Lignite and climate change:
The high cost of low grade coal

November 2010

Parliamentary Commissioner
for the Environment
Te Kaitiaki Taiao a Te Whare Pāremata

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Photography

Cover: Lignite deposit in Southland. Parliamentary Commissioner for the Environment archives.

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Appendix is available at www.pce.parliament.nz

Commissioner's overview

Thirty-two years ago, my interest in the oil price shocks of the 1970s took me to the University of California at Berkeley to study energy. That same year the Liquid Fuels Trust Board was established in New Zealand. The Board clearly saw lignite as the country's future source of transport fuel. However, because lignite is poor quality coal, extracting energy from it creates particularly high emissions of carbon dioxide. My concern about this is not new. Twenty years ago I co-authored a report called *Transport fuels in New Zealand after Maui – lignite on the back burner*.

It now looks as if lignite is making its way to the front burner. Two companies, state-owned enterprise Solid Energy and the L&M Group, are proposing to mine lignite in Otago and Southland and convert it to diesel. In addition, Solid Energy is proposing to make two more products from lignite: the nitrogen fertiliser urea, and briquettes (made by drying out lignite into a better form of coal) primarily for export. Using lignite for generating electricity is another possibility.

The foundation of this report is a set of carbon footprint calculations for these four uses of lignite – diesel, urea, briquettes, and electricity. These calculations are presented in as open and transparent a manner as possible. I ask those who may question these calculations to be equally transparent.

The standard technology for turning lignite into diesel is well-established. The Fischer-Tropsch process was developed in the 1920s and has been used in South Africa for many years to make diesel from coal. In greenhouse gas terms, such diesel is almost twice as bad as the diesel we use now.

It may be that this can be mitigated by carbon capture and storage, that is, trapping the carbon dioxide emitted from an industrial process and storing it underground. But carbon capture and storage is very much a technology under development.

On the other hand, no technological development is required to use trees for sequestering carbon. But a forest stops removing carbon dioxide from the atmosphere when it is mature, so over a long period of time a continually expanding permanent forest would be required.

At the Copenhagen Conference in 2009, New Zealand took responsibility for reducing our annual greenhouse gas emissions to between 10% and 20% *below* the 1990 level by 2020. Even with the current Emissions Trading Scheme (ETS) and other measures in place, our greenhouse gas emissions are on track to be 30% *above* the 1990 level by 2020.

This is a huge gap. Certainly, because our commitment is to a 'responsibility target', we can purchase carbon credits offshore. However relying only on this for closing the gap would be at odds with the clean green image that we use to differentiate ourselves in the international marketplace. Indeed for some of our trading partners, lignite is best known as the brown coal that powered East Germany with dire results for their environment.

The production of diesel from lignite on the scale contemplated would increase New Zealand's greenhouse gas emissions significantly. Just one of the two proposed lignite-to-diesel plants would increase the gap between the international climate change commitment we have made and where our greenhouse gas emissions are headed by 20%. If both proposed lignite-to-diesel plants were to be built, the gap would increase by 50%. The production of urea and briquettes from lignite would have a much smaller impact, but still do nothing to close the gap.

For good reasons the Resource Management Act does not give regional councils the ability to regulate greenhouse gas emissions. This means that the ETS is the only significant mechanism currently available for curbing the growth in the country's greenhouse gas emissions.

In its current form the ETS exposes the Government – and therefore the taxpayer – to potentially enormous financial risk. This is because of the rules governing the allocation of free carbon credits. For 'free carbon credits', read 'taxpayer subsidy'. New lignite developments may well qualify for significant subsidies under the scheme. The subsidy for one lignite-to-diesel plant would be likely to be billions of dollars over its lifetime. It makes no sense for taxpayers to subsidise *new* investment in carbon-intensive technology. This is the opposite of what the ETS is intended to achieve. The review of the scheme in 2011 provides an opportunity to address this and other serious shortcomings.

Lower prices, security of supply, and employment opportunities are all being spoken of as benefits of lignite developments. But diesel, urea, and briquettes are all traded internationally and so would be sold at world prices. As for supply security, it is many years since national self-sufficiency has been Government policy. If employment is to be subsidised indefinitely, there is no case for favouring carbon-intensive jobs in a region with relatively low unemployment.

If the ETS were to be revised so that new carbon-intensive industries were not eligible for any free carbon credits, some may still be commercially viable. A business case may well be made for converting lignite to diesel. The South Island lignite is generally more accessible than other coal in New Zealand, so while it is a poor resource it is a cheap resource.

However, there are wider matters to consider. For instance, the risk of such a long-term investment of billions of dollars must be very great, given the difficulty of predicting both oil prices and carbon prices. This is a risk that should not be underwritten in any way by the Government.

The value of our clean green image in the international marketplace can never be accurately measured. But the marketing strategies of the two biggest sectors of our economy – tourism and dairying – rest on it, along with those of many small innovative companies. If New Zealand can be said to have a brand, 'clean green' is it. Using lignite on a large scale is not consistent with that brand.

For all of these reasons, New Zealand's lignite should remain in the ground, at least until subsidies for its large scale exploitation are ruled out and mitigation options are proven sufficient and reliable. But even if these requirements were met, increasing the amount of lignite mined in this country by a hundredfold or more would not be the right thing to do because it would take the country in the wrong direction.

We face a carbon-constrained future and one way or another we will be paying the price for our greenhouse gas emissions. A decision to lock us into low grade coal would make that a very high price indeed.

Dr Jan Wright
Parliamentary Commissioner for the Environment

1 Introduction

Climate change is not a problem that can afford to wait ... It is a threat to future development, peace and prosperity that must be tackled with the greatest sense of urgency by the entire community of nations.[1]

Lignite, or brown coal, is a low grade form of coal containing relatively high moisture and low energy. Consequently, using lignite causes high emissions of carbon dioxide, the principal greenhouse gas. Products made from lignite have large carbon footprints.

There are very large lignite deposits in the south of New Zealand. Most lie under farm land. Mining these deposits would not be especially environmentally destructive, so the primary environmental challenge associated with large-scale lignite development is dealing with the greenhouse gas emissions.

A relatively small amount of lignite is already mined and used as a fuel to provide process heat for some industries in Southland. But current proposals for lignite developments are on a different scale entirely, with annual lignite use potentially increasing a hundredfold or more.

Four different uses of lignite are under consideration. The first is to use lignite to make transport fuel, specifically diesel. The second is to use lignite to make urea. The third is to produce briquettes for heating. The fourth is to use lignite for thermal generation of electricity.

New Zealand's greenhouse gas emissions are of course only a very small proportion of global emissions. But New Zealand has joined the international effort to reduce the risks of climate change.

Currently as a signatory to the Kyoto Protocol, New Zealand has undertaken to reduce its annual greenhouse gas emissions to 1990 levels by the end of 2012. Looking further ahead, New Zealand has promised to take responsibility for reducing annual emissions even lower by 2020. However, even without large-scale lignite developments, our greenhouse gas emissions are projected to keep growing until 2019. There is a huge gap between our commitment and where we are headed.

The Emissions Trading Scheme (ETS) is the only significant mechanism currently available for closing this gap. It is a highly complex policy instrument that is poorly understood by the public. The analysis of lignite in this report illustrates a major shortcoming of the ETS. This is, that under the current rules, new carbon-intensive industries are likely to receive considerable subsidises indefinitely.

This report analyses the impact on New Zealand of using lignite. The backbone of the report is the determination of the emissions intensities of various lignite products and the absolute impact on New Zealand greenhouse gas emissions inventory of making these products. The numbers, references, and assumptions inherent in the calculations of these numbers are described in detail in the Appendix to this report "Lignite and climate change: emission factor estimates". This appendix is available at www.pce.parliament.nz. The independent report by Covec consultants, called "Carbon Price Forecasts", can also be found at this website.

1.1 Purpose of the report

The Parliamentary Commissioner for the Environment is an independent Officer of Parliament, with functions and powers granted through the Environment Act 1986. Her role allows a unique opportunity to provide Members of Parliament with independent advice in their consideration of matters that may impact on the quality of the environment.

The origin of this report lies in a long-term interest of the Commissioner in the carbon intensity of lignite use, dating back over many years. Plans to develop lignite and the associated carbon footprint have led to the undertaking of this investigation.

This report has been produced pursuant to subsections 16(1)(a) to (c) of the Environment Act 1986.

1.2 Structure of the report

The remainder of the report is structured as follows:

Chapter 2 describes what lignite is, where it is located and what the proposals are for its development.

Chapter 3 discusses the domestic and international climate change policy context within which the lignite developments would occur. This includes New Zealand's international obligations to reduce emissions as well as projected emissions. New Zealand's primary tool to reduce domestic emissions, the ETS, is also discussed.

Chapter 4 investigates options to mitigate the emissions of greenhouse gases caused by using lignite. These include collecting carbon dioxide as it is made and storing it underground; planting new forests to remove carbon dioxide from the atmosphere; and using wood to replace some of the lignite that is used.

Chapter 5 describes the making of diesel from lignite, including the quantity of greenhouse gases emitted and who pays the costs of those emissions.

Chapter 6 describes making urea from lignite, including the quantity of greenhouse gases emitted and who pays the costs of those emissions.

Chapter 7 describes the other uses of lignite (briquettes and as a source of electricity) including the quantity of greenhouse gases emitted and who pays the costs of those emissions.

Chapter 8 compares the different uses of lignite for each product, and the impacts of each use on New Zealand's national greenhouse gas emissions inventory.

Chapter 9 contains the conclusions and recommendations from the Commissioner.

1.3 What this report does not cover

This report focuses on the nationally important issue of greenhouse gas emissions associated with lignite use. A number of issues have been treated as outside the main scope of the report. These include:

- environmental issues that are not directly related to greenhouse gas emissions, such as the potential adverse impacts of lignite developments on water resources or landscapes
- social issues resulting from the development of a new large-scale industry in Southland
- greenhouse gases emitted as a result of applying urea
- greenhouse gas emissions associated with the building of infrastructure.

Source: Martin Röll

Figure 1.1: Bucket-wheel excavator used to mine lignite in Germany

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Lignite as a resource

This chapter first describes New Zealand's lignite resources, followed by proposals for its use.

New Zealand has very large and well-characterised coal deposits. These include vast quantities of lignite in the southern South Island.[2] Plans to use this lignite are well underway. Some of these lignite proposals are very large scale, envisaging the use of tens of millions of tonnes of lignite annually.

2.1 Lignite: What, where, how much and current uses

Lignite is a very poor quality coal. It has been formed from peat deposits buried for millions of years, subjected to great pressure and heat from the earth. The peat was itself formed from decayed plant material, and some lignite still contains the fossil forms of ancient plants.

Southland and Otago lignite contains less energy, less carbon, and more water than other New Zealand coals (Table 2.1). Consequently it is a comparatively poor fuel, and relatively inefficient to transport from one place to another. Wood fuels have similar energy content to lignite.

Southern lignites can be cleaner to use than other coals. Because they tend to be low in sulphur, lignite mining is less likely to cause acid mine drainage issues. Southern lignite seams are generally low in methane, meaning emissions of this gas when the lignite is mined are comparatively low.

More than 6 billion tonnes of lignite deposits in Southland and Otago have been assessed as economically recoverable.[2] Together they contain as much energy as 70 Maui gas fields.[6] The largest deposits are around Gore and southwest towards Invercargill (Figure 2.1). These lignite deposits are readily accessible, close to the surface, and would be extracted from open cast mines.

