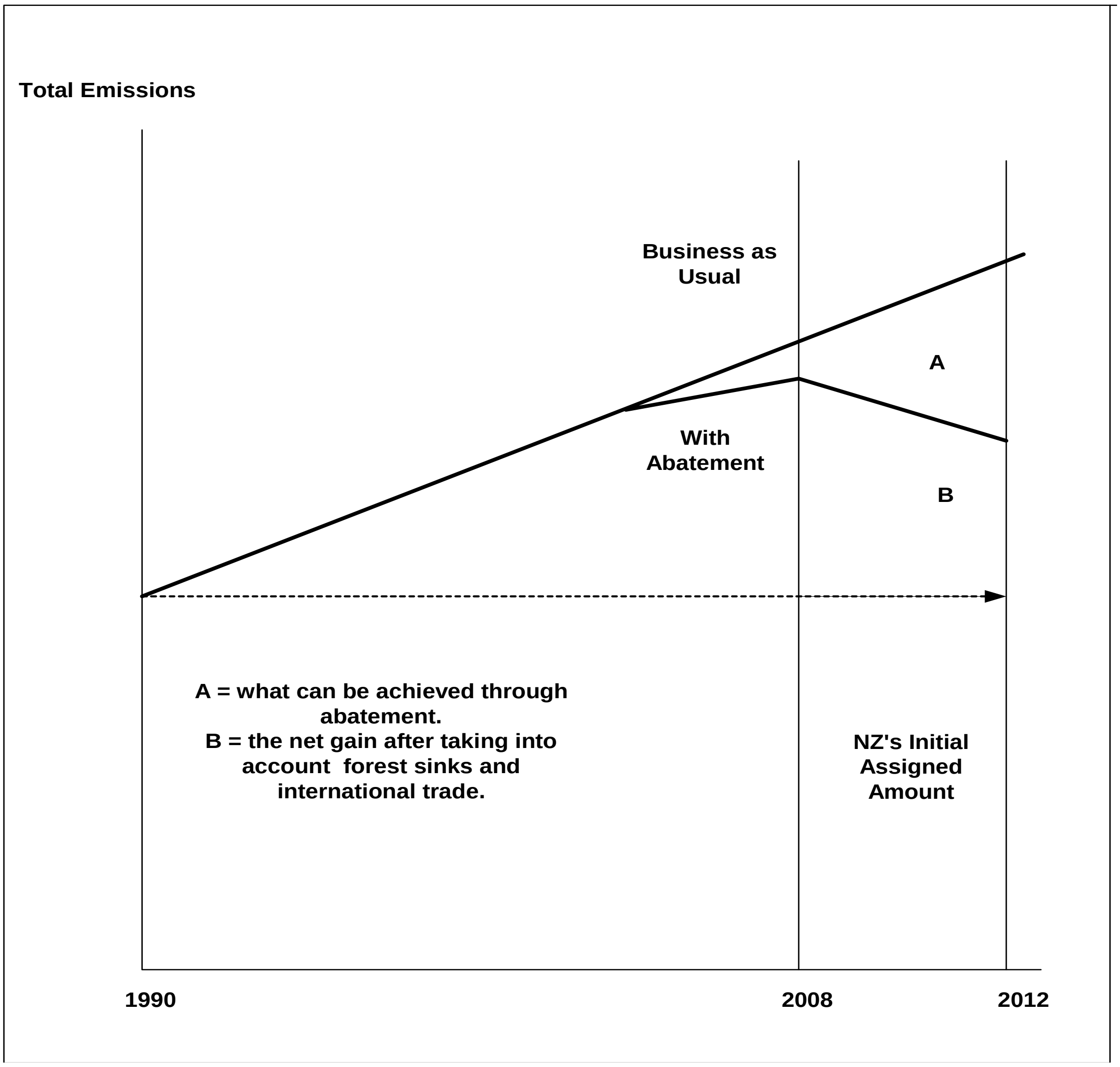


FIGURE 4: MANAGING NEW ZEALAND'S EMISSIONS: WITH AND WITHOUT ABATEMENT

In responding to the Kyoto Protocol, the Government has been developing policies to both cover the period leading up to the first commitment period, and the first commitment period itself.

Measures being investigated for implementation in the pre-commitment period include:

- Forward trading of emission units covering the 2008 – 2012 Commitment period (see below).
- Negotiated Greenhouse Agreements.
- Public education/communication (targeting changes in behaviour).
- (Options for) cost effective non-price measures in energy efficiency, agriculture, transport and waste.
- Depending on the outcome of the tax review (late 2001), a carbon charge (including accommodations for the NGA participants) to be implemented after the next election;

and

- Pilot emissions permit trading scheme.

Measures being developed for application during the Commitment period include:

- A domestic emissions trading regime capable of interfacing with an international trading regime. This is unlikely to be comprehensive (ie will not cover all emissions).
- A suite of other complementary measures (still to be determined).

Much of the detailed policy development work with respect to both periods is still to be finalised. With respect to the emissions permit trading regime, fundamental design issues still need to be concluded including the point of obligation (ie the point within the affected industry structure at which the obligation to hold permits will rest) and the allocation of New Zealand's assigned amount of emission units. The table below summarises the key dates in the policy development process.

Date	Policy milestone
December 2000	In principle, decisions on cross sectoral and price measures and the longer-term framework.
March 2001	Decisions on the proposed domestic policy package.
April – June 2001	Consultation on the domestic policy package.
August 2001	Detailed implementation decisions on the proposed policy package and proposals for legislation.
Early 2002	Introduction of legislation.
June 2002	Ratification of the Protocol.
2005	Requirement to show demonstrable progress.
1 January 2008	First five year commitment period commences.

TABLE 2: KEY DATES IN THE POLICY DEVELOPMENT PROCESS

3.3 THE TRADABLE EMISSIONS PERMITS SCENARIO

3.3.1 Overview

In broad terms, a tradable emissions permit regime for greenhouse gases requires anyone undertaking activities which lead to greenhouse gases being emitted into the atmosphere to hold a permit covering those emissions.

If a potential emitter does not hold a permit, they will be required to buy a permit from some other permit holder. If they are not prepared to pay the (market) price for permits they will be required to either cease (or not begin) the activity or to undertake the activity in a way that does not lead to emissions.

The tradable emissions permits regime is considered to be an "efficient" means of constraining emissions in that it tends to lead to the permits ending up in the hands of those who value them most. The holders of permits tend to be those who are producing valuable products for which there are few substitutes and/or do not have cost-effective means at their disposal to reduce emissions. This in turn means that abatement occurs in the economy where the cost of abatement is lowest.

To increase the efficiency benefits of the tradable emissions permits regime; the regime may be specified so that it encompasses all greenhouse gases. Thus a permit holder emitting CO_2 may sell his/her permit to someone wishing to emit methane, for example. This allows abatement efficiencies to occur across gases as well as within a particular gas type.

In order for this inter-gas permit trading to occur, all gases must be converted to a common currency in proportion to the impact they have on global warming (their Global Warming Potential). In most cases, the common currency is specified as CO_2 equivalent – reflecting the prominent nature of CO_2 as a greenhouse gas[4]. The table setting out the relevant conversion factors is included below[5].

Global warming potential (CO_2 equivalent per tonne emitted)	
CH_4	21
N_2O	310
HFC 125	2,800
HFC 134	1,300
HFC 143	3,800
PFC(CF_4)	6,500
PFC(C_2F_6)	9,200
SF_6	23,900

TABLE 3: GLOBAL WARMING POTENTIAL (CO_2 EQUIVALENT PER TONNE EMITTED)

3.3.2 Specification

Although the shape of the tradable emissions regime is known in broad terms, its development has not yet reached the stage where all of the relevant parameters are completely specified. Matters still to be determined include such things as the "point of obligation" (ie, where precisely in the production chain the obligation to hold the permit

---

[4] This is not necessary however. Any gas could be used.

[5] Table reproduced from http://www.med.govt.nz/ers/environment/climate/emissions/industrial/industrial02.html, Ministry of Economic Development, Wellington New Zealand, 2001

rests) and the way in which the permits will be initially allocated. However, for the purposes of this exercise it is necessary to specify a particular scenario that can be made the subject of the evaluation.

In the table below we have specified the tradable emissions permit regime in terms of all of its core parameters. For a number of the parameters we have identified core assumptions, along with an alternative that can form the basis of (qualitative) sensitivity analysis as we examine each of the individual sectors.

Parameter	Core Assumption	Alternative Assumption
Definition of emission unit	Enables a point of obligation to emit any greenhouse gas to the value of one tonne of CO_2 equivalent	
Initial allocation method	Competitive Tender	Allocated free to points of obligation on the basis of their share of total 1990 emissions.
Initial allocation quantity	Emission units sum to the total of five times New Zealand's emissions for the year 1990 (but some may be held in reserve by Government – given international tradability, this would not affect price)	
Tradability	Tradable both within New Zealand and internationally	
Value of permits in 2008	\$20 per tonne of CO_2 equivalent	\$10 per tonne of CO_2 equivalent \$30 per tonne of CO_2 equivalent
Point of obligation[6] (Energy related emissions)		
• Emissions from oil	Refinery and Importers of petroleum products	
• Emissions from gas	Pipeline operators + major users + extractors[7]	Pipeline + extractors[8]

---

[6] The point of obligation describes the point in the production chain where the obligation to hold emission units to cover greenhouse gas emissions will rest. For example, making the refinery accountable for emissions means that the refinery will need to hold units to cover the emissions that will occur when their petroleum products are eventually used in vehicles.

Parameter	Core Assumption	Alternative Assumption
• Emissions from coal • Emissions from geothermal	Major users + wholesalers + mines. Major users and extractors[9]	Mines only
Point of obligation (Non-energy emissions) • Emissions from industrial processes • Emissions of synthetic gases (SF_6, HFC etc.) • Emissions from waste • Emissions from Agriculture	Industrial plant owners Importers of equipment containing synthetic gases and bulk source materials Landfill and wastewater treatment plant operators Fertiliser manufacturers (and importers) and processing companies[10]	National sector bodies[11]
Treatment of sinks • Kyoto forests[12]	Kyoto forests will receive credits in the form of units equivalent to CO_2 sequestration during the commitment period. Units	Kyoto forests will receive credits in the form of permits equivalent to CO_2 sequestration rates during the period in which the

[7] In effect, the extractors of gas would be accountable for fugitive emissions at the wellhead, and the pipeline operators would need to hold permits for all gas delivered through the pipeline, except for that delivered to major users of gas (ie electricity generators and the methanex plant) which would be accountable for their own emissions.

[8] Under this alternative scenario, the pipeline operators would not need to hold permits. However, the gas retail companies along with the major users would.

[9] In effect this amounts to the electricity industry. We are assuming that no obligation would rest with householders extracting geothermal energy for domestic applications.

[10] In effect, the fertiliser manufacturers and importers would be accountable for the effect of fertiliser on enhancing nitrous oxide emissions from soils. The processing companies (meatworks, dairy companies, wool receivers etc.) would be responsible for the bulk of agricultural emissions, being nitrous oxides (not attributable to fertilisers) from soils, ruminant methane and emissions from waste management. The liability to surrender emission units would accrue at standard factors against individual product streams (eg milk, wool) for each reporting period – eg annual production of milk would be estimated to give rise to a certain level of emissions, depending on factors such as animal type, management regime etc. In the case of animals sent to slaughter, the liability would reflect the implicit emission from the animal not covered by the emissions during its productive life – eg cows before and after their productive milking period.

[11] As an alternative, permits to cover the agricultural sector could be held, on behalf of the sector by one or more umbrella organisations, probably new organisations but possibly including those already existing.

Parameter	Core Assumption	Alternative Assumption
	will need to be surrendered once the forest is harvested, for the full amount of carbon removed from the forest.	forest is growing. Permits will NOT need to be surrendered when the forest is harvested so long as it is replanted.
• Non-Kyoto forests	There will be no credits for the growth (carbon sequestration) of non-Kyoto forests. Units will be needed for all carbon removed from harvesting forests that are not replanted.	

TABLE 4: SPECIFICATION OF THE TRADABLE EMISSIONS PERMIT REGIME

[12] Kyoto forests are defined as new forests planted after 1 January 1990, where there has been a change in land use. It excludes re-plantings of existing forests (following logging).

4. COAL GAS AND GEOTHERMAL ENERGY

4.1 INTRODUCTION

The energy sector in New Zealand represents a significant source of greenhouse gases. As noted above, carbon dioxide is New Zealand's second most significant greenhouse gas (39%) of which the energy sector accounts for by far the largest proportion (around 90% of New Zealand's gross human-made CO_2 emissions). The primary sources of CO_2 emissions from within the energy sector are domestic transport (accounting for 43.2% of CO_2 emissions within the energy sector), industry (21.7%) and electricity generation (20.2%).

In this chapter we focus on the impact of tradable emissions on the gas, coal and geothermal sectors stemming both from their use as a direct source of energy and when converted into other forms of consumer energy.[13] These three energy sources are primarily used for electricity generation, the production of petrochemicals and reticulation as an end-user fuel. The chapter does not capture all end use consumption, especially that from private geothermal bores.[14]

4.2 DESCRIPTION OF THE SECTOR

4.2.1 Basic Conditions

As a fuel, gas is consumed primarily by the electricity sector, the petrochemicals industry and by end-use consumers. Coal is used for electricity generation and some industrial energy generation, in the manufacture of steel, and in a small way for domestic energy. Geothermal is primarily used for energy through electricity generation and in domestic applications.

The demand for gas, coal and geothermal as fuels in the production of electricity is driven (in part) by:

- the price and substitutes for electricity production – including the other fuels in this trio, and hydro and wind;
- the price of electricity; and,
- energy conservation initiatives.

A. AVAILABILITY AND SUBSTITUTES

Substitution by other fuels is limited by technological factors and supply restrictions on the alternative fuel sources.

[13] The use of gas, coal and geothermal as raw materials and inputs into industrial processes is covered in chapter 6. The use of energy in the transport sector is covered in chapter 5.

[14] As it is not proposed to make domestic geothermal subject to the emissions trading regime, this omission is not considered to be material.

Gas and coal are currently only direct substitutes at Huntly power station, which is a dual-fired station. At existing prices, the economics of the station are similar for gas and coal.

In the electricity sector, economic substitution in the short term is limited by the efficient use of water. Water has a zero unit cost at the margin and hence is generally used in preference to gas and coal.

However, water does not necessarily have a zero marginal value. Stored water has an "opportunity cost" (its value if it is held in storage and used in a future period). This opportunity cost is its true "marginal cost" in the current period.

In the long term, when looking at water as a substitute for gas and coal, we need to consider whether the "long-run marginal cost" (which includes the fixed overhead costs, and a return on capital invested as well as the operating costs) of producing electricity using a new hydro power station is less than the long-run-marginal-cost of producing electricity using a new thermal power station. From a societal perspective, environmental and social costs should be incorporated into the long-run-marginal-cost considerations as well.

Geothermal stations run at very high utilisation. Since geothermal resources have low marginal cost of extraction and have a steady throughput, these power stations provide base-load power.

Wind power is also regarded as a substitute for gas and coal. While there are some operational wind farms in New Zealand, it is not clear that a viable technology yet exists that seriously competes with gas and hydro from an economic perspective. Of course, a sufficiently high price for gas will enliven the development of new technology and the installation of further wind farms.

A similar story holds for end-use consumption. Gas has largely eliminated coal as a domestic fuel. There is only substitution with geothermal in a small region of New Zealand. The most threatening substitute for the trio of fuels is electricity. Gas and electricity are close but not perfect substitutes, since both fuels have advantages in their own right. In addition, the relative efficiency and cost of the fuels is not well understood by many consumers, and, the transaction cost of converting appliances makes substitution sticky. However, in the long term we expect that a change in the relative price will see substitution between these fuels.

B. PRICE ELASTICITY

The price elasticity for electricity and end-use gas is not known accurately. In the very short-run (for example, each half-hour) most consumers do not see the wholesale market price and do not have a reliable way of relating activities with the cost of energy supply. Several large industries do take careful note of the wholesale price of electricity in scheduling their energy consumption. In the medium term, most consumers face a fixed priced contract for the supply of energy. These can be, and are, varied by suppliers. So the price of energy will affect commercial, industrial and domestic customers.

Consequently, short-term quantities in the wholesale market are generally regarded as very inelastic to price. There have been numerous studies involving the medium term and long term demand elasticity. These are largely inconclusive because of the difficulty in isolating the factors. However, an elasticity in the range 0.2[15] to 0.4 is often postulated with figures as high as 0.8 being suggested for some sectors[16].

C. ENERGY CONSERVATION AND DEMAND GROWTH

In the last 10 years, the growth in demand for energy has been about 2% per annum. In general, household consumption of energy per capita has been falling, domestic electricity use increased at only 0.1% pa during the 1990s. In comparison, population growth averaged 1.15% pa through the 1990s. This improvement in energy use is possibly the result of production of more energy efficient appliances. It may also reflect the impact of energy efficiency and conservation initiatives directed at the domestic sector, including revisions to the building code. In the future we can expect the reliance on electrical appliances to increase rather than diminish. However, this is likely to be accompanied by further efficiency gains including the development of “smart appliances” able to optimise their use of cheaper power.

D. PRODUCTION TECHNOLOGY FOR PRODUCING ENERGY

There has been a significant advance in gas-fired power generation with the development of the combined cycle gas turbine. This technology has increased efficiency dramatically (the Otahuhu B CCGT plant is about 35% more efficient than New Plymouth, and 30% more efficient than Huntly). Break-throughs in gas-turbine peaking capacity are on the horizon. These would allow much more efficient production in periods of extreme demand. New gas-fired stations almost always have a lower cost than alternative technology.

New coal-fired stations are much less common. In Australia some new plant has been suggested which is 44% efficient at converting the energy in coal to electricity, whereas older plant is about 30% efficient. Apart from greenhouse emissions, coal-fired stations have greater particulate emissions than gas. New coal stations are increasing in capital cost because of the inclusion of particulate emission control equipment.

Hydro and wind power generation do not emit particulates or greenhouse gases, and, thus, are often considered attractive for environmental reasons. However, in both cases their capital cost is very high per unit of output. Large hydro stations normally require major civil engineering works. Both hydro reservoirs and wind farms can have environmental drawbacks. Reservoirs flood valleys, inhibit fish flow, and often destroy farms, wetlands and towns. They can create geological instability. Mini hydros and micro hydros are less environmentally damaging and present an interesting alternative if the price of electricity becomes sufficiently high. Further, both of these forms of power production tend to be weather dependent, which results in lower utilisation than a gas-fired plant.[17] In addition, traditionally, wind turbines have had a high maintenance cost and a short life, although recent technology appears to be cheaper and more robust.

---

[15] An elasticity of 0.2 means that if price doubles demand will fall by 20%.

[16] The stringent electricity conservation measures of 1992 saw only a 15% reduction in electricity usage. To be fair, the impact was not conveyed to the final consumer by price signals, nor were there good mechanisms in place for many consumers to respond effectively.

[17] It is interesting to note that the Brooklyn windmill suffered as often from excess wind speed as insufficient wind.

In New Zealand there are strong economic incentives to site a new power station close to Auckland, the centre of demand growth. This favours a gas-fired station in the top half of the North Island, since new geothermal stations and significant new North Island hydro stations are unlikely to occur.

Distributed generation is coming into favour globally. Here small communities or large users install their own power-generator. It can result in cheaper electricity if accompanied by a reduction in transmission grid charges and line losses. To date the technology is not quite at a stage where distributed generation becomes economic. The expected improvement in fuel cells is seen as the most likely basis for economic distributed generation.

4.2.2 Structure of the Industry

A. GAS INDUSTRY

All natural gas in New Zealand is produced domestically. The major source of gas is the Maui field, south west of Taranaki. Maui, which began production in 1979, currently produces around 75% of gas used in New Zealand. The field is expected to be depleted around 2010. However, estimates of the quantity of gas in the Maui field have been upgraded several times. Gas is also supplied from several smaller fields onshore in Taranaki. Several companies hold rights to extract gas from these fields; the major two being Shell New Zealand Limited and Todd Oil Services. Table 38 in C.1 shows the ownership of the currently producing gas fields, and their annual outputs and quantities of reserves, together with the ownership of the pipelines.

Following the acquisition of Fletcher Challenge Energy, Shell's stake in the Maui field will be 78%. The major industrial users and distributors of gas are: Methanex, Petrochem, Contact Energy, Genesis Power and On Energy. Together, these five make up 85% of New Zealand's yearly gas demand. The remaining 15% is used in cogenerating facilities, other industrial settings, and reticulation to the commercial and residential markets. It is expected that the demise of the Maui supply and the rising price of gas will result in the closure of the Methanex plants.

The economic supply of gas in the 2010–2020 decade depends on new gas fields being found that can be extracted and transported at a viable price. While there have been many new gas finds, none has matched Maui in size and extraction cost. On an international scale, New Zealand is still relatively unexplored. However, it is estimated that our current level of self-sufficiency in gas will not be maintained without a significant increase in the level of exploration.[18]

The high-pressure gas transmission system is owned and operated by the Natural Gas Corporation of New Zealand (NGC), with local distribution networks owned and operated by a number of companies, (Table 41 in D.5 gives details)

The gas sector is currently being reviewed, following close on the heels of the Ministerial Inquiry into the Electricity Industry last year. The outcome of the gas sector review is

---

[18] J Upasena, BD Ward, RA Cook, *Analysis of Oil and Gas Exploration and Discovery in New Zealand - A Basis for Supply Forecasting***,** 1998 New Zealand Petroleum Conference Proceedings (29 March - 1 April 1998)

unknown but may include regulation similar to the electricity sector. There is currently no short-term market in gas and no liquid gas contracts market. It is not clear that such a market is needed in the medium term but it may emerge as the supply-demand balance changes.

B. COAL INDUSTRY

Around two thirds of New Zealand's coal production is produced by Solid Energy New Zealand Limited, a state owned enterprise. The remainder is mined by Glencoal Energy, Francis Mining, Greymouth Coal (joint venture between Todd Energy and Solid Energy, each holding 50%), Newvale Coal Company, and about 20 smaller producers.

Coal comes from two main sources and is of very different characteristic and use. Coal produced in the Waikato at the Huntly and Rotowaro mines is used for firing the Huntly power station, and at BHP NZ Steel's Glenbrook mill. Coal produced in the South Island is of higher grade, and is primarily exported. We do not see this source of energy as a major component of New Zealand's energy use in the next 20 years, as there is little exploration, with coal companies concentrating on existing mines, and because new coal-fired electricity generating plant is unlikely to be economic.

C. GEOTHERMAL

Geothermal energy extraction is primarily for electricity generation, industrial heat and small-scale domestic supply. Within New Zealand geothermal power for electricity production has a long history. The withdrawals of steam match closely the generating capacity of the power stations. Geothermal power is classed as renewable energy, though the environmental impact of geothermal power stations can be significant (the water table has dropped 30 metres in the area of the Wairakei geothermal station). There is thought to be scope for developing over 1500MW of high-temperature geothermal generating capacity, albeit at some expense.

D. ELECTRICITY SECTOR

The structure of the electricity sector is set out in Table 39 in D.3. This table shows the major companies and their generation assets. The largest generator is Meridian, which holds only South Island hydro capacity. Contact has the most diverse portfolio of plant with gas fired generation in New Plymouth and Auckland, geothermal and a significant set of hydro stations (mainly run-of river) on the Clutha River in the South Island. Meridian, Genesis, and Mighty River Power are State-Owned Enterprises. They are required to show a return on assets similar to that expected by a private company. The other stations are all privately owned.

New Zealand is unusual in the proportion of electricity produced by hydroelectric stations. Water is a significant alternative fuel to gas and coal. Water as a substitute fuel is limited, inflows are volatile, and the country regularly experiences dry seasons. “Run-of-river” stations have almost no storage[19] so must either use their water when it comes or spill it. Even for stations with significant storage (such as those on the Waitaki River) there is

---

[19] Many run-of-river stations have less than 1-day storage so they are only able to move generation a few hours.

sufficient storage for only a few months generation. In all, hydro has the ability to use only about 60% of its capacity because of water availability[20].

The retail electricity sector has recently undergone significant restructuring, partly as a result of government decree and partly as a consequence of mergers and acquisitions by generating companies. Retail customers are held almost exclusively by one of the generation companies.

A final technical limitation to the substitution of gas and water is the backbone electricity transmission system. The South Island is the main source of hydro capacity and it has no thermal power generation. At times, although not usually, the ability of stations to get their power to market is limited by the transmission system.

4.2.3 Conduct

A. COMPETITIVE BEHAVIOUR

New Zealand neither exports nor imports natural gas. The New Zealand market is separated from the international market, and prices here are not affected by prices outside the country. Most contracts between gas producers and their customers are the subject of long-term take-or-pay agreements whereby the customer pays for a fixed quantity of gas each year and is contracted to use the contract quantity of gas in the current year or some defined future time. The incentive of this type of contract is always to use the gas or on-sell it rather than to conserve it for the long-term. Effectively, up to the contract quantity, the marginal cost of the gas is zero, unless there is a liquid market for excess gas. There is no short-term market in gas and no liquid market in gas contracts.

As New Zealand is a coal exporter, coal prices are to a large extent determined by the prevailing world price. New Zealand thermal coal (lower grade coal used for electricity generation) currently fetches around US$26/tonne, while higher grade coking coal is priced at US$43/tonne. Economic levels for coal production in New Zealand are about NZ$38/tonne.

Geothermal output is not subject to a market. The right to take geothermal energy for electricity production was first agreed when the power stations were State-owned. Like hydro- and wind-power, geothermal power stations obtain their fuel at very low marginal cost. This means that they are baseload stations, which generate power continuously.

In the electricity spot market this means that the volatility in demand may reflect immediately in price volatility. This price variation is further exacerbated by the variability of water inflows, together with prudent risk management, which sees hydro generators withholding generation to conserve their available water.

With only a few participants in the wholesale electricity market they are able to play a non-collusive game to improve their return and reach a market equilibrium. They may also be able to tacitly collude to keep prices higher than perfectly competitive levels. However, generally, with a high level of the customer load contracted, either through ownership of retail customers or financial hedging contracts, the market is expected to be quite

[20] This is eventually driven by the water inflows for the year. It is high by the standards of many countries.

competitive since a (relatively) large amount of residual generating capacity is chasing a small amount of uncontracted load.

When analysing the electricity market, as in any market, we need to be cognisant of both the short-term and long-term economics of the industry. No player can survive in the market if they only recover their variable costs when they sell their energy. So in an electricity market we may observe, for example, when the demand-supply balance is tight, a peaking plant, which only runs occasionally, setting a very high market price to capture its fixed and variable costs,[21] while simultaneously allowing base-load plant to also capture some of their fixed costs.

Since much of the supply is the subject of medium-term and long-term contracts, there are two separate disciplines on the contract price. We expect that these will normally be set at a price high enough to ensure they get a return on capital. Conversely, a long-term price much different from the average price expected from the spot market will be difficult to negotiate. So we anticipate that, on average, the contracts market price and the spot market price will be close.

While short term prices may be volatile, there is a sound economic argument to suggest that generators will not, on average, take excessive profits from the market but will limit themselves to receiving for that plant the long-run marginal cost of a new entrant plant used for the same purpose[22], provided, of course, there are no barriers to entry of new plant.

The retailing of gas and electricity is now quite well integrated in many parts of the country. This enables retailers to provide a more complete package of energy products. We may expect to see further diversification of these retail offerings to attempt to reduce the importance of price as the basis of retail competition. With most retailers also being electricity generators there is an easy pass-through of increases in wholesale prices.

B. BARRIERS TO ENTRY

There are very high barriers to short-term entry on the supply side of all sectors of the energy market because of the time delays in bringing on new sources of supply. In the current New Zealand gas market there are significant barriers to entry on the supply side created largely by the limited finds of new gas fields and the cost of exploration. Barriers to entry for coal and geothermal are created by the need to obtain resource consent, which in some instances will be considerable. In the electricity sector, there are few barriers imposed by the market. Fuel availability and resource consent are the most likely impediments to new entry.

4.2.4 Performance

New investment in gas is primarily in the exploration of new gas fields. Within New Zealand this is an on-going process which is driven by the expected price of gas in the long term. It is normal practice for an exploration company not to develop a field unless it

[21] Alternatively, in a hydro system with a shortage of water the high value of water may induce a high price of electricity.

[22] A base-load plant will look for a different new entry return than a peaking plant.

has a long-term contract for supply at an economic price. In an industry with so few players there are possibilities of price control. The normal way this is exhibited is for a company to postpone production from a new field in order to push up the price for gas from an existing field.

Coal, as a local fuel, being a close substitute for gas and electricity is disciplined by those industries. As an export industry it is subject to the competition of a very active international market.

Geothermal energy is most efficiently used directly for industrial heating. This type of energy use is approximately 10 times as efficient as use in electricity production.

The electricity sector has a half-hour spot market, long-term contracts and vertical integration in generation and retailing. In general, electricity generation plant is used to operate at efficient points on the efficiency curve in order to maximise the use of the fuel. At times, water is conserved and gas used in order to manage the risk of the hydro inflows. Since the gas industry is characterised by long-term take-or-pay contracts, there is an incentive to run a gas-fired station harder than would otherwise be efficient.

The electricity price is arguably close to a competitive price because of the efficient and transparent market for electricity. We expect that pricing in the spot market will reflect the economics of the market. This is borne-out by the increase in average price when hydro reservoirs are low. We suspect that there is some gaming in the spot market when the supply-demand balance is tight.

Since the electricity sector was corporatised, new entry in the sector has been, in most instances, the cheapest LRMC plant, ie combined cycle gas turbines. Some wind capacity has been introduced, although it is not clear that this is economic. New plant is being contemplated by all the major players. New hydro stations are largely expected to be too expensive, although the most recent scheme announced by Meridian is reputed to be as economic as a new CCGT plant. The new entry price in 2008 is estimated at $50-55/MWh, but may be lower if a low gas price is available.

It is expected that by 2008 the prices of all fuels will increase from current levels in real terms. In all cases we expect a tightening of supply and demand. Gas will be less plentiful with the Maui field coming off-stream. The electricity generation sector will probably have seen a new entry plant of about 350MW by 2007. Coal prices will continue to be disciplined by the price of gas. Consequently, we expect the prices given in the table below.

	Wholesale Price in 2001 $'s	Industrial Retail Price in 2001 $'s	Commercial Retail Price in 2001 $'s	Residential Retail Price in 2001 $'s
Gas	$3.5/GJ	$5.5/GJ	$11/GJ	$18/GJ
Coal	$3.0/ GJ	$5.0/GJ	$12/GJ	$13/GJ
Electricity	$55/MWh	$80/MWh	$90/MWh	$100/MWh

TABLE 5: 2008 FUEL PRICES WITH NO EMISSION PERMITS

4.3 IMPACT OF EMISSION PERMITS

4.3.1 Impact on basic conditions

We examine now the impact on the cost of production of the permit regime on the energy industries. For the purpose of this analysis, we assume the point of obligation for permits for gas to rest with pipeline operators, major users and, in the case of fugitive emissions, with extractors. Equivalently for coal it is with major users, wholesalers and mines, and for geothermal with the major users and extractors.

We look firstly at the permit cost for gas, coal and geothermal energy based on various permit prices. These costs are developed from the CO_2 content of the fuels. In all instances, these are average figures because fuel from different sources have different CO_2 content. The CO_2 content and resulting prices are given in Table 6. We have converted all prices to $/GJ. The "total" permit costs consist of the permits for CO_2 from the end use fuel plus the permit costs for fugitive emissions. This cost will be a simple addition to the production cost of the fuel. Geothermal is all regarded as fugitive.

	CO_2 equivalent	Permit Prices			
	In kT/PJ	$10/T	$20/T	$30/T	$60/T
		Permit Costs in $/GJ			
Gas	55kT/PJ [23]	$0.55	$1.1	$1.65	$3.3
Coal	91kT/PJ	$0.91	$1.8	$2.7	$5.4
Fugitive gas	2.8kt/PJ	$0.03	$0.06	$0.08	$0.17
Fugitive coal	6.4kt/PJ	$0.06	$0.13	$0.19	$0.26
Total Gas (including fugitive)	58kt/PJ	$0.58	$1.16	$1.74	$3.48
Total Coal (including fugitive)	97kt/PJ	$0.97	$1.95	$2.91	$5.82
Geothermal	42kt/PJ	$0.42	$0.84	$1.26	$2.52

TABLE 6: PERMIT-RELATED INCREASES IN FUEL COSTS

The permit cost consists of the permits for CO_2 from the end use fuel plus the permit costs for fugitive emissions. This cost will be a simple addition to the production cost of the fuel.

We discuss below the pricing policy in the gas and coal sector as a result of the increased production cost. Under the assumption that the permit cost is passed on in the final fuel

[23] The CO_2 content depends on the gas field from which it is sourced. It varies from 51.8 (Maui) to 84.1 (Kapuni), We chose 55 as an average figure.

price, the impact on the cost of production of down stream industries will depend on the extent to which substitute fuels become more economic both in the short term and the long term. We do not necessarily assume the fuel cost goes up with the cost of the permits.

The impact on the price of electricity is examined in detail in a following section.

4.3.2 Structure of the Industry

In looking at the impact on industry structure we need to consider separately the three major industries concerned (gas, coal and electricity) because the impact will be different for each. For each of the industries we will consider both the production / wholesale and retail sectors.

