Annexes

Annex 1: Background on forestry and rules

Forestry in New Zealand

Production forestry

- New Zealand has a forest resource that is a crop rather than a product of a natural ecosystem. This provides flexibility to manipulate the crop through management. Productivity and quality gains have also resulted from New Zealand's strongly developed forestry research and development capability. New Zealand recognises the important role that forests play as sinks and reservoirs of greenhouse gases. As at 1 April 2004, there were 1.82 million ha of sustainably-managed planted forest in New Zealand. The predominant species is *Pinus radiata*.

- More recently, there has been a decline in commercial forestry plantings, which has been driven by a combination of factors. These include: a relatively strong New Zealand dollar; substantial increases in shipping costs; negative sentiment attached to Government policy; tough international market conditions; and competition for land from alternative uses (which have pushed up land prices). There are no indications that the level of new planting will increase under current market conditions.

Indigenous forestry

- New Zealand indigenous forests represent a considerable reservoir of carbon. It is not known whether this reservoir is expanding or shrinking, but work is under way to monitor changes in indigenous forests (see the material on the Carbon Monitoring System below).

- Indigenous forests occupy 6.256 million ha, of which 5.187 million ha is owned by the Crown. The vast bulk of the Crown resource is managed for its conservation values. A further 1.069 million ha of natural forest is privately owned; half by Maori, with 124,000ha of this considered commercially viable for wood production under current market conditions. Less than 0.005% of New Zealand's total commercial wood production is from indigenous forests.

Climate change forestry policy for New Zealand: further detail

The significant policy areas that have been developed since the announcement of this policy package have included the PFSI and the FIFA. Work has also commenced on implementing the NZCAS to ensure New Zealand's ability to claim sink credits and account for deforestation.

Permanent Forest Sinks Initiative

The PFSI enables forest owners to receive carbon credits in proportion to the carbon sequestered by a given stand, in return for covenanting (registered against the land title) and managing the land to create a continuous canopy forest. Under the contract, the Crown agrees to provide an amount of tradable carbon credits equal to the amount of carbon sequestered by new forest stand over CP1. Forest owners would receive "returns" only after the amount of carbon sequestered has been measured and verified. All costs and risks associated with the release of the carbon from a stand would be borne by the forest owner. Forest owners would also be liable for ongoing monitoring, verification and administrative costs.

The mechanism is voluntary. The only forests that will be eligible to earn carbon credits over CP1 are Kyoto forests. No restrictions are placed on the selection of species that may be planted under the mechanism.

The mechanism has wide-ranging benefits beyond climate change, including retiring marginal land, bringing benefits through biodiversity enhancement, soil and water conservation, and improved flood protection. Legislation is currently before the House of Representatives to establish the Permanent Forest Sinks Initiative.

Forest industry initiatives

The Government noted that without measures additional to the above policy package, the decision to retain sink credits and liabilities, including capped deforestation liabilities, would have the following consequences:

- New Zealand generally under-investing in new forest planting, leading to forgone economic benefit from additional carbon sequestration
- higher levels of agricultural emissions than would otherwise be the case, as new forests tend to displace agriculture
- fewer sink credits being generated in the future, perhaps limiting the Government's ability to utilise forest sinks to manage future risks and liabilities and protect New Zealand's competitive position
- increasing emission liabilities as a result of relatively higher rates of deforestation during CP1.

To address these issues, the Government agreed to assign a proportion of the credits (or an equivalent value) to provide incentives to retain and enhance forest sinks. The only implementation of this policy to date has been a package of measures intended to enhance the general profitability of forestry and wood processing through the FIFA. The FIFA measures were not directly tied to planting or replanting behaviour; therefore, any incentive effects for retaining or enhancing forest sinks is minimal. Initiatives under this package included market access, bioenergy, labour and skills, alternative species promotion, and market development.

Monitoring carbon stocks and stock changes
Under the UNFCCC and the Kyoto Protocol, New Zealand is obliged to report greenhouse gas emissions and removals arising from LULUCF activities.

We have not yet fully defined "forest" in relation to Kyoto accounting but our definition is likely to differ from how we have previously reported vegetative cover and land use. Production forestry will certainly be included, as will exotic and native trees planted for soil and water protection and biodiversity enhancement.