Currently, some Southland and Otago lignite is being mined and burned for industrial heating, but only on a relatively modest scale at 250,000 tonnes per year. Most is being extracted from the New Vale mine on the Waimumu coal field, with a small amount from a mine near Roxburgh. Fonterra's dairy processing plant at Edendale is a major user. Lignite is also used by the Alliance meat processing group, timber companies, a hospital, wool scourers, and in the drying of lime and the production of field drainage tiles.[7]

Two companies – the state-owned enterprise Solid Energy New Zealand and the L&M Group - have significant investment in lignite, each holding rights over about a third of Southland and Otago lignite deposits. Solid Energy has exploration permits and mining licences over the Home Hills, Croydon, Mataura, and Waimumu deposits, covering just over 3,000 hectares.[8] The L&M Group has exploration permits over the Hawkdun, Benhar, Mataura, Edendale, and Ashers deposits, covering over 20,000 hectares.[8]

Table 2.1: Comparing lignite to other New Zealand fuels[3,4,5]

	Gross energy (MJ/kg)	Moisture (% mass)	Sulphur (% mass)
Bituminous coal	25-32	6-10	0.3-4.2
Sub-bituminous coal	19-25	15-31	0.2-2.0
Lignite	8-19	29-61	0.2-0.6
Wood pellets	>17	<10	<0.1
Firewood	12	38-41	<0.1

Figure 2.1: Lignite deposits in Southland and Otago

2.2 Lignite: What is being proposed

There are a number of proposals for large-scale exploitation of lignite deposits in New Zealand in the coming decade. They involve transformation of lignite to other products such as liquid fuels, urea, processed heating fuels and electricity (Figure 2.2). These processes are discussed in detail in Chapters 5, 6 and 7.

Current proposals include:

- A plant producing up to 35,000 barrels of diesel per day (which is about 2 billion litres of diesel per year) from at least 12 million tonnes of lignite per year.[9] This volume would be equivalent to two-thirds of New Zealand's current diesel use.
- Another plant producing about 50,000 barrels of diesel per day (which is about 3 billion litres of diesel per year, equivalent to New Zealand's entire diesel use), from 12–17 million tonnes of lignite per year. [10]
- Producing up to 1.2 million tonnes of urea per year by 2016, from 2 million tonnes of lignite. [11] This would be twice New Zealand's current urea use. [9]
- Producing up to 1 million tonnes of lignite briquettes per year for export by 2014.
- Previously proposed was a 500 MW lignite-fired power station,[12] possibly powering the Tiwai Point aluminium smelter.[13]

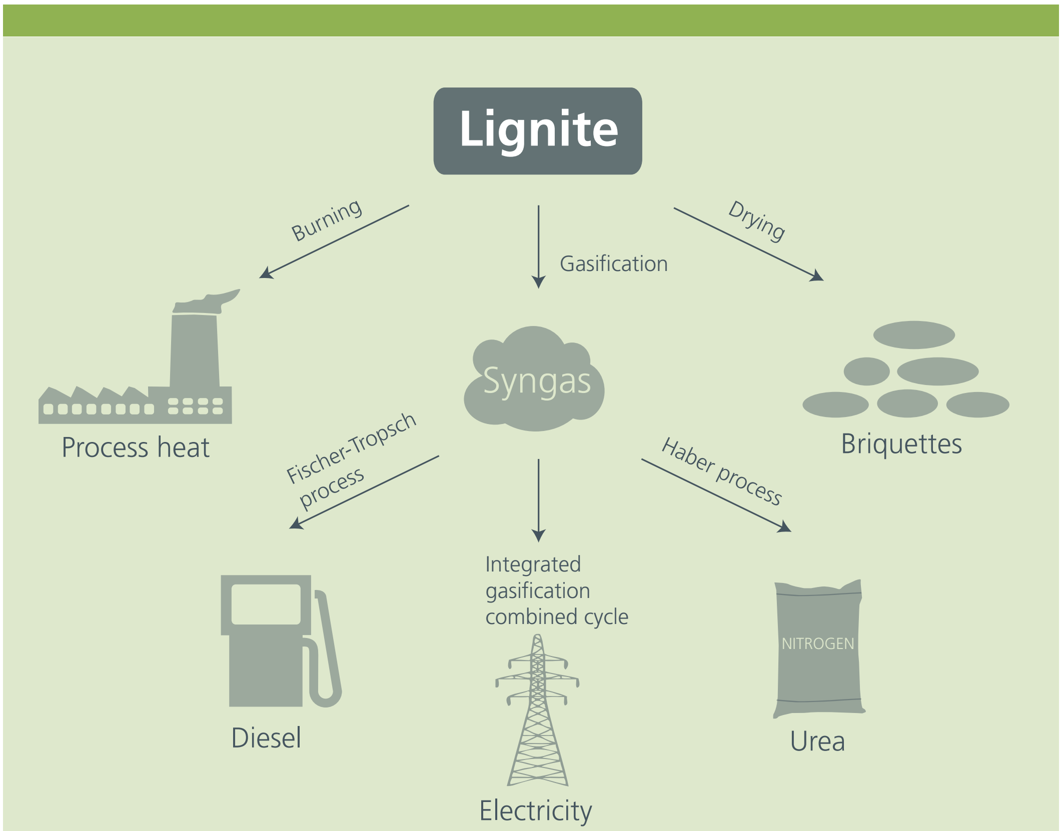

Figure 2.2: Potential uses of Southland and Otago lignite

3 New Zealand's climate change obligations

This chapter describes the substantial gap between New Zealand's international obligations and its projected emissions, which will only be widened by new carbon-intensive large-scale lignite industry. New Zealand's domestic policy to reduce greenhouse gas emissions, that is the ETS, is discussed with regard to how it is expected to impact new lignite operations.

3.1 Dealing with climate change

The Earth's climate is changing, and it is changing due to humans emitting too much greenhouse gas into the atmosphere. Without doubt this is the most significant environmental problem humans have ever faced. It is particularly challenging because climate change is a global problem that requires a near-global solution.[14]

For any country there are two separate but linked steps to mitigating climate change and its impacts (Figure 3.1):

- working with other countries and committing to reduce emissions
- enacting domestic policy that will deliver on the international commitment.

The problem with lignite is that it is a carbon-intensive energy source

New Zealand is engaged with climate change mitigation efforts on both levels.

The problem with lignite is that it is a carbon-intensive energy source. Large-scale lignite use can result in greenhouse gas emissions much greater than those when other sources of energy are used. Therefore, domestic plans for large-scale lignite operations appear to be incompatible with the promises the Government has made internationally to reduce greenhouse gas emissions.

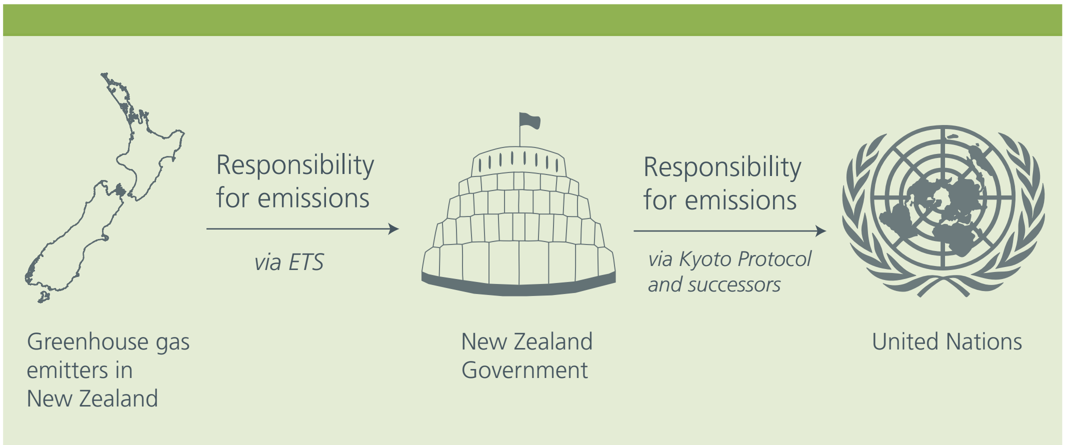

Figure 3.1: Chain of responsibility for our international climate change obligations

3.2 Our international promises versus projected emissions

Even though New Zealand is responsible for only 0.2% of global greenhouse gas emissions,[15] there are a number of reasons why we should support and encourage international efforts to reduce emissions.

- New Zealand will suffer physical and social impacts of climate change. Engaging with international efforts is the most effective route that New Zealand can take to contribute to mitigating the environmental problem of climate change.
- New Zealand is, by and large, subject to circumstances created by other countries. A favourable outcome for New Zealand is more likely if we participate actively.
- Good environmental credentials are essential for maintaining our clean green image, an image that is crucial to maintain and grow for much of our economy (Box 3.1). Making a credible emission reduction commitment is the primary route for New Zealand efforts regarding climate change mitigation to be recognised.
- Commitments under the 2010 Copenhagen Accord fall well short of what the scientists say is required to avoid dangerous climate change. Making a strong commitment encourages others and makes it more likely that aggregate commitments will be closer to the level of emission reductions that are required.

Supporting international agreements means making binding and ambitious commitments to reduce our national emissions, *and* being demonstrably able to meet these commitments.

New Zealand is currently subject to an emissions reduction commitment up to 2012 under the Kyoto Protocol (Box 3.2).[19] However, it is not known what international commitments will bind New Zealand if and when the large-scale use of lignite begins to occur.

Box 3.1: New Zealand's clean green image is important

Being ‘clean and green’ is critical to our identity and to our export industries. While its value is hard to quantify its commercial importance has been clearly signalled by politicians and business leaders alike. Current Prime Minister John Key said in 2007: *New Zealand’s clean green environment is vital to our unique kiwi lifestyle, and National is committed to preserving that lifestyle for future generations. Our environment is also vital to the clean green brand that New Zealand sells to the world.*[16]

Business leader Stephen Tindall has spoken about the commercial importance of being clean and green: *Unless we hold true to the ideals of New Zealand’s clean, green image, we could lose our reputation, which could mean hundreds of millions of dollars worth of exports and our whole standard of living could drop.*[17]

Air New Zealand CEO Rob Fyfe echoes these sentiments: *Our future as a nation lies in quality, sustainability and working with our environment to capitalise on our key competitive advantage - the land we live on.*[18]

Under the Copenhagen Accord New Zealand has made a `politically binding` commitment to reducing national net greenhouse gas emissions to between 10% and 20% lower than 1990 levels by 2020.[21, 22] In practice, the commitment is a promise to take responsibility for any net emissions over the commitment target. Taking responsibility for emissions above the target means that we will need to reduce our net current emissions by about a third, or pay other countries to reduce their emissions on our behalf (buying carbon credits offshore), or a mix of both.

The Government has published projections of national greenhouse gas emissions from now until 2020.[23] The model underlying this projection necessarily contains many assumptions, including the effect of the ETS and widespread use of nitrification inhibitors to reduce the greenhouse gas nitrous oxide, but no large-scale lignite use.

Box 3.2: The Kyoto Protocol

In 1992, the United Nations created the Framework Convention on Climate Change (UNFCCC) with the aim to “prevent dangerous anthropogenic interference with the climate system”.[20] The teeth to this treaty arrived via the 1997 Kyoto Protocol which requires emission reductions by developed countries. The Kyoto Protocol has been ratified by 187 countries, including New Zealand. New Zealand has committed that annual emissions for the five years from 2008 to 2012 will be reduced to the level of emissions in 1990, or the country will take responsibility for any excess emissions by paying for the necessary reductions in other countries. Emission reduction commitments under the Kyoto Protocol expire at the end of 2012. Negotiations for an agreement that applies beyond 2012 are currently underway.