A. GAS INDUSTRY

For the gas industry, the critical issue is the extent to which the increased cost of production can be passed on to the end-users. If it can, we expect no significant changes in the gas sector, except, perhaps a greater reluctance to explore marginal gas fields. It is likely that with a permit price of $20/t the increase in gas price can be tolerated by the industry without major effect. A price of permits of $60/t may have a more marked effect.

- Commercial, industrial and residential gas is considerably cheaper than electricity without permits and, as we will see shortly, continues to be so at all permit prices, although the comparative advantage diminishes.
- The electricity sector can, we will see, face a permit cost of $20/t without altering significantly the usage of gas in that sector but at $60/t would see a move away from gas.

B. COAL INDUSTRY

Domestically, coal has suffered from competition from gas. The addition of permits is likely to cause even further retraction of the industry to service only users who use coal for specialist reasons. Exported coal would not face permit costs in New Zealand so would compete on an equal footing in the importing country. This should keep the coal industry viable. Coal for electricity production will decline when Huntly is no longer viable or is re-powered as a combined cycle plant.

C. ELECTRICITY INDUSTRY

As the cost of gas and coal increases, the viability of alternative fuels for generating electricity generation improves. Based on current predictions, wind power has an LRMC of at least $70/MWh[24] and hydro an LRMC of about $65/MWh[25]. If the cost of new gas-fired

[24] The new entry price for wind power in 2008 is very uncertain because of the rapid development of wind technology. Many are confidently predicting wind power will become more economic.

generation reaches those figures, which indeed will be reached within the range of permit prices under consideration, then hydro and wind may replace gas as the fuel of choice for new plant.

The construction of both hydro and wind generation has its own problems in terms of environmental consent. Both are also subject to uncertain availability because they are dependent on the weather. Consequently, while some hydro and wind may be constructed, there may be difficulty obtaining enough capacity to cover the country's growing electricity needs.

Geothermal generators have a smaller increase in costs per unit of energy produced than either gas or coal. Since geothermal stations are already running as baseload generation, they cannot increase output. There is a limited amount of new geothermal capacity.

Mini-hydros and wind farms are well suited to small installations – perhaps of the order of 20MW to 100MW. As such, they can be built and operated by local utility companies. Unlike base-load gas plant and hydro schemes that need a large capital outlay, wind farms can be built progressively without the capital expenditure required for large-scale operations. Thus, within New Zealand we may see an increase in the generating capacity of the smaller industry players through such schemes. While not significantly detracting from the influence of the large companies, such installations provide a useful hedge against local retail load for the small generators.

D. GRANDFATHERING

Were the permits to be allocated based on 1990 usage, both the electricity sector and the retail gas sector would be short of permits, while the retail coal sector would have surplus permits. As a result, the electricity sector would need to purchase about 50% of the permits it required to maintain its use of gas and coal.

While the average cost of gas will not increase by the permit cost, the marginal cost of additional generation and new entry plant will face the full cost of permits. Some players will benefit from the alternative regime, particularly heavy users of gas and coal in 1990. Others will reflect the full cost of purchasing permits. The main new beneficiaries would be Genesis and Contact.

4.3.3 Conduct of the Sector

Our basic assumption is that energy industries will pass on the increased cost of fuel created by the emission permits. This is a reasonable assumption for the base-case permit cost of $20/t but may not hold for higher values. Table 7 and Table 8 give the calculated price of each of the fuels at both the wholesale and retail level based on the different prices of permits. The "no permit" price is the price of the fuel without any permit cost. We consider below how feasible it will be to achieve these prices.

---

[25] The new entry price for hydro depends heavily on the scheme. Unlike most other options where the construction and plant cost are reasonably well known, the cost of hydro schemes varies enormously. A scheme recently announced has a LRMC or about $40/MWh according to Meridian, which is a lot cheaper than we would expect of other schemes. Other schemes vary from $60/WHh upwards.

	New Fuel Price				
		Permit Prices			
	No Permit Fuel Price	$10/t	$20/t (base case)	$30/t	$60/t
Gas	$3.5/GJ	$4.05	$4.6	$5.15	$6.8
Coal (Thermal)	$3.0/GJ	$3.9	$4.8	$5.7	$8.4
Electricity - SRMC based on gas	$24.8/MWh	$28.4	$32.1	$35.8	$46.7
Electricity – LRMC based on gas	$55/MWh	$59.3	$63.5	$67.6	$80.2[26]

TABLE 7: WHOLESALE FUEL PRICES FOR DIFFERENT PERMIT COSTS

	Retail Price				
	Permit Price				
	No Permit Fuel Price	$10/t	$20/t (base case)	$30/t	$60/t
Wholesale Gas $/kWh	0.013	0.015	0.017	0.019	0.025
Industrial	0.020	0.022	0.024	0.026	0.032
Commercial	0.040	0.042	0.044	0.046	0.048
Residential[27]	0.065	0.067	0.069	0.071	0.077
Wholesale Coal NZ$/t	69	90	111	131	152
Industrial	115	137	159	181	247
Commercial	276	298	320	342	408
Residential	299	321	343	365	431
Wholesale Electricity $/kWh[28]	0.055	0.059	0.064	0.068	0.080
Industrial	0.08	0.084	0.088	0.093	0.105
Commercial	0.09	0.094	0.098	0.103	0.115
Residential	0.10	0.104	0.108	0.113	0.125

TABLE 8: WHOLESALE AND RETAIL FUEL PRICES FOR DIFFERENT PERMIT COSTS

[26] This price is higher than new entry by hydro and wind, and may induce strong conservation measures so is unlikely to be realised.

[27] Note that these prices do not include fixed daily connection charges levied by gas retailers.

[28] These prices assume a wholesale price at LRMC based on gas.

A. GAS INDUSTRY

The increase in price of wholesale gas is significant, ie over 30% for the base case. At this permit price ($20/t) the wholesale price of electricity increases to about $63/MWh. This gas price increase most probably can be passed on into the electricity sector because it is still competitive with other energy sources for electricity production. However, there will be resistance from substitutes to gas-fired power stations at higher permit costs.

If there is consumer resistance to the gas price, a substantial amount of the permit cost can be accommodated in the short-term without increasing the price of gas by the full cost of the permit. This is because the marginal cost of production of gas is close to zero. Such a policy is not sustainable in the long-term since new gas-fields are only worth exploring if the price of gas is sufficient to cover the exploration and infrastructure costs - the LRMC of gas production.

The gas sector is dominated by take-or-pay agreements with the major customers. As a result there is a financial incentive for them to use their gas (or on-sell it) rather than hold it in the ground. With limited permits available, gas customers may now choose to hold their gas rather than use it and realise the value of their additional permits. Indeed there will be pressure to negotiate contracts that do not include obligations to take gas beyond their needs after 2008. This suggests that either there will be a move away from take-or-pay contracts or that they will be struck at a lower “take” volume. From the viewpoint of the gas exploration companies, it is less desirable to have lower volume take-or-pay contracts since it will lengthen the time over which they can recover their up-front costs. Normally, this would result in a higher price for gas.

For end-user customers, the rise in the price of gas varies from 20% for industrial customers, through 10% for commercial customers to 6% for residential customers. This variation in price comes from the different proportion of the final price that covers the cost of reticulation. For residential customers, the price of gas is still very competitive to other sources of energy. However, for commercial and industrial customers, the increase in costs arising from such a high increase in the cost of gas is considerable.

B. COAL INDUSTRY

In the base case ($20/t) the increase in the wholesale price of coal is over 60%. This price will be prohibitive for power generation because even at a base price of $2.70/GJ, coal competes closely with gas as a fuel. Where coal is a major fuel source for an industry, a price increase of 38% will impact very significantly on its cost of production. For commercial and residential customers, prices also rise in the order of 15%. This is unlikely to affect residential sales substantially.

The increase in costs of production of high-grade coking coal is significant. For use in Annex 1 countries, coal will become a much more expensive fuel. So in those countries, unless cheaper methods of emissions reduction can be implemented, the use of high-grade coals is also likely to decline. Conversely, non-Annex 1 countries will benefit from coal use without permits so will tend to keep the international market for coal alive.

C. GEOTHERMAL

Apart from gas electricity production, geothermal steam is largely used in industrial heating. Industrial heating is a much more efficient use of geothermal steam (about 100% efficient) than electricity production (about 10% efficient). As the cost of geothermal steam rises with permit costs, there will be an incentive to use it more efficiently. We would expect to see a trend to using it directly rather than for electricity generation. Naturally, its use for direct heating is severely limited by geographic location. Industrial plants will need to be situated at the geothermal sites.

D. ELECTRICITY

There are two major effects in the electricity sector of an increase in the price of gas and coal:

- The short-term cost of fuel on the wholesale price of electricity; and
- The long-term effect on the choice of new entry technology.

In the short term, the price of gas is the primary determinant of the price of electricity. Most of the time the price-setting station is a gas station or a hydro taking advantage of the gas price.

The substitute “clean” fuels – wind and hydro – are dispatched either at their opportunity cost (in the case of hydro) or are bid at a very low price (perhaps $0/MWh) to ensure they are base-loaded (run-of-river hydro and wind). Thus, in the short term, there is no substitution effect with clean fuels. Similarly, geothermal is also base-load priced in the electricity market. The addition of a permit cost is unlikely to alter this behaviour since the fuel will still be much cheaper than gas and the generation company will still wish to run the plant at full utilisation.

In the longer term, the price of electricity will be determined by the long-run marginal cost of the most cost-effective station to be built. From Table 7 we see that the LRMC for a gas station is $63.5/MWh (for the base case) which is about the same as hydro. So the cost of gas is barely high enough to encourage substantial new entry from hydro or wind as a replacement for gas and coal. This is especially true with hydro having a much higher capital cost (and construction cost risk) and greater resource consent problems.

Despite an increase in the cost of gas, we expect gas-fired power stations to continue to operate and even new stations to be built. Existing stations may suffer a lower profitability, but with their capital cost “sunk” they can survive on a reduced margin above variable cost. It is even possible that the electricity generators will have sufficient market power in the gas sector to force a reduction in the price of gas that will result in the LRMC of new gas plant being no greater than alternative technology.

The other dimension to the story is the demand-side impact of a 16% increase in wholesale price of electricity. With a demand elasticity of 0.2 to 0.4 at the wholesale level we would see a reduction of 3% to 6% in demand from the increase in the wholesale price. Such a decrease in demand can be compared with an underlying increase in demand of at most 2% per annum. The growth in electricity demand suggests a new 350MW station every three years, so the demand side response would delay the introduction of new generation for 2-3 years after 2008.

The overall picture has wholesale electricity prices rising about 16% for the base case. This is much less than the increases of 30% for gas and 60% for coal. The flow through effect to end-users sees electricity prices to industry rising 10%, to commercial by 9% and to residential customers by 8%. The transmission and overhead costs are much lower for electricity consumers than gas consumers, so the wholesale electricity price has a greater relative impact on end-user prices than for gas prices.

The impact of these price increases will depend on the energy intensity of the industry. For users such as aluminium smelters, which have a substantial proportion of their production cost from electricity, the production cost increase may be significant. These industries are situated in New Zealand because of the low cost of electricity. New Zealand power is rather more than 16% cheaper than most other countries. Therefore, the threat is from regions with solely hydro generation (eg, Tasmania, Brazil, Norway etc.) and non-Annex 1 countries where the freight cost savings more than outweigh the higher power cost.

Table 9 gives the expected impact of permits on aluminium which is very energy intensive.

Permit Cost	$10/t	$20/t	$30/t	$60/t
Increased cost per tonne of Aluminium	$60	$119	$176	$353
Increase in Cost as % of 2001 world price ($1554/tonne)	3.87%	7.66%	11.35%	22.70%

TABLE 9 : IMPACT OF PERMITS ON ALUMINIUM PRICES

The impact on steel production is shown in Table 10.

Increased cost per tonne of steel from:	$10/t	$20/t	$30/t	$60/t
Electricity	$1.24	$2.46	$3.64	$7.28
Gas	$0.57	$1.14	$1.72	$3.43
Coal	$21.29	$42.59	$63.88	$127.76
Total	$23.11	$46.19	$69.24	$138.48

TABLE 10: INCREASED COST OF STEEL PRODUCTION

For most commercial and residential customers the cost increase for electricity, while not inconsiderable, will be absorbed and countered by energy efficiency measures.

E. GLOBAL ENERGY SECTOR

Overall, the impact on each of the sectors of the economy, and the economy as a whole, of emission permits at a price of $20/tonne is given in Table 11. The total cost to the economy of the increase in prices of gas, coal, and geothermal resulting from a $20/t permit scheme is about $570 million for the estimated 2008 usage (2000 usage with 2% growth) – see Table 12.

	Gas	Coal	Electricity	Total
Wholesale	30%	60%	16%	26%
Industrial	20%[29]	38%	10%	19%

[29] Including Methenex.

	Gas	Coal	Electricity	Total
Commercial	10%	16%	9%	10%
Residential	6%	15%	8%	8%
Total	19%	32%	9%	16%

TABLE 11 : PRICE CHANGES ASSOCIATED WITH A PERMIT PRICE OF $20/TONNE OF CO_2 EQUIVALENT

	Gas	Coal	Electricity	Total
Total Energy (PJ)	143	26	155	324
Total Permit Cost $/GJ	$1.10	$1.80	$2.36	$1.76
Total Cost ($million)	$157	$47	$367	$571

TABLE 12: TOTAL INCREASED COST OF GAS, COAL AND ELECTRICITY FROM EMISSION PERMITS AT $20/T

F. INTERNATIONAL COMPETITIVENESS

An increase in industrial and commercial energy costs of 10% - 20% will inevitably erode our competitiveness against non-Annex 1 countries where labour and other costs are already more competitive than in New Zealand. The impact on the aluminium and steel industries are the greatest concern since they can be relocated to non-Annex 1 countries.

4.3.4 Performance of the Sector

The introduction of permits will tend to force participants in the gas sector to be more efficient because they are competing vigorously with other fuels. In electricity production, gas is competing with hydro, and wind as a new entry alternative. In the retail gas sector, on the other hand, gas will become even more competitive.

Electricity generators will be affected differently. Existing generators who have predominantly geothermal and hydro plants will obtain a windfall increase in revenues without a corresponding increase in costs. Generators reliant on gas to fuel their plants will not gain the increase in profits because their additional cost of fuel, from the added permit costs, will absorb the increase in revenue.

At the retail side of the electricity sector, the increase in price will tend to increase incentives to conserve electricity. This will put the pressure on retailers to become more efficient and aggressive in their pricing.

4.4 CONCLUSIONS

The main effects of emission permits will be seen in both prices and technology shift.

1. We expect an increase in gas, coal and electricity prices as shown in Table 8 and Table 11.

2. The effect on industry will vary according to its energy intensiveness. The heavy energy users such as aluminium smelting may find the price increases too great and relocate to non-Annex 1 countries.

3. Households are expected to see a direct fuel price increase of about 8% overall. However, since they will also probably face a ripple through effect from other prices, the overall impact on consumer costs may be as much as 16%, mitigated only by industry's ability to absorb some of the costs through greater energy efficiency.

4. We expect to see wind and hydro generation becoming economic at a $20/t permit charge. This will be especially true of small wind installations and mini-hydros that are embedded in the distribution network.

5. We expect to see some pressure on the price of gas from electricity generators to keep new gas fired plant economic. In general, however, we do not expect a significant reduction in the use of gas for electricity production.

6. Electricity generators who rely heavily on hydro and geothermal generation are likely to gain significantly from a permit regime. The higher price of gas by pushing up the electricity price, benefits generators with low cost fuels.

7. Coal is expected to become more expensive. There will be pressure on coal mines that are of marginal value to shut, particularly those supplying the domestic market. However, with most of the coal being exported, and not subject to permit liability within New Zealand, the impact on the New Zealand coal industry of a domestic emissions permit regime will be somewhat muted.

8. With all fuels more expensive, we expect to see a demand-side response that will encourage fuel conservation. However, at a $20/t permit price, this response is not expected to be at more than 3-6% without other supporting conservation measures.

5. OIL (INCLUDING TRANSPORT)

5.1 INTRODUCTION

This chapter covers the wholesale supply of transport fuel to New Zealand and the distribution and use by the market in New Zealand. The (Upstream) Suppliers include the refiners of oil into marketable product, and importers of refined product. The (Downstream) distributors and users of the product, encompass the retail fuel distribution system, and the various users of that fuel grouped according to basic use, ie use of fuel for transportation or supply of goods, for holiday or event travel, or for day-to-day personal transportation.

The goods transportation area is relevant to all industries, and like the oil, gas and coal fuels discussed in the previous chapter will flow through into the remaining chapters in this report. The travel sector is a specific reference to New Zealand's tourism sector and its high reliance on different forms of transportation to get tourists to their destinations. The discussion on the personal transportation sector covers public acceptance of increased transport costs. This chapter will also touch on alternative fuels such as CNG and LPG. The characterisation of the transport sector used in this chapter is represented in Figure 5 below.

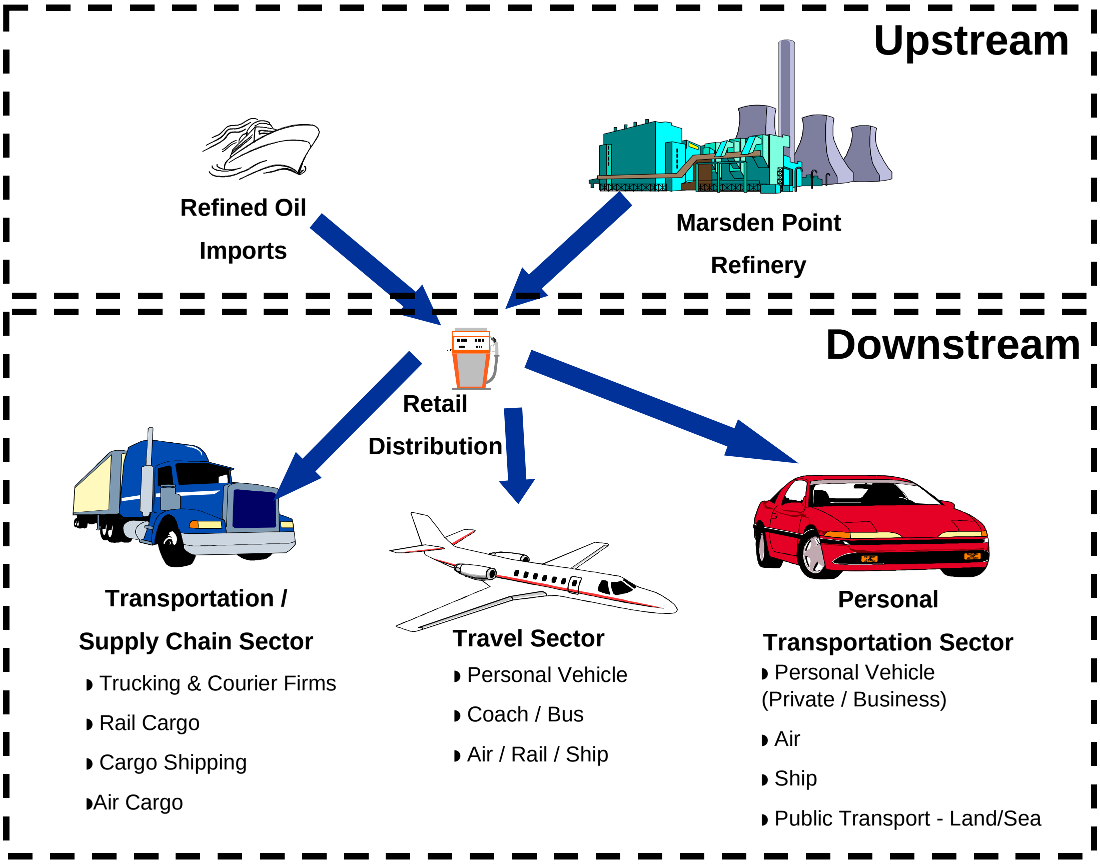


FIGURE 5: CHARACTERISATION OF THE TRANSPORT SECTOR

5.2 DESCRIPTION OF THE SECTOR

5.2.1 Basic Conditions

New Zealand's strategic approach to its oil based fuel supplies has its origins in the 1973, and subsequent, oil shocks. This began a series of large investments aimed at increasing New Zealand's self-sufficiency in supply, and increasing the availability of domestically produced oil substitutes. This led to an increase in domestic production of fossil fuels from 5% to a peak of 50% (currently 36%)[30]. Additional to this was the development of plant producing LPG, CNG, and the manufacture of petrol from condensate and methanol. The methanex petrol conversion plant in Motunui is no longer operative.

New Zealand refines fuel, both domestic and imported crude, at the Marsden Point oil refinery, owned by the "Big Four"; BP, Caltex, Mobil and Shell. LPG is produced at the gas processing site. New Zealand also imports refined fuel, mainly from Singapore and Australia. This comes ashore at Marsden point, and Gull's facility at Mount Manganui.

The Marsden Point refinery, with a daily capacity of around 90,000 bbl, is small compared to Asian refineries with a capacity of 400,000 bbl/day. By comparison, it is relatively inflexible in meeting new fuel standards, for example, the addition of ethanol to petrol. However, the refinery does allow the major oil companies to gain economies of scale in the local production of fuel from crude oil, both imported and domestically sourced. The plant has a history of regular upgrades allowing it to produce cleaner burning fuel in line with New Zealand regulations. It is considered extremely efficient with refining costs making up less than 3 cents per litre of fuel. This also gives New Zealand local control over its fuel types and standards. A strong driver for efficiency and low cost refining at Marsden Point is the willingness of all fuel supply companies to source refined fuel from outside the New Zealand market, usually from Singapore or Australia.

Consumer demand has been tested over the last two years by large fluctuations in fuel prices at the pump at a time of economic growth fuelled by a weak New Zealand Dollar, rising business confidence and a subsequent growth in exports. This has highlighted the inelastic demand within the New Zealand economy for transport fuel. Some of the factors underpinning this inelasticity are listed below.

- Significant investment in transport infrastructure is required for major mode or fuel switches to occur. (Auckland has been looking at a mass transit passenger system for some time. Infrastructure of this type is needed to bring about a pronounced, lasting change in transportation and fuel use).
- Consumers have little option in the short term but to absorb increases in fuel cost. For example, use of buses in Auckland increased very quickly by 5% as a response to increased fuel prices earlier this year. However, capacity constraints imposed by the existing infrastructure were quickly reached.
- Used car imports are hindering a transfer to newer cleaner burning, fuel-efficient cars. New hybrid vehicles are not expected to reach this market for some time.

---

[30] Country background, New Zealand – Energy Provision, Economist Intelligence Unit, 2000

- For the forseeable future, the private car is expected to be the preferred means of transport. 1996 Census data revealed that around 70% used a motor vehicle as a means of getting to work (See Figure 6).

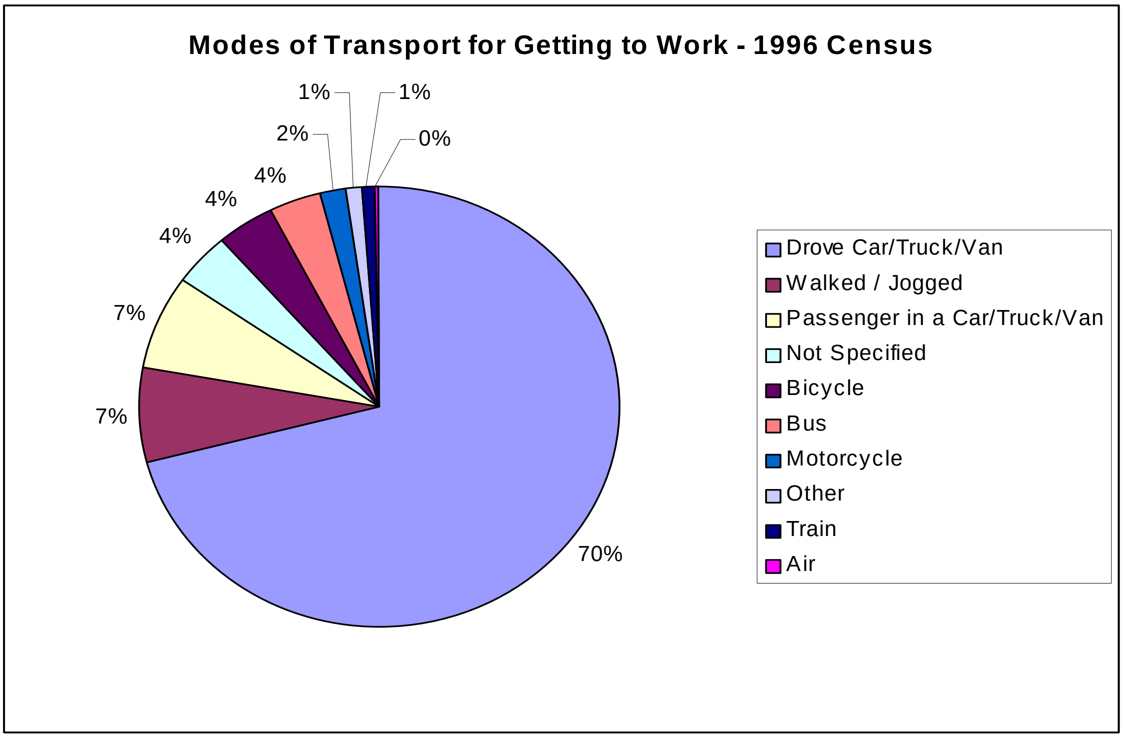


FIGURE 6: PREFERRED MEANS OF TRANSPORT FOR GETTING TO WORK[31]

Commercial transport customers tend to be made neutral when it comes to choosing how their products are moved from place to place. They feel free to choose the most cost-effective option. Consequently, competition between road, rail and coastal shipping is relatively robust, although to some extent, that competition is dependent upon local conditions such as the fortuitous positioning of factories, and other plant near railheads or coastal ports. There is traditionally an advantage to road from its flexibility and convenience as well as its low infrastructure cost through avoiding dedicated loading facilities and railway track networks.

The breakdown of transport energy by mode is given in Figure 7 below. Interestingly, we understand that, since 1996, the share of transport energy occupied by private cars has increased further.

The overall demand for oil based fuel in New Zealand has been on a steady increase since the mid 1980s (See Figure 8 below). Arguably, this coincides with the decline in concern about the state of world oil supplies associated with the 1970s oil shock. Another consequence of the time elapsed since the 1970s oil shocks is the dramatic drop off in sales of CNG in New Zealand, where current sales are less than 1% of 1985 sales.

---

[31] From Statistics NZ 1996 Census Data.

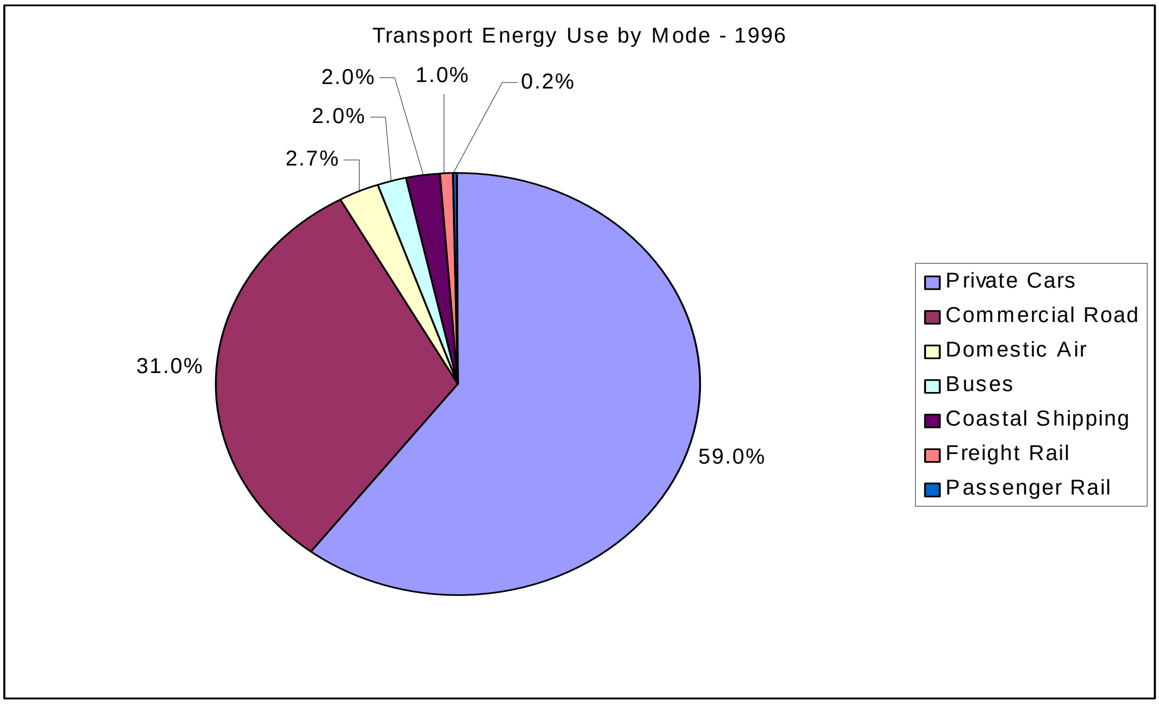


FIGURE 7: TRANSPORT ENERGY USE BY MODE[32]

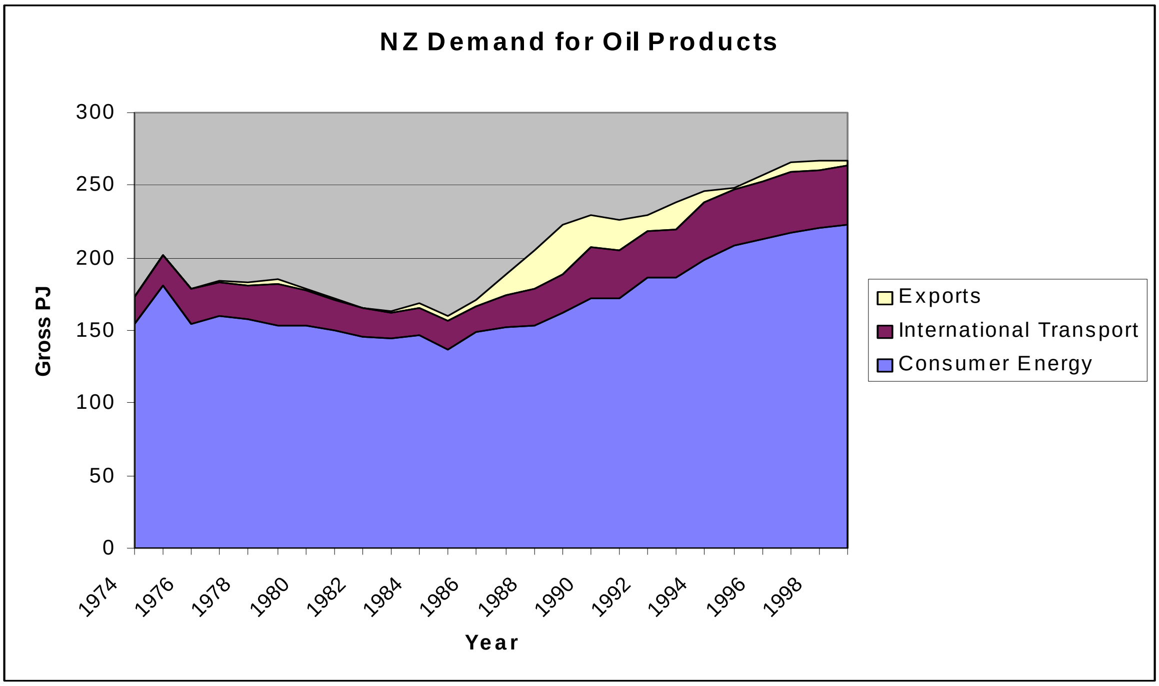


FIGURE 8: NEW ZEALAND DEMAND FOR OIL PRODUCTS

[32] From Energy Efficiency Trends in New Zealand, EECA 1997

5.2.2 Structure of the Industry

The structure of the upstream oil supply industry has two distinct components:

- The first comprises the established "Big Four" Oil companies and the Todd corporation with their years of experience in the New Zealand market, investment in the Marsden point Oil Refinery and the Wiri bulk storage unit, and port depots around New Zealand. They have also been a source of investment in developing New Zealand's own oil and gas fields.
- Countering this historical dominance of the industry are two new importers and distributors of fuel, Challenge and Gull. Challenge has incorporated many independent retailers and has caused lower average prices wherever it has outlets. Challenge imports fuel from Singapore so that Singapore oil now sets the marginal price for fuel in New Zealand.

There are also other oil exploration companies, many of which are American, involved in drilling off Taranaki and the East Coast.

The larger oil companies are vertically integrated. They own or control the entire value chain. They have an interest in the refinery and distribute the fuel to their own retail petrol stations. This allows them to capture the value associated with the market for oil products wherever it may occur in the production line.

This large investment in infrastructure has traditionally been viewed as a barrier to entry. However, the emergence of the two new entrants suggest that these barriers are not insurmountable. It is perhaps too early to form a judgement on this issue since both new entrants have stalled while trying to establish countrywide networks. (Challenge has about 100 stations and Gull only a handful).

The recent sale of Fletcher Energy solidifies Shell's investment in New Zealand. It is seen as good for the Taranaki oil industry as it gains commitment from a large player, and will free up assets that may allow another large oil company into the area[33]. It highlights the willingness of established players to rationalise the industry through acquisition with potential consequence for the smaller new entrants, if they cannot achieve critical mass and financial success fast enough.

