The New Zealand Energy Sector

Prepared for
A report prepared for Investment NZ

Prepared by
East Harbour Management Services Limited

East Harbour Management Services Limited
P O Box 11 595, Manners Street, Wellington 6142
Tel: 64 4 385 3398
Fax: 64 4 385 3397
www.eastharbour.co.nz

May 2009

East Harbour Project No. EH7500
Document Status: Final

Contents

Disclaimer

While every attempt has been made to ensure the accuracy of the material in this report, Energy Library makes no warranty as to its accuracy, completeness or usefulness for any particular purpose, and accepts no liability for errors of fact or opinion.

Glossary

PJ Joule is the Systeme International (SI) derived unit of energy and heat, while Peta is a factor of 10^{15}, and PJ = 10^{15} Joules (= 277.778 GWh)

MW A measure of energy (1 Million Watts = 10^{6} Watts)

GW A measure of energy (1 Giga Watt = 10^{9} Watts)

kWh A measure of work done by 1 kW of energy acting for one hour (MWh, GWh)

Introduction

This report is produced to provide Investment New Zealand and other interested parties with an overview of the New Zealand energy market. It is not intended to deal with energy costs except in a general sense.

It is presently a time of rapid change for the energy industry in New Zealand, and globally, and this report attempts to capture the situation as it is in May 2009. The global recession that commenced in 2008 has depressed prices for hydrocarbon fuels, reversing a trend of rapid increases, but in the longer term there seems to be little doubt that prices will increase as a response to a narrowing of the gap between demand and supply for oil and gas, and the likely imposition of costs associated with carbon emissions.

In New Zealand electricity prices have continued to rise in real terms over recent years, as have the prices of other forms of energy, though petroleum prices have reduced during the current global economic recession. Like the rest of the world, business will in the future be exposed to increasing energy costs, including those imposed by a cost of carbon.

The new National Government was elected in November 2008 with a programme to review energy and energy-related policies and legislation, including those associated with climate change. The National Government has committed to Kyoto and these strategy and policy reviews are now underway but some time away from completion. Therefore this paper cannot be definitive with respect to future policy.

1. Overview

New Zealand is relatively rich in energy resources and has until recently enjoyed low-cost energy which has been attractive for business and, in particular, primary industrial processing. Sources of energy are wide ranging but community attitudes to possible adverse environmental effects have reduced access to a number of potential energy sources, in particular hydro electricity and some wind developments. Nuclear power has been ruled out and this seems unlikely to change, and while a moratorium on thermal power plant development imposed by the previous Government has been rescinded, electricity generation developments over the next few years seem likely to be based largely on wind and geothermal resources.

Around two thirds of New Zealand's electricity supply is met by renewable energy

Until the current recession, rapid world-wide increases in the price of oil have impacted on New Zealand, though, because the bulk of petroleum fuel is used for transport, the impact has not been as great as in some other countries. The impacts of the world recession are starting to show here with increasing unemployment levels and slowing economic activity.

Electricity prices are now increasing to levels that support generation from sources of energy with lower potential environmental impacts. Current electricity generation is principally from hydro energy with additional power being provided from gas, a coal fired power station, geothermal and wind. Around two thirds of New Zealand's electricity supply is met by renewable energy; this proportion being higher in "wet" years and lower in dry ones given the variable climate and limited water storage.

Current Government targets are to increase renewable generation to 90% of the total by 2025. There has been a significant growth in wind energy projects with now nine operating sites plus many more at various stages of development. Further expansion of the hydro resource is constrained because of community concerns over environmental impacts and loss of amenity values, and competing demands for water resources. There has also been significant growth in geothermal energy use with extensive resources in the North Island. Future investment is likely to be in a mix of generating plants fuelled predominantly by wind and geothermal and the planned streamlining of resource management legislation is intended assist this development.

Potentially more than 12,600 GWh per annum of electricity can be generated from wind farms on sites with wind speeds of 6 m/s or greater

Electricity prices have been volatile in recent years which have seen increased incidences of low rainfall periods with hydro generation reduced because of limited hydro storage and prices lifted by the dependence on more expensive thermal electricity generation. In 2004 the previous Government commissioned the building of a diesel fired standby generation plant (155 MW) to provide additional generation in a one in sixty-year drought and also to provide a partial cap on prices. The operation of this plant is triggered by low hydro lake storage or high market prices and during the first six months of 2008 the plant generated over a number of periods as a result of high prices driven by the low rainfall and infrastructure maintenance. Reliability of supply will be impacted by the limitations on transmission between the islands until the DC link is replaced in 2012.

Total potential geothermal generation exceeds 1,600 MW, or 13,000 GWh per annum, from conventional and consentable resources

New Zealand has a number of small-sized gas fields with only those in the Taranaki region having been fully explored and developed. These produce natural gas for distribution throughout the North Island and also condensate, which is refined at New Zealand's single petroleum refinery at Whangarei or exported. The Government has introduced a number of measures to encourage exploration and development of areas which have been identified as having oil or gas potential, and concerns over the depletion of the Maui gas fields have been tempered by new gas finds and the development of previously discovered fields. While none of these fields are as large as Maui, these developments have lessened concerns over future supply; however importing of LNG to bolster supply in the medium term has also been investigated.

Gas supplies seem adequate to meet demand for at least the next 12 years with proven reserves of 2200 PJ and exploration activity is at record levels

Natural gas is reticulated throughout the North Island for residential and industrial applications and LPG, locally produced and imported, is available nationally though the price has increased substantially in recent years. The major industrial uses of gas are for the production of methanol and ammonia/urea, electricity generation, and some industrial heat. Production of methanol had been scaled back and at times halted in the 2003-2007 period due to supply and pricing concerns but resumed in 2008, as a response to new gas supplies becoming available.

Coal is mined in both the North and South Islands, and also imported, for heat and electricity production. Coking coals are mined in the South Island for export. Coal reserves are extensive but it seems unlikely that its use in New Zealand will increase significantly unless carbon sequestration, which is being investigated, can be achieved.

Total in-ground coal resources are approximately 15 thousand million tonnes

The timber industry uses wood processing waste extensively for heat production and some electricity generation. Energy crops are grown in Canterbury for biodiesel production and are being investigated for planting in other areas, though the recent removal of a biofuel obligation in transport fuels seems likely to impact on biofuel production and usage. Investigations into cultivating algae for biofuels are also underway.

An EnergyScape study concluded that purpose-grown energy forests, if planted today, could meet all of New Zealand's future transport fuel and heat energy needs

Transport fuels are principally imported with most being refined at the Whangarei refinery.

Future energy availability and price will be determined by changes in supply options, changes in the generation mix and by the availability of new technologies.

The introduction in 2007 of the New Zealand Energy Strategy (NZES) and the New Zealand Energy Efficiency and Conservation Strategy (NZEECS), which form, part of the strategy, are the major planks of Government energy policy. Following this was the introduction of an Emissions Trading Scheme (ETS) which will impose a cost on carbon emissions and have major energy-use and economic impacts. The new National Government elected in 2008 is committed to reviewing the previous Government's energy and environmental policies and legislation, in particular the Energy Strategy to increase the emphasis on support for economic growth, and the ETS. A number of legislative changes have already been made, other reviews are underway, and a new policy direction outlined. It is not yet clear how substantially policies will change given the constraints imposed by Kyoto, to which the National Government has confirmed a commitment.

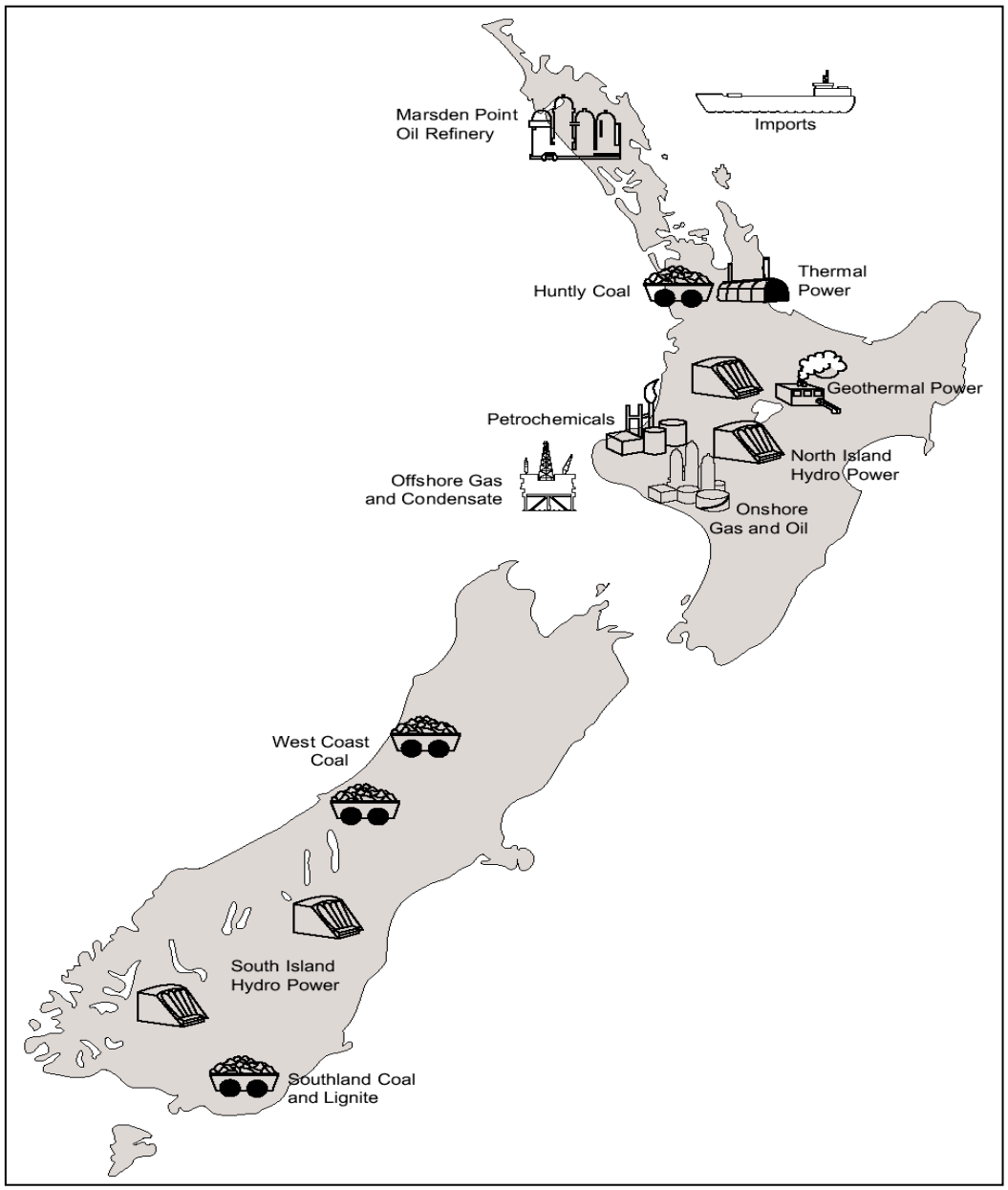
The over-riding goal of the new Government's energy strategy will be economic growth, with a focus on security of supply, affordability and environmental responsibility