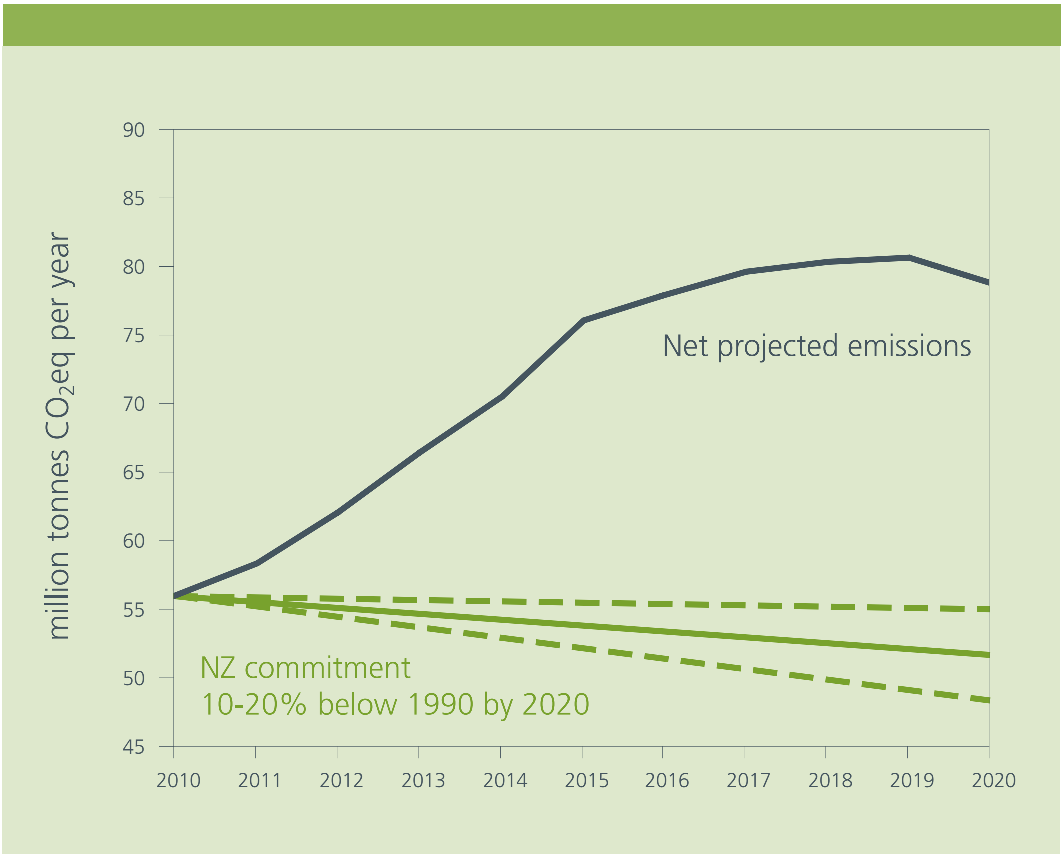

Figure 3.2: The gap between our likely international commitment to a 2020 target to reduce emissions and our current net projected path[25]

The projections indicate that even with a price on carbon, using methods to reduce agricultural emissions, and accounting for carbon removed by growing trees, New Zealand emissions will continue to rise, at least until 2019 (Figure 3.2). Net emissions are projected to grow 40% between now and 2020, taking New Zealand annual emission rate to 30% above the 1990 level.

The gap between our international commitment and New Zealand's current path is enormous – 24 to 30 million tonnes CO_2eq per year in 2020. The New Zealand Government could close this gap by buying carbon credits.

The Parliamentary Commissioner for the Environment received independent advice on likely future carbon prices. This advice provided "best guess" carbon credit price estimates for 2020, ranging from $35 to $200 per carbon credit depending on an assumed policy scenario. [24] The best guess carbon price for a world on track to stabilise greenhouse gas concentrations in the atmosphere at 550 parts per million is $50.

The cost of buying credits to meet our emissions obligations in the 2020 year alone would be about $1.2 billion to $1.5 billion at $50 per credit in that year. If the carbon price becomes $200 per credit, this cost could be up to $6 billion per year.

Greenhouse gas emissions occurring in New Zealand from new lignite exploitation will add to our net emissions and increase this gap. The impact of using lignite on New Zealand's net emissions is discussed in Chapter 8.

3.3 Domestic climate change policy

Domestic climate change policies are of two types, sometimes known as price measures and complementary measures. Price measures involve putting a price on carbon; this is shorthand for charging for the right to emit carbon dioxide into the atmosphere. Complementary measures include regulations, subsidies and education. These are designed to force or encourage reduction of carbon dioxide emissions. Most countries serious about reducing their emissions have, or are working towards, both a domestic price on carbon and a suite of measures complementary to that price on carbon.

New Zealand needs an effective domestic greenhouse gas emissions reduction policy to lower our carbon bill, to provide credibility to our international promises, and to support our clean green image.

New Zealand does have a few minor complementary measures in place to incentivise greenhouse gas emission reductions, such as subsidising the production of biodiesel. However, in the absence of new policies it is only our domestic carbon pricing system, the ETS (Box 3.3), that might impact lignite users. Introducing new domestic policies specifically to discourage major new sources of greenhouse gas emissions, such as new large-scale lignite operations, remains an option for the New Zealand Government.

Box 3.3: How does New Zealand's ETS work?

The intent of the ETS is to fairly pass on the cost of emissions that occur in New Zealand from Government to emitters. This is achieved by requiring those responsible for greenhouse gas emissions to give the Government a carbon credit for every tonne of greenhouse gas they emit. Carbon credits can be bought from the Government or private sources.

Much like our tax system, each year participants must file an emissions return detailing their annual emissions. This determines the number of carbon credits which emitters must give to the Government, called their carbon liability. Some industries (those that are trade-exposed and carbon-intensive) are given free carbon credits from the Government to help them meet their carbon liability. A company's carbon liability and the number of free credits they get are determined independently.

The Government introduced the domestic ETS in 2008, with the purpose of "assisting New Zealand to meet its international obligation [..and] reducing New Zealand's net emissions below business-as-usual levels."[26] The ETS aims to apportion the cost of our greenhouse gas emissions throughout the economy. New Zealand's ETS is unusual in that it covers all sectors and all greenhouse gases. This is to reflect New Zealand's atypical emissions profile. Unlike most other developed countries, half of our national emissions are the agricultural greenhouse gases methane and nitrous oxide. In addition, forestry in New Zealand removes significant amounts of carbon dioxide from the atmosphere. Both agriculture (from 2015) and forestry are included in New Zealand's ETS.

New lignite operations will face obligations under the ETS because they will emit greenhouse gases. This report contains estimates of potential emissions liabilities under the ETS for proposed uses of lignite. Precise values cannot be calculated. This is in part because specifications for these activities do not yet exist. While most of the ETS regulations are now in place, they may well change when periodically reviewed. Moreover, current rules have not been written in light of large-scale lignite exploitation.

Consequently, potential emissions liabilities are estimated in this report from the carbon-intensity of each lignite product (diesel, urea, and briquettes), and the proposed scale of the different operations. It is assumed that any emissions occurring in New Zealand will result in a carbon liability under the ETS, whereas emissions occurring abroad will not.

Users of lignite may be able to receive free credits from the Government; this transfers the cost of the emissions from the emitters back to the Government. Only those participating in specifically defined activities which are both trade-exposed and emissions-intensive are eligible to get free credits.[27] Some uses of lignite are currently listed as eligible activities, e.g. making urea, and so would most likely receive free credits under current law. Some uses of lignite are explicitly ineligible for free credits, e.g. generating electricity.

We need an effective domestic emissions reduction policy to lower our carbon bill and to support our clean green image

For other uses of lignite it is unclear whether they would, in future, be deemed eligible activities, e.g. making liquid fuel. Currently, emissions from conventional oil refining are exempt from the ETS because refining is subject to an alternative arrangement with the Government.[28] Some in the industry may argue that to avoid competitive distortion, process emissions from making liquid fuels from lignite should also be exempt from emissions liabilities under the ETS. It seems likely then that making liquid fuels from lignite will become an eligible activity, although there is no requirement for this to be so.

An important question for New Zealand is this: How do we decide what future activities should be eligible to receive free carbon credits?

The number of free credits an eligible activity receives[29] depends on whether it is considered moderately or highly emissions-intensive. Since most uses of lignite are likely to be very emissions-intensive, those responsible for these emissions would receive the highest rate of free carbon credits from the Government. It is possible that up to 80% (in 2020) of the emissions liability of users of lignite could be met as free credits from the Government. Large-scale use of lignite could qualify for considerable taxpayer subsidies.

An important question for New Zealand is how we decide what future activities should be eligible to receive free credits

4

Options to mitigate greenhouse gas emissions

Large-scale use of lignite would create a large new source of greenhouse gas emissions. Aside from purchasing carbon credits, there are three ways that have been proposed to reduce these emissions:[30]

- carbon capture and storage – collecting carbon dioxide as it is made and storing it underground
- storing carbon in new forests
- using wood instead of lignite.

4.1 Carbon capture and storage

Trapping carbon dioxide that is produced by an industrial process and storing it underground in order to prevent it from being emitted to the atmosphere is known as carbon capture and storage (CCS). CCS is a technology under development, with just four commercial-scale projects underway worldwide.[31]

There are two major barriers to the use of this technology in New Zealand and indeed elsewhere: the technology is expensive and risky, and a legal and regulatory framework is lacking. These barriers are described in this section.

CCS technology does have long-term potential to mitigate carbon dioxide emissions in Southland or Otago. But it would be irresponsible to make decisions now that rely on CCS becoming both practical and economic.

Technical difficulties

CCS is a three-step process: capturing and liquefying the carbon dioxide, transporting it to the storage site, and finally storing it underground.

The first two steps, capture and transport, are well understood and proven on a large scale. But they are expensive. The cost of just capturing carbon dioxide from coal-fired power plants has been estimated at $80 to $125 per tonne of carbon dioxide. The difficulty and cost of transporting liquid carbon dioxide depends on the transportation distance and terrain.[30,32]

The third step, storage, is highly problematic in New Zealand. In theory, finding a place to store carbon dioxide is simple. Fluid carbon dioxide can be pumped into certain kinds of deep, porous rock, including oil and gas reservoirs, coal seams and saline aquifers. If there is an unbroken seal of impermeable rock on top, the carbon dioxide could stay stored for millennia or more.[33]

But in practice there are many difficulties in storing carbon dioxide underground. A CCS reservoir must be secure, empty and big enough. If the reservoir seal is broken the carbon dioxide could leak out. This can happen slowly over time or abruptly.[34] Clearly, the leak-tightness of a reservoir must be understood before it can be considered a reliable place to store carbon dioxide. This is an expensive undertaking if the potential reservoir is deep underground, let alone under water.

Decisions should not rely on carbon capture storage becoming feasible

At present there is no known suitable reservoir to store carbon dioxide from a South Island lignite industry. While New Zealand has several sedimentary basins that might be appropriate for carbon dioxide storage, only the Taranaki Basin has been explored to any great extent. There may be suitable formations in Southland or offshore but none have yet been adequately characterised. One of the most promising storage prospects, the Great South Basin, may never be viable. ExxonMobil and Todd Energy recently announced that they were abandoning their current exploration licence there, because the area presented a "high technical risk... amplified by the remote location and the hostile environment."[35]

Lack of a legal and regulatory framework

Another very real challenge regarding CCS is the lack of a legal and regulatory framework. New Zealand has no laws, regulations, or even strategies that address CCS.[36] Creating rules to administer carbon capture and storage is a major challenge, requiring the resolution of a myriad of difficult issues.

First, the carbon dioxide must remain underground for many thousands of years. Who will monitor the reservoir and for how long? Who holds the liability for leakage, particularly catastrophic seal failure? If action to plug leaks is possible, who will undertake it, and who will pay?

Second, how will the government control CCS in oil and gas basins, and coal seams, which are Crown property in New Zealand? If licences are to be issued for CCS activity, what is sufficient proof that a potential reservoir is secure enough to use? Who would be eligible to receive a licence and what rights would the licence provide for? If coal seams are used for CCS, it probably will not be possible to extract the coal in the future without releasing the carbon dioxide it holds.