The structure of the transportation/supply chain sector is still heavily influenced by the mode of transportation used. Transportation companies have been largely seen as supplying a mode of transport: rail companies, trucking companies, air cargo companies, and shipping companies.

However, this situation is changing rapidly. Based on the fact that customers are mode neutral, a number of companies are focusing more closely on providing the service required by the customer (with less emphasis on mode). The most public example of this is the move to reshape Tranzrail from a "mode" company to a service company with multiple transport options available to best serve its clients. This model already exists in the Courier industry. Continued movement toward this model of transport company will help drive greater efficiencies across the economy by optimising for the lowest cost mix of transportation modes for businesses served by transport companies.

---

[33] As Good as it gets for Oil Industry, Evening Post, 24/3/2001

5.2.3 Conduct

The large oil companies in New Zealand have a strong incentive to 'meet the market' when it comes to pricing their product. In an industry with six players this has lead to any price changes being rapidly matched by the opposition and price stability quickly reasserting itself. Before the arrival of Challenge and Gull there appeared to be little competitive incentive from a strongly oligopolistic market. When those companies emerged with lower prices, the prices from the existing players fell sharply to match the new competition.

It can be argued that the four large oil companies have limited opportunity to compete on price as they all share the Marsden Point oil refinery and so largely start on the same footing. New entrants ship in refined oil from Singapore and Australia and so benefit from the economies of scale and scope of larger refineries. This has the advantage that they are able to source fuel with a wider range of specification than would be economic from Marsden Point.

The focus for competition has therefore been on service; product and brand, supported by extensive branding campaigns. Some competition comes through the results of the individual companies' research into cleaner burning or more environmentally friendly recycled oil products. Also the siting of retail outlets is an important factor in gaining market share. This allows them to feed off the most lucrative traffic flows. Lately, the oil companies have been attempting short-term price based competition with mixed success.

The transportation/supply chain industry has been under a price squeeze for many years and has undergone many changes as a result. This has included outsourcing of roles, through the use of contractors and service level agreements with subsidiaries. This has broken up the historical players and created a mix of service providers linked through contracts. All of these players compete extensively on both price and service, many are niche companies, and all have to be flexible to survive. Instead of the company itself providing actual pick up or delivery of goods, it packages a range of suppliers of those services in a way that best meets the client's transportation requirements. This has driven, and will help drive further efficiencies in the transportation sector. However returns can be low, especially if operators are forced to compete on price. Methods for competing on service include technology options such as those employed by the larger trucking firms. Technology is utilised to enable a central office, viewed direct through a website, to know at all times where an individual delivery is, who has checked it and when it should be delivered. This requires considerable investment, so is not an option for all players.

5.2.4 Performance

The combining of oil company investment in maintaining New Zealand's oil refinery has lead to an efficient refining capability, with refining costs of less than 0.3 cents per litre. In contrast, the drive to create vehicle fuel from our gas fields and methanol has been much less successful. The economics of New Zealand's alternative fuel industries (CNG and LPG) now hangs in the balance.

The performance of the distribution sector is determined by the existing infrastructure and the geographical location and distribution of end users. New Zealand's size and dispersed population will constantly act against cheap distribution costs. Currently, the majority of fuel is sourced from Marsden Point. Effectively split by region, the largest portion is sent via pipeline to a storage facility in Wiri to service the Auckland area, the largest petroleum market in New Zealand. It is then taken by tanker truck around the region. Other regions are serviced similarly but have coastal tankers offloading at port storage depots, before the fuel is distributed by truck. This generally matches New Zealand's population concentrations for personal transport and the majority of our industry. However, it does not match the source of New Zealand's primary products, which are dispersed across the country. This results in significant cost to industries such as Dairy, Forestry, Meat & Wool, and some horticulture. It often involves heavy trucks working on marginal roads.

Notwithstanding these constraints, a comparison of the before-tax price of petrol across OECD countries suggests that the cost of bringing transport to market in New Zealand is reasonably competitive by international standard (see Figure 9 below).

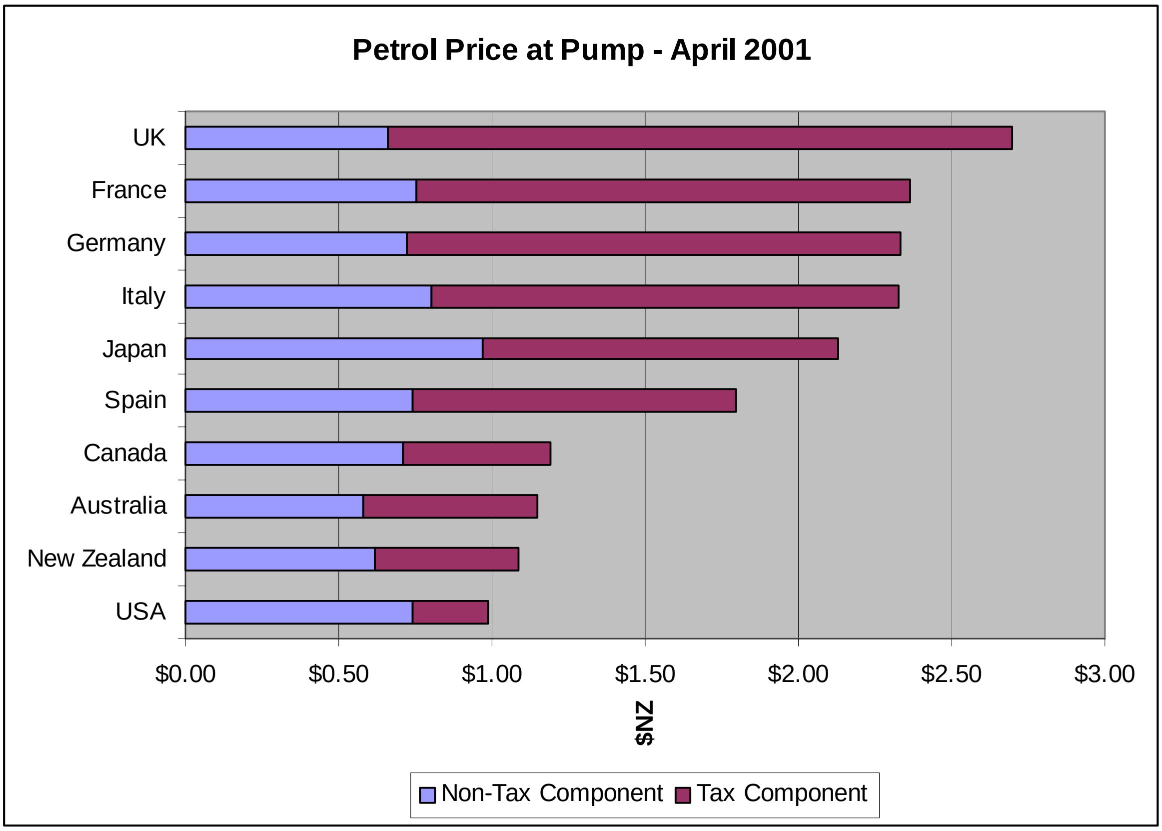


FIGURE 9: COMPARATIVE PRICE OF PETROL[34]

Performance with respect to fuel quality can be judged with respect to:

a) The extent to which it is "fit for purpose". New Zealand does not have a reputation for poor fuel quality.

b) The extent to which there is evidence of innovation in bringing new products to market. This has been an area for the oil companies to compete on, especially in lubrication products, but also in normal fuels. It can be seen in some of the cleaner burning fuel products currently being marketed, in advance of any government regulation in the area.

There are three basic factors affecting the price of fuel in New Zealand; world crude prices, government taxes & tariffs, and the operating costs and profits requirements of the

[34] Source; International Energy Australia (Shell website)

companies that produce and sell it. The first includes our exchange rate and ability to purchase product. The second accounts for 40% of the retail price. The third is more complex covering efficiencies from the scale of our local refining etc, higher distribution costs from our dispersed population and industry, oil company willingness to pass on world price increases, recent more dynamic competition and public/market reaction to price fluctuations.

5.3 IMPACT OF EMISSION PERMITS

5.3.1 Impact on basic conditions

The requirement for the refinery and fuel importers to pay for final emissions by 'buying' emission permits will cause fuel prices to rise as oil companies pass on the costs of compliance. In understanding the impact of the introduction of the permits, there are three things that need to be considered; the scope of the price rise; how elastic consumer demand will be in response and what substitutes exist and how quickly and easily it is possible to switch.

The impact of the introduction of an emissions permit regime on each of the main transport fuels is given in Table 13 below. Note that these figures are based purely on emissions per unit of fuel. Thus, they are independent of fuel usage or fuel prices within any sector.

	CO_2/ Litre	$10	$20	$30	$60
CNG	0.0020	$0.0201	$0.0402	$0.0603	$0.1207
LPG	0.0014	$0.0144	$0.0288	$0.0432	$0.0863
Petrol	0.0022	$0.0218	$0.0435	$0.0653	$0.1305
Diesel	0.0025	$0.0250	$0.0499	$0.0749	$0.1497
Fuel oil	0.0030	$0.0304	$0.0608	$0.0913	$0.1825
Aviation fuel/kerosene	0.0023	$0.0229	$0.0457	$0.0686	$0.1372

TABLE 13: PRICE PER LITRE INCREASES IN FUEL PRICE ASSOCIATED WITH VARYING ASSUMPTIONS FOR THE PRICE OF EMISSION PERMITS[35]

[35] The higher value for CNG vis-à-vis LPG is perhaps slightly counter intuitive and requires some explanation. Although LPG has a higher carbon content than CNG, emitting 60.4kt CO_2/PJ compared to CNG's 52.1kt CO_2 /PJ, when CNG is used in domestic transport, it has a high level of CH4 emissions – 567tCH4/PJ, compared to LPG's 40tCH4/PJ (see NZ Energy Greenhouse Gas Emissions 1990-1999, pp 113-119). Converting this to a CO_2 equivalent figure gives 11.9kt CO_2/PJ for CNG and 0.8kt CO_2/PJ for LPG. The two fuels have a similar level of N20 emissions (2.8tN20/PJ). When the GWP of these three emissions are combined into one figure, CNG has a CO_2 equivalent emission factor of 64.9kt CO_2/PJ, while LPG has a factor of 62.1. In addition, there are more litres.

In terms of the overall impact on the economy, Figure 10 below shows that the effect of the imposition of an emissions permit trading regime on diesel and petrol and their close substitutes (CNG and LPG) are the most important to consider.

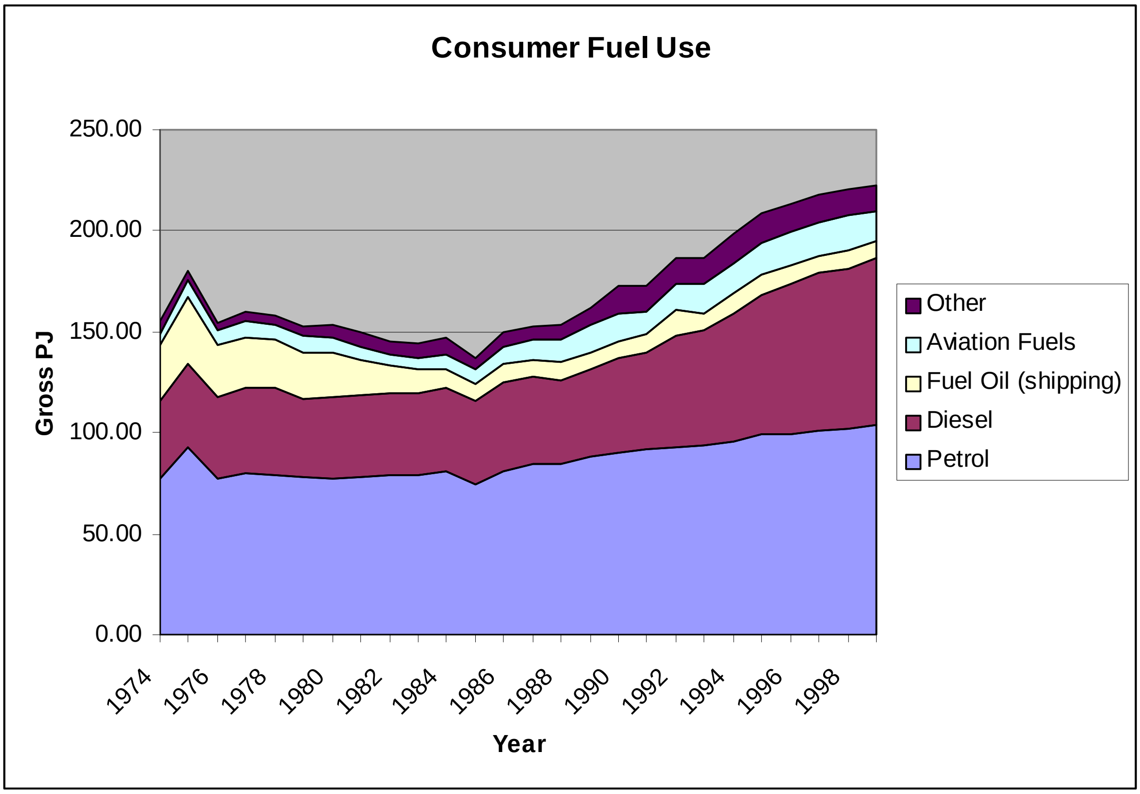


FIGURE 10: CONSUMER FUEL USE BY FUEL TYPE

It is notable that these price increases are within the scope of recent price rises and fluctuations. While not dramatically increasing fuel prices, this will add impetus to any shift in consumer behaviour with respect to fuel or transport mode choice. We noted earlier that consumers of fuel begin to react to the price rises largely by higher utilisation of public transport. A structural rise in the price of fuel, as opposed to a temporary fluctuation, will give greater certainty for people considering a shift in transportation mode. However, a minor fuel rise may do little to encourage a move away from single person car commuting – particularly if the fuel price rise flows through to a rise in public transport fares.

In terms of fuel type, the impost of the permit regime may change the relative competitiveness of fuels to a small extent. For example, it will make LPG marginally more attractive with respect to its petrol and diesel substitutes. However, the difference is probably not large enough to make a significant impact on the market shares of the various fuels. Certainly, emission permits alone will not resurrect the fortunes of the CNG industry without structural changes in the distribution, unless a price advantage can raise the interest of urban fleet managers. Diesel, while increasing as much per litre as petrol, will become an increasingly desirable fuel, given the efficiency and technological sophistication of the modern diesel engine. It is already a major fuel of choice for cars in Europe.

Within the transportation/supply chain sector, the expectation is that the leanly costed transport industry will pass on any fuel price rises to retailers. This is unlikely to impact on the modes of transportation currently used. The exception may be the domestic coastal shipping industry, as their internationally based competitors using exempt bunker fuels may be able to transport goods between local ports without incurring the extra cost of emission permits. New Zealand's own coastal shipping industry is already at a serious competitive disadvantage due to most government's use of heavy tax breaks for their shipping firms as a strategic economic asset. Deregulation in shipping has allowed foreign flagged shipping to take some market share away from land transport, especially road transport. Increasing New Zealand based shipping's fuel costs will exacerbate this, potentially at the cost of the demise of local shipping firms.

The first type of substitute for independent vehicle travel for the public is public transport. This is initially just a more efficient use of the same fuel.

After this there are technological advances being pursued by the world's vehicle manufacturers that may offer alternatives. The first of which are destined for commercial release from 2004 onwards.

While the size of the price increase is of itself probably too small to stimulate investment in alternative technologies, it is useful to consider what developments may be on the horizon.

Arguably, the new technology option closest to commercialisation is fuel cell powered vehicles. Fuel cells have been used by every manned space flight since 1965; the only by-product is water. The fuel required is Hydrogen, which is relatively easy to obtain from Natural Gas. New Zealand, with its extensive gas reserves, is well placed to exploit these technologies should they become commercially viable. However, there is at present no network for disseminating hydrogen as fuel. These power units are quite efficient, environmentally friendly, and running costs are similar to the internal combustion engine. However, the catalyst used to run the cell is Platinum which is itself a scarce resource; running 5% of the world's cars on fuel cells would require 33% of the world's Platinum production! The only car manufacturer currently ready to introduce this technology is BMW. However, obtaining hydrogen from natural gas for fuel cells also emits green house gases and would be impacted by emission trading,

The second option is known as the 'Hybrid' car. This combines a petrol engine with battery or fuel cell technology. This is cheaper as it doesn't require the full cost of fuel cells, while still much cleaner than traditional petrol engines.

The market for these types of vehicles is only in its infancy, and they will be highly priced due to initially small production runs. The high prices for new technology cars, will inhibit New Zealand's move to higher efficiency vehicles in the medium term.

5.3.2 Structure of the Industry

The structure of the Upstream Oil industry is not expected to alter greatly in the short to medium term as a result of the introduction of emission permits. The permit regime will increase their cost base. The effect upon demand would need to be dramatic to stop the oil companies from merely passing on the cost to consumers.

The personal transportation sector is likely to absorb the price increase and perhaps increase the interest in public transport in response to higher fuel costs. The trend towards cleaner and more efficient vehicles will continue but will be largely driven by higher fuel costs in other countries, especially Europe. The current resistance to diesel fuelled cars in New Zealand, compared to Europe, may erode in a quest for lower fuel costs.

The commercial transportation industry will face an increase in its operating expenses as fuel prices increase. This is a low margin industry, and, while fuel prices will be passed on to a large extent, it could drive further rationalisation, as some operators become less viable and leave the market.

Higher fuel costs in the tourist travel area could trigger some rationalisation, but the costs are likely to be passed on as much as possible. The bulk of the industry consists of small businesses which cannot absorb the cost. We do not expect this to significantly impact on the tourism industry since any effect is minor in comparison to the effect of exchange rate movements.

5.3.3 Conduct of the Sector

A minor structural price increase such as may result from the introduction of emissions permits would be just one of several issues facing this sector, and thus be unlikely to drive a change in conduct by itself. Consumers are likely to expect that permits will drive prices up. This expectation of a price rise, coupled with the relatively small size of the impact (in relation to normal fuel price fluctuations), will allow companies to pass on the cost of their emissions permits to the general motoring public.

Across much of the commercial sector, where cost increases are felt keenly and are often partially absorbed, the increase in cost will tend to drive more competitive behaviour, and trigger rationalisation if feasible. This will be driven by even lower margins, and a need for greater market share or volumes of business as a response. In this part of the economy even small price increases trigger greater efficiency in resource utilisation.

5.3.4 Performance of the Sector

The upstream oil industry will still retain its competitiveness when compared to other Annex 1 nations but will be disadvantaged when compared to the rest of the world. Downstream businesses will become more competitive due to tightening margins, and this may counteract some of the cost increase. However, the greatest performance impact of emissions trading in oil and transport will be the flow on effect of higher prices to the industry groups reliant on transport and delivery of goods.

It can be expected that, in response to these impacts, individuals and companies would move towards ways of mitigating the emissions themselves. This may involve technology responses such as fuel cell vehicles, etc, especially in the longer term.

The impact of permit prices for the national economy is given in Table 14 and Table 15. These tables show that the cost of permits for the consumption of the national economy as a whole is about $300m based on 1999 consumption, or $355m with oil consumption growth of 2% to 2008. The impact on sectors other than domestic transport do not include domestic transport fuel costs.

Total Cost of Permits					
	Usage (PJ)	$10/t	$20/t	$30/t	$60/t
LPG	5.1	$3.2m	$6.3m	$9.5m	$19.0m
Petrol	103.6	$71.3m	$142.5m	$213.8m	$427.6m
Diesel	82.6	$57.7m	$115.5m	$173.2m	$346.4m
Fuel Oil	8.4	$6.3m	$12.5m	$18.8m	$37.6m
Aviation Oil	15.0	$10.4m	$20.7m	$31.1m	$62.2m
Total	214.70	$148.8m	$297.6m	$446.4m	$892.8m

TABLE 14: INCREASE IN NATIONAL FUEL COST BASED ON 1999 CONSUMPTION

Total Cost of Permits					
	Usage (PJ)	$10/t	$20/t	$30/t	$60/t
Agriculture	15.55	$10.8m	$21.6m	$32.3m	$64.7m
Industrial	10.92	$7.6m	$15.1m	$22.7m	$45.4m
Commercial	5.00	$3.5m	$6.9m	$10.4m	$20.8m
Residential	2.17	$1.5m	$3.0m	$4.5m	$9.0m
Domestic Transport	171.28	$118.7m	$237.4m	$356.1m	$712.2m

TABLE 15: COST OF PERMITS FOR OIL BY SECTOR

The impact on households is a mixture of the small amount of residential consumption, mainly on heating, and the use of domestic transport. The additional cost of motoring for a car travelling 20,000km per annum is in the range $70 - $120 per annum. In addition, we can expect most of the $300m will eventually be passed through to final consumers by way of price increases, although some fuel efficiencies will reduce the total bill.

5.4 CONCLUSIONS

New Zealand's oil and associated transport industries are highly competitive. Margins, particularly amongst transport operators, are low.

The demand for transport services is very inelastic. Price increases generally only result in small shifts in demand.

The imposition of a tradable emissions permit regime will add a small premium to existing fuel prices (in the order of 0.4 cents a litre at an emission permit price of $20 per tonne).

The competitive nature of the industry, coupled with the inelastic demand, means that virtually all of these costs can be expected to be passed through to the consumer of fuels and to the end-consumer of transport services.

This increase is significant enough to be noticed, adding about $300 million to the national cost of oil products, but relatively insignificant when compared to fluctuations as a result of changing crude prices and exchange rate fluctuations.

In the short term, this (small) structural shift in the price of transport fuels may encourage more efficient vehicles, reinforce interest in public transport alternatives, and increase pressures for rationalisation in the low margin commercial transportation industry.

In the longer term, it may add impetus (however small) to the introduction of new alternative technologies (including fuel cells and “hybrid” cars), although this initiative is more likely to be driven by other factors.

In general, however, the size of the increase is not considered large enough to have any significant impact on transport mode or fuel choice.

6. INDUSTRIAL PROCESSES - CO_2 EMISSIONS

6.1 INTRODUCTION

This chapter considers those industries where manufacturing processes emit CO_2 over and beyond emissions from combustion of fuels. This covers specific metal production industries (iron and steel making from primary materials, aluminium smelting), specific mineral processing industries (cement manufacture and lime processing) and minor processes such as peroxide production.

As in other chapters, we provide a description of the sector and the likely impact of emission permits.

These industries in New Zealand consist of a small number of companies each with individual characteristics, which do not form a homogeneous sector.

6.2 DESCRIPTION OF THE SECTOR

6.2.1 Basic Conditions: Steel Industry

The steel industry in New Zealand is primarily focused on satisfying local demand, in competition with imported products. It also exports a significant proportion of output.

The nature of steel making is such that economies of scale are important. Most major steel making countries involve large scale integrated steel making plants, driven to achieve lowest cost of production and maintain competitiveness within international markets. Consequently, the New Zealand industry is at some disadvantage competitively due to its small scale and limited local market. For this reason the local industry tends to focus on a limited product range tailored to the needs of the local construction industry, including flat rolled steel products (roofing steel etc.) and to export this product range. The industry is therefore closely linked to the performance of the local economy, through activity levels in construction, manufacturing and agriculture.

It is the primary processes in this industry which emit CO_2 – in particular the chemical reduction of local iron sand in blast furnaces to produce molten iron, which is then converted into steel. This is an integral part of the steel making process and therefore is not readily modified to reduce the emission levels. The subsequent steel forming processes do not emit CO_2.

6.2.2 Structure and Conduct of the Steel Industry

New Zealand consumes approximately 600,000 tonnes of steel product annually. More than half of this product is manufactured locally (57%) with the balance imported.

There are only two primary steel processors in New Zealand:

- BHP New Zealand Steel - a subsidiary of the Australian based resources company. The parent company BHP is currently in the process of merging with Billiton to become a global resources company.
- Pacific Steel - a subsidiary of Fletcher Building, which includes residential and commercial construction, steel, building products, and concrete activities. Fletcher Building is a stand-alone publicly listed company, which emerged from the break up of Fletcher Challenge.

BHP New Zealand Steel operates an integrated steelworks in Glenbrook, near Auckland producing hot and cold rolled coil, plate, metallic coated and painted steel products, hollow sections and welded beams. Its direct reduction process is the main source of CO_2 emissions. Its primary raw materials being locally mined iron sand and coal.

BHP's fully integrated steel mill produces approximately 600,000 tonnes of steel per annum, of which approximately 60% is exported, to Australia, Japan, USA and Pacific Island Countries. Its product range includes Hot and Cold Rolled Steel Sheet and Coil, a range of Pipe and Hollow Sections for the manufacturing and engineering industries; and a range of coated steel products for the building and construction industry.

Pacific Steel's electric arc furnace produces steel from scrap metal and has much lower CO_2 emissions. It has a capacity of approximately 170,000 tonnes of steel per annum, the majority of which is sold locally. It produces angle, channel and rod sections for local construction and manufacturing industries.

Over and beyond local steel production, imports of steel product amount to approximately 260,000 tonnes pa (40% of consumption) to satisfy the specific needs of the local manufacturing and heavy engineering industries. Imported products include wire, pipe and structural steel products imported from Australia, Japan, China, Thailand, Korea and South Africa.

The distribution of steel products is both directly from the two primary steel producers and through companies within their respective groups, which also import complementary steel products. There are also a range of independent steel merchants and distribution companies, which sell both local and imported product. A limited number of large manufacturing companies import directly from offshore steel makers.

Competition with imported steel products is keen.

6.2.3 Performance of the Steel Industry

The performance of the primary processing steel industry must be understood in terms of the highly competitive international market for steel products. Because it is a highly capital intensive industry using assets which have a 20-30 year life cycle, and competing with much larger scale steel making operations, we anticipate that it is operating with relatively low profit margins.

As both companies operate within larger groups, no publicly released financial reporting has been available for these steel businesses for several years.

BHP is in the process of spinning off it's poorly performing Flat Products Steel business (BHP Steel) after successfully spinning off it's Long Products Steel business as OneSteel in October last year. This restructuring of BHP's Australian steel operations will effectively separate the mining operations from downstream steel processing and distribution, and is targeted for completion by the end of 2002.

BHP New Zealand Steel's financial performance has been in question for some years. Consequently, its position within a redefined, standalone BHP Steel could be in question depending on how the spinout is progressed. BHP has stated that it will consider other options for divestment, including a trade sale or stock exchange float via an initial public offering (IPO) of BHP Steel shares.

The financial performance of Pacific Steel within Fletcher Building is more difficult to gauge. It provides raw material feedstock to other steel manufacturing operations within the group (notably steel rod for input wire-making operations) as well as supplying end product into the market.

Commentators suggest that a recent strategic review within Fletcher Building may result in the disposal of its steel division to local distributor Steel & Tube Holdings (whose major shareholder is Australian based OneSteel).

6.2.4 Basic Conditions : Aluminium Industry

The aluminium smelting industry was established in New Zealand to take advantage of low cost hydro-electric power for the conversion of Australian mined bauxite.

The majority of the industry's products are exported, with more than 90% of production going mainly to Japan, Korea and other Asian markets.

The industry is highly dependent on low cost electricity to power its production processes, in order to remain competitive in international markets.

In the production process greenhouse gases are emitted. The oxidisation of the carbon anodes is responsible for 90% of the CO_2 emissions from aluminium production other than that created by the production of electricity.

6.2.5 Structure and Conduct of the Aluminium Industry

The industry is embodied in the aluminium smelting activities at Tiwai Point, which is owned by Comalco New Zealand Limited.

Comalco New Zealand Limited was established in 1988 and is a wholly-owned subsidiary of Comalco Limited, Australia, the world's eighth largest aluminium company, which is ultimately owned by Rio Tinto Limited, a global resources company. Comalco New Zealand owns Comalco's New Zealand interests, principally through its 79.36% stake in New Zealand Aluminium Smelters Limited (NZAS).

NZAS owns the Tiwai Point aluminium smelter, which was commissioned in 1971 and has been expanded from its initial capacity of 70,000 tonnes per annum to a current capacity of more than 318,000 tonnes per annum.

Comalco produces a wide range of primary aluminium products - ingot, t-bar, rolling block and billet forms. It exports these primary aluminium products to customers in Japan, Korea and other Asian countries as well as North America, the Middle East and Europe. It also serves the New Zealand market where a range of secondary processors and aluminium fabricators service the construction sector.

6.2.6 Performance of the Aluminium Industry

Internationally, the aluminium industry is highly competitive and profitability tends to fluctuate with movements in the commodity price of aluminium.

Recently Comalco's profitability has been boosted by high aluminium prices – US$1,562/tonne in 2000 versus US$1,389/tonne in 1999.

6.2.7 Basic Conditions : Lime Processing and Cement Industries

The lime processing industry's end products are used in a diverse range of agricultural and manufacturing applications, including steel making, paper making, fertiliser manufacture and various chemical industries. The bulk of the lime industry's output is consumed by local manufacturers.

New Zealand consumes 4.3 million tonnes of product, which is manufactured by the lime processing industry (refer to Table 16 below).

Product Category	New Zealand Consumption (tonnes)	CO_2 Emissions from manufacturing process
Agriculture	2,000,000	No
Aggregate	500,000	No
Cement	1,400,000	Yes
Burnt Lime	200,000	Yes
Industrial Uses	200,000	No

TABLE 16: LIME INDUSTRY OUTPUTS

It is only those processes involving calcination of limestone that give rise to CO_2 emissions.

The calcination of limestone is central to the cement production process. Calcination is the chemical reaction whereby CO_2 is released from the limestone as it is heated. It accounts for 50% of all CO_2 emissions from the cement industry. Even if the cement industry could eliminate emissions associated with fuel combustion and electricity consumption, they would continue to have 50% of current emissions because it is endemic to the manufacturing process.

The cement industry in New Zealand is similar to steel in that its primary focus is upon the domestic market, with a dependence on construction sector activity.

Burnt Lime (calcium oxide CaO) is manufactured by calcining high quality limestone at very high temperatures. Nearly half the limestone's weight is volatilised off as carbon dioxide to produce calcium oxide or burnt lime. Hydrated Lime (calcium hydroxide $Ca(OH)_2$) also known as slaked lime is a derivative of burnt lime, and is the most widely used alkali in the world. These two products form the basis for many of the industry's non-cement products.

Burnt Lime is used in the steel industry as a flux for removing impurities and in the construction industry as a soil stabiliser for roads, building foundations and earth dams.

6.2.8 Structure and Conduct of the Lime Processing and Cement Industries

The cement industry has a pivotal role within the lime processing industry, due to common ownership structures across several of the companies in the sector.

In New Zealand there are two main cement manufacturing companies:

- Golden Bay Cement, a subsidiary of Fletcher Building Limited; and,
- Milburn New Zealand Limited, a subsidiary of Holderbank Financiere Glaris Ltd (Switzerland)

Golden Bay Cement is New Zealand's largest cement manufacturer and supplier. The company's manufacturing operations are concentrated at Portland, 8km south of Whangarei. From Portland, bulk cement is distributed to Golden Bay Cement's eight Customer Service Centres around New Zealand, and provided to building and construction industry customers.

20% of Golden Bay's output is exported – primarily to Pacific Island countries, including Tahiti.

Golden Bay is a part of the Concrete Division within Fletcher Building, along with Firth Industries Ltd, Winstone Aggregates Ltd and Hume Industries Ltd.

The capacity of Milburn's Westport works has grown steadily over the years, currently producing 450,000 tonnes of cement a year.

While Milburn Cement remains the cornerstone of the Milburn Group of Companies, Milburn has vertically integrated its operations to add value to its core cement business. Its activities include:

- **Aggregates:** Large quarries in the Wellington region, Hawkes Bay and in Auckland supply a variety of Aggregates, primarily for the ready mixed concrete and roading markets;
- **Concrete:** A network of 34 ready mixed concrete plants owned by subsidiaries Ready Mixed Concrete and Allied Milburn (50% owned) demand a large share of the New Zealand concrete market. Ready Mixed Concrete also produces a diverse range of paving and masonry products; and
- **Lime:** High-grade agricultural and industrial lime is produced through Taylor's Lime in the South Island and McDonald's Lime (72% owned) in the North Island.

Milburn also has a small export business supplying cement into Pacific Island countries.

These two cement companies serve the New Zealand building and construction industry through their various subsidiary and sister companies.

Companies involved in non-cement Lime processing in New Zealand include :

- McDonalds Lime – subsidiary company of Milburn NZ Limited;
- Taylors Lime - subsidiary company of Milburn NZ Limited; and,
- Omya New Zealand – subsidiary of Omya AG Switzerland.

McDonald's Lime and its sister company Taylor's Lime produce high-grade agricultural and industrial lime.

At Omya's plant near Te Kuiti, high purity limestone is processed through crushing and milling circuits to produce a range of finely milled limestone powder (whiting) for industrial use in New Zealand. A major use of this high purity limestone powder is as a filler in paper and fibreboard. In addition, it is a vital ingredient in the production of paint, plastics, rubber inks, adhesives, glass, putty, and ceramics. However, Omya does not use any calcination process in its manufacturing activities.

We understand that New Zealand is relatively self sufficient in lime processing and that there are no major imports of cement or burnt lime products.

6.2.9 Performance of the Lime Processing and Cement Industries

As these industries are primarily serving the local market, without a high degree of competition from imported products. We understand that they are performing profitably, subject to major swings in the local construction sector.