The Minister of Energy and Resources said in a speech on 24 February 2009 that there will be a number of changes in the energy sector and that he is considering a Ministerial Working Party to reshape the regulatory functions of the electricity industry to speed up investment in electricity transmission assets. He also intends issuing a revamped national energy strategy with a focus on security of supply, affordability and environmental responsibility and an over-riding goal of economic growth.

2. The New Zealand Energy Sector

The New Zealand energy sector is based on indigenous and imported primary fuels, which are transported, stored and converted to end-uses including heat, electricity and transport. Figure 1 gives an indication of the locations of the major indigenous energy sources. Wind and bioenergy are available nationally though significant regional resource variations occur. Hydro electricity and coal are key resources in the South Island, while the North Island has a wider variety of resources including hydro electricity, geothermal heat, gas, coal and wind.

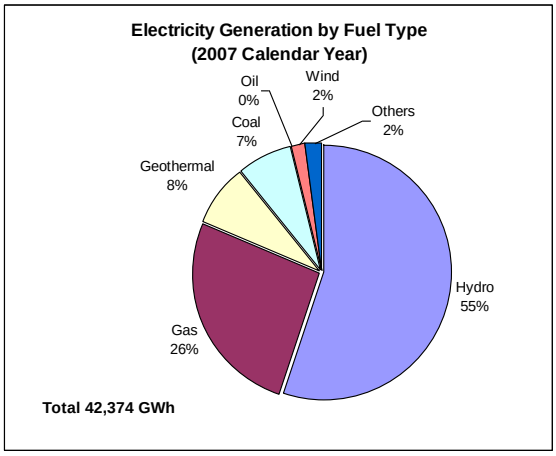
Figure 1: New Zealand main energy sources by geographic location and type

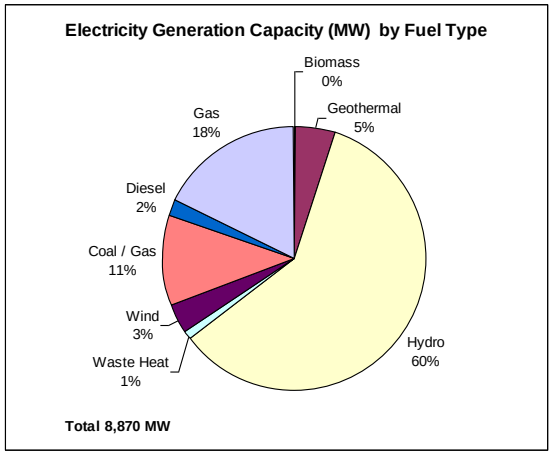


Source: Ministry of Economic Development

In the year ended December 2007, New Zealand's total primary energy supply was 752 PJ. After conversion and distribution losses are deducted, consumer energy usage was 508 PJ. The average energy consumption was 120 GJ per capita (equivalent to 20 barrels of oil consumed per person). Energy flows within each sector for 2007 are shown diagrammatically in Appendix A. Electricity generation and generation capacity, by fuel type are shown in Figure 2, and projects which are currently under construction or in the consenting process in November 2008 are given in Appendix 2.

Figure 2: New Zealand electricity generation





3. Sources of Energy

3.1 Hydro

New Zealand has a relatively high rainfall and is generally mountainous with many steep sided valleys suitable for hydro electricity generating facilities. Most of the best hydro sites have been used for construction of lakes and power stations and remaining sites face considerable opposition from environmental and other groups with land and water use interests or competing claims for the water resources.

Table 1: **Potential for further hydro development in New Zealand (in order of potential energy output)**

Region	Potential for Development MW			No. of Potential Schemes	Potential Energy Output GWh/y
	High Confidence	Medium Confidence	Low Confidence		
Canterbury	919	919	1,047	14	5,755
Otago	0	364	869	13	4,335
West Coast	0	373	758	24	3,414
Bay of Plenty	25	108	258	13	1,196
Hawkes Bay	51	154	154	7	779
Manawatu-Wanganui	53	144	144	8	704
Nelson-Marlborough	35	48	83	6	408
Southland	0	0	85	2	370
Waikato	8	24	44	8	252
Taranaki	0	22	48	4	230
Gisborne	12	37	37	3	163
Wellington	0	6	6	1	25
Total New Zealand	**1,103**	**2,199**	**3,533**	**103**	**17,630**

Source: Availabilities and Costs of Renewable Sources of Energy for Generating Electricity and Heat, Ministry of Economic Development, 2005

Existing hydro lakes, especially in the North Island, have little storage capability with total national storage only adequate for around six weeks' generation. It is likely that future hydro developments will be smaller than in the past, have even less storage, and be essentially run of river. Larger potential developments include the 260 MW North Bank scheme on the lower Waitaki, 72 MW on the Wairau River in Marlborough and a new 46 MW Arnold River project (not in the table above, but now with a resource consent for development) on the West Coast of the South Island. Contact Energy has also announced that they are revisiting a series of potential developments on the lower Clutha River.

Hydro generation has averaged around 24,000 GWh per annum since 2000 but with the relatively small storage capacity, seasonal rainfall variations have had a major impact on hydro generation and therefore electricity market prices. 2008 was the third year in that period in which prolonged dry spells have resulted in high spot prices and significant concerns over the industries' ability to maintain supply. This has been exacerbated by a reduced margin between demand and capacity to supply.

Meridian Energy

Meridian Energy, a state-owned enterprise, is New Zealand's largest electricity generator whose production is based solely on renewable sources, in particular hydro. Meridian is the only New Zealand supplier of carboNZero certified electricity and has positioned itself as a global reference company in renewable energy while investing in green technologies such as those offered by Whisper Tech.

The company owns and operates the Waitaki chain of eight hydro stations in the South Island, which provide some 25% of the country's power, and New Zealand's largest hydro station at Manapouri.

Meridian is also New Zealand's largest generator of wind energy from its two sites at Te Apiti in the Manawatu and White Hill in Southland. The company is also well advanced in developing the 140 MW West Wind project on the outskirts of Wellington, which on April 29 2009 marked its "first power" milestone. West Wind is expected to be fully commissioned by the end of 2009. Meridian has a resource consent for Te Uku, a 60 MW wind farm near Ragan in the Waikato, in a joint venture with WEL Networks.

Meridian has a number of other wind farm projects at various stages of the consenting process. Project Hayes, currently before the Environment Court, is a proposed development of up to 630 MW in Central Otago. Consent has also been received for Project Mill Creek - again on Wellington's West Coast - but this has been the subject of an appeal to the Environment Court, as has Project Central Wind, which is a 100 MW proposal in the central North Island. Several other sites in northern New Zealand are also being investigated.

Meridian is also pursuing a number of hydro projects, including the North Bank Tunnel on the Waitaki River. This project will have a capacity of some 250-300 MW and is being consented via a two-stage process, with the granting of water rights now subject to appeal in the Environment Court and with the land use consenting process to follow.

Also in the consenting process is a hydro development on the Mokihinui River on the West Coast, for which the hearing has just finished. Meridian is currently pursuing a number of wind development opportunities in Australia and is building the world's southernmost windfarm, a three-turbine development at Ross Island in Antarctica.

Transmission constraints will continue to limit the ability of generators to supply customers until 2012, when the Cook Strait cable is to be upgraded, and further upgrades elsewhere in the national grid are completed. Some of these developments are still in the planning and consenting stages and the National Government has indicated an intention to increase the pace of this work.

The growth in alternative uses for water, primarily for irrigation of dairy farms in the South Island, has put additional pressure on water resources. The previous Government in August 2008 announced a proposed National Policy Statement (NPS) for Freshwater Management and to set up a Board of Enquiry to consider the proposed NPS and undertake consultation. It is not yet clear what the effect of the proposed changes to the Resource Management Act will be in this area.