The overall aim of the NZCAS is to provide a robust and comprehensive accounting and reporting system that meets the IPCC's Good Practice Guidance and:

- is appropriate for UNFCCC LULUCF sector reporting
- enables reporting under Article 3.3 of the Kyoto Protocol in the first (and subsequent) commitment periods
- ensures New Zealand's eligibility to participate in international carbon trading
- supports and underpins New Zealand climate change policy development through to 2012 and beyond.

The NZCAS comprises five modules: natural forests (indigenous forest and scrublands); planted forests (both pre- and post-1990 plantings); a soil carbon monitoring system; land-use monitoring; and a database to store all point and spatial data and provide an accounting and reporting function.

The Carbon Monitoring System for indigenous forest and scrublands will be fully in place by May 2007. Some 1400 grid point locations meeting the land-cover criteria have been identified and randomly allocated to a five-year cycle to install the permanent plots. The system is expected to also consolidate and standardise existing forest information currently held by various agencies.

The United Nations Framework Convention on Climate Change and the Kyoto Protocol

Convention and Protocol articles

Article 4.1 (d) of the UNFCCC calls on all signatories to the Convention to:

> "promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs… including biomass, [and] forests..."

The UNFCCC defines a "sink" as "any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere". A growing forest is a sink. A "reservoir" is a component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored. Forests can also be "reservoirs" for carbon dioxide.

The development of the international agreement on "sinks" has evolved to cover emissions and removals of greenhouse gases resulting from LULUCF. Activities in the

LULUCF sector can mitigate and/or contribute to climate change. The relevant Kyoto Protocol Articles with respect to LULUCF are:

Article 3.3 of the Kyoto Protocol

The net changes in greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990, measured as verifiable changes in carbon stocks in each commitment period, shall be used to meet the commitments under this Article of each Party included in Annex I. The greenhouse gas emissions by sources and removals by sinks associated with those activities shall be reported in a transparent and verifiable manner and reviewed in accordance with Articles 7 and 8.

Article 3.4 of the Kyoto Protocol

Prior to the first session of the Conference of the Parties serving as the meeting of the Parties to this Protocol, each Party included in Annex I shall provide, for consideration by the Subsidiary Body for Scientific and Technological Advice, data to establish its level of carbon stocks in 1990 and to enable an estimate to be made of its changes in carbon stocks in subsequent years. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session or as soon as practicable thereafter, decide upon modalities, rules and guidelines as to how, and which, additional human-induced activities related to changes in greenhouse gas emissions by sources and removals by sinks in the agricultural soils and the land-use change and forestry categories shall be added to, or subtracted from, the assigned amounts for Parties included in Annex I, taking into account uncertainties, transparency in reporting, verifiability, the methodological work of the Intergovernmental Panel on Climate Change, the advice provided by the Subsidiary Body for Scientific and Technological Advice in accordance with Article 5 and the decisions of the Conference of the Parties. Such a decision shall apply in the second and subsequent commitment periods. A Party may choose to apply such a decision on these additional human-induced activities for its first commitment period, provided that these activities have taken place since 1990.

Under Article 3.3 of the Kyoto Protocol, parties have decided that greenhouse gas removals and emissions through certain activities — namely, afforestation and reforestation since 1990 — can be used to meet a country's emission targets. Conversely, activities that deplete forests, namely deforestation, are to be subtracted from the amount of emissions that an Annex I Party may emit over the commitment period. Article 3.4 of the Protocol enables parties to elect additional land-use activities.

The Marrakech Accords[149] provide additional detail to the Kyoto Protocol text. They elaborate definitions and the accounting for the activities described in Table 31 below.

149 See <www.unfccc.int/resource/docs/cop7/13a01.pdf#page=54>

Table 31 - Summary of LULUCF Activities

Activity	Kyoto Protocol Article	Start	Accounting	Base year	Cap
Afforestation	3.3	"to have begun on or after 1 January 1990"	Mandatory	Gross-net	
Reforestation					
Deforestation					
Forest management	3.4	"to have occurred since 1 January 1990"	Voluntary		Cap per country
Revegetation				Net-net	No cap
Cropland management					
Grazing-land management					

Source: Marrakech Accords

Article 3.3 of the Protocol - Kyoto forests

Under Article 3.3, it is mandatory for New Zealand to account for greenhouse gas emissions and removals as a result of new forest planting since 1990. New forests planted since 1990 are commonly referred to as Kyoto forests. Deforestation can occur on any forest land regardless of when that forest was first established. Non-Kyoto forests refer to forests established prior to 1990 and subsequently replanted following harvest post-1990.