World cement prices are currently $US50-55 per tonne.

6.2.10 Hydrogen Peroxide

Degussa produces hydrogen peroxide from their plant in Morrinsville. The world-wide capacity for hydrogen peroxide is 750,000 tonnes of which Degussa has a world-wide capacity of 430,000 tonnes. The Morrinsville plant has a capacity of 18,000 tonnes. Demand world-wide in 1998 was 570,000 tonnes and is projected to be 700,000 tonnes by 2002.

The major uses of hydrogen peroxide are pulp and paper (56%), chemical synthesis (12%), environmental uses (water treatment) (12%), textiles (10%) and miscellaneous (10%). Pulp and paper industry demand will continue to drive the hydrogen peroxide market in the foreseeable future, with established uses in water treatment and textile bleaching increasing at a more modest pace. Use in chemical manufacturing is essentially flat or growing only slightly. Peroxide prices remain constrained by an oversupply in the marketplace.

The historical prices between 1982-1997 have been as high as US113.5c per kilo and as low as US78c per kilo. The current price is US104.5c to US105.5c per kilo.

6.3 IMPACT OF EMISSION PERMITS

6.3.1 Impact on basic conditions : Steel Industry

Based on the assumption that emission permits must be acquired by plant owners, as the point of obligation within this industry, we have considered the acquisition cost for the industry and in particular for the major emitter, BHP New Zealand Steel.

The 1999 CO_2 emissions for the industry have been quantified at 1,508.17 Gg or 1,508,170 metric tonnes of CO_2. At a nominal $20/tonne this equates to a cost of $30 million to the industry, the major part of which would be carried by BHP New Zealand Steel.

The last reported turnover for BHP New Zealand Steel was $534 million. However this was for a 13-month period; a more representative turnover is $485 million pa. The emissions permit acquisition cost represents a major cost to the company, potentially in the region of 5% to 6% of turnover.

6.3.2 Impact on Structure, Conduct and Performance of the Steel Industry

We anticipate that if BHP New Zealand Steel was faced with this cost at the implementation of an emission credits system, the parent company would question the viability of the future business. It is likely that the primary processing operations could not carry this level of costs and primary steel production would cease.

This would leave the rolling mills dependent on imported billets from one of the company's lower cost Australian or Asian plants.

The viability of the rolling mills without access to local steel feedstock is not quantifiable without more detailed information at this point in time.

The position of the Pacific Steel operations within Fletcher Building could similarly be affected, with concentration on secondary processing of imported billets. This would also have implications for recycling of scrap steel in New Zealand, as Pacific Steel has the only local recycling furnace.

In these circumstances, substitution of locally produced steel with imported product from non-Annex 1 countries could be expected (in particular from China, Korea and South Africa), as New Zealand currently receives some product from these sources.

6.3.3 Impact on Basic Conditions : Aluminium Industry

Based on the assumption that emission permits must be acquired by plant owners as the point of obligation within this industry, we have considered the acquisition cost for the industry and in particular for the major emitter Comalco New Zealand.

The 1999 CO_2 emissions for the industry have been quantified at 534.64Gg or 534,640 metric tonnes of CO_2. At a nominal $20/tonne this equates to a cost of $10.7 million to the industry, all of which would be carried by Comalco New Zealand.

The last reported annual turnover for Comalco New Zealand was $700 million. Therefore, the emissions permit acquisition cost represents approximately 1.5% of turnover in the year of implementation (solely from CO_2 emissions inherent in the smelting process).

Because of the high dependency of this industry on input electricity costs, this process related cost would have to be considered in conjunction with any increase in electricity costs arising from the emission credit costs, which may flow through from the energy suppliers to Comalco (see Chapter 4[36]).

6.3.4 Impact on the Structure, Conduct and Performance of the Aluminium Industry

Comalco New Zealand has actively been seeking to reduce its greenhouse gas emissions and improve the energy efficiency of its process in recent years, with considerable success, including:

- Increased energy efficiency at Tiwai Point plant - Consumption 10% below levels a decade ago; and
- Reduced greenhouse gas emissions – Carbon Dioxide emissions down 14% per tonne of Aluminium produced, since 1990 (well beyond an initial 4% target!).

This suggests that despite a significant cost of an emission permit system, the company could manage the cost implications. However, the longer-term viability of the operation could be affected, particularly the cost implication of any capacity expansion, which would carry the cost of any additional future emissions.

---

[36] The data given for aluminium in Chapter 4 includes the expected electricity price increase. Hence the difference between the figure of 1.5% above and 3.22% in Chapter 4.

6.3.5 Impact on Basic Conditions : Cement Industry

Based on the assumption that emission credits must be acquired by plant owners as the point of obligation within this industry, we have considered the acquisition cost for the cement industry.

The 1999 CO_2 emissions for the industry have been quantified at 527.89 Gg or 527,890 metric tonnes of Co2. At a nominal $20/tonne this equates to a cost of $10.6 million to the industry in the year of implementation.

We have estimated the combined turnover of the cement industry to be in the range $300 - $400 million pa. Therefore the acquisition of emission permits would represent approximately 2% to 3% of turnover. In addition, the industry can expect other cost increases from electricity and transport which could be as much as a further 1% - 2% of turnover.

This is a significant cost for an industry, which is subject to cyclical movements in the construction and building industry.

6.3.6 Impact on Structure, Conduct and Performance of the Cement Industry

Because there are no major imports of cement into New Zealand, we anticipate that the cost of acquisition of emission credits would be passed on through the industry in price increases. This will be limited by the international price of cement. While New Zealand is not involved in significant international trade in cement, if the price differential between local and competing products from non-Annex 1 countries became great enough it would justify the cost of shipping. In that event it is likely the local industry will seek efficiencies in its production and perhaps revision in its production processes to combat the competition. This response is feasible for a cost increase of only 3%-5% of turnover.

We do not anticipate that a permit scheme would give rise to a major impact on the local construction industry.

6.3.7 Impact on Basic Conditions : Lime Processing Industry

Based on the assumption that emission permits must be acquired by plant owners, as the point of obligation within this industry, we have considered the acquisition cost for the lime processing industry, excluding cement operations.

The 1999 CO_2 emissions for the industry have been quantified at 107.01Gg or 107,010 metric tonnes of CO_2. At a nominal $20/tonne this equates to a cost of $2.14 million to the industry in the year of implementation.

We do not have a basis on which to estimate the combined turnover of the lime processing industry, as none of the companies' results are publicly quoted. Therefore, we cannot comment with any authority on the level of impact this would have on the industry.

6.3.8 Impact on Structure, Conduct and Performance of the Lime Processing Industry

Because there are no major imports of lime products into New Zealand, we anticipate that the cost of acquisition of emission permits would be passed on through the industry in price increases in the year of implementation. Note that this flow through would also impact the steel industry as a consumer of burnt lime.

In subsequent years, we anticipate that an emission permits system could impact investment decisions and may slow capacity replacement and capacity expansion to some degree.

6.3.9 Impact on Hydrogen Peroxide Industry

In the production of hydrogen peroxide, CO_2 emissions are 0.77kg of CO_2 per tonne of hydrogen peroxide. For a permit price of $20/tonne of CO_2, the permit cost is $14/tonne of hydrogen peroxide.

With a world price of hydrogen peroxide between $US750 and $US1,150 per tonne of hydrogen peroxide, a price increase of less than $US7 is not significant.

6.4 IMPACT ON INTERNATIONAL TRADE

With price impacts ranging from 1% for hydrogen peroxide to 6% for steel, the introduction of a permit scheme will have a varied effect on large industry with an export focus. Exchange rate fluctuations may be expected to overshadow these cost increases, although if the two move together they will create a significant challenge for some of the industries, especially the steel industry.

Aluminium production is vulnerable because its economics within New Zealand depend on the price of electricity. The cost of electricity supply is hedged against normal volatility by supply contracts. A permanent price rise based on the increased cost of permits will certainly be passed on to the aluminium industry in due time. If their costs increase against those of non-Annex 1 countries, there is a strong chance that the plant here will be moth-balled in the long term.

The cement and lime industries are likely to pass on their additional costs (even though they may be as much as 4%-5% of their turnover) because the availability of substitutes comes at a high transportation cost if they are produced in a non-Annex 1 country.

6.5 CONCLUSIONS

Based on this assessment of industries with processes emitting CO_2, the impact of acquiring permits to current emission levels differs by industry groups.

We consider that the Steel Industry would be most seriously affected, to the point that it could undermine the viability of the primary processing operations within the industry.

The Aluminium Industry could also be seriously affected – depending on the impact of increased electricity costs. However this industry appears to be in a better position to deal with the impact because of the improvements in energy efficiency and reduced CO_2 emissions already achieved vis-à-vis 1990 levels.

The Cement and Lime Processing industries appear to be in a better position to pass on additional costs to customers.

The Hydrogen peroxide industry will be scarcely touched by permit prices with costs rising by as little as 1%.

Allocating the credits (free of charge) on the basis of 1990 emission levels would have the effect of lowering the impact on the steel industry and cement / lime industries and would reward the aluminium industry for the improvements in its processes since 1990.

The projected impact of permits, excluding the additional cost of energy and transport, as a percentage of turnover for the industries concerned is summarised in Table 17 below:

Industry	% of Turnover	
	Emission permits @ 20/tonne (1999 production levels)	Emission permits @ 20/tonne (1999 less 1990 production levels)
Iron & Steel	6.22%	0.74%
Aluminium	1.53%	0.22%
Cement	2.61%	0.77%
Hydrogen Peroxide	0.65%	NA

TABLE 17: IMPACT OF EMISSION PERMITS ON KEY CO_2 EMITTING INDUSTRIES AS A FUNCTION OF ALLOCATION METHOD

7. INDUSTRIAL PROCESSES - NON CO_2 EMISSIONS

7.1 INTRODUCTION

The principal industries in New Zealand emitting non-CO_2 greenhouse gases are found in the insulation manufacturing, refrigeration and electrical transmission and distribution sectors[37].

The non-CO_2 gases considered are principally HFC 123 associated with the refrigeration industry and aerosols, and SF_6 associated with the electricity industry.

7.2 DESCRIPTION OF THE ELECTRICITY TRANSMISSION AND DISTRIBUTION SECTOR

7.2.1 Structure and Conduct of the Industry

The electricity transmission and distribution sector uses SF_6 gas as a prime insulator within switchgear and substations operating at voltages from 33 kV upwards. The use of SF_6 as an insulator allows the facilities to be smaller and to be built indoors, reducing the visual and foot print impact of the facility, particularly in urban areas.

The transmission and distribution sector is closely monitored with respect to its financial performance and the rates it charges electricity consumers. In the case of Transpower, it is subject to oversight through its Annual Statement of Corporate Intent and through its reporting both to its share-holding ministers and to the Parliamentary Select Committee. Distribution companies do not have this level of governmental supervision but are monitored by the Ministry of Economic Development and the Commerce Commission as to their financial performance.

Monitoring of the technical performance of either Transpower or the distribution companies is not carried out. However, Transpower reports its performance annually as an adjunct to its Annual Report.

Transpower currently has 704 outdoor and 108 indoor SF_6 switchgear, comprising 34% of the total population of switchgear. Modern SF_6 gas insulated switchgear are now the main type on the system at voltages of 66 kV and above. This form of switchgear is characterised by increased system reliability and greatly reduced maintenance costs. Transpower is also in the process of progressively replacing older switchgear, typically air or oil insulated, with SF_6 switchgear so as to achieve savings in maintenance costs and to be able to deliver a higher standard of service to its customers, due to its greater reliability.

As at March 2000, Transpower has 32 tonnes of SF_6 (this includes SF_6 in use in switchgear and kept as spare material); up from a 1990 baseline of 19 tonnes, Transpower estimates that its stock in 2008 might be 40 tonnes.

The stock of SF_6 is subject to an annual leakage of less than 2%, with 1% being Transpower's current target. Note, that in this regard, as older SF_6 circuit beakers

---

[37] Other industries with less significant emissions in this area, (and thus not covered in this chapter) include those associated with the production of aerosols and aluminium smelting.

are replaced, the expected leakage rate should decrease; newer switchgear can be expected to have a leakage rate of between 0.1% - 0.5%.

In principle, SF_6 gas which is not lost through leakage is retained due to the stringent maintenance practices required both to preserve the gas and to protect staff from the effect of the by-products produced during the operation of the switchgear. SF_6 gas which cannot be recycled is destroyed. Although, as noted above, there is some leakage of SF_6, the rate is sufficiently low that the time required for all gas to escape is much longer than the life of the equipment itself. Therefore the assumption that SF_6 is not ultimately lost into the environment is appropriate. This is in contrast to consumer items containing non-CO_2 gases for which the gas cannot be guaranteed to be safely contained during maintenance or disposal.

There is no correlation between the use of SF_6 gas, as an insulation material in switchgear and energy efficiency.

7.2.2 Impact of emission permits on the electricity transmission and distribution industry

The specification of the emission permit regime has significant implications for the electricity transmission and distribution sector. If permits are required to be held for the stock imported annually, the associated cost at \$20/CO_2 tonne equivalent is \$956,000 (the figures assuming a permit price of \$10/tonne and \$30/tonne are \$478,000 and \$1,434,000 respectively - see Table 18). This amounts to between 0.3% and 0.8% of the annual asset management expenditure and 0.09% - 0.27% of Transpower's annual revenue.

If, however, the permits were required only for the expected leakage from the existing stock of SF_6(loss of SF_6 to the environment) then the cost of the permits would be significantly reduced to \$76,480 per year (\$38,240 and \$114,720 per year for the alternative emission permit price assumptions). This is 0.02% - 0.06% of the asset management expenditure and 0.01% - 0.02% of Transpower's annual revenue.

The cost of the SF_6 emission permits would be recovered from Transpower's customers in one of two ways.

- The cost of permits required to cover new installations would be a charge against the customer or customers who are being charged for that new installation. As such, it could be up to a 10% impost on the cost of the installation (assuming a new substation costs \$10 million and permits were required to cover all of the SF_6 involved).
- The cost of permits to cover maintenance, including replacement of existing switchgear, would be recovered from all customers, producing an expected impost of 0.001% - 0.03%, depending upon the leakage rate and price of emission permits assumed.

The increase in costs due to the cost of emission permits must also be considered against the lower capital (land) costs associated with some SF_6 installations and against the lowered maintenance costs. This means that, notwithstanding the cost of the permits, SF_6 is likely to continue to be the preferred insulation product.

Distribution companies have some SF_6 switchgear in urban substations, although not as much as Transpower. The conditions under which it is used is expected to be similar to those used by Transpower so the impact of the permit regime is expected to be similar, as might the relative scale of permit costs. The distribution companies are understood to be holding off installing more SF_6 switchgear until the emission permit regime is more completely specified.[38]

7.2.3 Conclusions with respect to the electricity transmission industry

The net impact of requiring emission permits for SF_6 in the electricity industry will be to increase the capital and operational costs slightly. However, the advantages offered by SF_6, namely, reduced maintenance costs compared to non-SF_6 switchgear and the lowered capital costs with respect to the land required for the installation, mean that its use is likely to continue should the emission permits regime be introduced.

[38] Conversation with Electrical Engineers Association.

Hypothetical annual cost for an emissions based charge							
Transpower's stock of SF6 March 2000 (tonnes)	**Emission per yr (%)**	**Emission per year (tonnes)**	**CO_2 equivalent per yr tonnes**	**Emissions Unit Costs at $10/tonne**	**Emissions Unit Costs at $20/tonne**	**Emissions Unit Costs at $30/tonne**	**Notes**
32	1.0%	0.32	7468	$76,480	$152,960	$229,440	Design is less than 1%
32	0.5%	0.16	3824	$38,240	$76,480	$114,720	Overseas experience has shown actual leakage can be less than 0.5%
32	0.10%	0.032	765	$7,648	$15,296	$22,944	Recently designed equipment

Hypothetical annual cost for an "importation point" charge (ie, upfront on replacement equipment and gas)							
SF6 imported (tonnes/year)	**Charge**	**SF6 Content**	**CO_2 equivalent tonnes**	**Emissions Unit Costs at $10/tonne**	**Emissions Unit Costs at $20/tonne**	**Emissions Unit Costs at $30/tonne**	**Notes**
2	100%	2	$47,800	$478,000	$956,000	$1,434,000	

TABLE 18: INDICATIVE SF_6 EMISSION COSTS FOR TRANSPOWER

7.3 DESCRIPTION OF THE REFRIGERATION AND INSULATION SECTOR

7.3.1 Structure and Conduct

The New Zealand market for domestic refrigeration appliances is characterised by the existence of two major players, along with a number of small importers. Although details of market share are not known precisely, the following is an estimate based on discussions with leading retailers[39]:

- Fisher & Paykel has the largest market share at approximately 55-65%.
- Email Appliances (NZ) Ltd., which includes the Westinghouse and Simpson brands imported from Australia, is the next largest supplier with around 30-40% of the market.
- The remainder consists of other imported brands such as LG, Samsung, Sharp, Maytag and Whirlpool. Individually, each of these brands has a minimal proportion of the overall market. Niche market imported brands - Gaggenau, Liebherr and Sub Zero - make up about 0.5% of the market.

Figure 11 shows that 85% of imported fridges and freezers are from Australia and Korea, with Australia accounting for over 50% of imports. Of the countries of origin, China, Indonesia, Korea and Thailand are not Annex 1 countries. If we also include the “Other” 1% as being from non-Annex 1 countries, 37% of the imported fridges and freezers may come from non-Annex 1 countries, this being about 16% of the total number of units produced or imported each year.

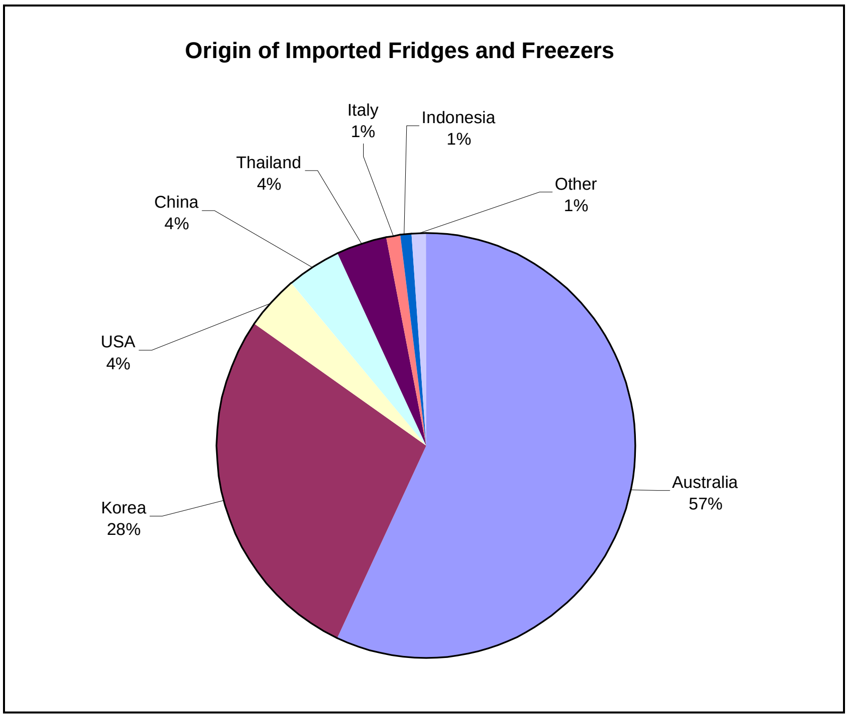


FIGURE 11: PERCENTAGE BREAKDOWN BY COUNTRY OF IMPORTED FIRDGES AND FREEZERS

[39] Information obtained from Pacific Retail Ltd. (Bond & Bond and Noel Leemings).

The commercial refrigeration sector similarly consists of a predominant New Zealand manufacturer, Skope, together with some imported products.

HFC gases are not used in the production of insulation in New Zealand, with hydrocarbon gases and water being used. However, the same is not necessarily the case for imported products. The majority of imported packaged air-conditioners are imported and, as is indicated below, the majority of these come from non-Annex 1 countries.

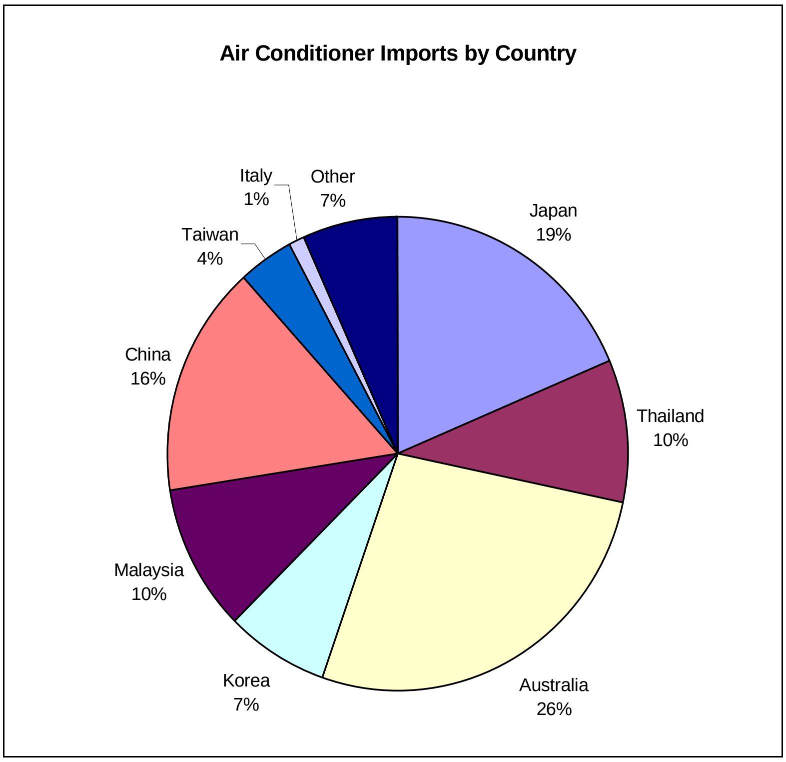


FIGURE 12: IMPORTS OF AIR CONDITIONERS BY COUNTRY OF ORIGIN

7.3.2 Impact of emission permits in the refrigeration sector

A. PRESENT CONDITIONS

Greenhouse gases have application in the manufacture of refrigeration units indirectly as foaming agents in the insulation and directly as a refrigerant. Historically, CFC gases were used for both purposes. However, the Montreal Protocol required the phasing out of CFC gases; this was achieved by Fisher & Paykel in 1994. In New Zealand, the sector currently uses hydrocarbon gas and water as the foaming agent and HFC 134 as the refrigerant.

The table below illustrates the impact of the possible introduction of a permit regime on the cost of a domestic refrigeration unit at the manufacturer, with respect to both the refrigerant and the foaming agent.

Typical Domestic Refrigerator				
	Refrigerant		Foaming Agent	
	HFC 134	Hydro-carbon	HFC 134	Hydro-carbon
GWP Value	1,300.0	0.3	1300.0	0.3
Required (kg)	0.14	0.14	0.5	0.5
CO_2 Equivalent (tonnes)	0.182	0.000	0.650	0.000
Permit @ $10/t	$1.8	$0.0	$6.5	$0.0
Permit @ $20/t	$3.6	$0.0	$13.0	$0.0
Permit @ $30/t	$5.5	$0.0	$19.5	$0.0

TABLE 19: IMPACT OF EMISSION PERMITS ON THE COST OF A DOMESTIC REGRIGERATION UNIT

With a cost of emissions at $20/tonne of CO_2, the use of hydro-carbon gas as the foaming agent and HFC 134 as the refrigerant, the resulting cost of the emission permit per unit is $3.6, at the point of manufacture. Assuming a mark-up to retail price of three, this would result in a price increase of $11 on a refrigeration unit with an average price of around $1,000.

Details on the gases used in imported refrigerators are not available. However, the impact of the Montreal Agreement can be assumed to be such that no units use CFCs. If units use HFC for both the refrigerant and the foaming agent, the resultant associated cost of permits required to cover the enclosed HFC would be $8.30 – $25.00 per unit, depending on the type and size of refrigerator.

Imported units from Annex 1 countries can be assumed to have emission permits for both the refrigerant and foaming agent from the country of origin with the cost of that permit being factored into the cost of the unit as with the New Zealand manufactured units.

Units manufactured in non-Annex 1 countries may not however be required to have purchased emission permits for either the refrigerant or the foaming agent. This would disadvantage New Zealand manufacturers compared to their overseas competition unless overseas manufactured units were made subject to the emission permits regime at the point of importation.

In the case of commercial refrigerants, the position is similar, although the quantities of gas required are larger. The example given below is at the larger end of the range.

B. SUBSTITUTABILITY OF HYDRO-CARBON FOR HCF 134

Hydrocarbon gases are used as refrigerants in European units. However they are not used in US units, principally due to a fear of litigation due to their flammable characteristics.

Fisher & Paykel have not yet switched to hydrocarbon refrigerants, despite their slightly better energy efficiency characteristics, for a number of reasons. At present, suitable compressors, which operate at 110Vac, as required for the North American market, are not readily available. Consequently, F&P would need to maintain two production lines, one for HFC refrigerants and one for hydrocarbon refrigerants, with the associated increase in costs. The savings in avoiding the cost of emission permits for HFC refrigerant gases coupled with the energy efficiency advantages may be sufficient to encourage manufacturers to change to hydro-carbon HFC 134 gases, particularly as there are eight years in which to source appropriate compressors.

	Typical Commercial Refrigerator	
	Refrigerant	
	HFC 134	Hydro-carbon
GWP value	1,300	0.3
Required (kg)	1,000	1,000
CO2 Equivalent (Tonnes)	1,300	0.3
Permit @ $10/tonne	$13,000	$3
Permit @ $20/tonne	$26,000	$6
Permit @ $30/tonne	$39,000	$9

TABLE 20: COST IMPOST OF PERMITS FOR A TYPICAL COMMERCIAL REFRIGERATOR

We are advised[40] that, apart from the cost of changing the manufacturing process from one technology to another, estimated to be at least $1 million, the net change in cost of a unit of switching from HFC refrigerant to hydro-carbon is likely to be small.

C. IMPACT OF GRANDFATHERING EMISSION PERMITS

A decision to allocate emission permits in proportion to historical 1990 emission levels would have little impact on domestic manufacturers such as Fisher & Paykel. At the time, they were using CFCs in their manufacturing processes, and only shifted to HCFs once they were required to phase out CFCs pursuant to New Zealand's ratification of the Montreal Protocol after 1990.

7.3.3 Conclusions with respect to the refrigeration industry

The diverse nature of the countries of origin for refrigeration and air conditioning units, with a significant proportion of the countries of origin being non-Annex 1 countries suggests that any cost impost would disadvantage New Zealand manufacturers vis-à-vis their international competition – unless steps were taken to bring non-Annex 1 sourced appliances within the scope of the emissions trading regime at the point of importation. Requiring all imported refrigeration units to either show evidence of an existing permit (Annex 1 countries), or purchase permits at the point of importation (non-Annex 1 countries) would ensure that New Zealand manufacturers would not be disadvantaged compared with manufacturers overseas.

[40] Fisher & Paykel, pers.comm.

The size of the cost impost, due to requiring emission permits on refrigerants, is not expected to be large as a proportion of the total cost of the unit, whether a domestic or commercial refrigerator, being probably of the order of 1-2% of the total cost of the unit. The sector has alternative refrigerants available, which are understood to provide economic substitutes, while also having slightly better energy efficiency and much lower values of GWP.

The allocation of permits free of charge in proportion to 1990 emission levels would not alleviate the impact on the industry.

If government were to supply permits to the 1990 level free of charge and then require payment for permits above that level, then all HFC refrigerant gases would require permits to be purchased and could provide the necessary incentive for manufacturers to switch to the use of hydro-carbon refrigerant gases.

8. WASTE MANAGEMENT

8.1 INTRODUCTION

This chapter discusses the potential impacts the introduction of a carbon emissions trading regime would have on the waste management sector.

Waste management is broken down into two sub-sectors – solid waste management and wastewater management. Solid waste management refers to waste disposed of in landfills, while wastewater management refers to treatment carried out in wastewater treatment plants, oxidation ponds and septic tanks.

8.2 DESCRIPTION OF THE SECTOR

8.2.1 Basic Conditions

The demand for solid waste and wastewater management is a function of waste supply. This, in turn, is a function of:

- Population levels; and,
- Industrial production levels.

Solid waste volumes are also dependent on consumption levels.

By corollary, wastewater and solid waste volumes follow economic cycles. During periods of favourable economic conditions, waste volumes increase. Conversely, during economic downturns waste volumes are reduced.

To enhance clarity in the remainder of this chapter, we will separate the analysis into solid waste and wastewater where it is sensible to do so.

A. SOLID WASTE

The latest available estimate of annual solid waste volumes is from 1999. It is estimated that in 1999, approximately 3.45 million tonnes of solid waste was disposed of in landfills in New Zealand. Of this, around one third of the volume is disposed of in Auckland. About 45% of the total volume consists of residential waste and the remaining 55% consists of industrial waste.

Substitutes for landfill waste disposal include recycling, composting and thermal treatment. Recycling is a reasonably large industry in New Zealand, although still small in comparison to landfilling. It is estimated that more than 80% of the New Zealand population has access to at least one recycling scheme. Composting is a relatively small industry, but is slowly growing. The rate of growth of these industries, however, is constrained by the fact that there is a limited market for the end products. New Zealand has only one thermal treatment plant. Thermal treatment is very expensive, so as a result demand is fairly low. Overall, landfills have a dominant position in the market for solid waste disposal.

The sensitivity of demand for landfill disposal to prices can be discussed in terms of the industry as a whole, and of individual landfills.

On an industry-wide basis, demand elasticities appear to be fairly low. Demand for disposal mechanisms is driven by the need to remove non-useable products from households and businesses. Demand for landfill disposal as a means of achieving this is driven in part by the lack of cheaper or similarly priced and effective mechanisms that deal with almost all forms of solid waste in as simple and widespread a manner as landfilling.

Anecdotal evidence suggests that although many landfills offer discounts for consumers that separate their recyclable materials from the remainder of their waste, consumers often do not do this. And although the price for disposals of full trailer loads is the same as for partially filled trailer loads, people generally do not wait until they have enough waste to fill up a whole trailer load for disposal. This suggests that disposal volumes are motivated by factors other than price.

In terms of individual landfills, demand elasticities more than likely vary across regions and categories of consumers. Economic theory suggests that demand elasticities are, in part, a factor of the level of competition in the market. An increase in disposal prices at one landfill in a highly competitive market would be expected to have more of an impact on demand for the site that raised prices than a landfill with much lower levels of nearby competition.

Demand is probably more sensitive to prices for commercial entities with large waste volumes than for residential users. The larger waste volumes produced by commercial organisations could introduce possibilities for cost reductions by transporting waste over larger distances. This would tend to expand their landfill market in comparison to residential waste producers. The expanded market would mean that demand for landfills would be more sensitive to prices for commercial entities, and competition between landfills for commercial waste would be greater.

In terms of waste collected under curbside collection contracts, it is unknown what proportion of the collections are made by firms that are contracted to deliver to particular landfills. Those that are able to deliver to any landfill would similarly have greater demand sensitivities to prices set by individual landfills.

The landfilling industry generally employs low to moderate forms of technology. Typical technologies include earth-moving mechanisms and leachate collection and treatment systems. Some of the larger urban and new or upgraded landfills possess gas collection systems. The gas collected can be then flared, used for electrical generation or used for heat/industrial use. In Wellington, for example, over 6% of the natural gas used is from landfills. The trend towards the introduction of gas collection systems is slowly growing.

B. WASTEWATER

Between approximately 525 and 705 million cubic metres of wastewater is produced in New Zealand in a year. This wastewater is treated via septic tanks, oxidation ponds and wastewater treatment plants. Treatment plants control their gas emissions. Treatment in septic tanks and oxidation ponds occur biologically and release greenhouse gases into the atmosphere.

The table below indicates the fraction of total wastewater handled by each type of treatment system.

Wastewater handling system	Fraction of wastewater treated by the handling system
Septic tank	12.5%
Oxidation pond	11%
Treatment plant	76.5%

TABLE 21: HANDLING OF WASTE WATER BY TYPE OF TREATMENT SYSTEM

Substitutes for wastewater management are minimal. Users of wastewater disposal mechanisms generally do not have a choice in the mechanism they use to treat their wastewater. Rather, it is determined by the infrastructure in the location that the wastewater is produced. For example, many rural dwellings are not connected to reticulated systems so rely on septic tanks for wastewater disposal. Most urban dwellings are connected to reticulated systems; relatively highly populated areas pipe wastewater to treatment plants, while some of the lower populated areas pipe wastewater to oxidation ponds for treatment.

Given that wastewater production is a by-product of everyday activities and is not for most part optional, demand is very inelastic.

Wastewater management technologies vary widely. The large treatment plants employ relatively high levels of technology with vast infrastructure and mechanisms to control adverse environmental consequences. Oxidation ponds are less technologically driven and septic tanks even less so.

Technologies for wastewater and solid waste treatment are generally not designed to make the waste disposal more attractive for consumers. Instead, the technological drivers comprise the need to meet environmental requirements and to enhance efficiencies in the industry.

8.2.2 Structure of the Industry

A. SOLID WASTE

In terms of the solid waste disposal industry, regional councils throughout New Zealand identified 221 open landfills, operated by 177 operators in 1998/1999. This number is down substantially from the 327 landfills identified in 1995.