The purpose of the proposed NPS is to help guide decision-making on freshwater management under the Resource Management Act (RMA) at national, regional and district levels. An NPS is a statutory document which provides direction to local authorities on how to address a resource management matter of national significance. It includes objectives and policies but not rules. Councils will still be responsible for setting local rules and standards for managing fresh water.

TrustPower

TrustPower generates electricity entirely from sustainable resources with no greenhouse gas emissions. This is important as New Zealand moves towards meeting its international climate change obligations and is in line with the New Zealand Government's long-term Energy Strategy. In New Zealand TrustPower has 36 small to medium hydro generating stations and a large wind farm, giving a total of 594 MW of totally renewable New Zealand generation. A wind farm at Snowtown in South Australia generates a further 98MW.

All of TrustPower's existing and planned new generation is located close to where the electricity is consumed. This minimises transmission costs and losses while providing some insulation from adverse regional climatic conditions. Where appropriate, TrustPower's existing and planned hydro generation facilities use water in association with local irrigation to ensure that the best possible use is made of the available resources.

TrustPower has a number of new generation projects in its development pipeline in New Zealand and Australia. In New Zealand canal-type hydro schemes are planned on the Arnold (South Island West Coast, 45 MW) and Wairau (Marlborough, 72 MW) Rivers. Both have been granted resource consents, but are now subject to the Environment Court Appeal process with positive outcomes anticipated before the end of the calendar year. Also in New Zealand, TrustPower has now been granted resource consents for wind farms at Mahinerangi in Otago (200 MW) and Kaiwera Downs in Southland (240 MW).

TrustPower is working on a number of smaller hydro developments, in some cases in conjunction with existing or proposed irrigation schemes. Wind resource monitoring is being undertaken at sites in both the North and South Islands where projected demand would justify development and agreements for land use and transmission capacity have been identified as having the potential to allow development.

In Australia TrustPower retains significant development opportunities at its Snowtown wind farm 140 km north of Adelaide, (some 200 MW of additional capacity), and at Myponga (48 MW), 50 km south of Adelaide. Wind resource monitoring is also being undertaken at other sites in South Australia and in other states where wind generation potential has been identified.

www.trustpower.co.nz

In summary, hydro generation will continue to be the major national source of electricity but most of the cheaper hydro generation resources in New Zealand have been exploited. This means that new hydro developments are likely to be limited and the electricity produced from them is likely to be more expensive.

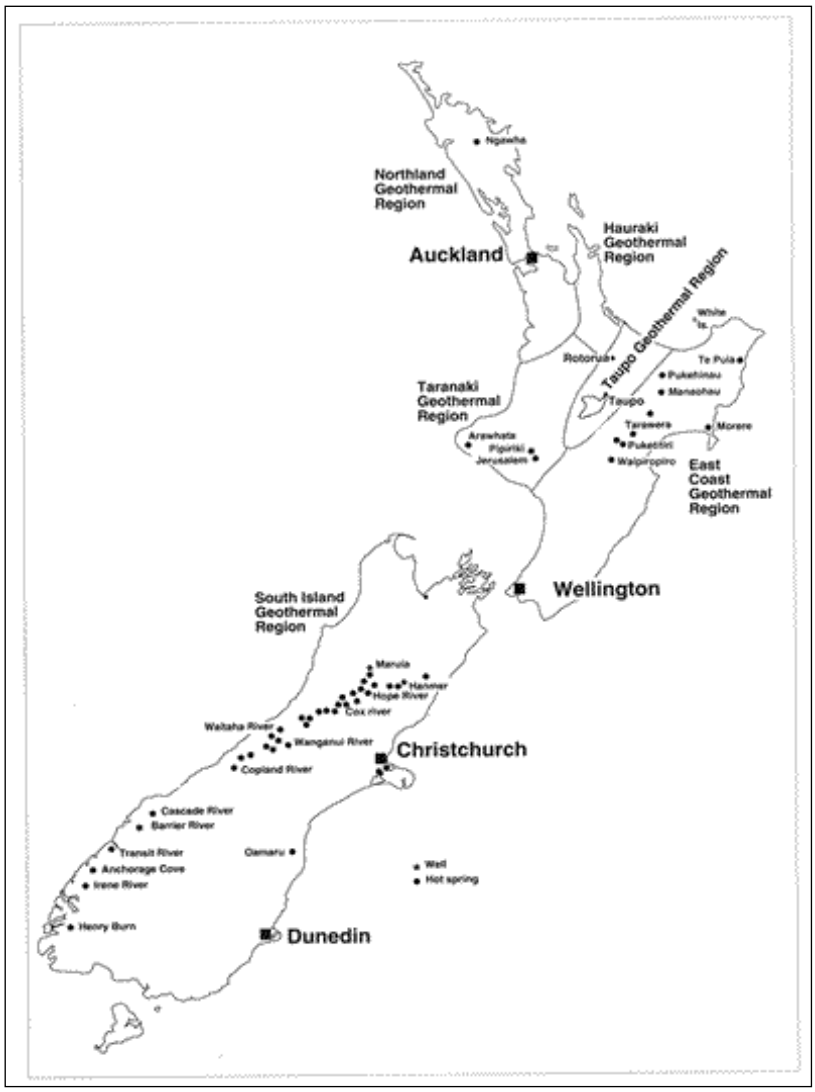
3.2 Geothermal

Surveys indicate that New Zealand has 129 geothermal areas, 41 with temperatures below 30ºC or unmeasured but only warm, and 88 areas above 30ºC. The latter can be broken into categories according to temperature: 30-69ºC - 52 areas, 70-140ºC - 14 areas, 140-220ºC - 7 areas, and >220ºC - 15 areas. Figure 3 shows the location of the geothermal fields.

The high temperature fields, which offer the most energy potential and provide almost all the present geothermal energy used, are found in the Rotorua/Taupo and Bay of Plenty regions, with the exception of Ngawha in Northland.

The potential for further use of high temperature fields for electricity production is constrained in some areas by preservation for scientific/tourism uses, but there are significant areas that can be developed provided landowner support is obtained. It is recognised by both Government and developers that geothermal electricity generation is one of the lower cost options so there is now accelerated development planned, with over 1,000 MW of electricity generation believed to be consentable and economically attractive. The potential of the lower temperature resources for direct heat uses or binary cycle electricity generation is large and little explored.

Figure 3: New Zealand geothermal fields



Source: New Zealand Geothermal Association

Currently there is approximately 580 MW of installed geothermal electricity generation, including more than 120 MW installed in 2008, this producing around 10% of national consumption at around 4,000 GWh/yr. A further 380 MW is currently under construction or through the consenting stage and expected to come on line over the next three years, and there is more than 340 MW in the planning or early consenting stages. Total potential generation exceeds 1,600 MW, or 13,000 GWh pa, from conventional and consentable resources.

In addition, there is approximately 10 PJ/yr of direct geothermal heat use, with this growing at around 1.5 PJ/yr.

Mighty River Power

Mighty River Power, a state-owned enterprise, is an integrated energy generation, trading, retailing and metering business. Its generation assets meet almost a quarter of New Zealand's peak electricity demand.

With a strong preference for renewable energy, Mighty River owns and manages a diverse and expanding portfolio of generation assets, including hydro, geothermal, gas and bioenergy throughout the North Island, and has advanced plans for significant investment in wind generation.

The company's major growth focus has been the development of geothermal energy resources. Mighty River Power has invested close to $1 billion in facilities such as the 100 MW Kawerau Geothermal Power Station commissioned in 2008 and the 132 MW Nga-Awa-Purua Geothermal Power Station now under construction.

In addition, it has exploratory drilling underway at Ngatamariki, north of Taupo. This $30 million exploration programme, which involves drilling at least three deep wells, will establish the extent of the geothermal reservoir ahead of the proposed lodging of consent applications in 2009 for a station expected to have a capacity of approximately 100 MW.

Mighty River's geothermal business is based on a shared ownership model with Maori Land Trusts. This model creates a large and diversified geothermal business with the scale to undertake high-risk exploration in new greenfield reservoirs. It has proven construction, technical and operational capability, which are all important in achieving strategic goals in geothermal.

By 2012, along with its partners, it aims to be producing enough geothermal energy to reliably supply approximately 8 percent, or around 3,500 GWh, of New Zealand's annual electricity requirements. Mighty River Power has also acquired a 25 per cent stake in a global geothermal company, GeoGlobal Energy (GGE), which provides international connections and opportunities as international geothermal investment options are pursued.