Creating rules to administer carbon capture and storage is a major challenge

4.2 Storing carbon in new forests

When trees grow they remove carbon dioxide from the atmosphere and store the carbon in wood. Because such removal is recognised in the ETS, foresters can earn carbon credits. For a company facing a large carbon liability, having such a relatively secure source of credits reduces risk. This is an option being considered by Solid Energy. There is potential but also limitations in planting forests for greenhouse gas mitigation in New Zealand.

Over long periods of time continual greenhouse gas mitigation requires a continually expanding permanent forest (Box 4.1). This is because a forest stops removing carbon dioxide from the atmosphere when it is mature. Consequently, growing trees for mitigation cannot go on indefinitely.

Nevertheless, growing more trees is a major opportunity to help New Zealand reduce its greenhouse gas emissions, at least for a few decades. Indeed, the forests planted in the 1990s as a result of high timber prices is a major reason why New Zealand will be close to meeting its first Kyoto Protocol commitment at the end of 2012. But planting has not continued at sufficient rates to maintain this advantage. There is considerable potential to increase forest land – at least 0.8 million hectares of privately owned marginal land could readily be covered with forest and a great deal more land might be afforested if the price of carbon credits was high enough.[37]

Box 4.1: Earning carbon credits from forestry is only a temporary fix

- Only 'new' forests can earn carbon credits, that is, forests planted after 1990.
- An area of land can only earn carbon credits as the first forest on it grows to maturity.
- When the forest is mature, no more credits can be earned. This is because at maturity the total carbon stored in the forest stops increasing. A fast growing forest could exhaust its ability to provide carbon credits after 20 years.
- If the forest is felled and not replanted, any credits earned must be repaid.[40] A 'replanted' forest will not earn any more credits as it grows, as it is replacing the carbon stored in the previous forest.

Both exotic and indigenous forests can earn carbon credits under the ETS. A radiata pine forest can typically earn between 17 and 29 carbon credits per hectare per year depending on where in New Zealand it is located. Because an indigenous forest grows much more slowly than exotic trees, the number of credits earned per year is much lower – about 8 credits per hectare per year over the same period.[38] On the other hand, a pine forest may exhaust its ability to provide credits after about 25 years, whereas an indigenous forest could earn credits for upwards of hundreds of years.

As described in Chapter 5, a plant making 35,000 barrels of diesel per day from lignite will emit an extra 5.5 million more tonnes of greenhouse gases per year than the same amount of diesel made from conventional crude oil. It would take between 190,000 hectares to 320,000 hectares of new plantation forest to offset these extra emissions.[39] To make the diesel produced from lignite effectively carbon neutral, about twice this forest area would be needed. This would increase the total amount of land in plantation forestry in New Zealand by about 20% to 30%. Again, such a forest would only supply credits for about 25 years; after this time more forest land would be required.

4.3 Using wood instead of lignite

A plant making diesel, urea, or electricity from lignite could also run on wood as well. When wood grows it takes carbon dioxide out of the air, so greenhouse gas emissions associated with its use are usually much lower than those associated with a fossil fuel like lignite. When wood is substituted for lignite, emissions can be reduced.

New Zealand's existing plantation forests are a huge source of low-quality wood suitable for fuel.[41] Wood can be at least as good as lignite, especially if pre-treated to make it easier to process and to improve energy density.[42] Renewable alternatives to wood such as grass crops or wastes have considerably less potential.[40]

The problem with wood as a fuel source is having accessible supplies. Very little of New Zealand's forestry is near where a lignite plant is likely to be built. Over the next 25 years, generally no more than 750,000 tonnes of wood per year could be supplied to an east Southland plant site, say Mataura.[43] This would replace only about 2% to 3% of the total amount of lignite used per year in a 35,000 barrels-per-day lignite-to-diesel plant, and reduce emissions by about the some proportion (see Chapter 5 and Appendix). More wood could be shipped in but this is likely to be prohibitively expensive.

4.4 Mitigation cannot be relied upon

Lignite developments must not be allowed to proceed on the assumption that mitigation will be available in future. CCS is one way of reducing greenhouse gas emissions from industrial sources. However, it is very expensive and is not a realistic option in Southland or Otago until a large and secure reservoir is proven to exist in the region. Planting large areas of plantation forests could offset lignite emissions for a time, but such forests are already needed to offset existing emissions. Similarly, lignite processing plants could be run partly on wood, but there is not enough wood in the region to reduce emissions significantly.

5 Making diesel from lignite

This chapter assesses the greenhouse gas emissions caused by making diesel from lignite compared with the greenhouse gas emissions caused by making diesel from conventional crude oil and wood.

Solid Energy and the L&M Group are proposing to build large-scale lignite-to-liquid fuel plants. While most lignite-to-liquid fuel processes can produce a range of fuels, diesel is a likely choice of product because our economy relies heavily on diesel use in trucks, trains, tractors, boats and buses. Both companies have indicated their intention to produce diesel. For this reason, this report focuses on diesel, but other liquid fuels made from lignite are likely to have similar carbon intensities.

5.1 The process for making diesel

There is more than one way to make synthetic diesel from lignite. Neither Solid Energy nor the L&M Group have announced which particular technology they will use.

The Fischer-Tropsch process is a proven large-scale lignite-to-liquid fuels technology.[44] This technology is likely to be the preferred choice for domestic liquid fuel production from lignite unless there are radical developments in other technologies. One new technology under development, known as Ignite, produces oil and black carbon (char) from lignite and is possibly less carbon intensive than other technologies.[45] Although Solid Energy has publicly shown interest in this technology, and has indicated plans to build a pilot plant to test it, they recently announced difficulties in achieving the necessary licence agreements.

The Fischer-Tropsch process was invented in the 1920s and commercialised in Germany in 1936. It involves two steps. First, the feedstock (which could be lignite or other coal, natural gas, or wood) is converted into syngas, a mixture of carbon monoxide (CO) and hydrogen (H_2). The syngas is then converted into a chosen liquid fuel, like diesel or jet fuel (Figure 5.1).

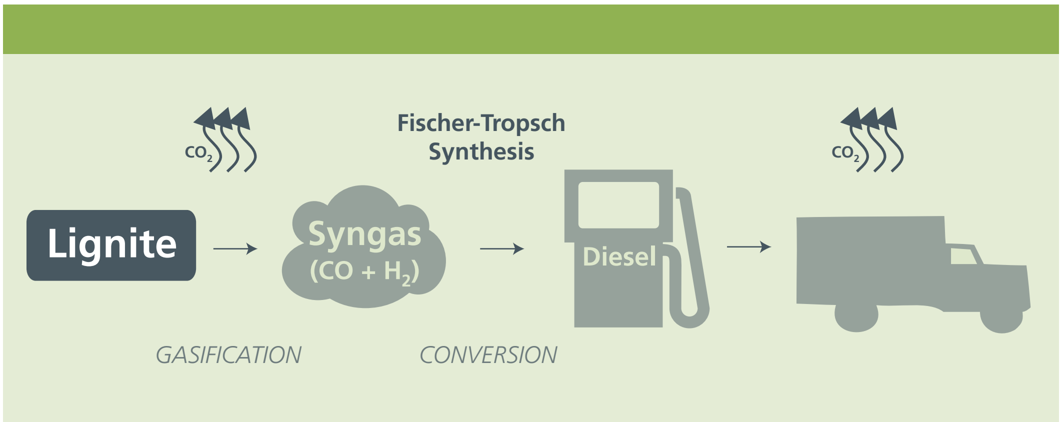

Figure 5.1: How diesel is made using the Fischer-Tropsch process

5.2 Greenhouse gas emissions intensity

This section describes the amount of greenhouse gases (measured in tonnes of CO_2eq) that is attributable to each litre of diesel produced from different source materials and processes.

The emissions intensities of the various ways that diesel is, or could be credibly, produced to meet domestic demand are described below and shown in Figure 5.2.

Details of the calculations and required assumptions leading to these figures are given in the Appendix. Emissions from diesel use comprise upstream and tailpipe emissions. The upstream emissions of diesel made from lignite are caused when the lignite is dug up and when it is processed into diesel. Tailpipe emissions are those that occur when the lignite is consumed. Both upstream and tailpipe emissions are accounted for in these calculations.

Since no suitable CCS reservoir has yet been identified in the southern South Island, emissions intensities described here assume there is no CCS facility in place.

Diesel from conventional crude oil

The emissions intensity of New Zealand's typical petroleum diesel is 3.1 kg CO_2eq per litre diesel.[46] This is composed of roughly 0.4 kg CO_2eq per litre upstream emissions (of which about half occurs during refining), and 2.7 kg CO_2eq per litre tailpipe emissions.

Diesel from lignite using Fischer-Tropsch technology

The emissions intensity of synthetic diesel made from lignite using the Fischer-Tropsch process is about 5.8 kg CO_2eq per litre of diesel. This is composed of roughly 3.1 kg CO_2eq per litre upstream emissions, and 2.7 kg CO_2eq per litre tailpipe emissions.

This is almost double the emissions intensity of diesel from conventional crude oil.

Diesel from wood using Fischer-Tropsch technology

The Fischer-Tropsch process can be used to produce diesel from biomass. The source material for such a plant would be wood since it is the only form of biomass available in sufficient quantity.

The emissions intensity of diesel produced from biomass (wood) using Fischer-Tropsch technology is about 0.3 kg CO_2eq per litre of diesel.[47]

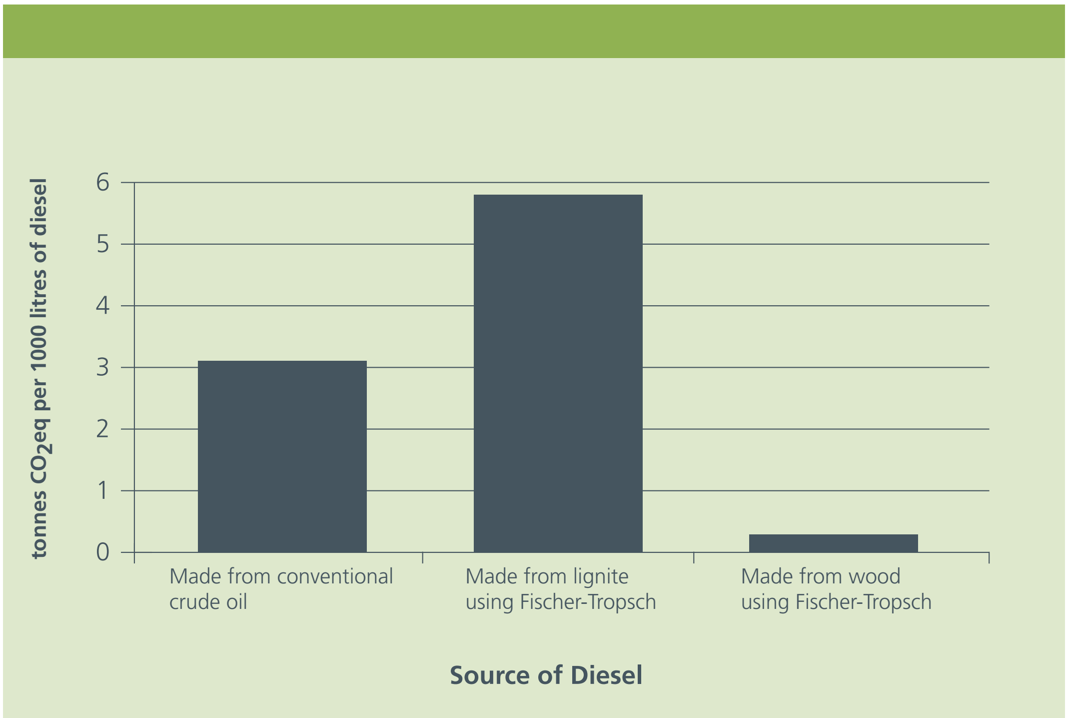

Figure 5.2: Emissions intensities for sources of diesel in New Zealand

5.3 Paying the greenhouse gas emissions cost

A lignite-to-diesel Fischer-Tropsch plant producing 35,000 barrels of diesel per day would emit about 5.5 million tonnes more greenhouse gas per year than conventional diesel production.[48] At $50 per carbon credit, this would cost New Zealand nearly $300 million more per year than the carbon cost of conventional diesel.