The largest 20% of landfills in terms of volume take about 80% of the volume of waste. This waste is concentrated to the more populated centres. These landfills generally have the greatest levels of technologies, such as gas collection systems. The larger landfills sometimes offer services additional to disposal, such as recycling and composting. However, for most part, these additional services do not comprise significant sources of revenue for the landfills.

Large variations exist in the ownership structure of the industry. The most common structure consists of government ownership of the sites, with private contractors operating the landfills. A limited number of landfills are owner-operated by private companies, and some landfills comprise joint ventures between councils and private companies. A small number of curbside waste collection companies are owned by the landfill operators.

Barriers to entry into the industry are extremely high due to the variety of consents required under the Resource Management Act (1991). While the exact requirements to obtain consents vary across regions, for most part, the criteria make gaining approval to establish new landfills extremely expensive and time-consuming.

There has been a distinct trend in the industry towards the market being serviced by fewer landfills, with the simultaneous growth of high-volume landfills with large catchment areas. Over recent years, many of the smaller landfills have closed. This has been fuelled by:

- The environmental standards now required of landfills pursuant to the Resource Management Act; and,
- The fact that it is substantially more efficient for landfills to operate on a high-volume scale, as this enables benefits to be derived from economies of scale.

As an illustrative example, in recent years the number of landfills in the Canterbury region has reduced from 52 to seven. Plans are currently underway to replace these seven landfills with one large one in around three years time.

There is also a distinct trend towards the exit of the public sector from the industry, particularly in the larger urban centres where landfills are increasingly being operated by private companies.

Large variations exist across the country in prices charged for landfill disposal. While the Government has attempted to encourage landfills to set prices that fully reflect all costs involved (including environmental costs) through user-pays systems, it has been suggested that councils often do not set prices in this way. In particular, many council operated landfills subsidise waste disposal through rates. The 1998/1999 National Landfill Census report showed that 44% of landfills charged through general rates and 45% through user charges (or a combination of both). However, more councils appear to be adopting the user pays principles in pricing. Overall, prices in the New Zealand market range from free to approximately $100 per tonne. The majority of landfills charge prices ranging from $30 to $45 per tonne.

B. WASTEWATER

In terms of the structure of the wastewater management industry, two wastewater treatment plants are operated under the Local Authority Trading Enterprise (LATE) model. These include Metrowater (which is owned by the Auckland City Council) and Watercare Services Ltd, which was formed under government legislative requirement.

Papakura District Council no longer operates its water treatment system. United Water Ltd now provides this service under a 30-year franchise agreement with the Council. The Council has, however, retained ownership of its treatment assets.

The remainder of the wastewater treatment plants and oxidation ponds are owned and operated by local authorities as non-commercial arrangements. Wastewater treatment plant costs are passed onto consumers through rates (excluding consumers whose wastewater is treated by United Water in the Papakura District).

Septic tanks are owned and maintained by individual households and businesses. Rates charged to septic tank owners do not include charges for wastewater management.

Wastewater management is a natural monopoly. Barriers to entry into the industry are enormous, as the costs of setting up the appropriate infrastructure would be substantial.

Additional barriers exist due to the very stringent regulations governing wastewater management. Treatment is currently regulated through four separate pieces of legislation: the Resource Management Act, the Health and Safety Act, the Local Government Act and the Public Health Act. It is considered that the compliance costs imposed on the industry by the regulatory regime are large.

8.2.3 Conduct

The solid waste disposal industry is reasonably competitive in most large urban centres. Competitive landfills that are not subsidised by rates tend to set prices according to the supply of waste in the market. Price competition therefore exists to some extent, although this is limited by the fact that demand for landfilling is fairly inelastic, particularly so for residential consumers. The natural monopoly characteristics of the wastewater management industry means that competition is less intense in that sector.

However, conduct (both for the wastewater and solid waste industry) is constrained by a variety of other factors. In particular, price and quality pressures are imposed on the industry through:

- Environmental controls; and,
- Expectations from the public that prices be maintained at reasonably low prices and that service reliability levels are high.

8.2.4 Performance

A. SOLID WASTE

As previously mentioned, many of the smaller less efficient landfills are leaving the market, and the market is becoming characterised by the existence of high volume landfills with larger catchment areas. These landfills have the ability to gain the advantages of economies of scale, meaning that greater efficiencies can be achieved.

Some of the smaller landfills are run less efficiently. However, many of these are under pressure to close due to their inability (both financially and physically) to upgrade operations to levels that enable them to comply with environmental regulations.

Given that the vast majority of landfills are privately operated, incentives are placed on the operators to maximise profits. To achieve this, cost minimisation and efficiency enhancements become important objectives. The need to enhance efficiency is generally more pronounced in high-volume landfills as in periods of high waste disposal, there is increased pressure to accommodate as much waste as possible into the landfills that are generally fixed in size, at least in the short-run.

B. WASTEWATER

It has been argued that the wastewater sector may be under-performing in efficiency terms due to it being primarily operated by councils in a non-commercial environment. This argument has been reinforced by the fact that the efficiency gains invoked by United Water taking over the operation of Papakura’s water network were substantial. Overall, a 10% cost saving has been passed on to ratepayers.

8.3 IMPACT OF EMISSION PERMITS

8.3.1 Impact on basic conditions

A. SOLID WASTE

The table below provides estimates of the additional costs that would follow the introduction of a domestic emissions trading regime. Costs are given according to permit prices being set at $10, $20 (the "core scenario") and $30 per tonne of CO_2 equivalent.

Price of permits	Value of permits required to purchase enough permits to cover 1999 emission levels	Average additional costs per tonne of landfill disposals
$10	$24,654,000	$7.14
$20	$49,308,000	$14.28
$30	$73,962,000	$21.42

TABLE 22: ADDITIONAL COSTS PER TONNE OF LANDFILL DISPOSAL

The column showing the average additional costs should be considered against the current cost structures. The average industry disposal costs in modern landfills currently lie in the order of between $30 and $45 per tonne. The $14.28 given above would apply to landfills with prices somewhere within this range.

The cost increases would presumably be incurred by all landfills, as although some landfills own gas collection systems, the systems typically collect only around 60–85% of emissions and no landfills collect all of the gas. Nevertheless, landfills with emission reducing technologies will be required to purchase fewer permits per volume of waste than other landfills. For these landfills, average additional costs would range between approximately $2.15 to $5.70 per tonne.

The extent to which these costs would be reflected in disposal prices set by individual landfills depends on:

- whether or not gas emissions are collected, and if so, the proportion of gas produced that is collected; and
- the pricing principles used by landfills. Those with complete user-pays pricing systems would be likely to pass these additional charges straight onto consumers. If user-pays pricing is not used, costs would be borne either by ratepayers through rate increases or by district/regional residents via cuts in other types of council services.

B. WASTEWATER

The table below provides estimates of the additional costs per person (domestic and commercial) for various wastewater handling systems that would result from the introduction of a domestic trading regime). Costs vary by handling system because of the different amounts of methane released into the atmosphere per volume of water treated.

	CO_2 equivalent produced in 1998 KT	Value of permits required			Estimated annual flow of water handled (million cubic metres)	Additional annual costs per person based on average per capita wastewater production ($20 permit)
		Cost of permits				
		$10	$20	$30		
Wastewater – Domestic and Commercial						
Septic tanks	50.2	$502,000	$1,004,000	$1,506,000	67 - 75	$2.00 - $2.20
Municipal oxidation ponds	26.1	$261,000	$522,000	$783,000	59 - 66	$1.19 - $1.33
Other wastewater	69.3	$693,000	$1,386,000	$2,079,000	400 - 450	$0.46 - $0.52

TABLE 23: ADDITIONAL COST OF WASTE WATER DISPOSAL

The costs derived above are based on the assumption that the proportion of wastewater handled by the different handling systems is the same for domestic/commercial wastewater producers and industrial wastewater producers.

Given the lack of substitutes for wastewater disposal, the additional costs for water handled by treatment plants and oxidation ponds will most likely be passed onto consumers through rates (assuming wastewater is charged on a cost based pricing system). Assuming that regional or territorial authorities would be responsible for purchasing the permits to cover septic tank emissions (given that septic tanks are too numerous to be assigned individual emission obligations), the degree to which tank owners of septic tanks pay for the additional costs would depend on how councils would cover the costs of buying the permits.

The average value of permits required per person would be expected to decrease over time as the proportion of wastewater being treated by treatment plants that collects its greenhouse gas emissions increases.

Given that industrial wastewater is a significant source of greenhouse gas emissions, it is worthwhile investigating the costs that the regime would impose on various industries.

Source of industrial wastewater	CO_2 equivalent produced in 1998 KT	Value of permits required		
		Permit = $10	Permit = $20	Permit = $30
Meat processing	131.4	$1,314,000	$2,628,000	$3,942,000
Pulp and paper	6.3	$63,000	$126,000	$189,000
Other industry	5.2	$52,000	$104,000	$156,000

TABLE 24: IMPACT OF PERMITS ON MAJOR WASTE GENERATING INDUSTRIES

As the table shows, the majority of the costs would be imposed on the meat processing industry. Given the size of this industry the additional costs would not be expected to have a substantial impact. For more detail on this sector, refer to chapter 9.

8.3.2 Structure of the Industry

A. SOLID WASTE

In terms of the landfill industry as a whole, the increase in prices would not have a significant impact on the demand for landfilling. Given that demand is reasonably inelastic, the anticipated price increases would probably not be large enough to warrant a change in behaviour by consumers.

While there could be a slight substitution towards other mechanisms such as recycling and composting, the substitution effect would not be substantial for the reasons discussed in Section 8.2.1. The estimation of the price at which diversion of waste to these other mechanisms could become viable is beyond the scope of this project.

The landfills that would experience the largest level of adverse impacts would be the landfills that display the following characteristics:

- Do not own gas collection technologies;
- Are in competition with landfills that do possess gas collection systems; and/or,
- Set landfill disposal prices based on user-pays principles.

The number of landfills that would fall into this category would not be large. The 1998/1999 National Landfill Census identified only 14 landfills that have technologies to manage gas emissions, and only approximately 45% of landfills price according to user-pays principles.

The landfills that could be affected in this way, however, are landfills in competition with those based in Auckland, Hamilton, Wellington, Timaru, Dunedin, Hawkes Bay, Motueka and Nelson.

It is therefore possible that the introduction of the regime could see the closure of some of the smaller, less efficient landfills that fall into this category that are unable to afford gas collection systems. This will be reinforced by the fact that many of these landfills are already under pressures to close as a result of the compliance costs imposed by the introduction of environmental requirements.

The implication of this would be an increase in the proportion of landfills that deal with larger waste volumes and control emissions.

B. WASTEWATER

In terms of the wastewater management industry, it is highly unlikely that an emissions trading regime would bring about any changes to the structure of the industry; the costs involved in purchasing permits to cover the emissions being minimal.

Incentives would not emerge for councils to extend reticulated systems to reduce the number of septic tanks in use, as the costs of doing so would far outweigh the costs of purchasing permits to cover septic tank emissions.

8.3.3 Conduct of the Sector

A. SOLID WASTE

The behaviour of landfills in areas where there is no opportunity for some landfills to gain competitive advantages over others over and above what advantages already exist would not be expected to change. Landfills that fall into this category include:

- Landfills in areas with very little competition;
- Landfills that have gas collection systems that compete only with other landfills with gas collection systems (it is questionable as to whether any landfills fall into this category).
- Landfills in areas where none of the competing landfills have gas collection systems (this excludes all landfills in competition with landfills in Auckland, Wellington, Hamilton, Hawkes Bay, Dunedin, Timaru, Motueka and Nelson).

For the remainder of landfills, incentives would be provided for landfills to install gas collection systems. If it is not financially feasible for the landfill to do this, the landfills with gas collection systems will have a cost advantage that would probably translate into a price advantage under a user-pays pricing system. Given the low ability of landfills to compete on product quality, firms unable to introduce a gas collection system would be placed in an unfavourable situation.

If price disparities between landfills became sufficiently large, waste could become increasingly diverted across larger areas towards cheaper landfills. This will result in greater levels of transport emissions. However, the relatively inelastic demand for landfilling will mean that we could expect the amount of diversion occurring to be reasonably small.

As mentioned in the previous section, the introduction of an emissions permit-trading regime could result in the closure of a small number of landfills. The resulting heightening of the trend towards landfills that have the capacity to secure economies of scale could, by implication, be coupled with increased levels of product differentiation and diversification. In general, the viability of landfills to offer additional products and services is limited to high-volume landfills, as experience has shown that many of the additional services/products are not as profitable as the core business offering of landfills. Recycling and composting could be encouraged as ways of reducing emissions and therefore the number of permits required. However, given the small number of landfills that would be expected to close as a result of the introduction of the permits regime, and the relatively small amount of waste that would require diversion to alternative landfills, such an impact is likely to be minimal.

Likewise, it is unlikely that the impacts would be sufficient to give rise to increased levels of vertical integration.

B. WASTEWATER

Given that the additional costs imposed on the industry would be small, an emissions trading system would have very little impact on the conduct of the industry. In particular, the additional costs would not be great enough to encourage councils to invest in mechanisms to reduce septic tank or oxidation pond emissions.

Under a worst case scenario, if permit prices rose to levels that imposed relatively high costs on councils, councils could either defer maintenance of wastewater management assets or cut services in other areas of council expenditure. This, by corollary, could result in increasingly degraded and problematic wastewater systems. However, given current permit price projections, it is unlikely that they would rise to levels high enough for this scenario to eventuate.

8.3.4 Performance of the Sector

It is generally accepted within the solid waste disposal industry that high-volume landfills are most efficient. If the permit-trading regime resulted in the closure of smaller (less efficient) landfills, the net impact would therefore comprise a better performing, more efficient landfill industry.

The need for efficiency enhancements to maintain acceptable profits could be imposed on a small number of landfills that are in competition with landfills that obtain cost advantages as a result of being able to purchase fewer permits per volume of waste.

Overall, however, the impacts on the performance of the sector would not be large, given the small number of landfills that would actually be affected by the permits regime.

Likewise, changes to the performance of the wastewater management industry would be marginal.

8.4 CONCLUSIONS

The introduction of a domestic emissions trading regime would have very little impact on the wastewater management industry. In general, the additional costs imposed on the industry would be too small to induce behavioural changes for either the treatment providers or wastewater producers. The possible exception is the meat processing industry, which may find the additional cost, along with the other permit costs it will face, difficult to absorb.

The likely impacts for landfills, however, are a little less clear cut. Industry wide, the additional costs would have minimal impact on the amount of waste being disposed of in landfills. The impacts will be felt in terms of the resulting distribution of waste volume disposals to the various landfills.

This impact would arise from the costs being applied unevenly across landfills; landfills with gas collection systems would not be required to purchase as many permits per volume of waste than other landfills. Depending on the degree to which individual landfills apply user-pays pricing principles, the introduction of emissions permits could see a slight diversion of waste towards the landfills that control their gas emissions. At worst, the permits regime could force the closure of a small number of landfills (which are already under pressure to close as a result of environmental requirements). This will reinforce the current trend in the industry towards the market being serviced by fewer, but larger landfills. However, given that only a limited number of landfills have technologies for reducing gas emissions, the expected impacts would not be substantial.

9. AGRICULTURE

9.1 INTRODUCTION

This chapter develops the possible outcome on the agricultural industry of introducing a domestic emissions trading regime. The sub-sectors focused on are dairy, wool, meat and deer. The description of the industry is broken up by these sub-sectors where necessary, as each is quite distinct. The manufacture and importation of fertiliser is also covered.

9.2 DESCRIPTION OF THE SECTOR

9.2.1 Basic Conditions

New Zealand is a major producer and exporter of agricultural products. It accounts for 31% of all dairy products traded on the world market. It is the second largest producer and exporter of all wool, supplies 75% of lamb world trade and 10% of world beef trade. Pastoral agriculture is by far New Zealand's largest industry. Exports from pastoral agriculture reached more than $9.6 billion in the year ended March 1999, representing 44% of all goods exported. 81% of all occupied land in New Zealand is used in the production of agricultural products.

The primary produce from farms in the form of meat, wool and milk are not individually branded or identifiable in the market. Farmers cannot generally influence the market price of their product; they are price takers. An increase or decrease in output will not affect the price of the product.

The agriculture industry as a collective has, for a long time, been trying to add value to its primary products through manufacturing processes performed in New Zealand. The manufacture of yoghurt, cheese, carpets, chilled pre-packed cuts of meat and velvet are examples. This has allowed some scope for differentiation of New Zealand product. These manufactured products have a higher value than commodity products. In the wool industry, for example, processed exports make up 9% of total wool product exported, but account for 20% of receipts.

New Zealand's primary or secondary pastoral products are predominantly exported, as indicated in the table below.

	Domestic Consumption	Export
Dairy	5%	95%
Wool	6%	94%
Lamb	20%	80%
Beef	20%	80%
Venison	20%	80%

TABLE 25: PERCENTAGE OF PRIMARY PRODUCTS EXPORTED[41]

[41] **Source:** www.maf.govt.nz

The demand for New Zealand's exports in many markets is limited by trade barriers put in place to protect domestic production from imported competition. Many countries have a desire to be self-sufficient in food production.

New Zealand has consistently supported research and development in the primary industries. This includes research to increase farm output, improve manufacturing processes and develop new products. The agriculture industry is a high technology industry with low costs by international standards as a result of favourable soil and climate conditions.

Further conditions specific to each sub-sector are discussed below:

A. THE NEW ZEALAND DAIRY INDUSTRY

There are few direct substitutes for dairy products, with the exception of margarine and oil for butter. An increasing number of dairy products reach the market in a manufactured form, such as cheese, yoghurt and butter. These are branded and compete with a range of other products from rival producers. Prices for processed dairy product are predicted to increase due to world economic growth and the up take of western food in non-traditional markets. Dairy farming is a growth sector in New Zealand in line with increased payouts to farmers from dairy companies over the last ten years. This is mainly due to the trend from commodity to branded products and the development of a larger number of higher margin new products.

B. WOOL PRODUCTION IN NEW ZEALAND

Around 90% of New Zealand wool is strong wool from crossbred sheep and is used in the manufacture of carpets and rugs. The wool industry operates to some very low margins due to the extended supply chain and tough competition from synthetic fibres. The synthetic manufacturers have an advantage in production as they can rapidly innovate and produce branded products to meet their customers' needs. However, technology is now allowing New Zealand Merino woolgrowers to adopt similar strategies. Testing facilities can provide measurements of commercially important characterises, thus giving farmers the ability to adjust farming methods so as to meet client needs.

C. NEW ZEALAND MEAT PRODUCTION (CATTLE, SHEEP & DEER)

There are various close substitutes for meat. These include the different categories of meat themselves, as well as poultry, fish and vegetables. The number of sheep in New Zealand has declined from 70 million to 45 million over the last 40 years and is predicted to continue to decrease over the next five years. Conversely cattle and deer numbers are predicted to increase, due to increasing beef and venison demand. Demand and price could increase as a result of the current spread of diseases such as BSE and Foot and Mouth through competing countries. New Zealand is free of both of these diseases.

9.2.2 Structure of the Industry

The sub-sectors of the agriculture industry differ slightly in structure and in their future development. Farmers produce the "raw" product, which is then processed by a co-operative company owned by its farmer suppliers or privately owned company. These companies supply the domestic market directly and export and promote New Zealand's agricultural products through Producer Boards or private exporters. The farming sector has minimal barriers to entry, and farmers should be able to enter and exit the market as they please, although the movement between sub-sectors has a relatively long lead-in time.

New Zealand's agriculture industry has recognised the financial benefits of product differentiation and diversification and now New Zealand exporters have a full portfolio of products reaching a wide market place. Many of the sub-sectors are currently facing major restructuring and deregulation as a result of diminishing returns in the case of wool or a wish to seize a global opportunity in the case of dairy. A more detailed view of each sub-sector follows:

A. THE NEW ZEALAND DAIRY INDUSTRY

At time of writing the dairy industry is in a state of flux, with major structural changes currently being considered.

At present, the New Zealand dairy industry is structured with farmers owning the co-operative processing companies, which in turn own the New Zealand Dairy Board (NZDB). Although there were over 400 co-operative dairy companies in the 1950s, currently there are two main players that make up 95% of production; Kiwi Dairy Company and New Zealand Dairy Group. Dairy companies are also responsible for marketing milk and other dairy products on the domestic market.

The NZDB's function undertakes the export and marketing of all dairy products manufactured for export. Its revenue comes from a range of differentiated products; around 40% coming from a wide variety of consumer products sold under well known international brands, and the remainder from the ingredients business.

The export market is limited, with only 5% of the world market freely accessible to New Zealand due to trade barriers. New Zealand's main markets are UK, other EU countries, Asia and Latin America.

The structure of the dairy industry is in the process of changing with the formation of Global Dairy Company (Global). The merging companies; the New Zealand Dairy Board, the New Zealand Dairy Group and Kiwi Co-operative Dairies, will create Global, which will control in excess of 95% of New Zealand milk production. This new organisation will be New Zealand owned. Global is to lose its exclusive marketing rights; new entrants are free to enter the New Zealand market. Some large multi-nationals have hinted at entering the market but no firm proposals exist. Global's initial market position will approximate that of a monopsonist. Normally, a merger that creates such a strong position in the market would have difficulty in gaining approval under the Commerce Act. In order to facilitate the merger, the Government has proposed to exempt the merger from Commerce Commission approval.

This new structure is designed to improve the market signals for farmers and provide free exit and entry into the New Zealand market, while retaining the marketing strength that the NZDB had built up. Global will have the opportunity to invest and form partnerships with other dairy companies offshore, especially in the 95% of the world markets in which New Zealand currently does not compete.

B. WOOL PRODUCTION IN NEW ZEALAND

There are three main wool types in New Zealand, classified according to fibre diameter; strong, mid-micron and fine. The main players in the New Zealand Wool industry are:

- Farmers;
- Brokers who receive a commission on the price for growers' wool and a fee for support services;

- Private buyers: wool sold in the woolshed and on sold to brokers and export markets
- Scourers: mostly owned by exporters, those independently owned charge a commission on the wool processed;
- Exporters: operate on thin margins, mostly sell on forward contracts; and
- Wool testers: take objective measures of samples of wool, provide services to assist processor with quality control and efficiency programs and meet offshore processors specifications.

In most cases, each of these supply chain partners are separately owned. Additionally, there is a national board, the New Zealand Wool Board, that trades under the name of the New Zealand Wool Group. The Group is comprised of two wholly owned subsidiaries and a 50% interest in Merino Wool. The subsidiaries and functions of each are as follows;

- *Wools of New Zealand*: funds research and development, creates customers for NZ wool, and promotes the use of NZ wool internationally.
- *Wool Production Technology*: provides services and technology to wool growers that assists them to improve profitability
- *Merino New Zealand*: a joint venture to market merino wool (fine wool used in the manufacture of apparel) under the New Zealand Merino brand, focus on promotion and management to maximise returns.

The Group is a statutory producer board and is funded by 2% producer levies on wool sold.

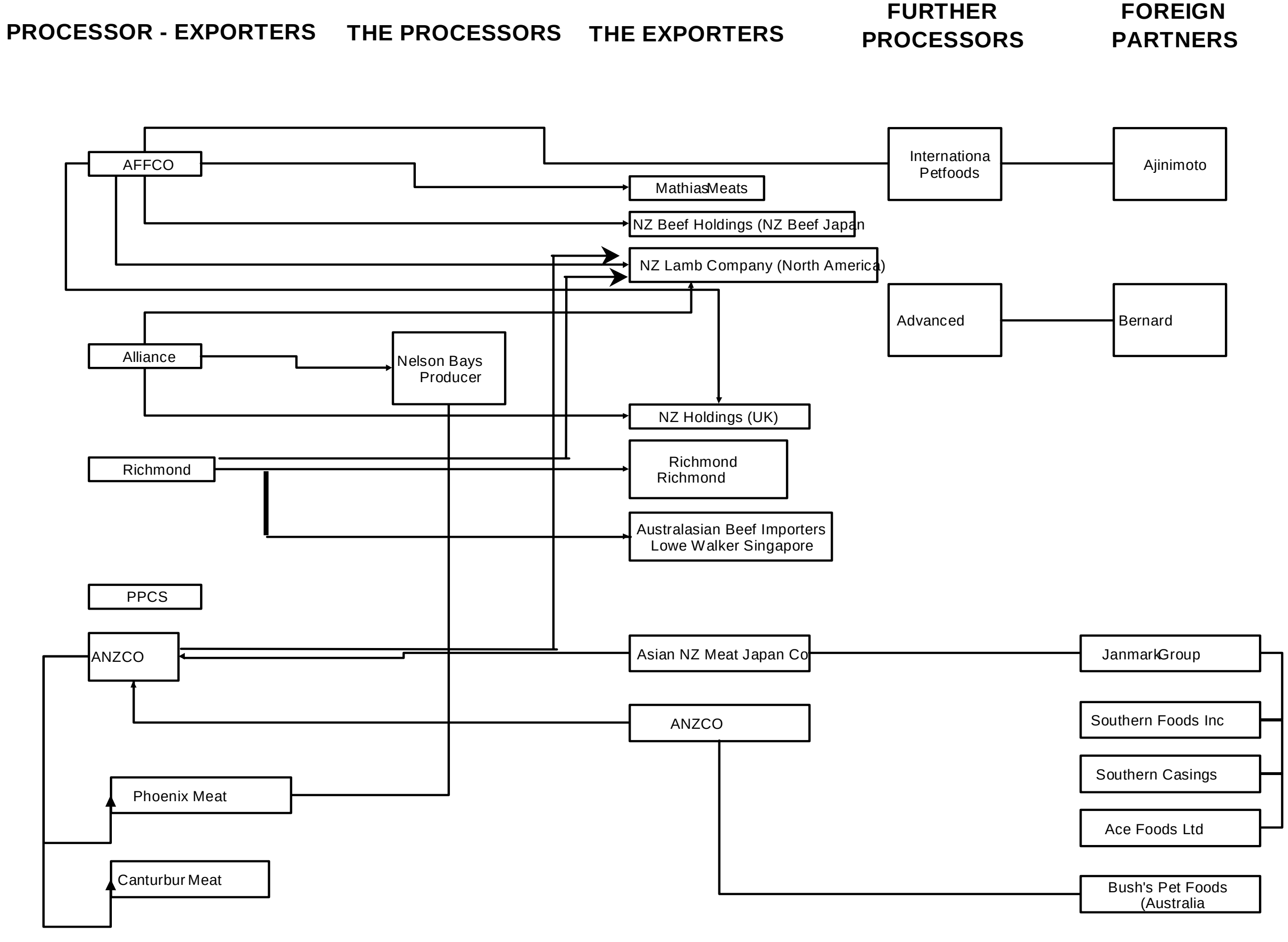
Farmers, traditionally, have not been able to differentiate their product. However the emergence of new technologies enabling the testing of wool may change this situation. Wool testing provides objective measurements of commercially important characteristics; condition, fibre diameter, colour, length, strength and bulk. This gives New Zealand wool a key competitive advantage, as it can be supplied to meet buyers specifications, and farmers can manage their flocks more efficiently. Wools of New Zealand and Merino New Zealand undertake promotional work internationally to try to differentiate this commodity in the market. New Zealand has diversified its markets into all five continents. New Zealand manufacturers are constantly expanding their consumer market portfolio. Wool products include; apparel, carpets and rugs.

There is a possibility of some restructuring in this industry. The Wool Board may merge with the New Zealand Meat Producers Board (discussed more in the next sub-section).

C. NEW ZEALAND MEAT PRODUCTION (CATTLE, SHEEP & DEER)

The meat processing industry includes 17 processor/exporters, ten processors who process only for exporters, 21 major exporters who do not process meat and a number of processors for the local market only. Four companies dominate the processing sector, controlling about 80% of output. These are public companies. The remaining processors and exporters are a mixture of public and private companies.

Over the last two decades the industry has faced major rationalisation as a result of declining stock numbers, low world prices for meat and protectionist policies by many of New Zealand’s markets. This has required processors to seek technological improvements, economies of scale and new work practices in order to achieve market strength.



Source: PA Consulting Analysis 1998

FIGURE 13: NEW ZEALAND MEAT INDUSTRY STRUCTURE

Farmers supply processing plants with sheep and cattle, which are bought on a per head price basis by the processing companies. The price paid is very dependent on international meat prices; especially UK lamb and US beef prices.

The New Zealand Meat Producers Board assists in the attainment of the best possible net ongoing returns for New Zealand livestock and co-products. It has a range of activities to increase the consumer demand for New Zealand meat and maintain confidence in the product. It encourages product differentiation, helps improve access to markets and encourages production and process efficiency. The Board expenditure is funded from a levy on farmers.

This sub-sector is similar to wool, as farmers cannot differentiate their product. There are no visible barriers to entry but there are lead-in times. The promotional work done by the New Zealand Meat Producers Board is targeted at ensuring the product is perceived to be different from its competition in the market. The New Zealand meat market is global, including all the major trading nations and other trading countries such as Saudi Arabia and Papua New Guinea.

There is currently work being conducted to amalgamate the Meat and the Wool Board, but the progress is slow with current indications that this may not happen until April 2003. This would create a single body for sheep, beef and goat farmers. The opportunity provides for a significant reduction in overheads, estimated at $5 million to $6 million annually.

The deer industry is led by the New Zealand Game Industry Board, a statutory producer board that takes a strategic role in co-ordinating industry marketing and market access, quality and research programmes. The New Zealand Deer Industry Association represents venison processors and exporters and the velvet/deer product industries. The New Zealand Deer Farmers' Association represents growers. Deer are frequently run as a secondary enterprise. However there are nearly 2000 farms where they provide over 50% of the revenue. There are nine companies that export venison from New Zealand; six of these operate their own processing facilities.

The product range is diverse; venison, velvet, hides, leather and co-products used in health remedies. New Zealand exports are sent to a narrow range of countries including the EU, Russia and Asia. The barriers to entry are small, the industry has expanded by 80% in the last ten years.

9.2.3 Conduct

The different players in the agriculture industry operate in slightly different ways, due to their different competitive structures.

A. FARMERS

Farmers are price takers; even large percentage changes in a farmer's own output has only a negligible effect on the market price. Farmers look for new ways that will give them the edge over their competitors, through improvements in farm management and the use of new technologies to increase output, because more volume will produce more revenue.

B. PROCESSORS

The dairy sector is dominated by the two main dairy companies and export marketing by NZDB. However, there are a number of smaller companies who are able to compete at the margin. There is an inherent tension within the industry between the need for competition to ensure economic efficiency and the need for international market strength.

With the proposed change in structure of the sector, there will be less competition in the near term but scope exists for a major international company to enter the market and create competition in the long term. With the overwhelming farmer vote in favour of the formation of Global, it may be difficult for a new entrant to succeed, especially if Global has secured the milk supply. So the existence of competitive pressure in the dairy industry later in the decade is uncertain until the effects of the new structure works its way through.

Meat processing has been a very aggressive and strongly competitive industry. Competitive pricing, shortage of stock numbers and inefficient processes has seen many plants shut down, several companies go out of business, and a number of mergers and acquisitions.

C. EXPORTERS/PRODUCER BOARDS

This industry operates in an open market. There are a large number of other exporters in the market, and no one exporter can overly influence what the other will do, nor can they significantly change the price in the market. There are two main sources of gain for these organisations namely;

- *Product Innovation*: seeking new products and markets that will provide New Zealand exporters with a competitive edge, even if temporary; and,
- *Advertising*: differentiating products by designing and introducing products that are different form those of the other exporters, or highlighting characteristics that are peculiar to New Zealand sourced products (such as New Zealand's environmental record).

New Zealand's main competition comes from the following countries:

	Competitors
Dairy	Germany, France, Ireland, Denmark, Netherlands, Finland Austria, Australia, US, Canada
Wool	Australia, China, Russia, Uruguay, Argentina, Turkey, South Africa, India, Pakistan
Lamb & Mutton	EU countries, Australia
Beef	EU countries, US, Australia, Brazil, Argentina, Canada, South Africa,
Venison	Germany, Spain, UK
Velvet	Russia, China, Canada, Nth America

TABLE 26: SOURCES OF COMPETITION FOR NEW ZEALAND'S MAIN AGRICULTURAL PRODUCTS[42]

[42] **Source:** www.maf.govt.nz

New Zealand is able to export profitably due to favourable agricultural conditions and the application of technology. Sources of New Zealand's competitive advantage include:

- The most cost effective scouring industries in the world;
- Advanced wool testing facilities, allowing farmers to adjust wool growth to market specifications;
- Low input pasture grazing systems;
- Year-round milk production due to rotationally grazing pasture; and,
- High genetic merit of stock and genetic databases.

We mentioned previously that the world agriculture markets are restricted by import quotas and tariffs. New Zealand's agricultural exporters also face non-tariff barriers in the form of subsidies given to domestic producers in the importing countries and subsidies on competing products in the market. The New Zealand government is continually increasing its portfolio of unilateral trade agreements, which will gradually improve current trading conditions.

9.2.4 Performance

A. PRODUCTIVE EFFICIENCY

During the late 1970s and early 1980s the New Zealand farming sector was heavily subsidised. Then in the later part of the 1980s the New Zealand government removed most of the subsidy programmes and support schemes to the agriculture industry. The removal of artificial price signals in the market lead to a fall in stock numbers, over capacity in the processing arena and diversification of farming activities and land use. This had different implications for farmers and processors:

- Farmers now produce what the market requires, rather than under or over supply; and,
- Processors went through a period of massive change due to excess capacity. Mergers, take-overs, closures and restructuring have taken place to realign capacity with demand.