In addition to its geothermal focus, Mighty River continues to monitor a number of potential sites for wind generation around New Zealand and is actively seeking more sites for assessment. It has also been exploring ways to bring international scale and expertise to its wind projects in support of the goal of developing some 500 MW of wind generation by 2015.

www.mightyriverpower.co.nz

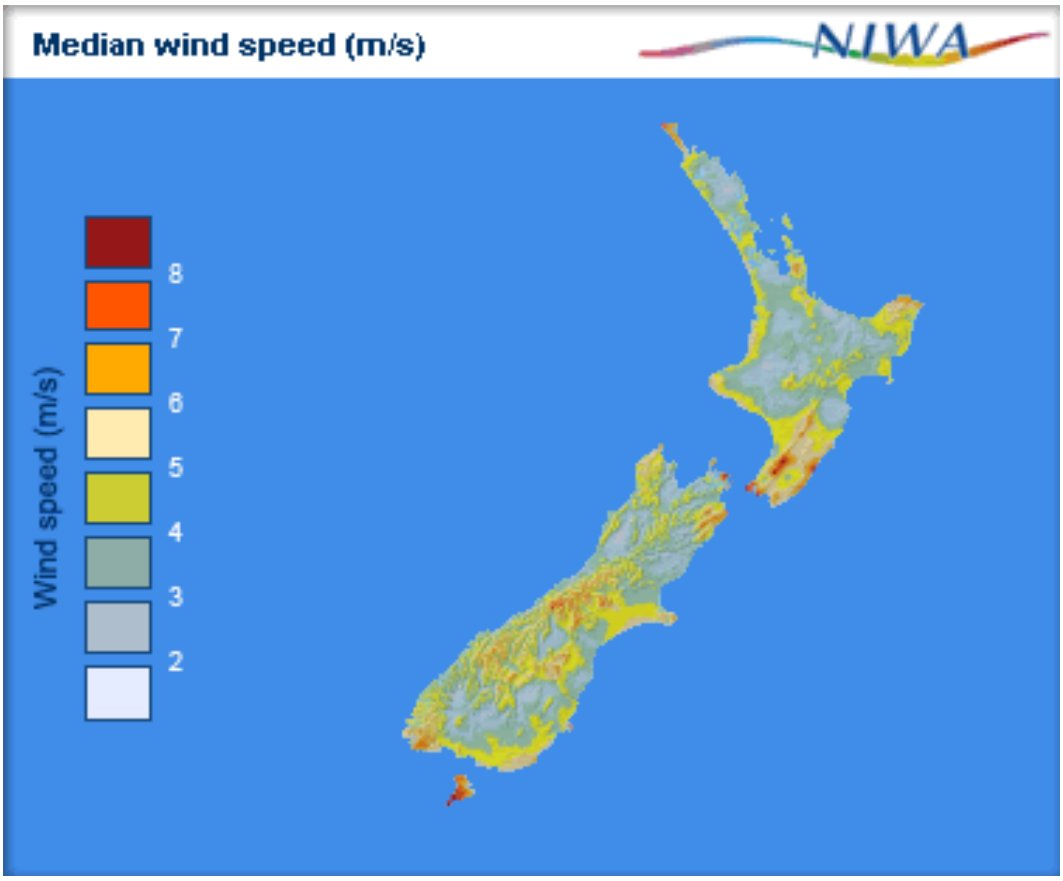
World-wide there is growing realisation of the potential of geothermal energy that is widespread at depth and can be developed using enhanced geothermal system (EGS) techniques now under development, in particular in Australia. Early stage research is now being undertaken into EGS applications in New Zealand and the thin earth mantle under New Zealand, particularly north of Taupo, suggests that deep heat could be a future source of energy, utilising these enhanced geothermal technologies.

Due to New Zealand's relatively temperate climate and low energy costs, use of ground source heat pump technology has just begun, but it is likely that the relatively high efficiencies offered by the technology will result in increasing uptake in the future for heat applications.

3.3 Wind

New Zealand is generally windy, thus providing a large resource as shown in Figure 4. However, development is likely to be constrained by community visual impact considerations, transmission and other system constraints, and the economics of lower wind-speed sites. The granting of consents for the construction of wind farms has been aided by changes to legislation requiring that the national need for renewable energy be considered as well as local considerations, and may be further facilitated by pending changes to the Resource Management Act.

Figure 4: New Zealand median wind speeds



Source: EECA

Currently New Zealand has 320 MW of wind generation capacity which in the year ended December 2007 provided over 2% of the total electricity generated at nearly 930 GWh.

Studies have indicated the potential to provide more than 12,600 GWh/yr from wind farms on sites with wind speeds of 6 m/s or greater and this estimate may be conservative. However there are practical limits to the proportion of wind generation the system can accommodate due to the fluctuating outputs from this source and periods without wind. Increasing the level of wind penetration requires an increasing level of reserve generation with the additional costs this imposes, though the hydro domination of New Zealand's generation means that this is less of an issue than with thermal dominated systems.

Windflow

Listed Christchurch company Windflow Technology Ltd is a manufacturer of wind turbines. It has developed the Windflow 500, a 500 kW machine with a range of innovative features designed for New Zealand conditions.

These features include a two bladed configuration with an active pitch control assisted by a pitch-teetering mechanism and torque limiting gearbox to absorb the energy of uneven wind gusts and reduce fatigue loadings and turbine weight. The unit is also fitted with a synchronous generator that allows for easier connection to the grid while its light weight means easier installation on difficult sites.

Production capacity in the Christchurch factory is currently 60 turbines per year and more than 100 units are committed or planned for wind-farms in the Tararuas and at Long Gully southwest of Wellington.

www.windflow.co.nz

A 2005 study prepared for MED and EECA suggested that the maximum level of installed wind capacity in the New Zealand system over the next 10 years was 35% of total generation capacity, giving a 20% market share in terms of electricity generated. During that time it was seen as conceivable that the development of the technology and more favourable economics would allow the limit to be pushed beyond that figure.

Most developed sites are in the North Island and while prospective sites under investigation are in both North and South Islands, development in the latter requires upgrades to transmission systems, most notably the DC link to the North Island. In December 2008 the status of New Zealand wind energy development was as shown in Table 2, indicating an intention to rapidly expand wind generation capacity. Some sites have been developed in stages but are reported as single entities.

Table 2: Existing and proposed New Zealand wind farms

Status	Number of Projects	Potential Capacity (MW)
Operating	8	322
Confirmed Resource Consents	8	903
Resource Consents under appeal to the Environment Court	2	730
Resource Consents sought or Carbon Credits allotted	10	1,592

Source: NZWEA

Details of the operating and consented windfarms are given in Tables 3 and 4.

Table 3: Operating Wind Farms

Wind farm	Operator	Region	Wind farm capacity (MW)
Brooklyn	Meridian	Wellington	0.225
Gebbies Pass	Windflow	Canterbury	0.5
Hau Nui	Genesis	Wairarapa	Total: 8.7
			Stage 2: 4.8
			Stage 1: 3.9
Southbridge	Energy3	Canterbury	0.1
Tararua	TrustPower	Manawatu	Total: 161
			Stage 3: 93.0
			Stage 2: 36.3
			Stage 1: 31.7
Te Apiti	Meridian	Manawatu	90.8
Te Rere Hau	NZ Windfarms	Manawatu	Operating 6, Under construction: 42.5
West Wind	Meridian	Wellington	140MW, progressively commissioned from May 2009
White Hill	Meridian	Southland	58
Total			462 (incl. Westwind)

Source NZWEA plus East Harbour

Table 4: Consented Wind Farms

Site	Developer	Project capacity (MW)	Region
Awhitu	Genesis	18	Franklin
Titiokura	Unison/Roaring 40s	Up to 48	Hastings
Hawkes Bay	Hawkes Bay Wind Farm	Up to 225	Hastings
Taumatatotara	Ventus	Up to 20	Waikato
Motorimu	Allco Wind Energy	Up to 68	Manawatu
Mahinerangi	TrustPower	Up to 200	Clutha
Te Uku	WEL Networks	Up to 84	Waikato
Kaiwera Downs	TrustPower	Up to 240	Gore

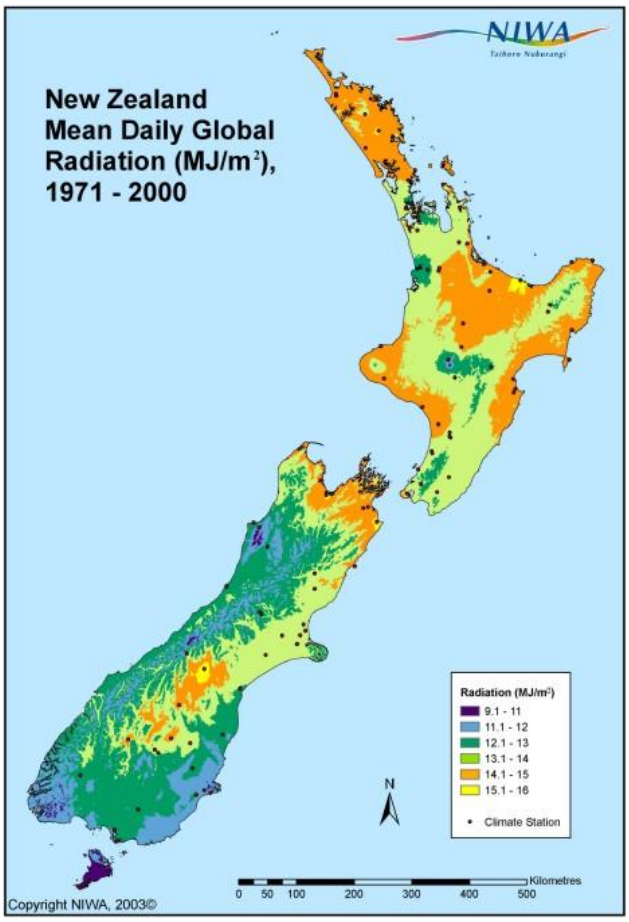
Source NZWEA

3.4 Solar

Solar energy, as indicated in Figure 5 is abundant in New Zealand, as it is overseas. It is currently expensive to harness, particularly for electricity generation, though costs are reducing as a result of research and development initiatives.

Solar energy is used, though not yet widely, for heating water in residential and commercial applications throughout New Zealand. There are a wide range of solar systems on the market and a network of suppliers and installers. Growth in uptake is small because of the current relatively low cost of gas or electricity heated water. The previous Government has introduced some measures, with limited impact to date, to increase the rate of uptake of solar water heating. These include support in areas such as industry standards and installation training, and modest grants for the installation of some packaged systems.