The harvesting of *Pinus radiata* production forest planted post-1990 would not normally occur until 2020 at the earliest. So, to a large extent, the harvesting rules are only hypothetical at this stage.

"Forest" is defined under the Marrakech Accords, which provide additional detail to the Kyoto Protocol text. New Zealand's elected choice of parameters is bolded within the following definition. "Forest" is a minimum area of land of 0.05 to **1.0**ha with tree crown cover (or equivalent stocking level) of more than 10 to **30**%, with trees with the potential to reach a minimum height of 2 to **5** metres at maturity *in situ*. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest. Young natural stands and all plantations that have yet to reach a crown density of 10 to 30% or tree height of 2 to 5 metres are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest.

The activities of afforestation, reforestation and deforestation are further defined as follows.

"Afforestation" is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources.

"Reforestation" is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For CP1, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989.

"Deforestation" is the direct human-induced conversion of forested land to non-forested land.

Article 3.4 of the Kyoto Protocol – forest management

Under Article 3.4 of the Kyoto Protocol, New Zealand can elect which additional Article 3.4 LULUCF activities, if any, it wishes to account for in CP1. The election of these activities is voluntary for Annex I Parties such as New Zealand.

Benefits and liabilities under the Kyoto Protocol

As well as providing benefits, the Protocol also imposes a number of liabilities and obligations on New Zealand. In the first instance, all benefits, liabilities and obligations under the Protocol arise to the Crown.

Table 32 below indicates the benefits and liabilities for New Zealand's forest sinks under current Kyoto rules.

Table 32 – Kyoto and non-Kyoto Forest Sink Credits and Liabilities

Sink Credits and Harvesting/Deforestation Liabilities (CP1) for Kyoto and non-Kyoto Forests			
	Sink Credit Benefits	**Emissions Liability upon Harvest**	**Emissions Liability Upon Deforestation**
Kyoto forest (forest planted on land since 1990 that was in some other land use on 31 December 1989)	Yes. Equal to the carbon sequestered over CP1 on eligible lands	Yes. Equal to the carbon released through harvesting **but** not more than the sink credits received over the same period	Yes. Equal to the carbon released at harvest
Non-Kyoto forest (established pre-1990 – also applies to forest that has been replanted following harvest after 1990)	Yes, if this activity is elected under Article 3.4 ("forest management"). However, this is subject to a cap (NZ – 1 MtC over CP1)	Yes, if this activity is elected under Article 3.4 ("forest management") and equal to the change in carbon stocks on the land accounted for over the CP1 No, if this activity is not elected under Article 3.4 ('forest management') and forest is replanted	Yes, whether or not "forest management" is elected and equal to the carbon released at harvest

Slightly anomalous rules exist within the Kyoto Protocol in terms of the way Kyoto forests and non-Kyoto forests are treated. This distinction is, to some extent, artificial.

These rules mean that New Zealand faces the liability associated with the deforestation (felling and not replanting) of non-Kyoto forests but does not face any liability associated with harvesting (felling and replanting) non-Kyoto forests. In contrast, however, New Zealand faces a liability associated with both the deforestation and harvesting of Kyoto forests.

There is one further major difference between the treatment of Kyoto forests and non-Kyoto forests in terms of treatment under the Protocol. The liability faced by New Zealand on the harvesting of Kyoto forests is limited to the amount of carbon claimed previously from that forest. This does not apply to non-Kyoto forests.

On deforestation of a non-Kyoto forest, the entire carbon liability in the forest is faced by New Zealand. If a non-Kyoto forest is deforested prior to 2008, however, New

Zealand does not face any liability (although New Zealand is liable for any resulting emissions from agriculture on that land).

In general, the number of credits (or debits) generated under Article 3.3 is equal to:

> carbon in Kyoto Forests as at 31 December 2012 minus
> carbon in Kyoto Forests as at 1 January 2008 minus
> (carbon as at 1 January 2008 in lands deforested between 1 January 1990 and 31 December 2012 minus carbon as at 31 December 2012 in lands deforested between 1 January 1990 and 31 December 2012).

Note that deforestation requires both the harvesting of trees and a conversion in land use. If the forest is harvested and replanted or even left to naturally regenerate, it does **not** create a deforestation liability because there has been no land-use change.