The New Zealand agriculture industry is now much more efficient to the extent that it competes against other (subsidised) countries very successfully.

B. ALLOCATIVE EFFICIENCY

Due to the nature of farming and its lead-in time, allocative efficiency is harder to achieve than in other industries. Farmers react to market prices and forecast prices when making decisions on resources. For example, the high returns being made in the dairy industry has seen a dramatic increase in the number of dairy herds and farms over the last five years. This can be contrasted with the decline in sheep numbers. The price of milk-solids has been predicted by MAF to drop slightly in the next few years, which will see the drop in the rate of up-take in dairy farming. The processing operations run by the dairy companies have also continued to expand as their current processing plants reach capacity. An example of this is the investment in new plants in the South Island. The processing industry in New Zealand is very quick to meet market demand in almost all sectors, due to a highly competitive export market.

The farming industry allows resources to flow where they are most beneficial, although there are some extensive time delays.

C. DYNAMIC EFFICIENCY

New Zealand farming has a global advantage with its low cost base. This has its foundation in the natural advantages of climate and soil, but this natural advantage has been further improved by the introduction of new farm management methods based upon scientific research and the development of new technology. The New Zealand dairy industry, for example, has a cost of production at around US$1.50 per kg of milk solids, which is a lower cost of production than any of its competitors. However, other countries are starting to catch up. Again in dairying, New Zealand's cash costs are rising at around 2.3% per annum whilst those of the USA are falling at 1.8% per annum[43].

This deteriorating competitive position has been recognised and is attributed to two main causes. Firstly, New Zealand's R&D expenditure has been more heavily focused in off-farm areas, such as dairy factory process improvement and new product development, rather than on-farm productivity improvement. In Australia, where most research has been focused on improving on-farm productivity, costs are reducing much faster than in New Zealand.

Secondly, the take-up of R&D by New Zealand beef, dairy and sheep farmers is still low. An analysis of R&D take-up versus profitability of wool growers shows that the most successful 25% of growers have a much higher take-up of R&D than the growers with an average return[44].

The formation of the NZ Dairy Centre of Excellence (Dexcel) and the establishment of a 4% on-farm productivity improvement target for dairy farmers is aimed at addressing this issue. A key to achieving this target is placing the responsibility for achieving it in the hands of farmers through the directors of organisations such as Dexcel.

9.2.5 Fertiliser Industry

The fertiliser industry in New Zealand is vertically integrated. The main fertiliser companies are co-operatives owned by New Zealand farmers. There are two predominant players - BOP Fertiliser with a 45% market share and Ravensdown with a 50% market share. Summit Quinphos, a specialist importer holds 5% market share.

Locally manufactured superphosphates make up 65% of local sales. Both manufacturers are operating at near capacity and had to import this current year. Imports are more costly than local products reinforcing the position of local manufacturers. The Co-operatives are not wed to local manufacture; if the cost of local fertiliser becomes prohibitive there would be a switch to imported finished product.

Approximately 70% of fertiliser costs come from imported raw materials. The weakening in the New Zealand dollar has a significant impact on local costs (imports are traded in US dollars). The profits made by the co-operatives are passed back to the farmers/shareholders through rebates on tonnes of fertiliser and dividends paid out.

---

[43] The Australasian Dairy Industry, a report by PA Consulting Group, March, 2000

[44] NZ Wool Board Performance and Efficiency Audit, 2000 conducted by PA Consulting Group

Ravensdown was recently benchmarked to US fertiliser counterparts. This comparison highlighted some areas in which the New Zealand fertiliser industry is particularly efficient, including;

- Distribution processes in New Zealand required half the amount of staff for the same output of fertiliser in the US;
- Due to vertical integration, savings of up to 40% on margins otherwise taken by private distributors can be made which can be passed on to farmers as cheaper fertiliser;
- The industry focused on achieving the best cost for farmers rather than corporate profit;
- The New Zealand Industry was more in touch with farmers as a result of more direct contact;
- Fertiliser industry is owned and operated in New Zealand, thus profits are given back to farmers rather then taken off shore;
- New Zealand industry is much more focused on environmental and animal welfare issues; and
- New Zealand has a better range of products and higher quality standards.

9.3 IMPACT OF EMISSION PERMITS

Greenhouse gases from farm sources account for as much as 55% of New Zealand's gross GHG emissions in 1998. These are primarily comprised of:

- methane from grazing livestock;
- methane from waste/manure management; and
- nitrous oxide from nitrogen in soils.

The industry will feel the impact of its direct emissions, as well as facing the flow through effect from the electricity and transport sector (refer chapters 4 and 5). Both effects will impact on costs at the farm and processing plants.

We base most of our analysis on the assumption that the permits will be tendered for competitively and that the point of obligation is the processing companies. However, we will also discuss the implications of grandfathering the permits and placing the obligation on producer boards.

The emission obligations are assumed to be attributed to each sub-sector as follows:

- All emissions from dairy cattle are attributed to the New Zealand dairy industry, as the final meat revenue is insignificant to the overall contribution of the animal to dairy farm income.
- For the sheep industry, based on income from each product, 40% is attributed to wool and 60% to meat. Of the meat, 90% is attributed to lamb and 10% to mutton.
- Emissions from all beef cattle are attributable to the meat industry.
- Costs attributed to deer are apportioned 80% venison and 20% velvet, based on revenues earned.

The introduction of an emission-trading regime will affect the different sub-sectors of the agricultural industry in a different manner, creating quite separate reactions and outcomes[45].

9.3.1 Impact on basic conditions

Emissions from the agriculture sector, for both 1990 and forecast 2008 levels are presented in Table 27.

Sheep have the lowest emission factor per head per year of 0.4 tonnes of CO_2 equivalent. However, in total they produce the most emissions per year (17 million tonnes of CO_2) due to the high number of sheep in New Zealand (42.5 million). This has declined significantly from the 1990 emissions (26 million tonnes of CO_2) as a result of the decline in stock numbers.

Dairy animals also produce high emission levels; the cause is the high emission factor per animal (2.95 tonnes per animal) rather than the stock numbers. With animal numbers increasing, the impact on emissions is also increasing so that the obligation on the dairy industry is approaching that of the sheep industry.

The impact of beef cattle has not changed significantly. However, the rise of the deer sector has been dramatic since 1990.

	Emissions Factor	Stock Numbers	Total Emissions	Stock Numbers	Total Emissions	
	(t CO_2d year)	1990	(t CO_2 year) 1990	2008	(t CO_2 year) 2008	Difference
Dairy Cattle	2.21	3,463,800	7,653,193	5,260,043	11,621,954	-3,968,761
Non-Dairy Cattle	1.90	4,600,703	8,748,857	5,155,862	9,804,566	-1,055,709
Sheep	0.41	57,852,192	23,582,607	40,639,644	16,566,162	7,016,445
Deer	0.79	976,290	774,928	4,652,322	3,692,773	-2,917,844
Agriculture Industry Total			40,759,586		41,685,455	-925,869

TABLE 27: AGRICULTURE EMISSIONS[46]

[45] Data used in this part of the analysis is based on the most current emission figures per unit of different sub-groups of livestock as provided by the Ministry of Economic Development. The per head emission incorporates methane from ruminant livestock, plus allowances for emissions from waste management systems and from nitrogen cycles in soils. The most up to date and forward-looking stock forecast figures, June 2005 were provided by the Ministry for Agriculture and Fisheries. These were extrapolated linearly through to 2008. Processors and Producer Board 2000 annual reports were used for analysis along with the surplus after tax figures (it is unknown whether this cost will be tax exempt or not).

It is estimated that overall the industry will experience a small increase in total emissions compared with 1990 levels.

The processing companies will be required to buy permits to meet the milk collected, animals slaughtered and wool purchased. These permits would probably be allocated on the quantities of produce processed (in litres of milk, tonnes of meat and tonnes of wool). This will not necessarily correspond with stock numbers on the farms since, as in the case of deer, the herd sizes are changing. With competitive tendering, all sectors of the industry will be dealt with in the same way, ie, all will be required to purchase permits to meet their obligation.

With permit allocation by "grandfathering" to 1990 emission levels, the effect on the industry is significantly unbalanced. The sheep meat and wool sectors will have a surplus of 30% of their production. Alternatively, dairying will need to purchase permits for 52% of their 1990 production, deer farming 370% of their production and beef farming 12% of their production. Since the obligation is on processors, the effect will be uncertain given the demise of many processors since 1990 and the different product mix (beef, sheep and deer) of the meat processors. In general, grandfathering will cause a wealth transfer from the growing sectors (dairy and deer) to the declining ones (sheep).

Under both allocation schemes, if the point of obligation is the industry boards, rather than the processors, there will be a substantial financial obligation on these bodies. In some instances (eg Meat New Zealand), the permit obligation far exceeds its annual revenue.

9.3.2 Structure of the Industry

The introduction of tradable permits may or may not affect the structure of the industry depending on the cost of the permits and how this is recovered.

If permit costs are high, for any of the sectors, we may see a move away from those products. Indeed there is a clear possibility that a significant cost imposition on the agricultural sector would see a change in land use towards forestry or farm-forestry which is expected to yield rather than use permits. Farming of marginal economic sustainability is likely to be driven out and further efforts made to gain economies from scale and technology.

Were any products to suffer comparative disadvantage, changes in the processing sectors will also occur, with possibly further closures and mergers. Since a number of the international competitors for New Zealand agriculture are non-Annex 1 countries (see Table 26), and the pricing in commodity markets is very keen, even quite small cost increases could significantly change the industry.

---

[46] Note, we have assumed here that the emissions per stock unit stay constant over the period. However, we have also assumed (in Table 28 and Table 29) that the average weight of a stock unit also remains constant. Any increase in emissions due to increased feed (for example) is also likely to be balanced by an increase in yield from the animal. This means that the cost of permits per kg of product (Table 28 and Table 29) are relatively insensitive to (small) changes in the feeding regime.

9.3.3 Conduct of the Sector

It is likely that most of the permit cost will be transferred back to the New Zealand farmer, by way of decreased commodity price received[47]. Some may be passed to final consumers if sufficient price pressure from Annex 1 countries lifts the international commodity price. Also some may be absorbed through increased supply-chain efficiency through economies of scale and improved process efficiency. In those instances where product is differentiated from their competitors, there is a higher chance of passing the price to the consumers.

It is unlikely, for commodity products at least, that emissions costs will flow down stream onto the international or domestic market place, since commodity prices are set globally and manufactured products have relatively small margins. Many competitors, either for the same products or for competing products such as chicken meat, are non-Annex I countries. Price movements in their favour will help expand their competitiveness. Of the Annex 1 countries, the main competitors, Australia and the UK are already taking steps to reduce methane emissions from the livestock, and discussing ways to meet the Kyoto protocol obligations.

The New Zealand domestic market will probably not be flooded with cheap commodity imports from non-Annex I countries, as New Zealand has a strong brand, good quality and local supply that exceeds local demand.

There may be an opportunity for New Zealand companies to invest in other countries which are not Annex I countries. If Global is established it could invest in non-Annex I countries' processing operations and buy milk at a cheaper price, as there would be no emission costs attached. This could lead to some investment funds otherwise being spent in New Zealand moving offshore.

Finally, the industry may look for ways to lower the incidence of emissions through changes to farming techniques.

A. MITIGATION TECHNIQUES

Three main possibilities exist for reducing ruminant livestock emissions:

- Reducing livestock numbers;
- Increasing the productivity of livestock; and
- Modifying rumen digestion.

New Zealand has recently joined forces with a French research team to look at ways of reducing methane emissions. It has been found under laboratory conditions that sheep are able to digest food and grow normally without producing any methane at all. A team of Australian and Japanese scientists have discovered they can cut methane emissions from cattle, and increase the amount of meat and milk produced by improving a cow's diet. It is understood that the Government's 2001 budget provides funds for more research into

---

[47] For the alternative point of obligation, the prices will be charged through an increase in national body levy.

methane reduction technologies. This research is unlikely to affect agricultural emissions in the foreseeable future.

If emission reduction measures were introduced before 2008, under the "grandfathering" system, the farming sector could receive millions of dollars worth of permit rights.

9.3.4 Performance of the Sector

Emission costs per animal, at various permit charge assumptions are illustrated in **FIGURE 14** below. These numbers, while interesting, do not give a full picture of the incremental cost of production for the end product, since the incidence of the permit cost is likely to fall on the end products rather than on live herd and flock. We examined in Table 29 the effect of placing permit cost on farm products – wool, meat, milk and velvet.

The effect on product cost varies widely. For the base case of $20/t permit price, cattle farmers, both dairy and beef, face the lowest cost increases of 5.5% and 10.2% respectively. Sheep farmers face a significant cost increase of 15.9% for lamb, 18.5% for mutton and 17.5% for wool. Deer farmers also face cost increases for venison of 21.5% and velvet 14%. In comparison to other sectors of the economy the impact on agriculture is very significant.

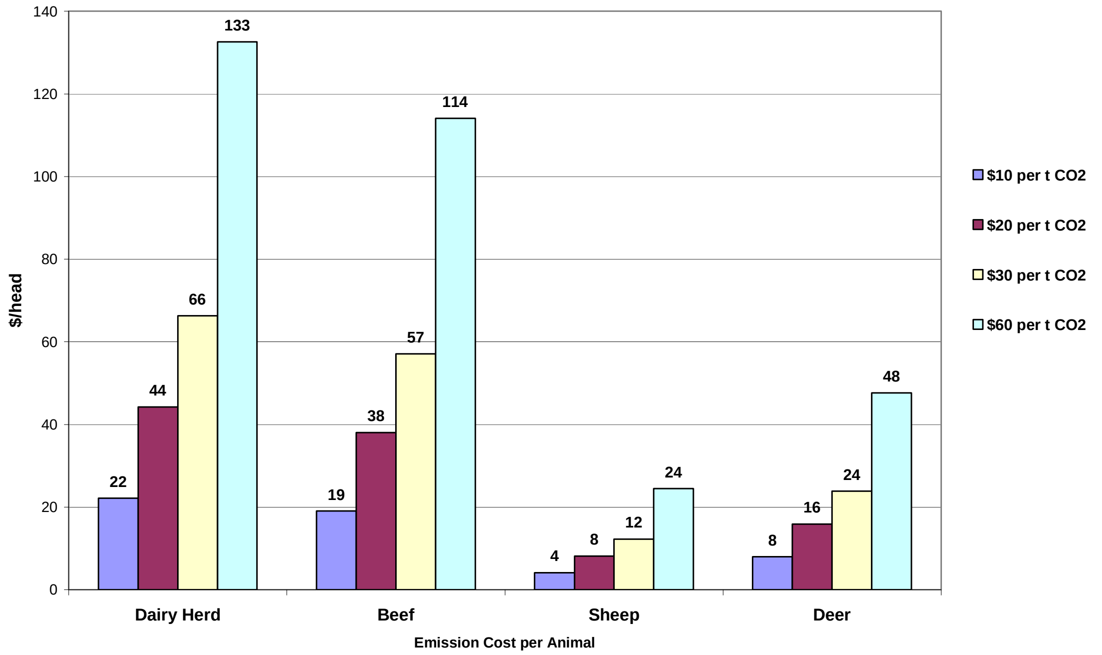


FIGURE 14: EMISSION COST PER ANIMAL

	2000 price to farmer	$10/t CO_2	$20/t CO_2	$30/t CO_2	$60/t CO_2
Milk Solids	$3.78	$0.10	$0.21	$0.31	$0.62
Beef	$3.06	$0.16	$0.31	$0.47	$0.93
Lamb	$2.97	$0.24	$0.47	$0.71	$1.42
Mutton	$1.12	$0.10	$0.21	$0.31	$0.62

	2000 price to farmer	$10/t CO_2	$20/t CO_2	$30/t CO_2	$60/t CO_2
Wool	$4.40	$0.39	$0.77	$1.16	$2.31
Venison	$6.00	$0.64	$1.29	$1.93	$3.86
Velvet	$114.00	$7.96	$15.92	$23.89	$47.77

TABLE 28 COST OF PERMITS PER KG OF PRODUCT[48]

	$10/t CO_2	$20/t CO_2	$30/t CO_2	$60/t CO_2
Milk Solids	2.74%	5.48%	8.22%	16.44%
Beef	5.08%	10.16%	15.24%	30.49%
Lamb	7.95%	15.90%	23.84%	47.69%
Mutton	9.26%	18.52%	27.78%	55.55%
Wool	8.76%	17.52%	26.28%	52.56%
Venison	10.73%	21.46%	32.20%	64.39%
Velvet	6.98%	13.97%	20.95%	41.91%

TABLE 29: PERMIT COST AS A PERCENTAGE OF AGRICULTURAL RETURNS TO FARMERS[49]

9.3.5 International Competitiveness

The agricultural sector is principally driven by exporting. Even though much of its product is sold domestically, pricing is based on international prices and its viability is ultimately based on its ability to compete in the international market place.

---

[48] Data in Table 28and Table 29 are calculated as follows:

1. Total 2000 animal emissions are allocated to the various end products as described above;

2. The allocated cost of these emissions is then divided by the total number of kilograms of that product produced in 2000, thus arriving at cost per kilo.

3. The percentages are then calculated by dividing the increase in cost by the price received by farmers in 2000 for that product.

[49] The percentages given in this table would of course change if the returns per kg vary from those assumed. One possibility for example is that the average return per kg of lamb and mutton increases with falling stock levels as the higher value quota markets make up an increasing proportion of total sheep returns.

We anticipate that permit costs at $20/t will have only a relatively minor effect on dairying[50]. The industry can probably pass most of the cost impost to consumers since most of the international competition comes from Annex 1 countries. Until viable competition emerges in the dairy sector, it is less likely that the cost increase will create process efficiencies, although it will be a further stimulus towards product specialisation and differentiation. Consequently, the final impact on farmers in terms of lower milk price will be somewhat less than 5%.

The meat industry faces rather higher permit cost increases. With the direct costs of permits alone increasing from 10% to 21%, the impact on the industry will be very significant. In addition, as with dairying, the sector will face price increases from energy and transport.

The highly competitive wool industry faces a tough competitive situation against the non-Annex 1 countries. It is fortunate for New Zealand that our main competitor, Australia, is also an Annex 1 country. However, New Zealand may find it necessary to move increasingly to high-end wool products where commodity pricing is less significant.

It is doubtful that all of these cost increases will be passed to the final consumer. Where the main competition comes from Annex 1 countries (sheep and deer) the possibility of increased prices is greater (although there will be competition from other meats, especially poultry, from non-Annex 1 countries). For beef, competing with the produce from South American countries as well as Annex 1 countries, the prospect of price increase is less certain.

When the longer term is considered, there is a strong possibility that non-Annex 1 countries will increase their agricultural production to compete effectively in the international market. At the same time, to protect their own internal agricultural industry, Annex 1 countries may become even more protectionist against imported agricultural products.

In general, from direct permits alone, the impact on the agricultural sector is significant. When the cost increases from oil and energy are added also, the prognosis for the industry looks bleak. The hope for New Zealand is to differentiate through product and country branding. The country has a strong marketing position against many non-Annex 1 countries with its "clean green image[51]". In food production, it is significant that we are free of BSE and foot and mouth disease. These advantages will need to be maintained and further exploited.

9.3.6 Impact on Households

To the extent that processors are able to pass on cost increases in prices, New Zealand households will face those price increases. Since the ability of the processors to pass on prices is uncertain, especially for meat products, we are unable to predict the costs to the New Zealand household.

---

[50] Of course, the dairy sector, like every other sector will also face additional energy and transport costs as a result of the impost of the permit regime in those industries.

[51] For example, current research is indicating that there would be a very significant drop in buying of New Zealand produce if we had a significant degradation in environmental quality.

In general, we will expect to see an increase in the cost of meat, dairy products and wool to the New Zealand consumer but not the full extent of the permit costs.

9.3.7 Impact on Fertiliser Industry

Like the agricultural processors and national bodies, this industry would not be able to absorb their attributed emission costs under the competitive tender regime. Costs would flow through to farmers.

Table 30 below shows the approximate increase in the price of the fertiliser per tonne under the different allocation options.

	$10 per t CO_2	$20 per t CO_2	$30 per t CO_2	$50 per t CO_2
$/tonne	2.91	5.82	8.74	14.56
Percentage Increase[52]	2%	4%	6%	10%

TABLE 30: IMPACT OF EMISSION PERMITS ON THE COST OF FERTILISER[53]

The 1990 calendar year saw the lowest fertiliser sales in the last decade due to an agriculture and economic downturn. The industry has expressed concern that the impact of the introduction of the emissions regime will have the same effect on fertiliser sales as the economic down turn, as farmers will have less to spend.

9.4 CONCLUSIONS

Where permits are sold by auction, the introduction of permits will increase the cost of production of agricultural products varying from a 5.5% increase for milk to a 21.5% increase for venison.

These costs will in some circumstances be passed on to consumers but it is likely that the farmers will bear the burden of the permit price.

The effect is least pronounced for dairy and beef farmers and we would expect it to have only a small impact on their industry. The cost increase is small and there is the possibility of passing it to consumers for dairying, if not for beef.

The impact is much greater on sheep farming, where it is unlikely that all the increased cost can be passed on to consumers. Cost increases above 10% will have a major effect on farm profitability. If the permits are grandfathered, sheep farmers will bear no additional cost of permits.

Deer farmers face a considerable problem. While venison and velvet are niche markets, it is unlikely they can carry a price rise of the order suggested in this report (21.5% for venison and 14% for velvet). Either there will need to be a dramatic change in deer

---

[52] Assuming cost of superphosphate of $145 per tonne

[53] Source: PA Consulting Group Analysis

farming regimes, or the industry is likely to face substantial restructuring and possibly decline. Grandfathering the permits does not help unless the agricultural industry cross-subsidises from sheep farming.

The point of obligation at processors will see permit prices linked to animal products processed. This is easy to administer. If sector boards become the point of obligation the permits may be linked to herd/flock size. This will be much more difficult to monitor and administer.

In general, from direct permits alone, the impact on the agricultural sector is significant. When the cost increases from oil and energy are added also, the prognosis looks bleak. The hope for New Zealand is to differentiate through product and country branding. The country has a strong marketing position vis-à-vis many non-Annex 1 countries with its “clean green image”. In food production it is significant that we are free of BSE and foot and mouth disease. These advantages will need to be maintained and further exploited.

10. FORESTRY

10.1 INTRODUCTION

This chapter discuses the potential impacts and outcomes of a carbon emissions trading regime on the forestry industry. The forestry industry includes forest owners, major primary processors of wood such as Pulp & Paper and Sawmilling. Given the export orientation of the New Zealand forest industry, this analysis considers what impacts carbon credit trading will have at an international level and the likely flow on impacts to the domestic market.

The chapter is split into two main sections. The first describes the industry as it is today, looking at issues such as ownership, supply and demand factors, conduct and performance. The second section takes these issues and discusses the possible impacts that carbon trading will have in each area.

10.2 DESCRIPTION OF THE SECTOR

10.2.1 Basic Conditions

The forestry industry has played a significant role in the economic development of New Zealand since the early 1800s, with forest and wood related products being a mainstay of the economy. The forestry industry is New Zealand's third largest exporter of goods behind Dairy and Meat with over NZ$3.75b dollars in export earnings in 2000 and is expected to become New Zealand’s largest export earner by 2025.

10.2.2 Demand factors and influences

Domestically, demand for forest products has remained static over the past decade with 5-6 million cubic metres being the average annual consumption. Demand within the domestic economy is largely constrained by the limited size and growth of the New Zealand population, and its small manufacturing base. The main consumer within the domestic market is the construction industry, which builds around 20,000 new houses per annum. It is heavily influenced by economic factors such as interest rates, and business confidence. Globally, trade in forest products represents 13.6% of world consumption. Population[54], economic growth and continuing social development have traditionally driven demand.

Internationally, forestry products such as Logs and Pulp and Paper are regarded as commodities, and as such, there is little differentiation between competing products. Price is largely determined by global stock levels, which result in the industry being characterised by large cyclical pricing patterns.

New Zealand's position in global forest products trade is largely that of a price taker. Most of New Zealand's export markets are price sensitive and open to competition. Re-engineered products such as laminated veneer lumber (LVL) and medium density fibre board (MDF) are considered differentiated products and have been able to attract premiums. However these products currently represent only 16% of log and sawn timber export volumes.

[54] Population growth alone increases demand for wood 77millon m^3 pa - FAO

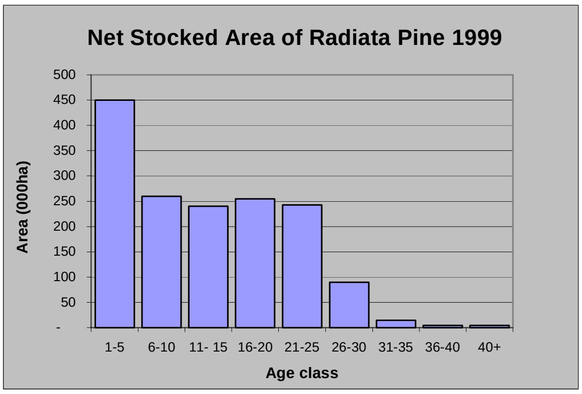
Internationally, New Zealand faces stiff competition from countries such as Chile, Brazil, South Africa and Australia, all of which have developed sustainable forestry industries with a similar wood resource to New Zealand's. Countries such as Chile will continue to develop as an international competitor with its similar product and its continuing aggressive pricing in export markets. Australia will become more self sufficient in the next few years as its forest resource matures, while Russia's largely untapped softwood forest (the world's largest) has the potential to significantly affect the global price of wood products (especially if it overcomes its capital crisis). The Forestry industry also faces continuing challenges from Steel, Aluminium and Plastics producers who continually outspend the forestry industry in R&D in an effort to develop cheaper and more effective wood substitutes.

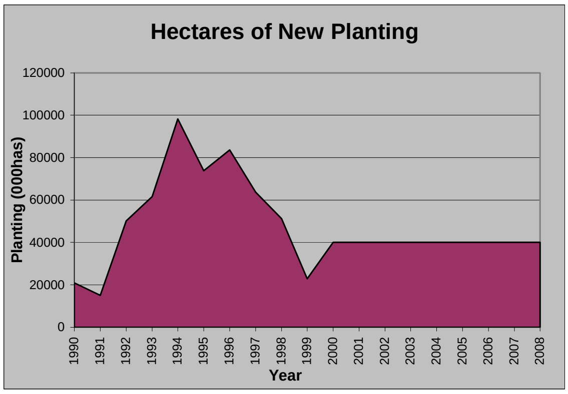
10.2.3 Supply factors and influences

New Zealand is covered by 8.1 million hectares of forest of which 6.4 million is native forest. The remaining 1.7 million hectares predominantly consists of man-made Pinus Radiata forest[55]. Native forests have become increasing protected with 4.9 million hectares (77%) of native forest unavailable for production. The remaining 1.5 million hectares available for production must be harvested using sustainable practices under the Forests Act.

The New Zealand Pine harvest has grown significantly over the last few decades, reaching 17 million cubic metres in 2000. Of this, 70% is further processed in New Zealand, with the balance being exported as unprocessed logs. Internationally, New Zealand ranks in the world's top 20 wood producing countries. However the output of the New Zealand forestry industry equates to only 1.1% of world forest product trade and 8.8% of Asia Pacific's.

Wood supply from plantation forests will grow significantly in the next 25 years with potential volumes likely to reach 28 million m^3 by 2010 and 55 million m^3 by 2040 (assuming 40,000 ha of new planting pa). This jump in supply (known as the wall of wood) has resulted from the vast amount of planting undertaken since 1990.





Source: MAF

FIGURE 15 :NEW ZEALAND'S FOREST RESOURCE; AGE STRUCTURE AND NEW PLANTING

---

[55] Over 90% with Douglas fir and eucalyptus making up a significant portion of the remainder.

This growth in plantation forestry is likely to stabilise post 2000, with MAF estimating new planting to average 40,000 ha pa. Potential growth however is huge, with suitable land estimated at over 9.4 million ha[56].

A. WOOD PROCESSING

New Zealand's wood processing industry is primarily concentrated in the central North Island, where the majority of the mature planted forests are located. The major wood processors, who are also New Zealand's major forest owners, have their processing plants close to, or within, their forests. Production capacity is made up of approximately seven Pulp and Paper plants, nine panel board plants, more than 350 sawmills and approximately 80 remanufacturers.

The major challenge facing the New Zealand industry is the lack of capacity to cope with the increasing wood supply. Over the past eight years, over $NZ1.25b has been spent within the industry on upgrades and greenfield plants. It is estimated however that New Zealand will need an additional $NZ6.5b spent on new capacity over the next 15 years to process the increasing harvest level.

Product	Production forest	Native	Total
Export logs	4,800,000 m^3		4,800,000 m^3
Sawn timber	3,188,000 m^3	38	3,226,000 m^3
Pulp	1,400,000 t	-	1,400,000 t
Paper and Paper board	814,000 t	-	814,000 t
Veneer, Plywood, Fibre/particle board	1,248,000 m^3	-	1,248,000 m^3

TABLE 31: PRODUCT BREAKDOWN OF THE NEW ZEALAND WOOD HARVEST

The adoption and development of new product in the forestry industry is somewhat variable. The use of biotechnology in the development of trees is well advanced with New Zealand recognised as a world leader. At the other end of the scale, processors of wood have not invested significantly in product development, especially when compared to the steel and plastics industries.

Adoption of new technology within the forest processing industry is high, with New Zealand seen as a leading innovator in the design and use of processing technology. New Zealand's major pulp and paper mills are within the top quartile of cost effectiveness and our panels and MDF plants are equipped with state of the art equipment. Investment in new technology is slowly occurring amongst smaller operators who are realising the need to invest to stay competitive.

On an international scale, New Zealand's forestry industry is seen as a low cost producer, in part due to regulatory reform, natural advantage and a low value dollar. Operationally

[56] Based on land classes 3-7 and excluding current land used for farming - source MAF

the forest industry has two significant cost areas[57] - Electricity and Transport. The industry is New Zealand's second[58] largest consumer of energy at around 12% of total consumption. However, significant investment in co-generation plants has seen the industry able to meet over 50% of its total energy requirements internally. The industry's reliance on transport is linked to its harvesting activities and the need to move logs to processing plants or ports.

The New Zealand forestry industry is well placed to grow, as countries look towards sustainably grown wood to supplement their own diminishing supplies due to unsustainable production practices or where population and economic growth outstrip supply.

Since 1988, the New Zealand forestry industry has increased its export volume by 171% and value by 245%. The future also looks positive with its leading markets (Australia, Korea, Japan and the USA) all experiencing significant growth in recent years.

10.3 STRUCTURE OF THE INDUSTRY

The forest Industry has undergone significant structural change in the past 10 years. Key components of this restructuring include:

- Privatisation of over 500,000 ha of Crown forests;
- Globalisation within the industry which has resulted in a number of New Zealand's leading companies controlled or in joint venture relationships with offshore entities; and,
- The rise of the small forest owner/investor.

A breakdown of the ownership of New Zealand’s forests is given in Table 32 below.

Ownership Category	Ownership %
Public Companies	47
Private companies	44
Central Government	3
Local government	3
SOE's	3
Total	100

TABLE 32: OWNERSHIP OF NZ PRODUCTION FOREST ESTATE

New Zealand’s wood processing industry comprises a mix of four pulp and paper companies, five panelboard companies, more than 400 sawmills and 80 remanufacturers. Processors follow a similar ownership pattern to that of the forest estate. Large vertically integrated companies such as Carter Holt Harvey, Fletcher Forests, Pan Pacific Forest

[57] Excluding labour.

[58] Behind the basic metals manufacturing industry.

Industries, Juken Nissho and Rayonier, along with multinationals such as Fletcher Building and Norske Scog control the major production facilities with smaller scale operations predominant in the sawmilling and remanufacturing arena.

Of significant interest within the New Zealand scene is the large proportion (approx. 50%) of forest plantations, owned or controlled by foreign investors. This has largely come about though the sale of the Crown's forestry interests and the acquisition of 50.1% of CHH by US forest products giant International Paper in the 1990s.

A significant portion of the processing industry is owned within New Zealand. However, given the increasing capital requirements of the industry, foreign ownership and investment is likely to continue.

A. THE FUTURE OF FOREST OWNERSHIP

Irrespective of any ramifications of carbon emissions trading, the future ownership structure of New Zealand's forests is likely to undergo more change. The recent interest of individuals and groups of small investors in the forestry industry has seen a lessening in the role large companies play in new planting[59]. Continued forest ownership by the traditional forestry companies hangs in the balance, with a number signalling their dissatisfaction at the returns their forest assets are generating. This could lead to significant portions of forest changing hands in the near future and potentially see a clear split between forest owners and processors. Whatever the outcome, it is likely that there will be a continuation of the offshore ownership or control of New Zealand's forest asset.

10.4 CONDUCT

Globally, forestry is firmly established as a cyclical commodity industry. Every player in the industry faces the continuing cost/price squeeze as a result of increasingly volatile cycles, declining commodity prices [60] and high capital investment requirements. This is further exacerbated by the consolidation of their customer base, who demand lower pricing.