Figure 5: Solar radiation levels



Source NIWA

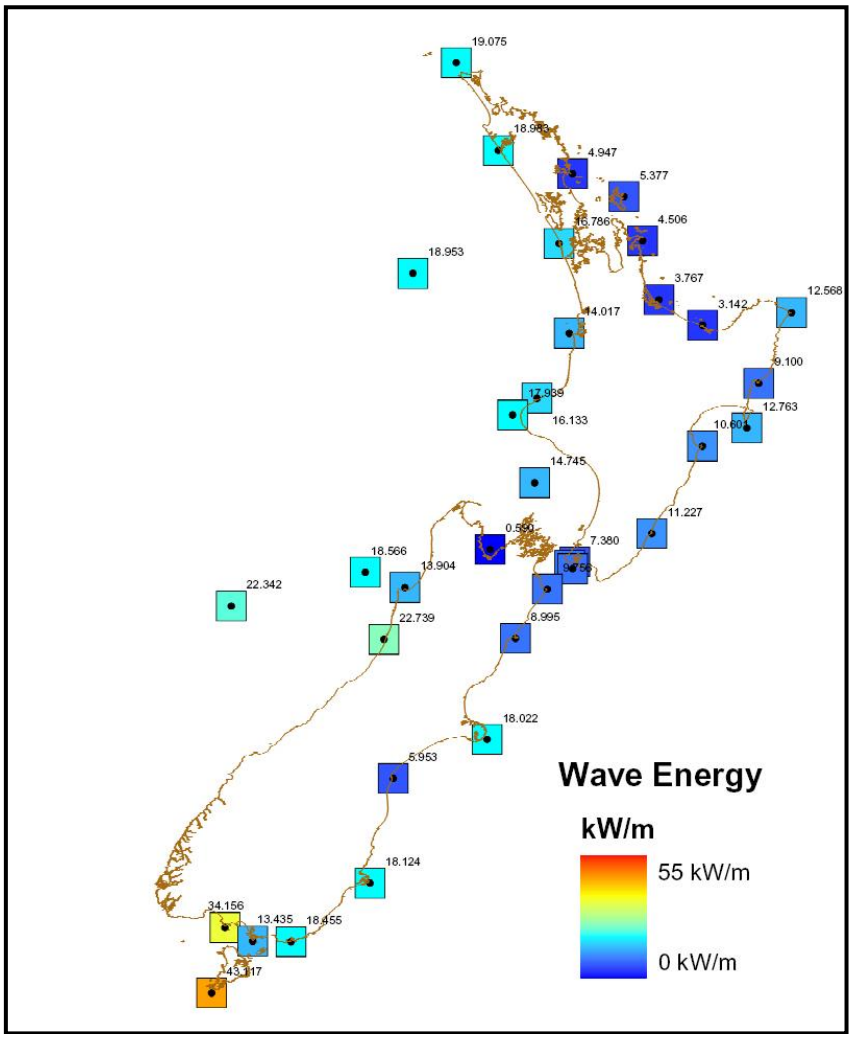
Generation from photovoltaic cells remains very expensive and the use of such equipment has been mainly limited to off-grid use, although some electricity retail suppliers will purchase grid connected photovoltaic generated electricity at the current market price.

3.5 Marine (Wave and Tidal)

New Zealand has a large coastline and wave energy resource, as shown in Figure 6, with a major driver being waves generated by the winds of the "Southern Ocean" hitting the western and southern coasts of the main islands. Average wave power can exceed 55 kW per metre of wavefront arriving on southern and western facing coasts.

Wave energy is intermittent while tidal movements and tidal currents are also intermittent, but predictable. The tide rotates anticlockwise around New Zealand's islands meaning that it is always high tide at one location around the country and low tide elsewhere, but New Zealand's tidal range is low at 2 to 3 metres. There are, however, a number of locations where the tidal currents are significant, particularly through sections of Cook Strait (Figure 6) as well as the "narrows" at the exits of some harbours, providing opportunities for tidal current devices.

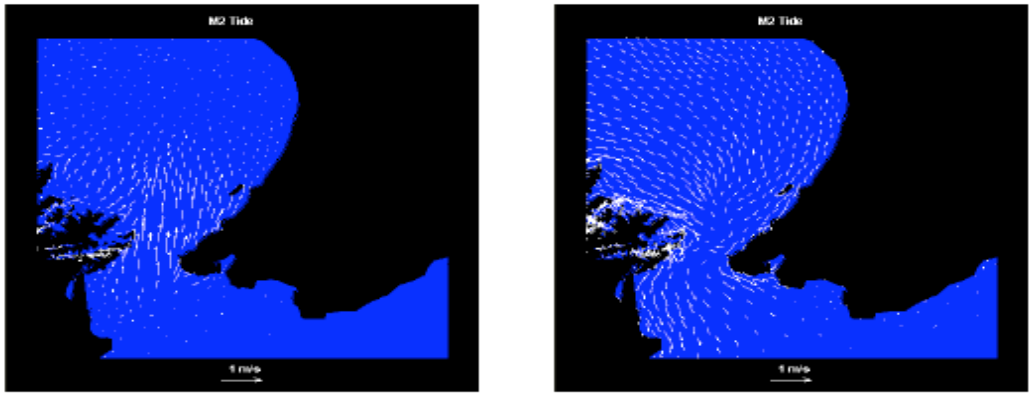
Figure 6: New Zealand average wave energies



Source: NIWA

In New Zealand a number of marine energy projects are in some stage of consideration. Of these, four projects in particular have received some publicity. Two are focussed on wave energy with Wave Energy Technology New Zealand developing a prototype wave energy device (their first stage experimental generator is capable of a peak output of around 2 kW of electricity) and Power Generation Projects planning to import a Pelamis wave energy converter.

Figure 7: Tidal currents in Cook Strait



Source: NIWA Source Frazerhurst, data courtesy of NIWA

Planning is underway for two tidal current power projects with Crest-Energy proposing to have two hundred 1MW turbine units on the sea bed in the deepest parts of the entrance to the Kaipara Harbour in Northland while Neptune Power plans to generate power from tidal turbines in Cook Strait.

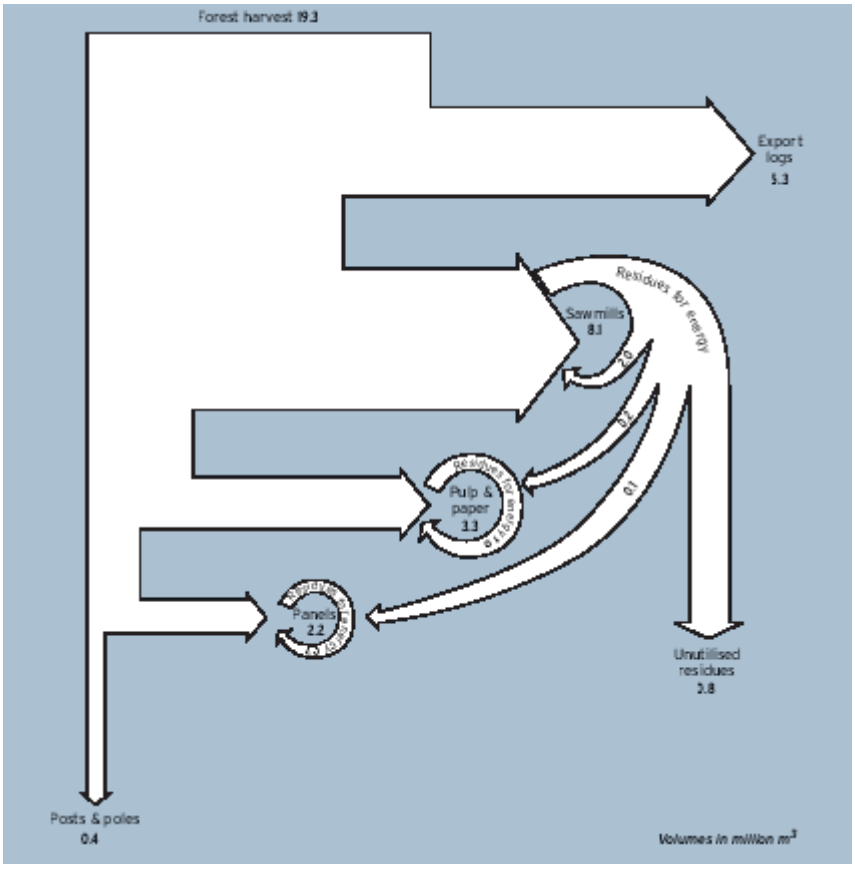
As wave power is variable it has some of the characteristics of wind generation, requiring other sources of electricity generation to cover the periods in which tides are not flowing, and integration into the national grid system may be limited.

Marine energy has considerable potential based on the large resource but the uptake of this technology is likely to be limited until the current very high costs become competitive with alternative generation technologies.

3.6 Biomass

There are a wide range of potential biomass feedstocks in total equating to around 27 PJ of energy per annum. Much of this resource is residues from forest or crop production and harvesting, a resource that is underutilised, or from timber processing activities (Figure 8).

Figure 8: National wood processing volumes and residue flows



Source: Bioenergy Options for NZ, Scion

High grade residues can be turned into valuable commodities such as wood pellets and chip, some of which are exported, while low grade residues from timber processing are largely used for heat production in on-site boilers, sometimes also producing co-generated electricity. Forest residues are beginning to be extracted from forests, and this is expected to increase while the trading and use of such residues for non-timber process heat is an emerging trend.

Wood pellets are now extensively produced, with the domestic market saturated and surpluses exported, providing a high quality low emission fuel for domestic and commercial heat production. A wide range of heaters and boilers are now imported to utilise the pellets which are a premium fuel and priced accordingly.