Under the current legislation and regulations, the carbon cost will be partly paid by the company making the diesel, partly paid by consumers, and partly paid by taxpayers. How much each pays depends on how many free carbon credits are given to the company by the Government (Box 5.1), and how much of the carbon cost (and other costs) the company can pass on to the consumers of diesel.

It is not clear how many free carbon credits a lignite-to-diesel plant would receive from the Government.[49] Upstream and tailpipe emissions are treated differently under the ETS.

Upstream emissions

Emissions caused when the lignite is dug up are unlikely to be eligible for free carbon credits. However, there is a question about process emissions. At present, emissions from petroleum refining are exempt from the ETS.[50] Because of this it is possible that process emissions for making liquid fuels out of lignite will also be exempt from a carbon liability under the ETS. This liability could well be removed by providing free credits for lignite-to-diesel process emissions. This would be achieved by making diesel from lignite a new activity eligible for free carbon credits.

Tailpipe emissions

There are no free credits provided by the Government for tailpipe emissions of liquid fuels. The current ETS rules were written anticipating that the cost of these emissions could be passed from fuel companies to consumers.

Box 5.1: Determining the number of free carbon credits

In order to receive free credits, the activity must be defined as being eligible. The number of free credits an eligible activity will receive is determined by the allocative baseline for that activity, the level of assistance and the volume of product produced. The allocative baseline is the number of tonnes of emissions per unit product for the defined activity.

Determining the allocative baseline for process emissions

If making diesel out of lignite becomes an eligible activity, it is unclear how the allocative baseline for such a new activity would be determined. If it is set to be equivalent to the effective level of allocation that refineries currently receive (by being exempt from an emissions liability), this will be roughly 0.2 tonnes CO_2eq (i.e. 0.2 credits) per 1000 litres of fuel. On the other hand, the allocative baseline for lignite-to-liquid fuel process emissions could be set at actual process emissions for this activity, which is about 3.1 tonnes CO_2eq (i.e. 3.1 credits) per 1000 litres of liquid fuel. In this case the taxpayer subsidy for a lignite-to-liquid fuel plant producing 35,000 barrels of diesel per day would be significant – up to $252 million per year in 2020 (at a carbon credit price of $50).

6 Making urea from lignite

This chapter assesses the greenhouse gas emissions caused by making urea from lignite, compared with the greenhouse gas emissions caused by making urea from its current sources.

Urea, a nitrogen-rich compound, is an important fertiliser in New Zealand and around the world. In recent years, New Zealand has used about 430,000 tonnes of urea fertiliser per year. A further 200,000 tonnes per year is used in making plywood and particle board (see Appendix).

About 40% of the urea used in New Zealand is made domestically. Ballance Agri-Nutrients produces an average of about 240,000 tonnes per year of urea at its Kapuni plant in Taranaki.[51] The remaining 390,000 tonnes per year is imported, mostly from Saudi Arabia, Qatar and Kuwait where it is also made from natural gas.[52] A small variable amount of urea is also imported from China, where it is made (very inefficiently) from coal.[53]

6.1 The process for making urea

The commercial production of urea involves first turning source material (natural gas, coal, or lignite) into syngas, a mixture of hydrogen and carbon monoxide (Figure 6.1). The carbon monoxide is then converted to carbon dioxide by reaction with steam. The hydrogen component is reacted with nitrogen from air to make ammonia. Then the carbon dioxide is recombined with the ammonia, yielding urea. This last stage is known as the Bosch-Meiser process.

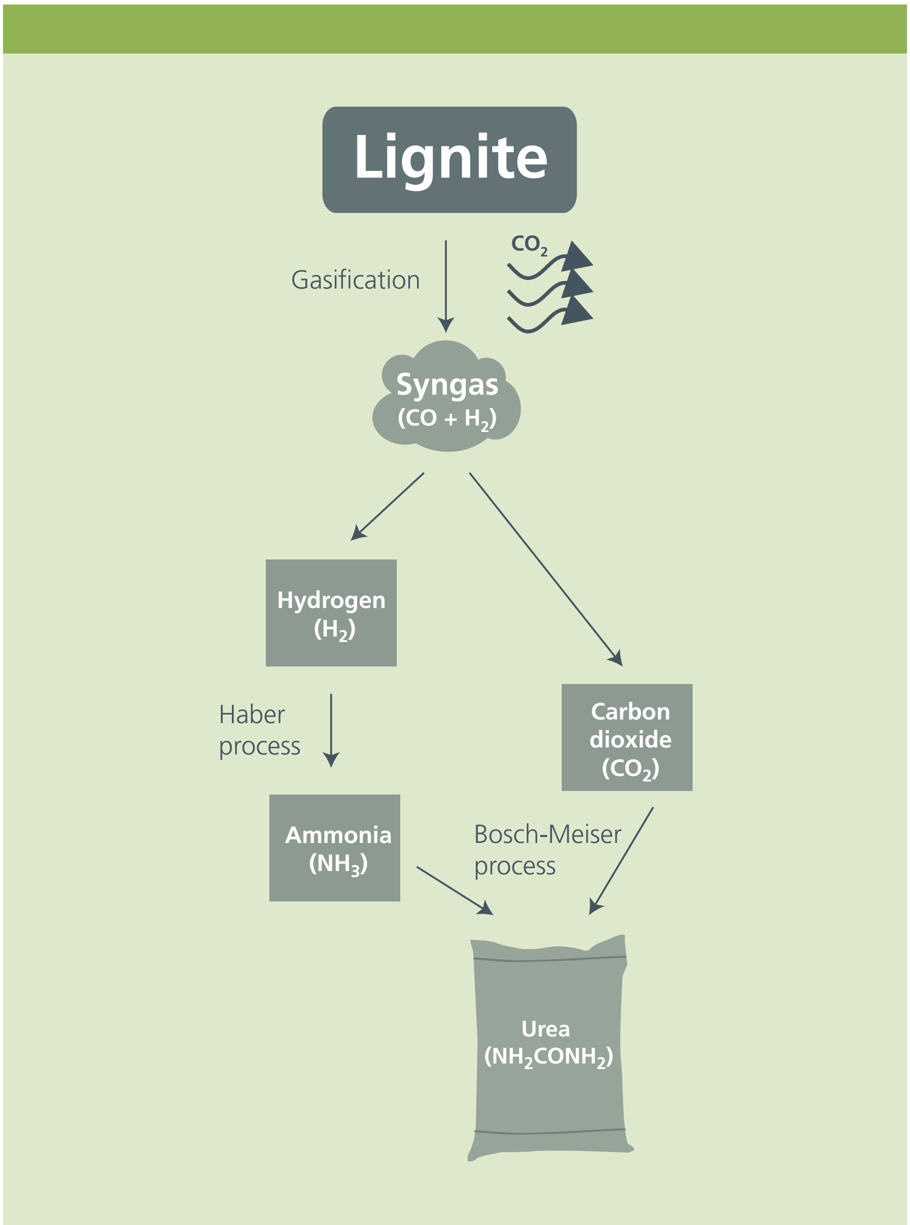

Figure 6.1: How urea is made from lignite

6.2 Greenhouse gas emissions intensity

This section presents the amount of greenhouse gases (CO_2eq) that are emitted per tonne of urea produced from New Zealand and Middle Eastern natural gas and Chinese coal, and what would be emitted were urea to be made from lignite in New Zealand (Figure 6.2). Details of the calculations and required assumptions leading to these figures are given in the Appendix. Given that there is currently no proven CCS reservoir in Southland or Otago (see Chapter 4), it is assumed that there is no CCS facility in place.

Urea production creates greenhouse gas emissions. Carbon dioxide and methane are emitted when fossil fuels such as coal or natural gas are extracted, and when fuel is burned. When urea is used as fertiliser more greenhouse gas emissions result. In this report the emissions intensity includes emissions that occur only during the production of urea and extraction of the fossil fuels used to make it.[54] This is because subsequent emissions depend on how the urea is used, and not on how it is made. Also, carbon in the urea itself is excluded from the emissions intensities estimated here.

Urea made from natural gas in New Zealand

The Kapuni urea plant uses natural gas from several local Taranaki gas fields as source material and fuel. Gas from the Kapuni field is unusually high in carbon dioxide; it contains more than twice as much carbon dioxide as hydrocarbons by volume.[55] Most of this carbon dioxide is removed at the Kapuni Gas Treatment Plant before the processed gas is sent to the urea plant. Including these emissions of carbon dioxide, the emissions intensity of urea made from the Kapuni natural gas-to-urea plant is estimated to be 1.1 tonnes CO_2eq per tonne urea. Just over half of these emissions are due to the carbon dioxide in the natural gas.

Urea made from natural gas in the Middle East

The emissions intensity of urea made from natural gas in the Middle East is estimated at about 0.8 tonnes CO_2eq per tonne urea. Less than 0.1 tonnes CO_2eq per tonne urea is ascribed to carbon dioxide in the natural gas when it is extracted.

Urea made from coal in China

Urea made from coal (mostly anthracite) in China has an estimated emissions intensity of about 2.1 tonnes CO_2eq per tonne urea. It is possible to make urea from such coal with lower greenhouse gas emissions intensity, but urea plants in China generally use small-scale, relatively dated, technology.[53]

Urea made from lignite

It is estimated that urea made from lignite in New Zealand would have an emissions intensity of about 1.3 tonnes CO_2eq per tonne urea. This is a little more than the emissions intensity of urea made from Kapuni natural gas.

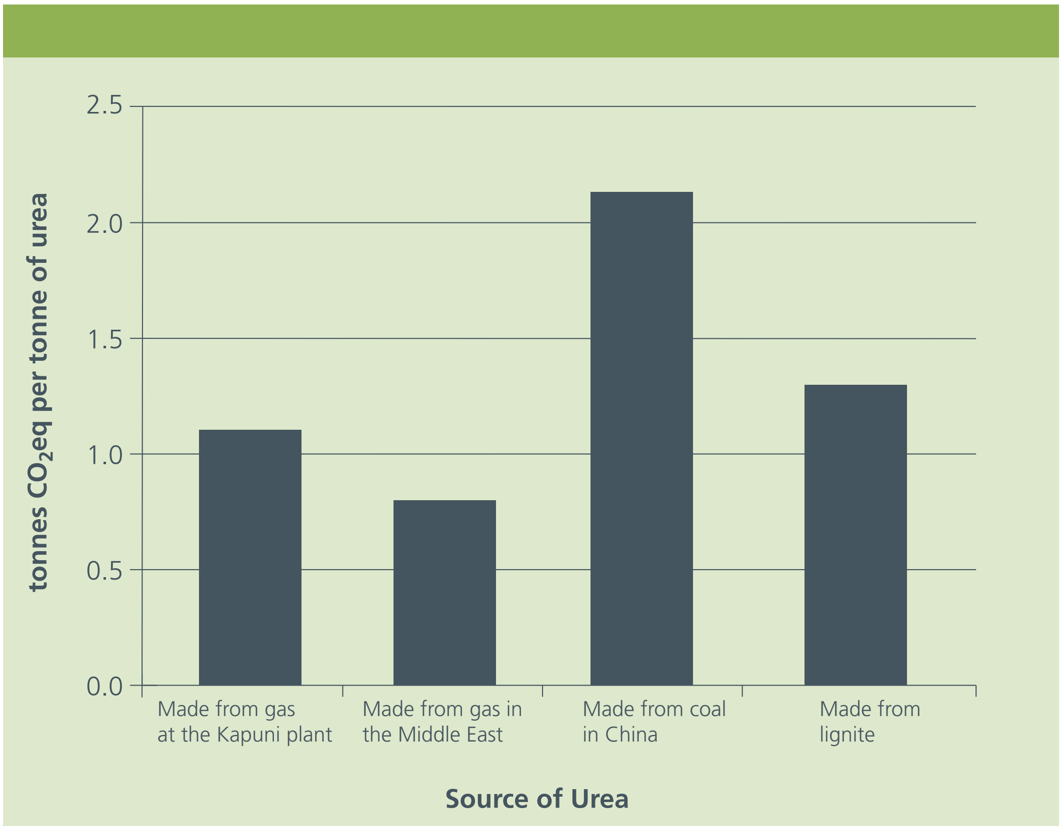

Figure 6.2: Emissions intensities of urea used in New Zealand

6.3 Paying the greenhouse gas emissions cost

New Zealand's greenhouse gas inventory, upon which our international commitments are based, covers all greenhouse gases emitted to the atmosphere *that occur within our borders*. This means that New Zealand is responsible for the emissions caused by the domestic production of urea, and emissions that occur when urea is used as a fertiliser within New Zealand.