Annex 2: The role of non-climate policies in a sustainable forestry framework

Production forestry also offers a range of co-benefits, including improved water quality, erosion control, and biodiversity. Reference is made here to these key non-climate policies and programmes.

In addition to the above climate change policies, there are a range of other policies and programmes that contribute to positive climate change outcomes. These are listed here in Annex 2, but not discussed in detail. Some will have a greater role in future should international negotiations require the accounting of all land-use activities.

East Coast Forestry Project

The East Coast Forestry Project addresses eroding soils on pastoral land in the Gisborne Region by encouraging sustainable land use through a contestable fund for landowners to plant trees or allow the land to revert to scrub.

The aim of the project is to cover 60,000ha of the most erosion-prone land in trees and encourage retirement of some land so it can revert to native forest. Since the project's inception in 1992, 32,000ha of planted forest has been established. This includes about 17,000ha of the targeted at-risk land with the balance being adjacent land established to form sustainable forest management stands.

Biosecurity Act 1993

The importance of biosecurity for forestry in terms of loss of productivity resulting from an incursion of a damage-causing pest is obvious. Under current policy, the Government has a vested interest to ensure that forest resources that generate forest sink credits are adequately protected. Any reduction in carbon stocks results in liabilities.

Forest biosecurity has both active and passive surveillance programmes in place that are developed to detect the emergence of any previously unknown pest, and to detect any changes in the health status of New Zealand's commercial and urban forests. The forestry industry recognises this critical issue and the majority of corporate investors operate (or contribute to) regular monitoring programmes.

Sustainable-development frameworks

The Government has in place a number of statutes that create the conditions for sound management of natural and physical resources. The New Zealand forestry industry and its processing sectors rely heavily on the quality of these natural and physical resources.

In addition to this, the Government is developing, improving and supporting existing systems such as environmental indicators for land, research, new policy tools, market incentives and regulations.

The **RMA** promotes the sustainable management of natural and physical resources. Its core purpose is to help achieve sustainability in New Zealand. The Act governs the use and development of our land, air and water resources, concentrating on managing the environmental effects of human activities.

The overriding purpose of the **Soil Conservation and Rivers Control Act 1941** is to provide for the conservation of soil resources and the prevention of damage by erosion, and to better provide for the protection of property from damage by floods. A number of activities are undertaken by regional councils under this Act, including the use of forestry for catchment-control purposes.

Regional councils also undertake farm planning programmes under the **Local Government Act 2002**. The use of **Environmental Farm Plans** offers a method for local government to give landowners technical and scientific information that is matched to their individual property, including the planting of trees where this is a more appropriate land use than current alternatives.

Space planting of trees on hillsides, the establishment of protection and production-protection forests and farm woodlots have all provided slope stability to significant areas. Much of this work has been achieved through cost-sharing programmes involving Government, local government and landowner funds. The various regional programmes administered by regional councils continue this work, along with contributions from individual planting by farm foresters and forestry companies.

Other policies – Article 3.4 and full carbon accounting

Many other non-climate policies and programmes contribute to climate change outcomes and could assist any move to fuller carbon accounting (eg, accounting for practices under Article 3.4).

Sustainable Forest Management under the Forests Act 1949 (Part IIIA)

MAF administers the indigenous forestry provisions of the Forests Act 1949, under which indigenous timber can be produced only from forests that are managed within acceptable ecological limits, so that they are maintained in perpetuity.

Research on forestry

Crown Research Institutes such as Scion (New Zealand Forest Research Institute) and Landcare Research undertake research on forestry management and biomaterials science. This work also contributes to the development of the NZCAS.

The School of Forestry at the University of Canterbury examines the multiple benefits of forestry. The findings from this research are published nationally and internationally. This research investigates such issues as biosecurity, conservation biology, forest ecology, forest soils and silviculture of indigenous forests.

The Sustainable Farming Fund, administered by MAF, provides project-based grant funding to help the land-based primary production sectors solve problems and take up opportunities to overcome barriers to economic, social and environmental viability. The Fund has funded a number of forestry-related projects.

Queen Elizabeth the Second National Trust

The Trust was established by the Queen Elizabeth the Second National Trust Act 1977 "to encourage and promote the provision, protection and enhancement of open space for the benefit and enjoyment of the people of New Zealand".