Wood Waste Fuel

Wood processing residues arise from sawmilling, pulp and paper manufacturing and panel production processes. Typical residue streams consist of sawdust, shavings, off-cuts, chip fines, bark, chip and log-ends. Wood waste as a fuel contributes around 45% of the energy currently used to dry timber, followed by gas and coal, and this proportion is increasing significantly.

With increases in gas prices, and to a smaller extent coal prices, wood waste is becoming a more economic fuel, despite the capital cost of new heat plants and there are some opportunities for co-firing of coal and woody biomass. Table 5 shows the estimated use of wood processing residues, demonstrating the waste and other uses that compete with energy.

Table 5: Estimated use of wood processing residues

	Landscape, Animal Bed, Mulch	Landfill	Fuel	Firewood	Chip	Panel Manufacturing
Sawdust	20%	18%	59%	-	-	3%
Bark	54%	15%	31%	-	-	-
Shavings	4%	5%	5%	-	-	5%
Trim and Sander dust	-	2%	43%	37%	-	-
Slabs or Chip	-	1%	1%	1%	97%	-

Source: Scion and East Harbour

Heat production is generally the primary reason for investment in new boiler plant, but cogeneration plant is generally uneconomic except at large scale or where electricity prices are higher due to transmission constraints, though the economics will improve with a carbon cost applied to hydrocarbon fuels which will lift electricity prices.

New Zealand Clean Energy Centre

The New Zealand Clean Energy Centre (NZCEC) is a government and industry funded non-profit organisation established in 2007 with a focus on accelerating the uptake of renewable energy in New Zealand. Its objectives include working with industrial and institutional heat users to develop business cases for switching from fossil fuels to renewable energy as well as identifying technologies and services that can improve and accelerate the viability of renewable energy use. In addition, NZCEC supports technology providers when it comes to accelerating the adoption of their solutions and is planning a new facility for a collaborative cluster of "physical" and "virtual" tenants, where clean energy demonstrations, education and events can also take place.

The renewable energy option most universally applicable to industrial and institutional heat users is biomass. Barriers to the adoption of this fuel for heating include uncertainty over availability and price; lack of familiarity with biomass technology; the capital costs involved in switching boiler systems; and a perception that burning biomass may result in emissions problems. NZCEC is working to address these barriers with several projects close to realisation.

NZCEC also has plans to build a 2000 square metre business center, exhibit and demonstration facility in Taupo, in the centre of New Zealand's North Island with construction scheduled to be completed in October 2010.

NZCEC enjoys the support of New Zealand Trade & Enterprise, Fitzroy Engineering and Energy for Industry, a business of Meridian Energy. It also has close links with a number of leading European organisations who provide technical support and extensive experience in biomass energy conversion.

www.nzcleanenergycentre.co.nz

Forest Residues
The harvesting of forests produces very large volumes of wood residues that can be collected and processed as a source of energy, and opportunities for such use are becoming economic where there are economies of scale. Residue collection and processing into a transportable and usable form is generally economic only in flat terrain locations but it is expected that forest residues will become more widely used over the next few years. Estimated supplies of forest residues are given in Table 6.

Table 6: Regional landing and ground based cutover residues supply (tonnes)

	2005-2010	2011-2015	2016-2020	2021-2025	2026-2030
Otago Southland	203,000	253,000	203,000	536,000	620,000
Canterbury	148,000	147,000	157,000	321,000	337,000
West Coast	23,000	21,000	17,000	37,000	52,000
Nelson Marlborough	212,000	271,000	204,000	476,000	330,000
Southern North Island	191,000	168,000	173,000	634,000	488,000
Hawkes Bay	134,000	199,000	78,000	416,000	342,000
East Coast	105,000	200,000	195,000	456,000	364,000
Central North Island	758,000	1,368,000	1,103,000	1,358,000	1,866,000
Auckland	91,000	125,000	80,000	194,000	145,000
Northland	280,000	565,000	438,000	461,000	509,000
National Total	**2,149,000**	**3,321,000**	**2,653,000**	**4,893,000**	**5,058,000**

Source: Scion

Energy Crops
There is a growing interest in dedicated energy crops for bioenergy use in New Zealand. At present the only commercial crop is canola, which is now grown in Canterbury for the production of biodiesel.

Crop trials underway include salix (a type of willow) and miscanthus, both of which have potential to displace coal and gas in heat and cogeneration applications but it is likely that a cost imposed on carbon emissions will be required to lift the price of alternative fuels so that these green fuels become economic. These crops are also of considerable interest as feedstocks for other high-value purposes such as the production of lignin and bio-ethanol, areas in which considerable research work is underway.

EnergyScape

Purpose-grown energy forests, if planted today, could meet all of New Zealand's future transport fuel and heat energy needs, without threatening the country's important agricultural industry, according to a study completed by Crown Research Institute, Scion.

This conclusion is outlined in the Bioenergy Options for New Zealand report completed by Scion as part of the EnergyScape programme. The report is the result of collaboration between Crown Research Institutes Scion and NIWA, and CRL Energy, with input from Landcare Research, Crop and Food Research, Waste Solutions and Process Developments.

More information on EnergyScape projects can be found at

http://www.energyscape.co.nz/

3.7 Hydrogen

Hydrogen, like electricity, is a carrier of energy, and like electricity it must be produced from an energy resource. Through its reaction with oxygen, hydrogen releases energy explosively in heat engines or quietly in fuel cells; in both cases water is the only by-product produced.

Industrial Research Ltd

Industrial Research Ltd (IRL) is a crown-owned science and technology company with an international focus and links. In the energy area it is developing a range of technologies, products and services intended to help maximise the efficient and sustainable use of energy resources. Research and development areas of expertise include distributed energy technologies, integration of fuel cells, solar, wind, biomass, geothermal and wave power:

***Hydrogen**. The company is involved in the development of production, purification and storage to provide options for future energy security and environmental management based around a hydrogen energy economy. IRL is prototyping hydrogen energy systems which converts surplus wind energy into hydrogen and then later use the hydrogen as a fuel. It has pioneered and is developing commercial wind-powered remote area power systems based on a low-pressure hydrogen pipeline concept, HyLink.*

IRL is also working on specific energy products which can be used by customers as components in a distributed generation system - including a new electrolyser design for the production of hydrogen from water using wind energy.

***Wave power.** IRL is leading a joint New Zealand-based research project to develop a cost-effective wave energy converter system. A design prototype has been developed and is being tested.*

***High temperature superconducting technology**. IRL is developing new materials and manufacturing technologies for energy-efficient, high-performance products such as magnets and coils. The enabling technology, cryogenic cooling, is being developed to help drive down the cost of the technology. Also under development is a fabrication process for low AC-loss superconductor cables comprised of multiple strands.*

The research programme supports HTS-110 Limited, a spin-off company which produces highly specialised industrial and scientific magnets, while IRL is also in partnership with American Superconductor Corporation for the development of high temperature superconducting wire.

***Fuel cells.** The company is developing technologies for distributed generation applications to provide a cost-competitive alternative to main grid supply. Research is also being conducted to improve the lifetime and efficiency of electrodes for fuel cells and electrolysers.*

***Carbon capture.** IRL is developing cost effective technology for the capture of carbon dioxide as a high purity phase, which permits this greenhouse gas to be readily managed for subsequent sequestration.*

www.irl.cri.nz

In 2002 the previous Government allocated funding to research into hydrogen technologies as a long term project to help position New Zealand to plan for a potential economy based on the wide distribution of hydrogen as a fuel, "the hydrogen economy". This has resulted in a number of projects including:

- Trials of technology for converting low rank coals to high purity hydrogen suitable for use in fuel cells
- Exploring options for community micro-generation, and developing and demonstrating viable combinations of renewable and hydrogen storage based small-scale energy systems
- Developing a method of generating high purity hydrogen using nanostructured ceramic membrane materials
- Design of a new solid state hydrogen storage materials system using chemical hydrides. This research is part of a wider collaborative International Partnership for the Hydrogen Economy programme with several international partners
- Development of a new patented process for generating high purity hydrogen from water using a New Zealand ironsand catalyst

3.8 Oil and Gas

New Zealand is self sufficient in the supply of natural gas, which is widely reticulated in the North Island but not available in the South Island, using around 155 PJ per annum over the last five years sourced from oil/gas wells in the Taranaki region. Gas supplies seem adequate to meet demand for at least the next 12 years with proven reserves of 2200 PJ. About 15% of gas consumption is presently used by the petrochemical industry, 60% for electricity generation and the balance reticulated to industrial plants and most major centres in the North Island for industrial, commercial and domestic use. Liquefied petroleum gas (LPG) is also collected from the Taranaki wells and much of this is distributed through local networks in the South Island which has no natural gas resources. There is a small trade in both export and import of LPG.

New Zealand's needs for liquid petroleum fuels are met by imports of refined products or by output from the local refinery using imported feedstock supplemented with a small amount of New Zealand produced crude. Crude oil is imported mainly from Australia, the Middle East and the Far East. New Zealand's crude oil and condensate production for the year ending September 2008 was 138 PJ, 133 PJ of which was exported. Its total use of liquid petroleum fuels for the period was 211 PJ.

Crown Minerals

The Crown Minerals Group manages the Government's "Crown Mineral Estate" covering New Zealand's state-owned oil, gas, minerals and coal resources; advising on policy and operational regulation, and promoting investment in the exploration and development of the Crown's mineral estate.

Investment in New Zealand's mineral resources has never been stronger. In a world looking for new oil and gas reserves, and strategic mineral resources, interest in New Zealand's mineral estate is extremely active.