For urea that is made here and exported only the production emissions are New Zealand's responsibility. For imported urea New Zealand is only responsible for emissions that occur when it is used.

This means that any New Zealand produced urea that is exported or displaces imported urea will increase national greenhouse emissions. If a lignite-to-urea plant displaces 390,000 tonnes of imported urea per year, this will add half a million tonnes CO_2eq to New Zealand's greenhouse gas inventory. If a lignite-to-urea plant produces 810,000 tonnes of urea that is exported per year, [56] this will add about 1 million tonnes CO_2eq to New Zealand's greenhouse gas inventory. Together this could cost New Zealand $75 million per year, at a carbon credit price of $50[57].

ETS design is a major factor in determining who would pay the cost of greenhouse gas emissions from urea. The use and production of urea fall under different parts of the ETS.

Emissions from urea use

Emissions that occur when urea is used as fertiliser fall under the agriculture section of the ETS. The agriculture sector is scheduled to join the ETS in 2015. While the agriculture ETS rules are yet to be written, producers and importers of urea will be liable for the costs of these emissions. They are also expected to be able to pass these costs through to those who buy the urea.

If the Government considers that the application of urea should be subsidised, then free carbon credits may be provided independently of whether the urea was produced domestically or not, transferring some costs of these emissions from the consumer to the taxpayer.

Emissions from urea production

Emissions that occur during the domestic production of urea fall under the Stationary Energy and Industrial Processes section of the ETS. Urea production, that is converting carbon dioxide and ammonia into urea, is eligible to receive free credits from the Government. This activity has an allocative baseline of 1.620 credits per tonne urea product.[58] But this allocative baseline includes allocation for carbon in the urea itself, whereas the estimations of emissions intensity in this report exclude this carbon. Assuming 0.7 credits per tonne urea of the allocative baseline is based on the liability relating to carbon in the urea itself, an allocative baseline excluding allocation for carbon in urea could be set to be about 0.9 credits per tonne urea.[59]

Urea production receives allocation at the highly emissions-intensive rate, which in 2020 would be 80% of the baseline. This would mean a lignite-to-urea producer could be eligible to receive 0.7 credits per tonne urea in 2020 (plus allocation for carbon in the urea itself). Since the emissions intensity of making urea from lignite is about 1.3 tonnes CO_2eq per tonne urea, the taxpayer would pay more than half the carbon costs of producing urea from lignite, whether this urea is used domestically or exported.

7

Other uses of lignite

There are other products that can be made from lignite. This chapter describes the emissions intensity of making briquettes and generating electricity from lignite. These values are compared to current sources of coal and electricity.

See the Appendix for details of calculations and related assumptions.

7.1 Briquettes

Lignite can be converted into a product equivalent to medium-grade coal product by drying it out. This lignite product, called briquettes, can be used as a source of process heat.

A briquette plant using a process called GTL technology[61] would produce briquettes with an emissions intensity of about 1.75 tonnes CO_2eq per tonne briquettes. This is similar to the emissions intensity of sub-bituminous coal, which is about 2.1 tonnes CO_2eq per tonne of coal.[62]

By comparison, making and burning wood pellets generate much lower emissions. Wood pellets are already produced for domestic and industrial heating, and for export. Torrefied (roasted) wood is an even better fuel, with an energy content similar to that of lignite briquettes, and an emissions intensity estimated at around just 0.2 tonnes CO_2eq per tonne of wood pellets.

Since the emissions intensity of lignite briquettes is similar to that of coal, making briquettes just for the domestic market would be unlikely to change New Zealand's national greenhouse gas emissions. Since the production of briquettes from lignite would probably not be classed as an emissions-intensive process, under the ETS such activity would be unlikely to be eligible for any allocation.

For exported briquettes made domestically, New Zealand would only be responsible for the process emissions, that is fugitive emissions from mining the lignite, and emissions from when the lignite is dried into briquettes. These are relatively small. For 1 million tonnes of briquettes, these emissions are likely to be 90,000 tonnes CO_2eq in total. At a carbon credit price of $50, this would cost $4.5 million.

7.2 Electricity generation

The power plants that are largely responsible for the high carbon dioxide emissions per capita in Australia burn lignite (known there as brown coal) to generate electricity using old inefficient technology. A more efficient approach would be to turn lignite into syngas (a mixture of carbon dioxide and hydrogen) and then burn the gas in an integrated gas combined cycle (IGCC) power plant. Such a power plant would still emit 0.7 tonnes CO_2eq per MWh.

This is more emissions-intensive than marginal electricity generation in New Zealand, which is about 0.5–0.6 tonnes CO_2eq per MWh. However, the average emissions intensity of current electricity generation is only 0.23 tonnes CO_2eq per MWh.[63]

It is perhaps most useful to compare a lignite power plant with other potential new power plants. Proposed electricity generation projects in Otago and Southland include over 1000 MW of wind generation[64] and 360–630 MW of hydroelectric generation.[65] Both types of electricity generation have extremely low greenhouse gas emissions.

Impact of lignite use on greenhouse gas emissions

This chapter first presents the differences in emissions intensities between products made from lignite and other sources, and then the absolute impact that using lignite will have on New Zealand greenhouse gas emission inventory.

8.1 Relative emissions intensity

Different products made from lignite have different emissions intensities. For every use of lignite discussed in this report, there are other viable ways of producing the same product which cause lower greenhouse gas emissions (Table 8.1). Continuing with the status quo would generate lower emissions than using lignite products, with the possible exception of making briquettes for the domestic market.

All uses of lignite are likely to increase New Zealand national greenhouse gas emissions

Table 8.1: Emissions intensity, in tonnes CO_2eq per unit product, for products made from lignite compared to current sources of those products

Product	Emissions intensity when made from lignite	Emissions intensity of status quo	Emissions intensity of other sources of product
Diesel, per thousand litres	5.8	3.1 (conventional crude oil)	0.3 (biomass)
Urea, per tonne	1.3	1.2 (weighted average, by amount, of total urea usage in NZ)	1.6 (Kapuni gas) 0.8 (Middle East gas) 2.1 (Chinese coal)
Briquettes, per tonne	1.7[62]	2.1[62] (sub-bituminous coal)	0.2[69] (torrefied wood)
Electricity, per MWh	0.8	0.2 (NZ generation mix average 2005-2008)	approx. 0 (renewables)

8.2 Absolute impact

Making diesel from lignite will emit 2.7 tonnes CO_2eq per 100 litres of fuel more than making it from conventional crude oil. In this report this is called the 'excess emissions intensity'. The excess emissions intensity and the scale of production together enable the calculation of the additional emissions attributable to the use of lignite and the increase in the national emissions inventory. From this, the effect of a lignite-to-diesel plant on the gap between New Zealand's international obligation and projected emissions can be estimated. The same calculations can be done for urea, briquettes and electricity (Table 8.2).

All uses of lignite are likely to increase New Zealand national greenhouse gas emissions and widen the gap between our international obligations and our projected emissions. In particular, making diesel out of lignite will increase emissions significantly.

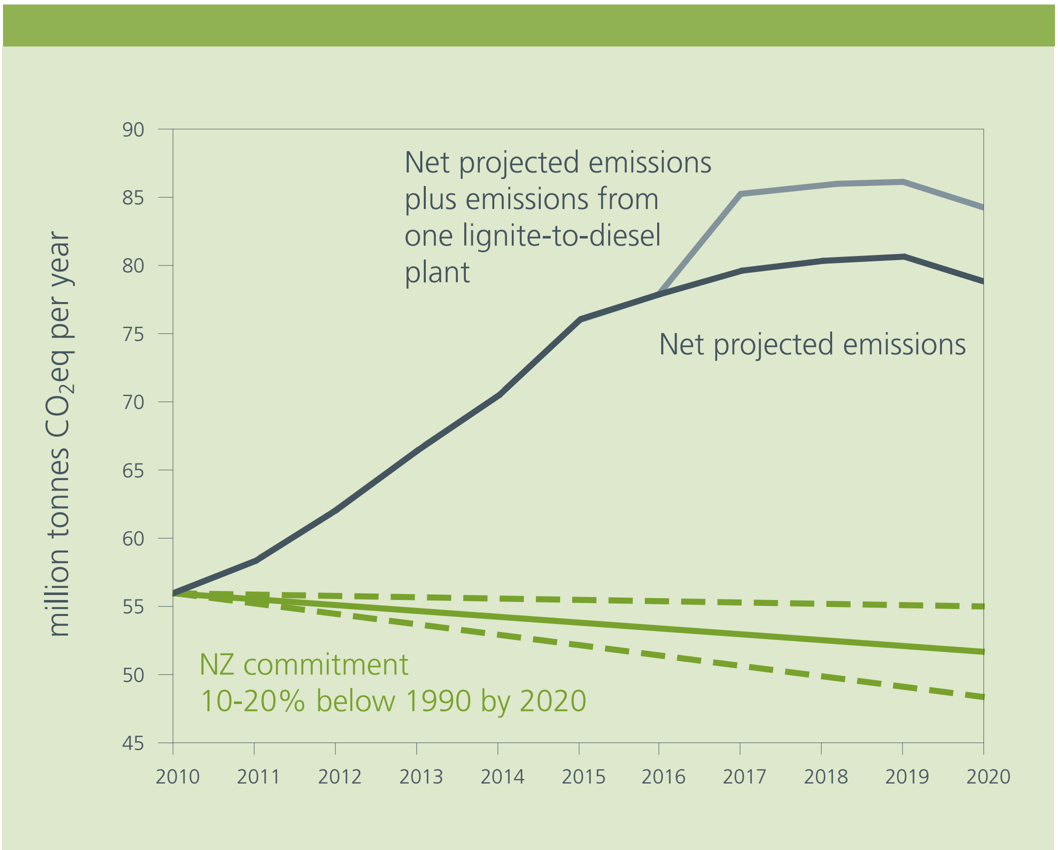

Figure 8.1: Projections of New Zealand net national emissions, with and without emissions from one lignite-to-diesel plant, compared to New Zealand international commitments

Figure 8.1 is an extension of Figure 3.2 in Chapter 3. It shows the gap between our projected emissions in 2020 and our international commitment. The line above the status quo projection shows the additional impact on national greenhouse gas emissions of one lignite-to-diesel plant producing 35,000 barrels of diesel per day, assuming it is in full production by 2017. One lignite-to-diesel plant significantly increases the gap. Two plants, as proposed, could double it.

One lignite-to-diesel plant will increase our national greenhouse gas emissions bill by 20% – that is an extra cost of $275 million per year at a carbon price of $50 per tonne. At a carbon price of $200 per tonne this would cost more than $1 billion per year extra by 2020.

Even without lignite use, the projected gap between our international commitments and our projected emissions is huge (24 to 30 million tonnes of CO_2eq per year in 2020, Figure 9) and too costly to ignore. On our current path this gap will cost New Zealand in the order of $1 billion to $6 billion per year by 2020.