The trust works with a wide range of people and organisations, from individual land owners through to representatives of local and central government. The trust receives base funding from the Crown, along with funding for biodiversity advice and condition-improvement funding. It also receives donations from organisations and private individuals.

Annex 3: Policy criteria

Regardless of the uncertainties outlined in the forestry Section (4.6) about future arrangements on land-use change and forestry, or interpretation of the current rules on LULUCF, policy criteria are needed to guide the inclusion of climate change considerations into land-use change and forestry decisions out to 2020. The policy criteria are not mutually exclusive and achieving some of them will help to achieve other criteria.

The consideration of forestry and land-use change in the medium term (to 2020) should involve making policy choices based on the following criteria.

Appropriate land-use signals: Appropriate signals are sent to decision-makers involved in land use and land-use change regarding the Government's overall climate change goal and any obligations under international climate change arrangements (such as the Kyoto Protocol). This means that foresters, potential foresters and landowners face appropriate incentives to invest or divest in forestry, taking into account as many costs and benefits as possible. This includes economic costs and benefits and Kyoto Protocol/climate change implications.

Reduction of uncertainty: This requires reducing the uncertainty facing forest owners about both the international situation and domestic policy settings. This could include the removal or reduction of uncertainty around how liabilities will be treated during CP1. Similarly, it could also involve less uncertainty around the treatment of forest benefits and liabilities post-2012.

Resilience: Any policy response needs to be robust and effective over time under new international climate change frameworks or changes in targets and rules within existing international frameworks. Resilience also includes adjusting to achieve any change in New Zealand's overall climate change policy goal and being able to achieve other Government non-climate policies. Furthermore, this resilience also includes and provides for flexibility in land-use decision-making, given the appropriate signals discussed above.

Equity: Any policy response needs to consider equity between the treatment of different land uses and different forests (ie, Kyoto forests versus non-Kyoto forests), and in relation to other parts of the economy.

Sector acceptance of policy: Acceptance of the policy will aid its implementation. This includes acceptance by the owners of Kyoto forests and non-Kyoto forests.

Maximising co-benefits: There are other positive externalities that may arise from the climate change policy when applied to forestry (eg, soil conservation benefits, nutrient management and biodiversity). To the extent possible, these should be maximised.

Minimisation of Crown fiscal risk: There may be fiscal risks for the Crown; eg, retention of liabilities, or deadweight costs for the economy associated with devolution where expenditure results in no behaviour change, only a wealth transfer.

International obligations: The policy is consistent with New Zealand's international obligations (eg, the World Trade Organisation and bilateral-trade agreements and other multilateral environmental agreements such as the CBD).

Note that the options outlined in this section were not assessed against this criterion, because greater detail about each option is required in order to assess the implications of the options against any international obligations.

Feasibility: The practicality of the policy approach (eg, data needs, monitoring requirements, compliance requirements, transaction costs and enforceability).

Annex 4: The European Union Emissions Trading Scheme

Box 5: The European Union Emissions Trading Scheme (EU ETS)

The largest and most publicised carbon market is the European Union Emissions Trading Scheme (EU ETS). This works through 25 countries and covers emissions from four broad sectors:

- production and processing of iron and steel
- minerals (eg, cement, glass)
- energy
- pulp and paper (forestry is not included, the focus is on industrial emitters).

This is a cap-and-trade system (ie, an overall cap is placed on emissions and trading may occur within the cap). It covers about 45% of European Union CO_2 emissions or 30% of its overall greenhouse gas emissions (CO_2 emissions only are covered in the EU ETS).[150] In total, 12,000 installations are covered in the EU ETS.

European Union Member State governments are required to set an emission cap for all installations covered by the scheme. Within this cap, each installation is allocated emission allowances for the particular commitment period in question (the EU ETS covers the 2005 to 2007 period and then the 2008 to 2012 period).

A company can purchase allowances on the EU ETS if it plans to pollute more than its allocated number of allowances would imply. Similarly, it can sell allowances if its emissions reduce. Considerable penalties apply if a firm has insufficient permits to cover its emissions. Given this, an incentive operates for polluters to invest in technologies/work practices to reduce their emissions – if the cost of reducing emissions is less than the cost of purchasing allowances then it is sensible for firms to reduce emissions (and vice versa).