Crown Mineral's aim is to maximise the mineral estate's contribution to the economy, in line with the Government's objectives for energy and economic growth. Through a focus on high-quality policy advice and excellent service the group delivers solutions that help make New Zealand an attractive place to do business, while securing client and investor confidence.

Crown Minerals is part of the Ministry of Economic Development and has three public-facing business units covering petroleum, minerals and compliance. Central to the successful development and management of the mineral estate are investment, advocacy, regulatory effectiveness and capability.

Key recent initiatives include the use of NZ$21 million of Crown funding between 2004 and 2007 to acquire new 2D seismic data across three petroleum basins (Great South, East Coast and Raukumara Basins) as well as to purchase previously closed file seismic data over a further two petroleum basins (Northland and Deepwater Taranaki). This data has been made freely available to industry. In addition, earlier this year 2D seismic data was also acquired over the Reinga Basin.

The data acquisition initiative has led to the successful award of exploration permits across three of these offshore basins with an aggregated work programme commitment by new permit holders exceeding NZ$1.4 billion over the next five years. The Raukumara and Northland Basins are currently the subject of a competitive tender allocation process (Petroleum Exploration Blocks Offers) and are generating considerable interest from international exploration companies. Further, a Reinga Basin blocks offer is scheduled to open late 2009

An online news service and technical database are maintained which provides free public access to investment initiatives, exploration data and maps. Permit holders, prospective explorers and the public can preview and access information by browsing catalogues and maps online with data able to be directly downloaded or ordered for delivery.

www.crownminerals.govt.nz

The New Zealand Refining Company Limited (NZRC) operates the only oil refinery in New Zealand, located at Marsden Point, near Whangarei. A refinery-owned pipeline transports about a third of the refinery's production to bulk storage facilities at Wiri in South Auckland, supplying the Auckland area, New Zealand's major petroleum market. Petroleum products are distributed to the rest of New Zealand by coastal tankers supplying port depots, or directly from overseas sources.

Deregulation of the oil industry in the late 1980s removed price control, Government involvement, licensing of wholesalers and retailers, and restrictions on imports of refined products. Ownership interests in petroleum distribution and retailing are dominated by international oil companies.

Hydrocarbon exploration and production in New Zealand has generally been focussed on the Taranaki region, though other regions have been explored to some degree. Sub-commercial discoveries of offshore gas have been found in the North Island East Coast area and the Canterbury and Great South Basins. Figure 9 shows the regional basins in and around New Zealand.

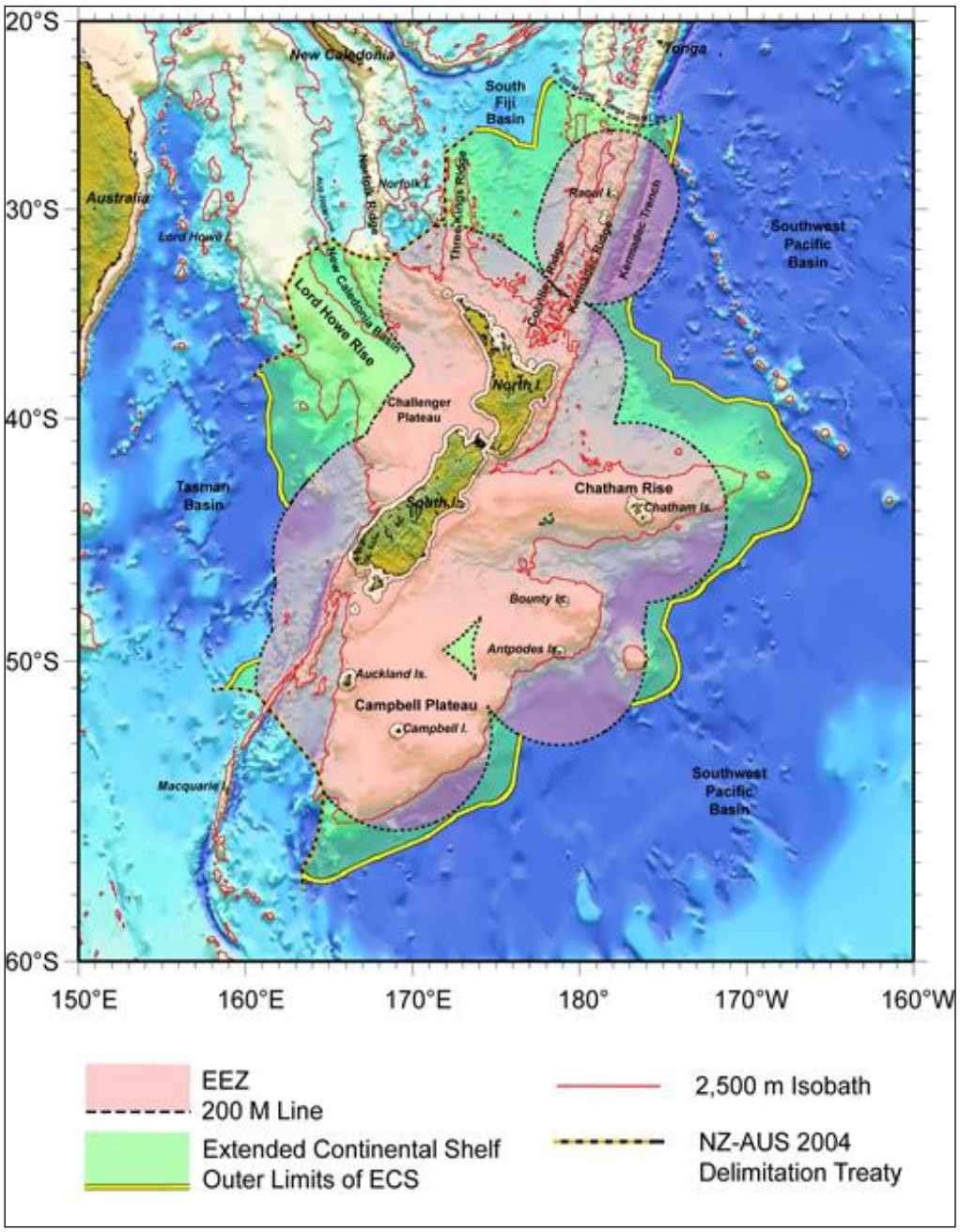
There are currently 10 fields producing crude oil, condensate and naphtha. New Zealand's oil production is now dominated by the offshore Pohokura and Tui fields following the decline in the Maui field. The Tui field, developed over 2006 and 2007, started production in July 2007 and the Kupe gas condensate project is now entering its last stage with the construction of the onshore production station near Hawera. Gas and condensate sales are expected to begin in late 2009.

New Zealand's maritime jurisdiction

New Zealand is 1,600 kilometres long with a total land area of 270,000 square kilometres and a coastline of 15,134 kilometres. Its maritime jurisdiction is large in comparison with the size of the country, covering 1,700,000 square kilometres.

Figure 9 shows the boundaries for the Exclusive Economic Zone, the extended continental shelf boundaries submitted to the Commission on the Limits of the Continental Shelf and the boundary agreed in the New Zealand and Australia Maritime Treaty. Boundary delimitation negotiations with Fiji and Tonga are still to be completed

Figure 9: New Zealand's maritime jurisdiction



Source: Land Information New Zealand

Offshore exploration

The previous Government introduced measures to encourage increased exploration and development of offshore and deepwater basins, which attracted increased attention as international prices for oil and gas increased resulting in petroleum exploration being at its highest levels for some years. Activity remained high by New Zealand standards during 2007 with 42 wells being drilled, while 30 had been drilled in 2006. Wells drilled during 2007 were in the onshore and offshore Taranaki basin, onshore East Coast basin and in the West Coast and West Southland-Solander basins (refer Figure 10). Of the 42 wells drilled in 2007, 26 were exploration wells and 16 were appraisal or development wells.