One lignite-to-diesel plant will increase our national greenhouse gas emissions bill by 20%

Table 8.2: Excess emissions to New Zealand's net greenhouse gas inventory through lignite use

Product	Amount of lignite used, tonnes per year	Level of production, per year	"Excess" emissions intensity	Excess emissions, tonnes CO_2eq per year	Percentage increase in 2020	
					on projected emissions	on the "gap"[i]
Diesel (from one lignite-to-diesel plant)	10 million	2 billion litres (35,000 barrels per day)	2.7 tonnes CO_2eq per 1000 litres diesel[ii]	5.5 million	7%	20%
Urea	2 million	1.2 million tonnes	1.3 tonnes CO_2eq per tonne urea[iii]	1.6 million	1.8%	5.7%
Briquettes for export[iv]	1.4 million	1 million tonnes	0.09 tonnes CO_2eq per tonne briquettes	0.09 million	0.07%	0.3%
Electricity (500 MW of new generation)	2.1 million	3500 GWh[v]	0.7 tonnes CO_2eq per MWH[vi]	2.6 million	3.3%	9.5%

[i] The "gap" is the difference between the midrange of New Zealand international obligations (i.e. 15% less than 1990 emission rates by 2020) and projected emissions.
[ii] This is the difference between the emissions intensity of diesel made from lignite and of diesel made from conventional crude oil.
[iii] Assuming the urea made from the lignite-to-urea plant replaces imports of urea (390,000) and the remained (810,000) is exported, and that this urea does not displace urea production from the Kapuni facility.
[iv] For briquettes that are exported, all process emissions caused by the production of these briquettes will be additional to the national inventory.
[v] Assuming 80% load factor of a 500MW power plant.
[vi] This is the difference between the emissions intensity of making electricity from lignite versus making it from new wind or hydro power capacity.

9 Conclusions and recommendations

Responding to climate change demands behaviour change. New Zealand has made an international commitment to reduce its greenhouse gas emissions to between 10% and 20% *below* the 1990 level by 2020. Yet, we are on track to *exceed* the 1990 level by 30%. This is a huge, and very expensive, gap. The gap could be closed, in theory at least, by purchasing carbon credits offshore. But too much of this would make a mockery of our clean green credentials and would miss the opportunities for New Zealand to take advantage of changing world circumstances.

The only real tool New Zealand has in place currently to help meet our international obligations is the ETS, which aims to reduce national greenhouse gas emissions. It does this by putting a price on greenhouse gas emissions – the carbon price.

Having an ETS has been a good choice for New Zealand to make. However, the rules for allocating free carbon credits significantly undermine the scheme and are deeply flawed. Some of the problems with the allocation rules are described in the Parliamentary Commissioner's submission on the Climate Change Response (Moderated Emissions Trading) Bill 2009 available at www.pce.parliament.nz. Particular problems identified are the never-ending promise of free carbon credits and the lack of transparency surrounding this form of industry assistance. In 2011 the ETS will be reviewed. This is a prime opportunity to improve the effectiveness and fairness of the scheme.

This analysis of future lignite use brings another substantial flaw in the ETS into sharp relief. Using lignite causes large amounts of greenhouse gas emissions. None of the proposed uses of lignite help to close the gap between our promise to reduce emissions and the current path we are on. One proposed use of lignite will significantly increase the gap – making diesel from lignite. As things currently stand, companies that develop products from lignite on a large scale are likely to receive subsidies of millions of dollars per year from the taxpayer.

Clearly, subsidising the development of *new* emissions-intensive industry is contrary to the intent of the ETS. The first two recommendations in this report are designed to rectify this flaw in the ETS that has been illustrated through the lignite story. These recommendations could be incorporated into the terms of reference for the upcoming ETS review.

This report is focused on avoiding particular decisions that would increase the gap between what we have promised and where we are heading with regard to greenhouse gases. But equally importantly, New Zealand should look for opportunities to *reduce* the gap. The third recommendation is aimed at identifying and harnessing such opportunities.

9.1 Subsidising lignite developments

The production of diesel and urea from lignite are both new activities that may well qualify for much of their greenhouse gas liabilities to be met by the Government in the form of free carbon credits. But it makes no sense that the ETS rules would lead to taxpayers subsidising, even at a modest level, *new* investment in outdated dirty technology.

In particular, making products from lignite on a large scale should not receive government assistance in any form. This is because large-scale lignite use will have negative impacts of national significance. There is enough lignite available to supply large-scale lignite operations for decades. Supporting such new developments locks in the use of already outdated dirty technology for the next 30 years at least.

It is difficult to argue that *all* new entrants should not receive free carbon credits, particularly since some may be less emissions-intensive than their existing competitors. But subsidising new uses of such a carbon-intensive resource as lignite simply makes no sense. There is a precedent for excluding some activities from receiving free carbon credits; in the current legislation, electricity generation is not eligible for this form of subsidy.

I recommend that:

1. **The Minister for Climate Change Issues introduce legislation to amend the ETS so that new industries which use lignite on a large scale are specifically excluded from receiving any free carbon credits.**

9.2 Subsidising new activities

The intent of the ETS is to change the nature and mix of goods and services in our economy in order to lower our national greenhouse gas emissions. Such change requires that new industrial activities are exposed to the price on carbon. But when free carbon credits are provided, the effectiveness of the ETS is undermined. As long as any free credits are provided by the Government, there will be ongoing pleas for new industrial activities to be defined as eligible for allocation. Allocation to new industry should be granted only after very careful consideration.

New activities are not automatically eligible for free carbon credits. The decisions regarding eligibility are made by an Order in Council based on recommendations by the Minister for the Environment, because the law is silent on this matter. These decisions should be made transparently with a full understanding of the potential impacts of the activity on both New Zealand's national greenhouse gas emissions and the fiscal impact of such industry assistance. The 2011 review of the ETS provides an opportunity to initiate such changes.

I recommend that:

2. **The Minister for Climate Change Issues introduce legislation to amend the ETS to provide criteria for deciding which new activities are eligible to receive free carbon credits, including a requirement that the new activity will reduce New Zealand's national net greenhouse gas emissions.**

9.3 Promoting clean technology

Actively promoting clean and green technology is an obvious choice for New Zealand. Using such technology would reduce the gap between our obligations and projected greenhouse gas emissions while simultaneously improving our clean green brand, encouraging growth, and future-proofing our economy.

An ETS where all greenhouse gas emitters face emissions liabilities and no free credits are given away would certainly incentivise clean green technology. But New Zealand could, and should, do better. Other countries serious about taking advantage of the opportunities inherent in climate change mitigation have, or are working toward, both a price on carbon and policies that encourage clean green technology. New Zealand should too.

The way in which our industry and productive capacity develops is a national issue. A deliberate and coordinated approach is required in order to harness green growth opportunities for maximum benefit for New Zealand. Currently, New Zealand has no mechanism for dealing with this issue. This lack is well illustrated by the inconsistency between our climate policy and the Draft New Zealand Energy Strategy, where greenhouse gas emissions is the last of 12 considerations.

Earlier this year the Minister for Climate Change Issues proposed the establishment of a private-public taskforce to help develop clean green technology in New Zealand. Such a group could provide a forum for a national discussion of whether large scale exploitation of lignite would undermine New Zealand's image.

I recommend that:

3. **Cabinet establish a clean green taskforce comprising members from both the private and public sectors to explore growing our green economy, including considering the implications for New Zealand of the large-scale exploitation of lignite.**

Endnotes

1 Lamy, P. and Steiner, A. 2009. *Trade and Climate Change*. p.(v). World Trade Organisation / United Nations Environment Program. Geneva.

2 Crown Minerals 2006. *South Island lignite*, New Zealand coal resources fact sheet, Crown Minerals, Ministry of Economic Development, Wellington.

3 Eng, G., Bywater, I. and Hendtlass, C. 2008. *New Zealand Energy Information Handbook* 3rd edition, New Zealand Centre for Advanced Engineering, University of Canterbury, Christchurch.

4 Black, P. 1989. *Petrographic and coalification variations in the Eastern Southland lignites, New Zealand*, International Journal of Coal Geology 13 127-141.

5 BANZ 2009. *Wood fuel classification guidelines*, Bioenergy Association of New Zealand, Wellington. Values in table are for Class B wood pellets or better.

6 MED 2010. *New Zealand energy data file: 2009 calendar year edition*, Ministry of Economic Development, Wellington.

7 Solid Energy 2007. *New Vale mine*, information sheet, Solid Energy New Zealand, Christchurch.

8 Crown Minerals 2010. http://www.crownminerals.govt.nz/cms/coal/

9 Solid Energy. *2010 annual result*, profit announcement presentation by Chairman and CEO, Solid Energy, Christchurch, September 2010.

10 L&M 2006. *L&M plans full feasibility study on lignite to diesel project*, press release, L&M Group, Christchurch, 28 September.

11 Ravensdown. *Exciting new Ravensdown and Solid Energy project, lignite-to-urea*, press release, Ravensdown Fertiliser Co-operative Ltd., Christchurch, 24 September 2009. Solid Energy. *Solid Energy and Ravensdown investigate lignite*, press release, Solid Energy New Zealand, Christchurch, 24 September 2009.

12 Solid Energy 2004. *Coal producer predicts continuing strong performance despite high NZ dollar*, media release, Solid Energy, Christchurch, 30 March.

13 Weir, J. Coalfields pushed as key to power problems, *The Press*, 11 February.

Gorman, P. Surprise at coal-plant talk, *The Press*, 27 September 2004.

Options for Tiwai Pt smelter plant considered, *Southland Times*, 30 August 2004.

Arnold, K. $2b plan for coal power station, *Southland Times*, 23 September 2004.

Arnold, K.. Coal-fired power plan on standby for Tiwai smelter, *Southland Times*, 29 September 2005.

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Gorman, P. Inter-island costs may stymie station, *The Press*, 22 March 2006.

Weir, J. Tiwai Point Aluminium Smelter, *The Press*, 2 October 2007.

Holland, N. Timeframe extended for lignite-fired power plant, *Southland Times*, 12 March 2008.

14 Effective mitigation of climate change does not require action from every country in the world – only the countries responsible for the majority of emissions.

15 MfE 2009. *New Zealand's 2020 Emissions Target*. INFO 422, July 2009. Ministry for the Environment, Wellington.

16 Key, J. Speech to the Central North Island Regional Conference, Rotorua, 27 May 2007

17 Greenpeace New Zealand. *Unlikely Bedfellows Unite Over Climate Change*, press release, , Saturday, 23 May 2009

18 Keeping it clean, *World Conservation* magazine, 25 January 2008

19 New Zealand is currently committed to hold national emissions between 2008-2012 at 1990 emission rates or to take responsibility for any excess, under the Kyoto Protocol. Projections of our net emissions (that is, our gross greenhouse gas emissions minus carbon dioxide removed from the atmosphere by growing trees) over these 5 years indicate that New Zealand is likely to be near to meeting our commitment. (See MfE 2010. *New Zealand's net position under the Kyoto Protocol*. Published online at http://www.mfe.govt.nz/issues/climate/greenhouse-gas-emissions/net-position/index.html, Ministry for the Environment, Wellington). This is not because New Zealand has reduced its emissions – to the contrary, emissions have increased by 18% since 1990. New Zealand's saving grace, regarding meeting our Kyoto commitment, is the expansion of forestry in the 1980s when timber prices were high.

20 United Nations 1992. *United Nations Framework Convention on Climate Change*. Article 2: Objective. New York, 9 May 1992.

21 United Nations Framework Convention on Climate Change 2010. *Report of the Conference of the Parties on its fifteenth session, held in Copenhagen from 7 to 19 December 2010*. Addendum. Part Two: Action taken by the Conference of the Parties at its fifteenth session. United Nations office, Geneva, Switzerland.