As a result, the forest industry is highly competitive and undergoing significant consolidation as companies seek economies of scale and global reach. The New Zealand industry has not escaped this trend, with a number of global conglomerates entering New Zealand in the past decade. New Zealand's international presence is dominated by CHH and Fletcher's who own the majority of the log harvest. However, undercutting by smaller players is not uncommon in key export markets such as Korea.

Domestically, Pulp and Paper production is dominated by CHH whose main competition comes from imports from Australia and Asia. Sawmilling continues to be highly competitive. However, the large integrated companies control the majority of capacity.

[59] It is predicted that over one-third of plantation forests will be owned by small-scale growers by 2005 - MAF

[60] Averaging 2% pa - Mckinsey & Co

10.5 PERFORMANCE

New Zealand is rated as one of the world's lowest cost plantation softwood producers. This has largely been the result of three key ingredients:

1. Deregulation within key sectors such as Labour, Ports, Transport and Energy;
2. Significant cost reduction initiatives undertaken by the country's major forest owners and processors; and,
3. The close proximity of forests to processors and ports.

Despite a relatively competitive production environment, companies within the wood processing industry are still struggling to make profits and returns in excess of their cost of capital. This situation can be put down to a number of contributing factors, as follows:

1. Lack of investment in value adding processing;
2. Inability to adapt to changing markets or the ability to lift Radiata from it's widely held perception as a low-value wood; and,
3. The implementation and/or (inconsistent) interpretation of the Resource Management Act, which has complicated investment decisions and increased compliance costs.

On the whole, however, the forestry industry is best described as "under performing with a bright outlook".

10.6 IMPACT OF EMISSION PERMITS

Under the 1997 Kyoto Protocol, the forest industry was given a major role in ensuring that countries had options for reducing net emissions. The Protocol allowed countries to use carbon sinks to help meet their emission obligations. Sinks could only be created through the conversion of land into forests, which absorb CO_2 as part of their natural process.

For the purposes of the Kyoto Protocol; forests are classified into one of two types;

Non-Kyoto forests (NKF): These are defined as forests planted prior to 1 January 1990 and any areas restocked post harvest. Under the Kyoto rules, these forests will not attract credits. However they will require harvesting companies to purchase permits if the forest is harvested without replanting.

Kyoto Forests (KF): These are defined as forests planted after 1 January 1990 as a result of changes in land use (for example farmland planted with trees). Under the Kyoto rules, these forests will accumulate credits.

The details of the regime as it relates to Kyoto forests are still the subject of international negotiations. However, the most likely scenario has the credits accruing to the forest owner over the life of the trees, with an obligation to surrender the credits at harvest. As such, the owner of a Kyoto forest will be in a continual cycle of earning and surrendering credits, in line with the planting and harvesting cycle[61].

10.6.1 The Value of carbon credits to the forest industry

By 2008, it is forecast that New Zealand will have a Kyoto forest estate in the region of 900,000 - 1,300,000[62] ha with a weighted average age of 9.5 years. During the first commitment period, forest owners will receive credits based on a combination of the age of their forests and the typical carbon absorption levels at that age.

Assuming a planted area of Kyoto forests of 900,000 hectares, and taking into account the age structure of the Kyoto forest estate in 2008, it is estimated that permits to the value of around $400 million will accrue to the forestry industry during the first year of the commitment period[63]. The figure will rise in subsequent years as the new plantings continue to attract credits.

In contrast to the asset accruing to Kyoto Forest owners, non-Kyoto forest owners will face a contingent liability. To harvest the estimated 60,000 ha (30 million m^3) of non-Kyoto Forests in 2008 (without restocking) forest owners would require permits to the value of around $800 million (depending on the value of permits assumed).[64]

As these numbers indicate, forestry companies with Kyoto Forests will receive a significant fillip to their balance sheets during the commitment period. In contrast, companies holding non-Kyoto Forests will need to create significant contingent liabilities to cover the potential obligations they may face, should they want to keep open the option of not replanting.

10.6.2 Impacts on the Decision Making of Forest Owners

The analysis above suggests that the sink component of a tradable emissions permit regime will have a significant impact on forest owners. However it is not at all obvious how forest owners may react in the face of this new dimension to their business. Much will depend on their assumptions relating to the future movement in permit prices and expectations relating to the returns from forestry generally.

---

[61] Alternatively, the regime could be specified so that the forest owner accumulates credits to the long term average value of the amount of carbon sequestered, assuming the land is continued to be used for forestry. Under such a scenario, the forester would earn less credits for new planting but would not be required to surrender them at harvest – so long as the land was replanted. Where relevant, throughout the analysis, we have noted how this alternative specification might impact on the behaviour of the sector.

[62] Based on actual planting to 1999 and average new planting of between 40 & 85,000 ha pa

[63] See Appendix C for the model used to calculate this value. The median estimate is $423 million, assuming a credit value of $20 / tonne of CO_2 equivalent. The estimates for $10 / tonne and $20 / tonne are, respectively, $212 million and $635 million.

[64] Assuming a permit price of $20/tonne of CO_2 equivalent and no replanting. The assumption of "no replanting" is of course highly unrealistic. Indeed, some of the Crown forests for which cutting rights have been sold require new planting. Thus, it is highly unlikely that this contingent liability would be realised.

In addition, it seems likely that the owners of non-Kyoto forests may adopt different strategies from the owners of Kyoto forests. This in turn may impact on the structure of the forestry industry as a whole. Some of the more important considerations likely to impact on the decisions of forest owners are discussed below.

A. OWNERS OF KYOTO FORESTS

On the surface at least, the owners of Kyoto forests stand to benefit from the (credit creation aspect of the) introduction of a tradable emission permits regime. As discussed above, they stand to receive a windfall gain of approximately $400 million per annum during the first commitment period.

However, accompanying every dollar of gain is a dollar of contingent liability, to the extent that the owners of the forest are likely to have to surrender the permits gained during the forest's life at the time of harvest.[65] In this sense, the gaining of permits is more like a loan than a one-off windfall gain.

As foreshadowed above, the behaviour of the owners of Kyoto Forests with respect to their newly gained credits is likely to be a function of a range of factors, including expectations about the future price of credits.

For example, those who take the view that the value of the credits will stay the same (or increase at a rate up to the opportunity cost of capital) are likely to want to sell the credits with a view to buying the requisite permits again at the time of harvest. Those who take the view that the credits are likely to increase in value at a rate above the opportunity cost of capital are likely to hold the credits – as are those who are risk averse.[66]

(As an aside, it is interesting to speculate on what the strategies adopted by Kyoto forest owners may do to the world price of permits. As indicated above, it is quite possible that the owners of Kyoto forests may choose not to put their credits on the market (preferring to keep them for when they are required at the time the forest is harvested). This in turn may lead to a shortfall in the supply of credits on the world market bidding up prices, which in turn could increase the propensity of Kyoto forest owners to hold permits, which could drive the price even higher).[67]

The introduction of the credit regime may also have a significant impact on the decision-making of forest owners at the time of harvest. At the time of harvest, the forest owner will, as before, need to consider the costs and benefits of harvesting the trees. However, with a tradable emission permit regime in place, the forest owner will be weighing up the

---

[65] There is some uncertainty about this, as the harvest of Kyoto forests will mostly take place after the first commitment period. Rules beyond the first commitment period have yet to be determined. Nevertheless, the logic of the regime suggests that it is probably safe to assume that the felling of Kyoto Forests will require the surrendering of permits whenever it occurs.

[66] In essence, the credits act as a hedge against future price increases with the premium being equal to the opportunity cost of capital.

[67] Note this effect is likely to be less of an issue under the alternative specification of the regime outlined in Footnote 61. In particular, if the owners of Kyoto forests are not required to surrender the permits gained as a result of new plantings at the time of harvest, they are more likely to put them on the market – increasing liquidity.

benefits (in terms of the proceeds from the sale of the timber) against the costs (in terms of the harvesting and transport costs *and the (opportunity) costs of purchasing the requisite carbon emission permits)*. As discussed above, the forestry sector is a notoriously cyclical industry. The requirement to cover the costs of the permits over and above all the other harvest costs may impact on decisions about the timing of the harvest – or at the extreme, about whether or not to harvest at all.

B. OWNERS OF NON-KYOTO FORESTS

The incentives facing the owners of non-Kyoto Forests are a little different. As indicated above, the owners of non-Kyoto Forests will not receive credit for the carbon sequestered during the first commitment period, nor will they be required to surrender permits at the time of harvest – *so long as they replant*.

The most significant issue facing the owners of the non-Kyoto forests is the introduction of a contingent liability associated with the non-replant option that they currently enjoy. Put another way, the introduction of the regime has the effect of locking them into their existing forests.

Note that the regime not only locks existing forest owners into forestry as a land use option, but also restricts the ability of forest owners to rationalise their estates[68]. For example, a forest owner who chooses to log a non-Kyoto forest and replant the equivalent land in another area, perhaps closer to processing facilities, would be faced with the prospect of acquiring permits to cover the felling of the non-Kyoto forest. (No permits are required to replant on existing non-Kyoto forestland.)

Thus, the owners of non-Kyoto forests face a loss of flexibility in terms of their ability to manage their existing forests and to exit the industry in the future. We anticipate a number of implications as a result.

First, it seems likely that the owners of non-Kyoto forests will look at the possibility of increasing their harvesting rates in the period leading up to the introduction of the first commitment period. While premature felling carries with it a cost in terms of foregone revenue from greater wood volumes, it carries with it the benefit of removing the contingent liability associated with possible future exit or rationalisation strategies.

Second, we anticipate some adverse impact on the valuations of companies. This may be consequential on the real losses associated with premature harvesting or the contingent losses associated with reduced options in terms of future management – or both.

Third, it is possible that the impact on the owners of non-Kyoto forests (above) may flow through to levels of investment in the forest processing industry. As indicated above, the ownership of non-Kyoto forests lies primarily with the larger forestry companies, most of which now operate on a global basis. We can anticipate that these companies will be alert to the threats and opportunities of investing in forestry in New Zealand (or any other Annex 1 country) vis-à-vis the non-Annex 1 alternatives.[69]

---

[68] Recall that most of the Non-Kyoto forests are owned by the larger forestry companies. As such, the loss of ability to rationalise their forestry estates in line with existing or planned infrastructure is likely to be a reasonably significant consideration.

[69] This point is picked up and discussed further in the discussion on “supply” in the next section.

It is extremely difficult to estimate in quantitative terms the size of the impact of these effects. As with the owners of Kyoto Forests, much will depend on individual perceptions of key parameters such as the future course of permit prices, log prices in the time leading up to the first commitment period and the value attributed to the option of future rationalisation or exit. Nevertheless, it is clear that the introduction of credits for forest owners as a consequence of the introduction of a tradable emissions permit regime may not be the bonanza that it appears to be on the surface.

10.6.3 Impacts on the Supply and Demand of Forest Products

In the discussion above, we have focussed on the possible impact of the introduction of a tradable emission permit regime on the decision-making of the individual forest owner. In the sections below, we focus more generally on the possible implications for the introduction of the regime on supply and demand conditions for forest products generally.

A. DEMAND

On the demand side, domestic and international consumption levels and patterns are likely to continue to follow current trends, regardless of the introduction of carbon credits. Domestically demand is likely to show steady but relatively slow growth in the next 8-10 years as New Zealand's population expands. On the international level, the key driving factors in increasing demand for wood products will continue to remain as they are now.

In many respects, the more interesting impact occurs on the supply side (discussed below).

B. SUPPLY

In the short to medium term, the supply of wood is determined to a large extent by past planting activity. This allows potential supply, both domestically and internationally to be determined 15-30 years in advance. The global supply of industrial roundwood is predicted to reach 5.5 billion m^3 by 2008[70], of which New Zealand will be in a position to supply 28 million m^3.

As foreshadowed above, it is likely that the introduction of a permit regime will increase the supply of wood from non-Kyoto forests in the period leading up to the first commitment period as forest owners seek to minimise their exposure to the future liabilities associated with exit or rationalisation.

In the longer term, the supply of wood (at least from Annex 1 countries) will be determined by the actions of Kyoto forest owners. As discussed above, we do not believe that the incentives created by the regime will be significant enough to increase considerably the rate of new planting. In fact, the impact of the (opportunity) cost of surrendering permits at the time of harvest may serve to *constrain* the supply of logs – depending on the market conditions at the time.[71]

---

[70] FAO - Global outlook for future wood supply from plantations - growth scenario 2

[71] The requirement to surrender permits at harvest time adds an extra cost to the decision to harvest. At the margin, this reduces the return from harvesting at any particular point in time.

However, in forming a view about the supply of wood products, it is also necessary to consider how the introduction of a tradable emissions permit regime may impact on suppliers from non-Annex 1 countries.

The discussion above has already suggested that the introduction of the regime will create an incentive on the part of the larger (non-Kyoto) forest owners to exit as much of their plantings as possible in Annex 1 countries prior to the introduction of the regime. Further to this, there are a number of reasons for believing that any new investment by these companies will tend to be directed towards non-Annex 1 countries.

First, new investors in non-Annex 1 countries will not be encumbered by the transaction costs associated with the permit regime existing in Annex 1 countries. Second, they will not have to bear the costs of the impacts emission permits that are expected to have on key energy inputs required in the forest industry transportation and processing subsectors. Third, and probably most significantly, they have the potential to benefit from the “clean development mechanism” agreed to under the Kyoto Protocol aimed specifically at encouraging carbon emission reduction activities in non-Annex 1 countries.

On balance, we anticipate that the potential to earn credits for carbon sequestration will do little to encourage supply from Annex 1 countries but may well increase the international competitiveness and supply of wood from non-Annex 1 suppliers.

10.6.4 Impacts associated with increases in the price of energy

In the discussion above, we have focussed on the impacts of the introduction of the tradable emissions permit regime on forest owners. In the main, this comes in the form of the credits to be gained from new plantings (or lost at the time of harvest).

However, in addition to the impact associated with the carbon sequestration side of forestry, the sector will also be affected by a rise in the input costs associated with the CO_2 emitted from fossil fuels used in the transport of logs and in the forest processing sector.

As indicated above, the forest processing industry is a major user of energy, accounting for approximately 12% of New Zealand’s total energy consumption. We have already seen in Chapters 4 and 5 that the introduction of a tradable emissions permit regime is likely to increase the cost of energy to industrial consumers by 19% on average (gas 20%, coal 38% and electricity 10%). In addition, transport prices will rise in the order of 5%.

Furthermore, we have argued above that the forest industry generally is highly competitive internationally and that the New Zealand wood processing industry struggles to make a return in excess of the cost of capital. This suggests there is little room for the forest processing industry to absorb the impact of an increase.

To some extent, the impact of an increase in the price of energy will be mitigated by the relatively high level of self-sufficiency the forest processing industry currently enjoys; currently around 50% of the industry’s energy requirements are met internally. The relative attractiveness of biomass as a fuel source under an emissions trading regime is likely to see this figure increase in the future.

10.6.5 Summary of impacts on the structure of the Industry

We have seen above that the introduction of a tradable emissions permit regime will impact on the various participants in the industry slightly differently. In summarising these impacts it is useful to distinguish the small investor owners of Kyoto forests from the large vertically integrated owners of non-Kyoto Forests and forest processing facilities.

We anticipate that small investors will continue to play a significant role in new land plantings leading up to and beyond the commencement of the first commitment period. However, we do not anticipate that the introduction of the regime will do a great deal to encourage new planting over and above what would occur anyway.[72]

In contrast, we expect the major forest companies such as CHH and Fletchers to look closely at the impact the regime will have on their balance sheets, investment returns, future options and cash flows. We suspect they may consider reducing (or not increasing) their exposure to forest holdings within New Zealand and Annex 1 countries generally. We envisage that non Annex 1 countries may become more attractive at the margin in terms of future investment in forestry and forest processing.

In summary, this is likely to lead to an increasing proportion of the forest estate being owned by the small investor, and the relative demise of the larger players. We do not anticipate that this will do anything to alleviate the issues associated with the rapidly increasing supply of wood and the relative lack of wood processing facilities.

10.6.6 Summary of Impacts on the Conduct of the Sector

In a similar vein, we also anticipate that the conduct of Kyoto Forest owners under a tradable emission permit regime will be different from the conduct of the vertically integrated owners of non-Kyoto Forests.

The owners of the Kyoto Forests will continue to invest more or less as they did before. They face complex decisions as to whether or not to place the credits they receive for carbon sequestration on the market. While some may choose to sell their credits, we suspect that many will hold on to them as a hedge against their liability at harvest time. In addition, the existence of a requirement to surrender credits at the time of harvest will, at the margin, reduce the returns from felling the trees.

We anticipate that the larger vertically integrated owners of non-Kyoto forests will be looking to protect their options for the future. To this end they may look to fell some of their forests prior to the commencement of the first commitment period and/or re-direct some of their new plantings. They may also re-consider investment plans in forest processing in the light of opportunities which may exist in non-Annex 1 countries.

10.6.7 Summary of Impacts on the Performance of the Industry

It is likely that the impacts of the introduction of the tradable emission permit regime will also flow through to the performance of the sector.

---

[72] Note, this conclusion assumes the base case scenario in terms of the specification of the regime, ie permits would need to be surrendered at the time of harvest. Under the alternative regime (specified in footnote 61) however, forest owners would retain credits associated with new plantings – so long as they replanted at the time of harvest. We suspect that this may increase the propensity to convert land to forestry.

In particular, the incentives created by the liabilities introduced for the owners of non-Kyoto Forests are likely to lead to behaviour which is inefficient from an economic perspective. The incentives to fell non-Kyoto forests prematurely prior to the start of the first commitment period and to plant in new locations rather than replant are obvious examples.

In addition, the loss of competitiveness of the New Zealand industry vis-à-vis its competition from non-Annex 1 countries is likely to squeeze further the profit margins available to New Zealand growers and (particularly) New Zealand forest processors.

The consequential negative impact on the much needed new investment in the forest processing sector in the face of the “wall of wood” coming on stream is likely to further reduce the performance of the New Zealand forestry industry.

10.7 CONCLUSIONS

The introduction of a tradable emissions permit regime constitutes a “policy shock” to the sector capable of inducing some change within the forestry industry.

On balance, we conclude that the introduction of the regime will not favour the New Zealand forest industry. Whilst the carbon credits will generate a lump sum asset for the owners of Kyoto forests, this will be offset by the creation of liabilities (for all forest owners) distortions to investment and harvest decisions and a loss of international competitiveness vis-à-vis non-Annex 1 competitors.

11. CROSS-SECTORAL, REGIONAL, HOUSEHOLD AND TRADE IMPACTS

In this final chapter of the report, we draw together the issues that have been raised in the separate sectors to create an understanding of the overall impact of the emissions permit regime. This chapter is not so much a summary of the conclusions of the previous chapters but a synthesis of the insights developed thus far. It is presented under four headings:

- Cross sectoral analysis;
- Regional implications;
- International trade implications; and,
- Effects on households.

Permit cost calculations in this chapter are all based on the assumption of $20 per tonne of CO_2 equivalent.

11.1 CROSS SECTORAL ANALYSIS

Of the sectors covered in this report, the major cross sectoral effects come from the increased cost of energy – gas coal, geothermal and electricity – and the increased cost of transportation arising from the permit cost impost on the price of petrol and diesel. These fuel cost increases will impact on the costs of all commercial and industrial organisations as well as households. (We discuss the impact on householders in a later section).

The effect on individual companies and commercial establishments is beyond the scope of this report. However, we are able to provide some insights into the macro level effects and the impacts on major industries.

In broad terms, we found as follows:

- Energy:
  - the expected increase in costs for energy is 16% overall, 19% for industrial customers (gas 20%, coal 38% and electricity 10%) and 10% for commercial users (gas 10%, coal 16% and electricity 9%);
  - the total cost of emission permits for the industrial sector is about $300 million of an annual turnover of $90 billion or about 0.3% of turnover; and
  - the total cost of emission permits for the commercial sector is about $80 million of an annual turnover of $200 billion or about 0.04% of turnover.
- Oil:
  - the expected cost increase in oil fuels is 5.5% overall and about 5% for domestic transport;
  - the total cost of oil permits for the industrial sector, excluding domestic transport, is about $15 million of an annual turnover of $90 billion or under 0.02% of turnover;

- the total cost of oil permits for the commercial sector, excluding domestic transport, is about $7 million of an annual turnover of $200 billion or under 0.01% of turnover; and
- the cost of transport is about 0.03% of industrial and commercial turnover[73].

On this basis, the additional cost of energy and oil to the industrial sector is about 0.35% of turnover and for the commercial sector is under 0.1% of commercial turnover. These cost increases are within the normal fluctuations in electricity and petrol prices. Clearly, for some industries the cost will be much higher.

We have discussed in the individual chapters the cost implications for aluminium, steel, chemical processes, agriculture and forestry. Where we have not mentioned explicitly the cost of transport, for example, we have taken the view that it is minor in comparison to the impact of permits for their specific processes.

The other potential cross-sectoral impact is between forestry and agriculture. We saw that agriculture, especially sheep and deer farming, may face high permit costs to the extent of making it uneconomic for many farms. There will be a tendency for marginal farms to be converted to forestry, thereby earning a carbon credit.[74] It is possible that farm-forestry could increase in popularity allowing forestry credits to be gained while still rearing livestock.

11.2 REGIONAL IMPACTS

The impact of the introduction of a tradable emission permit regime will (by virtue of its impact on energy and transport costs) reach all sectors of the economy and all regions. However, it is possible that the regime may affect some regions more than others, as well as the urban/rural balance. The main regional impacts will come via the impact of the regime on the agriculture and forestry sectors as well as some large industries.

While we may see an expansion of renewable energy sources, especially wind and hydro, only the growth of generation from biomass is likely to have a significant regional consequence. This in turn will be connected closely to the expansion of the forestry sector. Wind and hydro stations have employment consequences mainly at the time of their construction.

The main regional implication of the impact of the regime on the electricity sector is that it will increase the benefits of new energy intensive industry locating in the South, close to any major hydro-electric developments such as the one signalled by Meridian for the Waitaki.[75]

---

[73] This assumes about 64% of domestic transport usage is by private motor vehicles.

[74] We note however, that the benefits of forestry credits are not as clear-cut as first thought because of the need to surrender or buy permits of an equivalent value to those received when the forest is felled and not replanted.

[75] There is an advantage in locating close to the source of energy supply, insofar as it avoids transmission costs (including line losses and congestion rentals) associated with the transport of electricity.

Countering this influence is the fact that an increase in the cost of transport fuel arising from the introduction of the regime, even though it is within the normal variation of the price of oil, will increase the propensity for industry and commerce generally to continue its drift northward to the main population centre.

With the size of the predicted impact of permit costs on the agricultural sector, there are grounds for concern that rural New Zealand will be hit hard by the regime[76]. Dairying is the least affected so those regions that have a strong dairying presence are likely not to be significantly affected.

Sheep farming and deer farming are expected to suffer the brunt of the impact of the introduction of the regime. High country regions and areas unsuitable for dairying may face an economic down-turn. This may be mitigated by a move towards forestry as a use of agricultural land.

Specifically, we expect the farming areas in the west of the North Island (Taranaki and Waikato) to survive the impact of the regimes reasonably well, along with the newly developed dairy industry in Southland. However, Canterbury, Otago and the South Island high country may suffer, unless they are able to move into higher return activities such as Merino sheep farming, horticulture (or possibly forestry). There may be some consequential impact on land values.

The most likely industry to decline is the steel industry. With increased costs of 5%-6%, this industry may find it difficult to compete with imported commodities. If the mill closes, there will be a (short-run) impact on local employment in that region.

The effect of the permit regime on the Central North Island is likely to be mixed. With so much of the forestry in the region being based around non-Kyoto forests, it is possible that there will be little further growth in the sector in that region. On the other side of the ledger, the relative attractiveness of geothermal steam as a cost effective source of industrial heat may well encourage new industry into the area.

All areas where there are Kyoto forests and which are close to suitable port facilities can expect to see a continued expansion – although any new growth in forest plantings is unlikely to be spectacular. Any new investment in processing plant is likely to be situated near to the forests to reduce transport costs. The obvious areas are those already planted including; Nelson / Marlborough, Hawkes Bay, and Northland, in addition to the Central North Island. In addition, as mentioned above, we may also see a switch to forestry in Canterbury (despite difficulties with the climate in the region) as a response to the declining economics of pastoral farming. For reasons mentioned in the body of the report, however, we consider it unlikely that there will be considerable new investment either in forestry or in forest processing.

11.3 INTERNATIONAL TRADE

The potential impact of the introduction of the regime on New Zealand's ability to compete on the world market is a matter of considerable importance. We have already seen the USA signal its dissatisfaction with the Kyoto Protocol on the grounds of what it sees as an inequitable effect on its economy, in comparison to non-Annex 1 countries.

---

[76] This impact will not be nearly as severe if permits are grandfathered rather than auctioned in the first instance.

In theory at least, the introduction of the regime could affect the competitiveness of the economy generally through its impact on energy and transport costs. However, in practice, we do not expect the impact to be large enough to be significant. As indicated, the cost imposts associated with the regime amount to less than 0.5% of turnover. A cost increase of this magnitude is within the normal price fluctuations for energy, oil and the exchange rate.

The introduction of the regime does, however, have the potential to affect the international competitiveness of some industries and sectors more than others.

As discussed in chapter 6, the steel industry is likely to find the 6% increase in cost resulting from permits difficult to absorb. It produces a commodity easily traded on the international market. We anticipate that the introduction of the regime will result in a switch from locally produced steel to imported product from non-Annex 1 countries. New Zealand already imports some steel from these sources.

The aluminium industry would carry both the permit cost of electricity and the permit cost of the oxidisation of the carbon anodes in the production process. Together these amount to a cost increase of about 7.6% of the cost of aluminium. At this level of increase, the competitive edge New Zealand has from cheap electricity prices will be eroded, and non-Annex 1 countries may become more competitive. Currently, Comalco is protected from electricity price variations by a bilateral supply contract. While this would probably continue in the short term, we would expect it to eventually be struck at the long-run average spot price.

The effect on the refrigeration industry depends on the foaming agent and refrigerant used. If the industry uses HFC 134 as either the foaming agent or the refrigerant, the cost is much greater than if hydro-carbons are used for both. Fisher and Paykel use hydro carbon gas and water as a foaming agent and HFC 143 as a refrigerant. As a consequence, F&P will face a permit cost of about $3.60 per refrigerator. Since this, on a $1,000 unit, is almost insignificant, we suspect that the competitiveness of local refrigeration manufacture will not be put in jeopardy.

The cement industry, while also paying for permits for both its power and its chemical process, is not as severely affected as either steel or aluminium. This industry is likely to face a cost increase of 3% - 4%. While not insignificant, it is likely that a corresponding increase in selling price will not be enough to encourage the importation of cement from elsewhere.

Our analysis of the hydrogen peroxide industry suggests a cost increase of less than 1% of the sale price. We believe this will have no impact on the viability of the plant in New Zealand.

Coal mining is potentially at risk. However, with most of the New Zealand coal being exported it does not attract permit liability in New Zealand. So there will be no international trade implication of a permit regime.

Perhaps the industry most likely to face substantial stress from the permit regime is the agricultural sector. In order to pay for the cost of greenhouse gases that animals emit, the sector has increased costs ranging from 5.5% for dairying to 21.5% for venison.

We anticipate that the dairy industry will be able to absorb the cost of the permits in price increases, albeit with probable reduced returns to the farmer, so that the permit cost will not harm the industry.

The meat industry will have much more difficulty coping with the resultant cost increases – of between 10% (beef) and 21.5% (venison). It is unlikely these costs can all be passed on in the price of meat, even though many of New Zealand's competitors are also Annex 1 countries. The competition from substitutes alone (poultry and non-meat food products) will limit the extent of possible price increases. (Note also that, as the introduction of a permit regime is also likely to lead to cost increases in local agriculture in other Annex 1 countries, there is a risk of greater protectionism in key export markets.)

With both lamb increasing in cost by 15.9% and wool by 17.5% the sheep farming sector is severely hit with increased costs. When a further 0.5% to 1% for general cost increases is added, the sector struggles to stay viable. The sheep farming sector would not be so severely hit if permits were initially "grandfathered" rather than auctioned. A declining flock size since 1990, means that the industry would have more than enough permits to cover the level of emissions from the sector predicted for 2008.

The most vulnerable agricultural sector is deer farming. It is difficult to see a solution to the difficulties they will face, unless they are able to differentiate their product enough to be able to pass on the considerable cost increase to their customers. Grandfathering does not help this sector since deer farming was almost unknown in 1990.

The forestry sector is a difficult one to analyse. Notwithstanding the fact that the sector will be rewarded for the creation of new carbon sinks, it is by no means certain that the sector generally will benefit from the introduction of the tradable emissions permit regime. New forests are only an attractive option as a substitute for alternative land use if forestry is to become the permanent use of the land. Since all credits must be surrendered when a forest is harvested, the benefit of obtaining credits is not permanent. In addition there will be a significant increase in industry costs stemming from its energy consumption and transportation requirements. In our view, it is most unlikely that the sector will receive the windfall gain that some have predicted.

11.4 HOUSEHOLDS

The emission permit regime will impact on households through increases in the cost of energy (electricity and gas) and the increase in cost of goods and services as a result of the increase in their cost base. Most especially we anticipate that meat and dairy prices will rise.

We estimate that direct energy costs to a household will rise by 8% and transport fuel costs will rise by about 4%. In addition we expect to see a general price rise of about 0.2% from energy and oil price rises, although these could be greater if firms add a mark-up on the cost increase.

Some commodities will be expected to rise more substantially. With meat costs to the processor increasing by 10% to 20% we will expect to see some of that in domestic price increases to the extent that the international market will bear the increased price. Similarly, wool and wool-based products will increase in price to some extent.

The overall impact is likely to be of the order of a 1% -2% rise in the consumer price as all of the repercussions filter through the economy.