For the second period of the EU ETS (2008 to 2012), there will be the ability for member states to use the Kyoto flexibility mechanisms (the CDM and JI initiatives – credits from nuclear facilities and land-use change and forestry activities are not accepted).

There is a limit on the number of emission permits allowed to enter the EU ETS through the Kyoto flexibility mechanisms. This means that much of the CO_2 mitigation must occur within the European Union (and reflects a specific European Union policy decision). As a result, the price of emissions permits within the EU ETS is significantly higher than the price of emission reduction units under the Kyoto flexibility mechanisms.

[150] Consideration is being given to including other sectors of the economy and other greenhouse gases in the EU ETS.

Annex 5: Computable General Equilibrium Model

Outline of the Global Trade and Environment Model

ABARE has developed a computable general equilibrium model known as the Global Trade and Environment Model (GTEM) to specifically address policy issues with global dimensions. ABARE developed GTEM from the internationally respected Global Trade and Analysis Project (GTAP) model, developed at Purdue University (Indiana, USA), which is used worldwide for global trade analysis. GTEM simulates the impact of policy changes or specific events on a large number of economic variables of a particular national/regional economy, including GDP, consumption, production, trade, investment, greenhouse gas emissions and carbon prices.

Computable general equilibrium models such as GTEM are built up from microeconomic foundations and account for all transactions within an economy. Depending on the level of sophistication of the specific model, the model can represent a diverse range of economic agents, including households, industries, regions, government(s), investors and international trade.

The strength of computable general equilibrium models for climate change modelling lies in their detailed representation of industry, captured through the input-output tables. The input-output structure of the models traces resources and materials used in the economy, starting with the production of raw materials from agriculture and mining through to final products for consumption or trade. The accounting of emissions and prices from raw materials to final goods can easily be represented in this input-output structure, and shows how carbon is integrated into the production chain.

GTEM can represent up to 68 regional economies (corresponding to individual countries or country groups) that are linked through trade and investment flows, allowing for detailed analysis of the direct as well as flow-on impacts of policy and changes for individual economies – the model tracks intra-industry trade flows as well as bilateral trade flows, allowing for detailed trade policy analysis. The detailed international trade links are important, as these determine where production, particularly carbon-intensive production, will shift as international abatement costs increase.

GTEM is a dynamic model accounting for capital and debt accumulation and solving for population growth, which enables the model to account for transactions between sectors and trade flows between regions over time. As a dynamic model, it accounts for the impacts of changes in labour force and investment on a region's production capabilities.

GTEM has a comprehensive international greenhouse emissions database accounting for combustion and non-combustion carbon dioxide, methane and nitrous oxide emissions, which account for around 98% of global anthropogenic greenhouse gas emissions. Methane and nitrous emission from waste and agriculture residues, and synthetic and industrial-process emissions, are not covered in the emissions database.

GTEM has a detailed representation of international energy supply and demand. The database distinguishes a number of different fuels, including three types of coal (brown coal, or lignite; black coal, or steaming coal; and coking coal), natural gas and oil. Electricity may be generated through seven technology types, including brown coal, steaming coal, oil, natural gas, nuclear (New Zealand uses no nuclear energy by assumption), hydroelectricity and geothermal, and other renewables (eg, biomass and wind generation), and generation by technology substitutes with the relative cost of generation.

Other considerations

As with all models, GTEM has imperfections from a policy-analysis viewpoint.

GTEM is only able to estimate the economic costs associated with climate change abatement policies and cannot project the economic impact of climate change.

The technology response in GTEM to climate change policies is limited. Increasing the costs imposed on carbon-intensive industries will reduce emissions intensity through fuel switching (eg, natural gas for coal), substituting towards less carbon-intensive industries (eg, steel making in electronic arc furnaces from blast iron furnaces), and new proven technology may be introduced as it becomes economic. However, GTEM (as with most economic models) is unable to solve for endogenous technical change, such as new energy-saving technology, alternative fuels and research and development.

The most recent official input-output table for New Zealand from Statistics New Zealand represents 1995/96. Although the input-output table has subsequently been updated using synthetic methods, the method of updating does not guarantee the database represents the current structure of the New Zealand economy. Typically, computable general equilibrium model results have not been overly sensitive to updates in the official input-output tables.

GTEM does not include waste-sector emissions and policy options for abatement in the waste sector. Furthermore, forestry sinks and land-use and land-use-change emissions are not policy responsive in the model.