22 The setting of the target is conditional on a number of outcomes from the international process.

23 Ministry for the Environment 2009. *Fifth national communication under the United Nations Framework Convention on Climate Change*, Ministry for the Environment, Wellington.

24 Covec 2010. *Carbon price forecasts*, report for the Parliamentary Commissioner for the Environment, Covec, Auckland. "Best guess" projections in this report for carbon prices in 2020 were $35 per credit for a relatively low ambition policy scenario (no effective international emission reduction framework), and $200 per credit for a relatively high ambition policy scenario (where the world is on track to stabilize greenhouse gas levels at 450pm CO_2eq). The "best guess" price estimate for a medium ambition policy scenario (where greenhouse gas levels are stabilised in the atmosphere at 550ppm.) in 2020 was $50/per credit. This report is available at www.pce.parliament.nz

25 Projected emissions are taken from the Fifth National Communication (reference 23). They are net of UNFCCC forestry CO_2 removals, and assume certain measures are in place, including a price on carbon and widespread use of nitrification inhibitors. The indicated 2020 target range is calculated from New Zealand's 1990 baseline gross emissions, also as given in the Fifth National Communication.

26 Climate Change Response Act 2002. Section 3: Purpose.

27 The proposed uses of lignite would be considered trade-exposed because the products are traded internationally (regardless of whether the particular products from the entity receiving the allocation are traded internationally). They are also very likely to be emissions intensive. The allocation regulations define emission intensity as the amount of CO_2eq emitted per $1million revenue (rather than per unit product as elsewhere in this report). There are two thresholds for allocation of eligible industry: at least 800 tonnes, and at least 1600 tonnes of CO_2eq emitted per NZ$1million revenue, and at least 1600 tonnes, attracting 60% and 90% of baseline allocation respectively. See Climate Change Response Act 2002.

28 This is a Negotiated Greenhouse Agreement, which was put in place before the ETS. It exempts emissions from refining from the ETS in return for placing an obligation on refineries to achieve and maintain best practice in energy efficiency.

29 The number of credits an eligible activity will receive each year is given by the following formula: Allocation = (level of assistance) x (amount produced) x (allocative baseline).

The level of assistance depends on whether the activity is moderately emissions intensive (>800 tonnes CO_2eq emitted per $1million revenue) or highly emissions intensive (>1600 tonnes CO2eq per $1million revenue), receiving 60% or 90% of the allocative baseline. This rate declines at a relative 1.3% per year from 2012.

The allocative baseline is the number of tonnes of emissions per unit product for the defined activity. It is determined by the industry average. See Climate Change Response Act 2002.

30 Solid Energy. *Solid Energy and Ravensdown investigate lignite*, press release, Solid Energy New Zealand, Christchurch, 24 September 2009.

31 CCS Task Force 2010. *Report of the Interagency Task Force on Carbon Capture and Storage*, available from Environmental Protection Agency or Department of Energy, Washington, USA.

They are:

a) Sleipner in the North Sea, where CO2 from natural gas is stored in a deep saline aquifer. Since 1996, Sleipner has stored about one million tonnes of CO2 a year.

b) Snøhvit gas field in the Barents Sea has a similar process to Sleipner, storing 700,000 tonnes of CO2 each year.

c) Weyburn-Midale in Saskatchewan, Canada, where CO2 is captured from a coal gasification plant and injected into a oil reservoir at about 1.5 million tonnes CO2 per year.

d) In-Salah, Algeria, where CO2 from natural gas is re-injected underground at a rate of about 1.2 million tonnes per year.

32 CCS Task Force 2010 states that techniques for separating carbon dioxide from other gases on a large scale have been around since the 1930s. Today, Vector's Kapuni Gas Treatment Plant extracts hundreds of thousands of tonnes of carbon dioxide from natural gas every year, by 'scrubbing' with potassium carbonate solution. The Shute Creek Gas Plant in Wyoming, USA captures more than 3,600,000 tonnes of CO_2 a year using the Selexol process. Estimates of capture costs are given as USD$60-$95 and have been converted to NZ$ using October 2010 interbank exchange rates.

Transporting liquid carbon dioxide around is also well understood in other countries. The United States alone has more than 5,000 kilometres of CO_2 pipelines, some dating back 40 years.

33 Metz, B., Davidson, O., de Coninck, H., Loos, M. and Meyer, L. 2005. *Intergovernmental Panel on Climate Change special report: carbon dioxide capture and storage*, Cambridge University Press, Cambridge, UK.

34 A spectacular example of catastrophic failure occurred in Hutchinson, Kansas, in 2001, when 4 million cubic metres of compressed natural gas leaked from a storage reservoir through abandoned brine wells. Kansas Geological Survey 2001. http://www.kgs.ku.edu/Hydro/Hutch/Background/index.html

35 Todd Energy. *Todd Energy and ExxonMobil Joint Venture surrender Great South Basin permit*, press release, Todd Energy, Wellington, 11 October 2010.

36 Barton, B. 2009. *Carbon capture and storage law for New Zealand: a comparative study*, New Zealand Journal of Environmental Law 13 1-36, University of Auckland, Auckland.

37 Hall, P., Hock, B., Palmer, D., Kimberley, M., Nicholas, I., Jack, M., Heubeck, S., de Vos, R., Stroombergen, S. and McKissack, D. 2009. *Bioenergy options for New Zealand: transition analysis: the role of woody biomass from existing plantation forest, and drivers for change in energy supply*, Scion, Rotorua.

Note that much of the marginal land identified as most suitable for afforestation is in South Canterbury and Otago. Note that this land is generally below average quality for forestry.

38 Climate Change (Forestry Sector) Regulations 2008 (SR 2008/355) as at 01 October 2010.

Calculations average growth over the first 25 years.

39 5.5 million tonnes of CO_2eq emitted requires 5.5 million carbon credits for mitigation, every year. Using the sequestration rates in the regulations as they currently stand, 17 to 29 credits per year per hectare, it would take 190,000 to 320,000 hectares of carbon credit earning forest to provide these credits.

40 Under the Kyoto Protocol, once a tree is cut down its carbon is considered to instantly return to the atmosphere. This is known as the "instant oxidation rule". There are efforts to change this rule to better suit New Zealand circumstances, however it is unclear as to whether this will be achieved.

41 Hall, P. and Gifford, J. 2007. *Bioenergy options for New Zealand: situation analysis: biomass options and conversion technologies*, New Zealand's EnergyScape report, Scion, Rotorua.

Wood processing produces at least 4 million cubic metres of residues every year, and logging residues could contribute as much again given sufficient demand.

42 Williamson, G. and McCurdy, M. 2009. *Biomass to liquids*, report for the Parliamentary Commissioner for the Environment, CRL Energy Ltd., Lower Hutt.

43 Hall, P., Hock, B. and Nicholas, I. 2010. *Volume and cost analysis of large scale woody biomass supply; Southland and Central North Island*, report for the Parliamentary Commissioner for the Environment, Scion, Rotorua.

44 Other processes for converting coal to liquids include high temperature pyrolysis and direct liquefaction of coal. The former is particularly inefficient, and the latter requires very large volumes of hydrogen. For an overview, see WCI 2006. *Coal: liquid fuels*. World Coal Institute, Richmond, UK.

45 Ignite Energy Resources Ltd's Catalytic Hydro-thermal Reactor (Cat-HTR) technology

46 Barber, A. 2009. *NZ fuel and electricity life cycle emission factors: total primary energy use, carbon dioxide and GHG emissions*. Paper for Ministry of Economic Development by AgriLINK NZ Ltd., Kumeu.

47 PCE 2010. *Some biofuels are better than others: thinking strategically about biofuels*, Parliamentary Commissioner for the Environment, Wellington.

48 The difference between the emissions intensity of Fischer-Tropsch (FT) lignite diesel and conventional diesel is 5.8-3.1= 2.7 kgCO2eq/L. 2.7 kgCO2eq/L x 35,000 barrels per day x 365 days in year x 159 litres in a barrel / 1000 kg in a tonne =5.5 million tonnes CO_2eq per year. Since the extra emissions caused by FT lignite diesel are in the processing which would occur domestically, the cost of these emissions would be faced by New Zealand whether this diesel is used domestically (replacing conventional diesel) or exported.

49 One particular problem relevant to lignite use is that under our ETS, if an activity would get free credits under the Australian emissions trading scheme, it is also eligible to receive equivalent allocation under our ETS. However, the Australian scheme is not law, and it is unclear whether, and in what form, a carbon price will be introduced in Australia.

50 This is because refining is subject to a Negotiated Greenhouse gas Agreement with the Government.

51 Ministry for the Environment 2010. *New Zealand's greenhouse gas inventory 1990-2008*, Ministry for the Environment, Wellington.

52 Statistics New Zealand 2004-2008. Harmonised trade statistics, Statistics New Zealand, Wellington.

53 Zhou, W. Zhu, B., Li, Q., Ma, T., Hu, S. and Griffy-Brown, G. 2010. CO_2 emissions and mitigation potential in China's ammonia industry, *Energy Policy* 38 (7), 3701-3709

Bush, T. and Du, L. 2009. *2010 China agriculture outlook: industry overview*, Merrill Lynch, Hong Kong.

54 Note this is not consistent with the New Zealand Greenhouse Gas Inventory, which includes the carbon in the urea itself, and excludes emissions from processing Kapuni natural gas, in accordance with IPCC 1996 reporting rules.

55 NZIC 1998. *The processing of natural gas at Kapuni*, http://nzic.org.nz/ChemProcesses/energy/7C.pdf, New Zealand Institute of Chemistry, Christchurch.

56 A lignite-to-urea plant producing 1.2 million tonnes of urea per year, using 390,000 to replace imported urea, will have a production excess of about 810,000 tonnes of urea, assuming domestic use remains constant.

57 This assumes that a new lignite-to-urea plant does not displace the Kapuni urea plant.

58 Climate Change (Eligible Industrial Activities) Regulations 2010, SR 2010/189

59 The carbon content of urea is about 0.73 tonnes CO_2eq per tonne urea.

60 GTL Energy Ltd, an Adelaide-based company, has proprietary technology for making briquettes out of lignite.

61 On a volume basis. On an energy basis, the emissions intensity of briquettes and sub-bituminous coal are almost identical. Eng, G., Bywater, I. and Hendtlass, C. 2008. *New Zealand Energy Information Handbook* 3rd edition, New Zealand Centre for Advanced Engineering, University of Canterbury, Christchurch.

62 Average of 2007-2009. MED 2010. *New Zealand Energy Quarterly*, June Quarter 2010

63 Current Otago and Southland wind proposals where consents have been applied for include: Project Hayes (Meridian) 630MW, Kaiwera Downs (TrustPower) 240MW, Mahinerangi (TrustPower) 200MW, and Mt Stuart (Pioneer Generation) 6MW. National Infrastructure Unit 2010. *National Infrastructure Plan*, March 2010, http://purl.oclc.org/nzt/i-1266

64 Current Otago and Southland hydro proposals where consents have been applied for include: North Bank Tunnel (Meridian) 260MW, Hawea Control Gate retrofit (Contact) 17MW. Other hydro proposals not yet applied for: four Clutha options (Contact) – Option 1 86MW, Option 2 160MW, Option 3 185MW, and Option 4 350MW. National Infrastructure Unit 2010. *National Infrastructure Plan*, March 2010, http://purl.oclc.org/nzt/i-1266

65 The weighted average assumes a urea supply of 260,000 tonnes from Kapuni, 355,000 tonnes from the Middle East, and 27,000 tonnes from China, and emissions intensities given in this report.

66 Note that New Zealand is not responsible for production emissions of urea produced abroad.

67 By the Ministry of Economic Development's (MED) accounting, emissions from wind and hydro electricity generation are negligible, excluding emissions caused by construction of wind and hydro electricity generating capacity. MED 2010. *New Zealand Energy Quarterly*. Issue 11, June Quarter 2010

68 The energy content of wood and briquettes is very similar.