APPENDIX A: INFORMATION SOURCES

A.1 COAL GAS AND GEOTHERMAL ENERGY

Barlow Jonker Pty ltd, *Coal World Production and Trade*, http://www.coalportal.com/GenericASP/wce.asp, 2000

Brockway, D. J., *Clean competitive energy from low-rank coal*, Symposium of the Australian Academy of Technological Sciences and Engineering, November 1997

Contact Energy, *Investor Presentation*, http://www.contactenergy.co.nz/pdf/contact_presentation.pdf, April 1999

Counsel, J., *Coal supplies tighten as Japan seeks more*, http://www.smh.com.au/news/0007/10/business/business15.html, 10 July 2000

Crown Minerals, *1997 New Zealand Minerals Activities Summary*, http://www.med.govt.nz/crown_minerals/minerals_info/97_min_activities.html, 1999

Crown Minerals, *NZ Petroleum News 34*, http://www.med.govt.nz/crown_minerals/petroleum_news/nzpnews034.html, March 2001

Dunstall, M., *Geothermal Energy - The Forgotten Renewable*, in New Zealand Engineering, July 1999, http://www.ipenz.org.nz/nze/jul99/energy/energy.htm

Ellis, A. J., *The Development of Geothermal Power*, in Hogan, D. and Williamson, B., *New Zealand is Different*, Clerestory Press, Christchurch, New Zealand, 1999, http://www.techhistory.co.nz/pages/Geothermal.htm

Environment Australia, *Emissions Estimation Techniques Manual for Aggregated Emissions from Fuel Combustion (Sub-Threshold)*, http://www.environment.gov.au/epg/npi/handbooks/aedmanuals/pubs/subcombustion_ff.pdf, September 1999

FreshStart Energy, *FreshStart Energy: Gas Prices,* http://www.freshstartenergy.co.nz/fs/prices/gas.html, 15 October 2000

Institute of Geological and Nuclear Sciences, *Environmental Impacts of Geothermal Development*, http://www.gns.cri.nz/earthres/geothermal/enviro.html

M-Co, *Power Stations North Island*, http://www.m-co.co.nz/PowerstationsN.htm, March 1999

M-Co, *Power Stations South Island*, http://www.m-co.co.nz/PowerstationsS.htm, March 1999

M-Co, *Power Companies*, http://www.m-co.co.nz/C1changes.htm

Ministry of Economic Development, *Energy Data File*, Wellington New Zealand, 2000

Ministry of Economic Development, *Energy Outlook to 2020,* Wellington New Zealand, 2000

Ministry of Economic Development, *Ministerial Inquiry into the Electricity Industry*, http://www.electricityinquiry.govt.nz/, 2001

Ministry of Economic Development, *New Zealand Energy Greenhouse Gas Emissions 1990-1999*, Wellington New Zealand, 2000

Ministry for the Environment, *National Inventory Report: New Zealand Greenhouse Gas Inventory 1990-1999*, Wellington New Zealand, 2001

OnEnergy, *Energy Home, Are we in your area?*, http://www2.onenergy.co.nz/eh_are_we_in_your_area_.html, 2000

Phaceas, J., *BHP Extracts 8pc Coal Price Rise*, http://www.news.com.au/common/story_page/0,4057,1715269%255E462,00.html, 16 February 2001

Reuters, *BHP says has negotiated some coal prices*, http://au.yahoo.com/finance/20010223/reutersfinance/982907040-1879801962.html, 23 February 2001

The Dominion, *Solid Energy Positive on Exports*, Wellington New Zealand, 14 December 2000

Todd Energy, *Todd Energy Presentation to the Ministerial Inquiry into Electricity*, http://www.todd.co.nz/te/documents/ElectricityInquiryPresentation.pdf, March 2000

UnitedNetworks, *Gas Supply, New Zealand*, http://www.unitednetworks.co.nz/display.asp?PageID=89, 2001

Upasena, J., Ward, B. D. and Cook, R. A., *Analysis of Oil and Gas Exploration and Discovery in New Zealand - A Basis for Supply Forecasting*, Proceedings of the New Zealand Petroleum Conference, 1998

Waikato Regional Council, *Energy and Extraction*, http://www.ew.govt.nz/ourenvironment/geothermal/energy.htm, 2001

M-Co, *Electricity Price Index*,

http://www.comit.m-co.co.nz:8118/web_aggregates/owa/c3_index.summary, 2001-06-22

Comalco New Zealand, *Comalco 1999 Annual Results*, http://www.comalco.co.nz/06_announce/01_00_02_18.htm, 2000

Comalco New Zealand, *Fact Sheet - Smelting Aluminium*, http://www.comalco.co.nz/07_education/02_fact_smelting.htm, 1999

Comalco New Zealand, *Tiwai Point Smelter*, http://www.comalco.co.nz/05_operations/07_tiwai.htm, 2000

Comalco New Zealand **,** *Production report for the quarter ended 31 March 2000*, http://www.comalco.co.nz/04_financial/03_00_1qtr.htm, 2000

London Metals Exchange, *Historical Data*, http://www.lme.co.uk/data_prices/historical_data.asp, 2001

BHP Steel, *Energy Use in BHP Steelmaking*, http://www.bhpsteel.com/bhp/steel/steelenv/environment/energy.cfm

Steel Profiles, *The Largest Steel Producing Countries*, http://www.steelprofiles.com/market/index.htm, 1999

Australian Bureau of Statistics, *1292.0 Australian and New Zealand Standard Industrial Classification (ANZSIC)*, http://www.abs.gov.au/Ausstats/abs@.nsf/66f306f503e529a5ca25697e0017661f/7cd8aebba7225c4eca25697e0018faf3!OpenDocument, 1993

International Energy Agency, *Retail Prices of Energy in Selected Countries*, http://www.iea.org/statist/keyworld/keystats.htm, 2001

A.2 OIL (INCLUDING TRANSPORT)

ARCADIS Geraghty & Miller, Inc., *FuelCost 1.0: A Tool for Evaluating the Costs of Fuel Options for Transit Buses User's Guide,* http://www.nas.edu/trb/publications/tcrp/tcrp_rpt_38-c.pdf, February 1998

Australian Greenhouse Office, *Greenhouse Challenge Factors and Methodologies*, Canberra, ACT Australia, 2001

Energy Efficiency and Conservation Authority, *Energy Efficiency Trends in New Zealand*, Wellington New Zealand, 1997

Ministry for the Environment, *National Inventory Report: New Zealand Greenhouse Gas Inventory 1990-1999*, Wellington New Zealand, 2001

Ministry of Economic Development, *Energy Data File*, Wellington New Zealand, 2000

Ministry of Economic Development, *Energy Outlook to 2020,* Wellington New Zealand, 2000

Ministry of Economic Development, *New Zealand Energy Greenhouse Gas Emissions 1990-1999*, Wellington New Zealand, 2000

Shell Australia, *Australia has the Cheapest Pre-Tax Petrol in the World*, http://www.shell.com.au/petrolpricing/tas/index_l2_world.html, 2001

US Environmental Protection Agency, *Fuel Economy Impact Analysis of RFG*, http://www.epa.gov/otaq/rfgecon.htm, August 1995

A.3 INDUSTRIAL PROCESSES (CO_2 EMISSIONS)

BHP New Zealand Steel http://www1.spectel.co.nz/colorsteel

Ministry of Economic Development, *New Zealand Energy Greenhouse Gas Emissions 1990-1999*, Wellington New Zealand, 2000

New Zealand Minerals Industry Association http://www.minerals.co.nz

Omya New Zealand http://www.omya.com

Pacific Steel http://www.homepages.ihug.com.au/~fcsp

Ravensdown Fertiliser http://www.ravensdown.co.nz

BHP New Zealand Steel http://www.nzsteel.co.nz

BHP Steel http://www.bhpsteel.com

Comalco New Zealand http://www.comalco.co.nz

Fletcher Challenge Limited http://www.fcl.co.nz

Golden Bay Cement http://www.goldenbay.co.nz

Milburn New Zealand Limited http://www.milburn.co.nz

Omya New Zealand Limited http://www.omya.com

New Zealand Minerals Industry Association http://www.minerals.co.nz

Das, A. *Cement Majors Step Up Exports*, The Economic Times, 17 April 2001

http://www.economictimes.com/170401/17comp04.htm

European Chemical Industry Council, *Ecoprofile of Hydrogen Peroxide*, http://www.cefic.be/sector/peroxy/ecohydro/tc.htm, 1997

Degussa, *Degussa Peroxide - Hydrogen Peroxide*, http://www.degussa.co.nz/hp.html, 2000

ChemExpo.com, *Chemical Profile - Hydrogen Peroxide*, http://www.chemexpo.com/news/profile980824.cfm, 1998

The New Zealand Refining Company Limited, *Production Volume and Income Figures*, April 2001

A.4 INDUSTRIAL PROCESSES (NON CO_2 EMISSIONS)

Fisher and Paykel http://www.fp.com.au

Ministry for the Environment, *Inventory of Actual HFC and PFC Greenhouse Gas Emissions for New Zealand (1990 - 1999) - Draft*, 2000

Transpower New Zealand Ltd http://www.transpower.co.nz

A.5 WASTE MANAGEMENT

Law, Garry, *Local Government Ownership of Water Businesses – Does It Add Value?,* October 1999

Ministry for the Environment, *Contract Brief – Invitation for Detailed Proposal,* http://www.mfe.govt.nz/issues/waste/bried.htm, 2000

Ministry for the Environment, *Facts about Solid Waste and Landfills,* http://www.mfe.govt.nz/issues/waste/Facts%20about%20waste%20and%20landfills.htm, 2001

Ministry for the Environment, *Waste Policy,* http://www.mfe.govt.nz/issues/waste/Waste_new2.htm, 2001

Ministry for the Environment, *New Zealand Greenhouse Gas Inventory 1990 - 1999,* Wellington New Zealand, 2000

Ministry for the Environment, Project Update: *First National Waste Data Report*, Wellington New Zealand, September 1997

Ministry for the Environment, *The 1998/1999 National Landfill Census Report,* Wellington New Zealand, March 2000

Ministry of Economic Development, *Greenhouse Gas Emissions Trading: Cross-Sectoral Issues*, Wellington New Zealand, March 2001

Ministry of Economic Development, *Managing Greenhouse Gas Emissions: The Waste Sector*, Wellington New Zealand, February 2001

Ministry of Economic Development, *Managing Greenhouse Gas Emissions: The Waste Sector – 2,* Wellington New Zealand, March 2001

Ministry of Economic Development, *Summary of Dialogue Session with Waste Management Industry Stakeholders*, Wellington New Zealand, February 2001

New Zealand Business Roundtable, *Politics and Water Don't Mix,* April 1998

New Zealand Water and Waste Organisation http://www.nzwwa.org.nz

SCS Wetherill http://www.scseng.com

Taranaki Regional Council www.trc.govt.nz

Waste Management New Zealand http://www.wastemanagement.co.nz

Watercare Services http://www.watercare.co.nz

A.6 AGRICULTURE

AFFCO Holdings Limited, *Annual Report 2000*

Belfast Newsletter, *Methane Quotas Mooted*, Nov 2000

Brian Fallow, The NZ Herald, *Barter is the Best Way to Cut Emissions*, Jan 2001

Charles River Associates*, An Approach to Ensuring Efficient Price Setting by the Global Dairy Company*, 6 April 2001

Economics and Law Consulting Limited, *Evaluation of the December 2000 Dairy Industry Merger Package Form the Perspective of Competition Policy*, 11 Jan 2001

Gill, M. A., *Boomer Year for Sheep*, Beef, March 2001

http://www.maf.govt.nz/MAFnet/publications/overview : The New Zealand Dairy Industry, The New Zealand Deer Industry, Wool Production in New Zealand, Sheep and Beef Cattle Farming, NZ Agriculture & Forestry: The Future

Jamieson. B., National Business Review, *Government Subsidies Rotten for Meat*, March 2001

Lashof DA., Tirpak, DA., *Policy options for Stabilising global climate*, 1990

Leng, R.A., Australian Journal of Agricultural Research 44, *Quantitative Ruminant Nutrition - A Green Science*, 1993, pp 363-80

MAF, *Climate Change: More then just carbon dioxide*, March 1998

MAF, *Global Dairy Company - Questions and Answers*, April 2001

MAF, *Greenhouse Gas Emission Policies: Impact on Agriculture*

McKinsey & Company, *Report to New Zealand Woolgrowers on Improving Profitability*, June 2000

Meat New Zealand, *Annual Report 2000*

Ministry of Justice, *Directory of Official Information*, 1999-2001

National Science Strategy Committee for Climate Change, RSNZ, *Current status of Non-CO_2 greenhouse gas emissions from agriculture: potential for mitigation*, Dec 1996

New Zealand Dairy Board, *Annual Report 2000 - This is winning world-wide*

New Zealand Dairy Group of Companies, Annual Report 2000

New Zealand Game Industry Board, *Annual Report 1999/2000*

New Zealand Wool Board, *Annual Report 1999/2000*

NZPA, *BOP Fertiliser Revenue up to record $309.9M in May Year*, Oct 2000

NZPA, *BOP Fertilisers says it will hold price rises until February*, Nov 2000

NZPA, *Dairy Board Blames MAF Devolution for Gaps in Technology Transfer*, Nov 2000

NZPA, *Fertiliser Industry in Healthy State*, Oct 2000

NZPA, *Future Farming Technologies will be Precise*, Feb 2001

NZPA, *Kiwi Scientists Look to French for Flatulence Free Sheep Diet*, Oct 2000

NZPA, *Meat Board Urges Unity, Public Support for Industry "Vision"*, Feb 2001

NZPA, *Ravensdown Adds Big Rebate to Price Reductions For Shareholders*, August 2000

PA Consulting Group, *New Zealand Wool Board - performance and efficiency audit 2000*, October 2000

PA Consulting Group, *The Australasian Dairy Report*, March 2000

Parkin, M, *Economics*, 2nd ed., 1994

Peart, Mark, *BOP Holds off Competition to Maintain Market Share*, Oct 2000

Peart, Mark, *Ravensdown Passes $300 Million in Sales*, August 2000

Rhodes, David, MAF, *Trends in methane emissions from ruminants in NZ, including the influence of forestry*, 1992

Richmond New Zealand, *Annual Report 2000*

Stevenson, P., *Landcorp Farming Almost Trebles Earnings*, Oct 2000

Stevenson, P., *Super Board for Meat and Wool Gains Ground*, November 2000

The Daily News, *No Merger Soon*, April 2001

The Dominion, *Wrightson Sees Benefits in Genetic Modification*, Nov 2000

Wallis Anna, The Evening Standard, *Getting to The Bottom of Our Belching Sheep*, Oct 2000

West Australian, *DNA Work to Reduce Methane Emissions*, March 2001

Ministry for the Environment, *National Inventory Report: New Zealand Greenhouse Gas Inventory 1990-1999*, Wellington New Zealand, 2001

Ministry of Economic Development, *Managing Greenhouse Gas Emissions: The Agriculture Sector*, http://www.med.govt.nz/ers/environment/climate/emissions/agriculture/overview.html, 2001

New Zealand Wool Board, *New Zealand Sheep Numbers and Wool Production,* http://www.woolgroup.co.nz/market_info/historical_info.html, 2001

Ministry of Agriculture and Fisheries, *Situation and Outlook for New Zealand Agriculture and Forestry 2000,* http://www.maf.govt.nz/MAFnet/publications/SONZA/sonzaf00/s00_01.htm, 2000

Ravensdown Fertiliser, *Annual Report 2000,* http://www.ravensdown.co.nz/AnnualReport2000/index.cfm?page=9 2000

New Zealand Wool Board, *Wool - A Global View*,

http://www.woolboard.co.nz/our_wool/global_view.html, 2000

Meat and Livestock Australia, *Australia's Sheepmeat Industry*, Sydney, Australia, 2000

Canfax Research, *Statistical Briefer*, Calgary, Alberta, Canada, May 2001-06-22

A.7 FORESTRY

Brown, Christopher, *The Global Outlook for Future Wood Supply from Forest Plantations Working Paper,* Food and Agriculture Division of the United Nations, 2000.

BT Chapman Chair Forest Industries Council Environmental Task Group, *Accounting for Harvested Wood Products Under the Kyoto Protocol,* February 2001

Ford-Robertson, Justin, *Carbon Stocks and Flows in the Forest Industry,* Presented at the International Technical Workshop on Harvested Wood Products, February 2001

Forestry Insights http://www.insights.nzforestry.co.nz

Griffiths, James, *Development of New Zealand's Plantation Based Forestry Industry,* Presented at Asia Pacific Plantation Forestry Conference, 1997

Hopman, Roef, *Pine Magazine (December/January),* Carbon Credits Threaten Forestry

Ministry of Agriculture and Forestry http://www.maf.govt.nz

Neilson, Dennis, *Importance of Global Forest Trade,* Presented at the International Technical Workshop on Harvested Wood Products, February 2001

Neilson, Tony, *Pine Magazine (January/December),* One Man's Crusade

Neilson, Tony, *Pine Magazine (February/March)*, Wanted: A Profit in our Own Land

New Zealand Forest Industries Council http://www.nzfic.nzforestry.co.nz

New Zealand Forest Owners Association http://www.nzfoa.nzforestry.co.nz

New Zealand Institute of Forestry http://www.fore.canterbury.ac.nz

Statistics New Zealand http://www.stats.govt.nz

United Nations - Food and Agriculture Organisation http://www.fao.org

APPENDIX B: EMISSIONS DATA

B.1 GLOBAL WARMING POTENTIAL OF SELECTED GREENHOUSE GASES

This appendix contains a series of datasets relating to New Zealand's emissions of greenhouse gases.

Greenhouse Gas	Global warming potential (CO_2 equivalent per tonne emitted)
CH_4	21
N_2O	310
HFC125	2800
HFC134	1300
HFC143	3800
PFC(CF_4)	6500
PFC(C_2F_6)	9200
SF_6	23900

TABLE 33: GLOBAL WARMING POTENTIAL

Table reproduced from http://www.med.govt.nz/ers/environment/climate/emissions/industrial/industrial02.html, Ministry of Economic Development, Wellington New Zealand, 2001

B.2 GREENHOUSE GAS EMISSIONS SUMMARY – 1999

GREENHOUSE GAS SOURCE AND SINK	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
CATEGORIES	CO_2 equivalent (Gg)						
Total (Net Emissions)	**8,407.03**	**33,596.20**	**12,392.09**	**209.86**	**74.47**	**33.32**	**54,712.96**
1. Energy	**27,656.38**	**1,138.54**	**241.33**				**29,036.26**
A. Fuel Combustion (Sectoral Approach)	26,984.14	223.19	241.33				27,448.67
1. Energy Industries	6,629.28	5.55	14.64				6,649.46
2. Manufacturing Industries and Construction	5,825.66	10.71	39.90				5,876.27
3. Transport	11,729.46	149.89	155.65				12,035.00
4. Other Sectors	2,799.74	57.05	31.15				2,887.94
5. Other	0.00	0.00	0.00				0.00
B. Fugitive Emissions from Fuels	672.24	915.35	0.00				1,587.59
1. Solid Fuels	0.00	543.10	0.00				543.10
2. Oil and Natural Gas	672.24	372.25	0.00				1,044.49
2. Industrial Processes	**2,869.04**	**2.31**	**0.00**	**209.86**	**74.47**	**33.32**	**3,188.99**
A. Mineral Products	634.90	0.00	0.00				634.90
B. Chemical Industry	191.33	2.31	0.00	0.00	0.00	0.00	193.64
C. Metal Production	2,042.81	0.00	0.00		74.47	2.87	2,120.15
D. Other Production	0.00						0.00
E. Production of Halocarbons and SF_6				0.00	0.00	0.00	0.00
F. Consumption of Halocarbons and SF_6				209.86	0.00	30.45	240.31
G. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Solvent and Other Product Use	**NE**		**0.00**				**0.00**
4. Agriculture	**0.00**	**29,727.18**	**11,989.87**				**41,717.05**
A. Enteric Fermentation		29,369.55					29,369.55
B. Manure Management		355.53	130.20				485.73
C. Rice Cultivation		0.00					0.00
D. Agricultural Soils		0.00	11,859.67				11,859.67
E. Prescribed Burning of Savannas		0.00	0.00				0.00
F. Field Burning of Agricultural Residues		2.10	0.00				2.10
G. Other		0.00	0.00				0.00
5. Land-Use Change and Forestry	**-22,118.39**	**119.18**	**12.09**				**-21,987.13**
6. Waste	**0.00**	**2,608.99**	**148.80**				**2,757.79**
A. Solid Waste Disposal on Land	NE	2,466.06					2,466.06
B. Wastewater Handling		142.93	148.80				291.73
C. Waste Incineration	NE	0.00	0.00				0.00
D. Other	0.00	0.00	0.00				0.00
7. Other *(please specify)*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
							0.00
CO_2 Emissions from Biomass	**3,248.30**						**3,248.30**

TABLE 34 GREENHOUSE GAS SOURCES AND SINKS (1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	**CO_2 equivalent (Gg)**					
A. Changes in Forest and Other Woody Biomass Stocks	0.00	-23,245.00	-23,245.00			-23,245.00
B. Forest and Grassland Conversion	1,126.61		1,126.61	119.18	12.09	1,257.88
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	0.00	0.00	0.00			0.00
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	1,126.61	-23,245.00	-22,118.39	119.18	12.09	-21,987.13
Total CO_2 Equivalent Emissions without Land-Use Change and Forestry						76,700.09
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry						54,712.96

Source: *National Inventory Report, New Zealand Greenhouse Gas Inventory 1990-1999*, Ministry for the Environment, Wellington New Zealand 2001

TABLE 35 GREENHOUSE GAS SOURCES AND SINKS (2)

B.3 GREENHOUSE GAS TRENDS

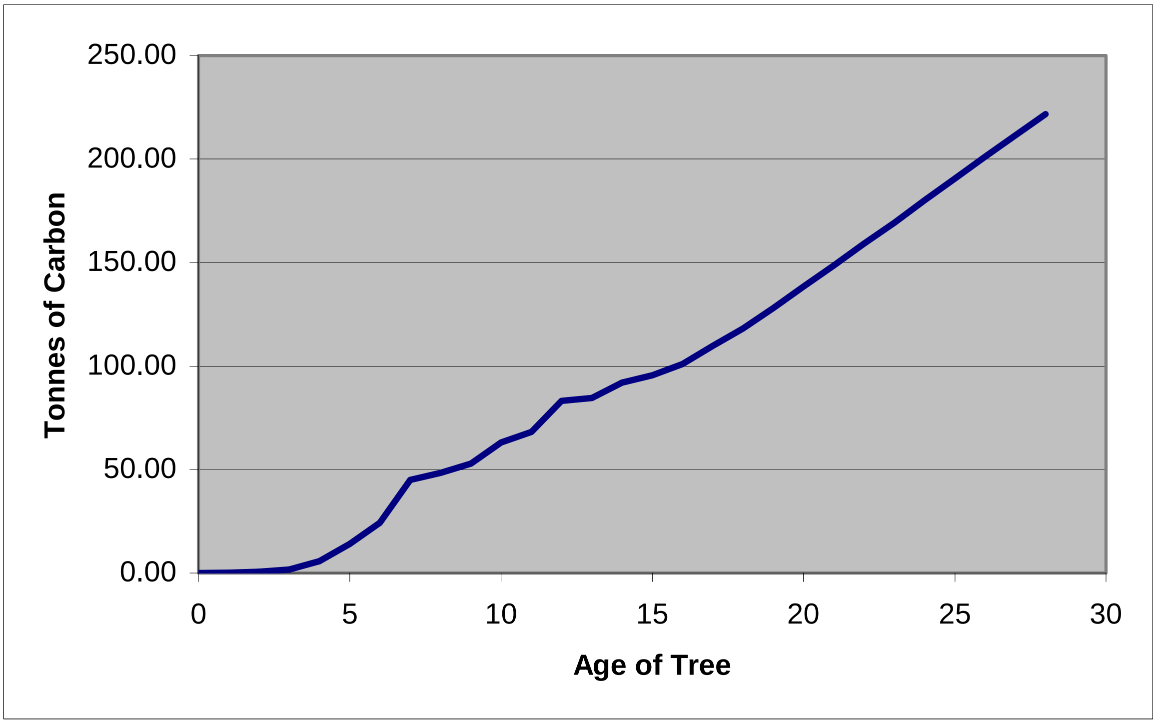
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 equivalent (Gg)									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. Energy	23,989.11	24,310.38	26,054.04	25,312.80	25,549.78	25,628.90	26,877.39	28,795.17	27,408.24	29,036.80
2. Industrial Processes	2,994.27	3,166.07	3,294.77	3,019.98	2,974.22	3,049.52	3,158.04	3,013.72	3,154.55	3,186.61
3. Solvent and Other Product Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4. Agriculture	42,850.89	42,012.01	41,528.17	41,629.37	41,895.85	41,903.37	41,546.86	41,320.87	41,520.54	41,719.61
5. Land-Use Change and Forestry	-21,539.94	-20,390.15	-18,315.12	-16,344.92	-15,688.26	-16,164.86	-16,459.12	-18,040.34	-20,816.95	-21,987.12
6. Waste	3,132.26	3,158.93	3,025.32	3,073.41	3,084.49	3,033.88	3,040.97	2,847.56	2,784.56	2,756.79
7. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**51,426.59**	**52,257.24**	**55,587.18**	**56,690.63**	**57,816.07**	**57,450.81**	**58,164.15**	**57,936.98**	**54,050.94**	**54,712.68**

Source: *National Inventory Report, New Zealand Greenhouse Gas Inventory 1990-1999*, Ministry for the Environment, Wellington New Zealand 2001

TABLE 36 TRENDS IN GREENHOUSE GAS EMISSIONS

APPENDIX C: FORESTRY

C.1 FORESTRY SECTOR CREDIT CARBON IN A STAND OF RADIATA OVER A 28 YEAR ROTATION



Source: Based on data supplied by The Ministry of Agriculture and Forestry

C.2 MODEL OF CARBON AND CREDIT VALUES

Year Planted	Age at 2008	Planted Area (ha)	Tonnes of carbon sequestered (per ha)	Incremental amount of carbon (tonnes) sequestered	CO_2 Equivalent[77] (Per ha)	Total CO_2 Sequestered tonnes (000)	Credit Value $(000) At $10 per tonne	At $20 per tonne	At $30 per tonne
1990	18	21000	118.2	8.5	31.3	657	6575	13150	19725
1991	17	15000	109.7	8.7	32.0	480	4805	9610	14415
1992	16	50200	101.0	5.5	20.3	1018	10184	20369	30553
1993	15	61600	95.4	3.4	12.6	777	7768	15536	23303
1994	14	98200	92.0	7.4	27.1	2658	26584	53168	79751
1995	13	73900	84.6	1.3	4.8	357	3574	7148	10722
1996	12	83600	83.3	15.0	55.0	4602	46019	92037	138056

[77] Conversion factor of 3.667 used to derive CO_2 levels from carbon stored in trees (Source: PA Analysis).

Year Planted	Age at 2008	Planted Area (ha)	Tonnes of carbon sequestered (per ha)	Incremental amount of carbon (tonnes) sequestered	CO_2 Equivalent[77] (Per ha)	Total CO_2 Sequestered tonnes (000)	Credit Value $(000) At $10 per tonne	At $20 per tonne	At $30 per tonne
1997	11	63700	68.3	5.3	19.5	1245	12448	24896	37344
1998	10	51200	63.0	10.0	36.7	1881	18815	37629	56444
1999	9	22900	52.9	4.4	16.3	373	3728	7456	11184
2000	8	40000	48.5	3.5	12.8	511	5108	10215	15323
2001	7	40000	45.0	20.8	76.4	3057	30574	61148	91722
2002	6	40000	24.2	10.1	37.0	1481	14815	29629	44444
2003	5	40000	14.1	8.39	30.8	1231	12311	24622	36933
2004	4	40000	5.7	3.86	14.1	565	5655	11309	16964
2005	3	40000	1.8	1.29	4.7	189	1886	3773	5659
2006	2	40000	0.5	0.33	1.2	49	486	971	1457
2007	1	40000	0.2	0.20	0.7	29	293	587	880
2008	0	40000	0.0	0.0	0.0	0	0	0	0
		901300				**21163**	**211626**	**423252**	**634878**

TABLE 37 : CARBON AND CREDIT VALUES OF A RADIATA FOREST.

The model is based on the age of the forest in the year 2008 (given by the second column of the table). Hence, the age of a forest planted in 1996 is 12 years.

The third column gives the area of forest planted in the year given by column one, while the fourth column gives us the amount of carbon sequestered (in tonnes per hectare) for a forest of a given age. Thus, a forest which is 18 years old sequesters 118.2 tonnes of carbon per hectare, while a 17 year old forest sequesters 109.7 tonnes of carbon per hectare. The amount of carbon sequestered between the ages of 17 and 18 is merely the difference, and is given by the fifth column of the table (ie the incremental amount of carbon sequestered). The $C0_2$ equivalent of the carbon sequestered (tonnes per hectare) is given by column 6 of the table and column 7 indicates the total amount of $C0_2$ sequestered in the forest.

The total amount of $C0_2$ sequestered in 2008 (given the “planting structure” as defined in the table) is 21,163 tonnes (ie the total of column 7). The last three columns of the table yield the value of carbon credits for three different pricing regimes ($10, $20 and $30 per tonne of $C0_2$ sequestered).

APPENDIX D: COAL, GAS AND GEOTHERMAL DATA

D.1 NEW ZEALAND GAS FIELDS, OWNERS , PRODUCTION AND RESERVES

Field	Ownership	Net Production (September 99 year)	Remaining Reserves (July 2000)
Maui	Shell 77.5% Todd Energy 12.5% Shell to divest 10%	171.47PJ 80.2%	1373PJ
Kapuni	Shell 50% Todd Energy 50%	22.02PJ 10.3%	346PJ
McKee	Shell to divest 100%	9.19PJ 4.3%	61PJ
TAWN/Piakau	Bligh Oil 3.24% Shell to divest 96.76%	8.55PJ 4.0%	103PJ
Ngatoro	NZ Oil and Gas 35.43% Ngatoro Energy 5% Shell to divest 59.57%	1.28PJ 0.6%	8PJ[78]
Kaimiro	Shell to divest 100%	1.07PJ 0.5%	9PJ
Kupe	NZOG 16.5% Genesis Power 40% Shoseki Oil Development Co of Taranaki 10% Minister of Energy 11% Shell to divest 22.5%		236PJ
Mangahewa	Shell to divest 100%		112
Pohokura	Shell 48% Preussag Energie 33.3 Todd Energy 15% Shell to divest 3.66%		1050

TABLE 38: NEW ZEALAND GAS FIELDS, OWNERS, PRODUCTION AND RESERVES[79]

[78] Ngatoro is primarily an oil field, and any gas production is incidental to the extraction of oil and condensate.

D.2 GAS PIPELINE OWNERS AND OPERATORS

The high-pressure gas transmission system is owned and operated by the Natural Gas Corporation of New Zealand (NGC). NGC also operates the Maui pipeline, which is a dedicated pipeline carrying Maui gas - and only Maui gas - from Taranaki to Rotowaro, near Huntly, and to the Huntly power station. The high-pressure pipeline runs from Taranaki north to Kauri, above Whangarei, south to Tawa, north of Wellington, and east to Gisborne and Hastings. NGC also owns some local low-pressure distribution systems (Northland, Auckland, Waikato, Bay of Plenty, Taranaki and Kapiti), and operates the Hutt Valley low-pressure distribution system owned by AGL (the parent company of NGC). The remaining low-pressure distribution systems are owned by Wanganui Gas (Wanganui), United Networks (Auckland, Hawkes Bay, Wellington, Horowhenua and the Manawatu), PowerCo (Taranaki) and NovaGas (Wellington, Porirua, the Hutt Valley, Hastings, Hawera, Papakura and Manakau City).

D.3 GENERATORS AND GENERATION ASSETS - 1999

Power Station	Owner	Capacity (MW)	Type of Station
Otahuhu A	Contact	85	Gas
Otahuhu B	Contact	390	Gas
Ohaaki	Contact	104	Geothermal
Wairakei	Contact	153	Geothermal
Whirinaki	Contact	162	Diesel
New Plymouth	Contact	580	Gas
Stratford	Contact	198	Gas
Huntly	Genesis	1000	Coal/Gas
Te Awamutu	Genesis	52	Co-Generation
Kinleith	Genesis	40	Co-Generation
Waikaremoana	Genesis	135	Hydro
Tokaanu	Genesis	240	Hydro
Rangipo	Genesis	120	Hydro
Haunui	Genesis	7	Wind
Southdown	OnEnergy	120	Co-Generation
Taranaki Combined Cycle	OnEnergy	354	Gas
Kaimai	TrustPower	42	Hydro
Matahina	TrustPower	72	Hydro

[79] Sources: Energy Data File, www.crownminerals.govt.nz

Power Station	Owner	Capacity (MW)	Type of Station
Wheao	TrustPower	26	Hydro
Patea	TrustPower	30.7	Hydro
Tararua	TrustPower	31.7	Wind
Greenmount / Rosedale	Mighty River Power	8.2	Landfill Gas
Karapiro	Mighty River Power	96	Hydro
Arapuni	Mighty River Power	172	Hydro
Waipapa	Mighty River Power	59	Hydro
Maraetai A	Mighty River Power	180	Hydro
Maraetai B	Mighty River Power	180	Hydro
Whakamaru	Mighty River Power	100	Hydro
Atiamuri	Mighty River Power	84	Hydro
Ohakuri	Mighty River Power	112	Hydro
Aratiatia	Mighty River Power	84	Hydro
Ngawha	Independent	8	Geothermal
BHP NZ Steel	Independent	70	Co-Generation
Rotokawa	Independent	24	Geothermal
Waiere & Mokauiti	Independent	6.2	Hydro
Kuratau & Piriaka	Independent	7.2	Hydro
Bay Milk	Todd Energy / Pacific Hydro	10	Co-Generation
TO1 & TG2	Todd Energy / Pacific Hydro	6.4	Geothermal
Aniwhenua	Todd Energy / Pacific Hydro	25	Geothermal
McLachlan	Mercury Energy / McLachlan	55	Geothermal
Kapuni	NGC / Todd Energy / Pacific Hydro	25	Co-Generation
Kiwi Co-op	Kiwi Co-op / Todd Energy	65	Co-Generation
Mangahao	Todd Energy / King Country Energy	25	Hydro
Clyde	Contact	432	Hydro
Roxburgh	Contact	320	Hydro
Tekapo A	Meridian	25	Hydro
Tekapo B	Meridian	160	Hydro
Ohau A	Meridian	264	Hydro
Ohau B	Meridian	212	Hydro

Power Station	Owner	Capacity (MW)	Type of Station
Ohau C	Meridian	212	Hydro
Benmore	Meridian	540	Hydro
Aviemore	Meridian	220	Hydro
Waitaki	Meridian	105	Hydro
Manapouri	Meridian	585	Hydro
Cobb	OnEnergy	32	Hydro
Branch River & Waihopai	TrustPower	13	Hydro
Coleridge	TrustPower	35	Hydro
Highbank	TrustPower	25	Hydro
West Coast (multi)	TrustPower	19.5	Hydro
Paerau	TrustPower	12.25	Hydro
Waipori	TrustPower	84	Hydro
Monowai	TrustPower	6.8	Hydro
Opuha	Independent	7	Hydro
Central Otago	Independent	19	Hydro

TABLE 39: MAJOR COMPANIES AND THEIR GENERATION ASSETS[80]

D.4 RETAIL COMPANIES AND CUSTOMERS - 1999

Retail Company	Number of Customers	Share of Market
OnEnergy (TransAlta and NGC)	586,000	35%
Contact	355,000	21%
Mighty River Power	271,000	16%
TrustPower	208,500	12%
Genesis Power	158,000	9%
Meridian Energy	68,000	4%
Other	51,000	3%

TABLE 40: RETAIL COMPANIES AND CUSTOMERS - 1999[81]

[80] Source: http://www.m-co.co.nz/PowerstationsN.htm, http://www.m-co.co.nz/PowerstationsS.htm

[81] *Source:* http://www.m-co.co.nz/C1changes.htm

D.5 GAS DISTRIBUTION NETWORK OWNERS

Owner - Operator	Distribution Networks
NGC	Northland, Auckland, Waikato, Bay of Plenty, Taranaki, Kapiti
AGL (parent of NGC)	Hutt Valley (operated by NGC)
Wanganui Gas	Wanganui
UnitedNetworks	Auckland, Hawkes Bay, Wellington, Horowhenua, Manawatu
PowerCo	Taranaki
NovaGas	Wellington, Porirua, Hutt Valley, Hastings, Hawera, Papakura, Manukau City

TABLE 41: GAS DISTRIBUTION NETWORK OWNERS[82]

[82] Source: http://www.unitednetworks.co.nz/display.asp?PageID=89, http://www.novagas.co.nz/more1.htm, http://www.powerco.co.nz/about/profile.htm, http://www.agl.com.au/about/international.asp, http://www.natgas.co.nz/mainframe_pipeline.html