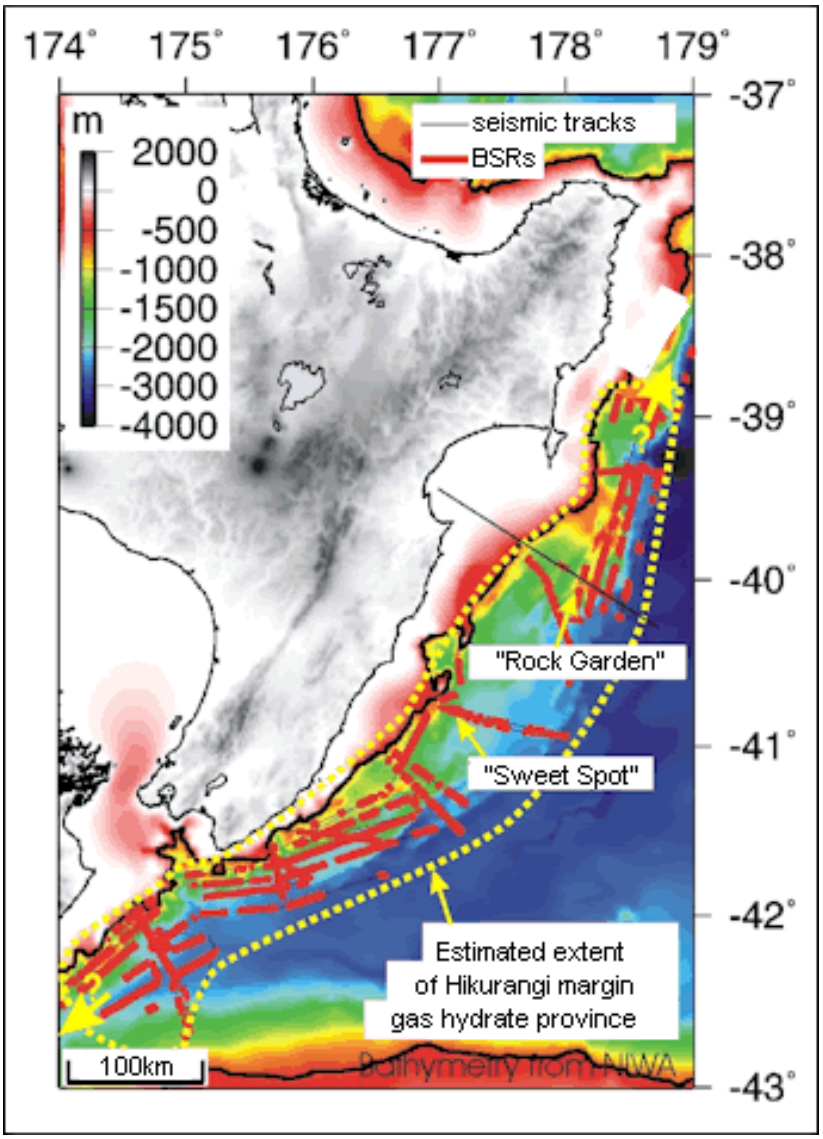
Figure 10: New Zealand gas basins

Source: Ministry of Economic Development 2006

Gas Hydrates

Frozen methane gas hydrates lie just below the seabed deep off New Zealand's east coast and may contain a resource of over 8 trillion cubic feet of natural gas. The sheets of gas hydrates, which are made up of ice-like crystals of water and methane molecules intermixed with sediments, are found over an area of 50,000 square kilometres offshore from Marlborough to Gisborne. There is also an area of gas hydrates about 2,500 square kilometres in area at the southwest of the South Island near Fiordland.

Figure 11: The gas hydrate province on the Hikurangi margin east of the North Island



Source: Crown Minerals

Coal Seam Gas

In November 2008 coal producer Solid Energy began producing the first electricity from coal seam gas at pilot wells west of Huntly in the North Island. Commercial scale production from the coalfield will depend on gas production estimates, the cost of drilling and the price at which the gas can be sold. The company has previously estimated that the area has a potential resource of 300 PJ of gas.

Another company exploring coal seam gas, L&M Coal Seam Gas Ltd, has estimated that they have gas volumes containing 780 PJ of gas from one area in South Waikato and 400 PJ in Southland and Otago.

More detailed information on New Zealand's petroleum industry is available from the Ministry of Economic Development's Crown Minerals website at http://www.crownminerals.govt.nz/petroleum/index.asp.
Also at GNS http://www.gns.cri.nz/research/gashydrates/what.html.

3.9 Liquid biofuels

The previous Government's encouragement for the production of biofuels through the introduction of the New Zealand Energy Strategy to 2050, the ETS, and the mandatory biofuel obligation (under which a small proportion of biofuel had to be blended into liquid fuels from 2008) led to the development of a number of biodiesel production facilities using waste oils, canola and tallow as the feedstock, and the localised blending of Fonterra produced ethanol into petrol supplied in some areas by Gull.

There are several groups investigating the growth of algae crops on sewage and other effluent ponds for conversion into biodiesel and crude oil. Two companies have produced small quantities of crude oil, which when distilled have produced synthetic paraffinic kerosene and biodiesel.

Companies in New Zealand are also developing technologies that convert forest residues to liquid fuels for transportation or power generation.

Scion

Crown-owned institute Scion has a long history in renewable energy research dating back to the 'Wood-to-Ethanol Programme' that was commissioned by the Liquid Fuels Trust Board in the 1970s. Scion undertakes a range of research and development activities in the area of energy from woody biomass, covering the whole production chain from resource establishment through to conversion. These initiatives include:

Woody biomass resources
Scion was the lead organisation in the 'Bioenergy Options for New Zealand' study funded by the Foundation for Research Science and Technology (FRST). This study carried out a strategic assessment of New Zealand's bioenergy potential and highlighted the key role that forestry could play in New Zealand's energy future. The study identified that there was the potential to produce enough woody biomass to supply 100% of New Zealand's liquid fuel needs and significant volumes of industrial heat. It also analysed that forestry is the most viable bioenergy feedstock option for New Zealand in terms of scale, environmental sustainability and economics; when compared with other biomass resources, such as agricultural crops, effluents and municipal wastes.

Building on this potential, further research at Scion has focused on short-rotation crops, multiple-use forestry and the application of biotechnologies for tree improvement.

Modelling and system analysis
Scion has developed a Geographic Information Systems model for biomass recovery to enable the assessment of potential volumes and delivered costs to centralised energy plants. The model can be used to optimise energy plant scale and siting, and to understand long-term feedstock supply security.

Conversion technologies
The New Zealand Lignocellulosic Biofuel Initiative is the largest bioenergy research programme at Scion. This FRST and industry-funded programme, based on New Zealand's softwood feedstocks, aims to develop a bioethanol process to pilot scale with a primary focus on the pre-treatment phase of making wood fibres more susceptible to enzymatic digestion so as to maximise co-product potential. In addition to liquid fuels, high-value products and chemical intermediates are also produced from the lignin by-products of the conversion processes.

Scion is working with a number of national and international partners on this programme, including BP New Zealand, BecaAMEC and the USA-based enzyme and bioethanol production company Verenium Corporation. Other current energy-related research involves re-fitting school and industrial boilers to wood pellet feedstocks and the development of novel thermo-chemical processes to enhance energy generation from municipal wastes and woody-biomass residues.

www.scionresearch.com

The blending of locally produced ethanol into petrol continues but the growth of biodiesel production is currently uncertain given the removal by the National Government of the mandated biofuel obligation. The economics of biodiesel production do not provide sufficient incentive for the installation of the required distribution systems for mass use and the market is currently confined to private sales.

The National Government has indicated that it intends to encourage biofuel use with a tax incentive. Under consideration is a tax potentially proportional to the level of biofuels in the fuel up to a maximum of 10%. (i.e. a 5% biofuel level in the fuel will attract a tax reduction of 5%, a 10% biofuel level in the fuel will attract a tax reduction of 10%) but it is not clear that this will be sufficient to foster production or the development of blending and distribution infrastructure by the oil companies.

LanzaTech

LanzaTech was founded in early 2005 to develop and commercialise proprietary technologies for the production of low-cost fuel ethanol from industrial waste gases. The company has attracted Series A investment from a US investor consortium led by Khosla Ventures, highlighting the potential of its technology in the field of ethanol production.

With this funding the company was able to expand the focus of its process development programme to include biomass-derived syngas (which contains elevated levels of hydrogen gas) so that its gas fermentation technology can be applied to the production of fuels from either industrial waste gas or waste cellulosic biomass (woody biomass) derived syngas. Almost any organic waste or biomass can be used, allowing a focus on those that are available in high volumes, are low value, and are non food (e.g. municipal waste, organic industrial waste such as tyres and waste wood).

In 2008 the company received additional funding from the Foundation for Research, Science and Technology enabling it to scale up its process to running a world first pilot plant at the Glenbrook steel mill in South Auckland.

Sean Simpson, CEO and CSO, says that the clear advantage of LanzaTech's approach is that through gasification over 90% of the energy is made available for fermentation, whereas more conventional technologies (for instance, cellulose fermentation) may only access the carbohydrate portion of the biomass.

LanzaTech's plan is to develop an ethanol production process that can be retrofitted to industrial facilities to generate ethanol from the carbon monoxide component of waste flue gases. Huge global potential is seen in making fuel from waste gases, which are produced in big volumes and are currently unutilized.

The LanzaTech process addresses the global need for cost-competitive low carbon transport fuel, with the flexibility to either be used to reduce GHG emissions from steel manufacture or to directly displace fossil fuels with biomass derived ethanol.

www.lanzatech.co.nz

3.10 Coal

New Zealand's total in-ground coal resource is approximately 15.5 thousand million tonnes of coal. The South Island contains just over 13 thousand million tonnes (84% of the total) largely in the huge lignite resource in the Southland region, which has 9.2 thousand million tonnes.

Just over half of New Zealand's coal is considered to be economically recoverable, with almost all of this in the South Island. The bulk of the recoverable resources are South Island West Coast bituminous coal and Otago and Southland lignite regions, plus sub bituminous coals in Waikato and Taranaki in the North Island.

Approximately 40% of New Zealand's current annual coal production is exported, mainly in the form of high quality South Island bituminous coal for use in the steel making industry. Some coal is imported for use at Huntly Power Station in the North Island, reflecting high mining costs in the areas coalfields.

Government-owned Solid Energy produces about 85% of New Zealand's total coal with a number of smaller private companies mining the balance. 70% of Solid Energy's sales are to the electricity and steel industries. With increasing exports a long-term trend of increasing extraction volumes continues.

Coal supplies about 5% of New Zealand's consumed energy supply (508 PJ for the year ending December 2007) with the majority used to generate electricity in steel making and some process heat applications. The need to supplement local production with imported coal suggests a shortage of coal but is in reality more a reflection of extraction difficulties and costs.

Solid Energy

For over a century Solid Energy and its predecessors have produced coal as a cost-effective fuel to power many of New Zealand's key energy-intensive industries and exporters, thereby assisting industries such as dairy, steel, cement, timber and industrial processing to remain competitive in world markets.

Today, Solid Energy is one of New Zealand's two largest producers of primary energy, producing more than 114 PJ a year, well over half of which is high-grade coking coal supplied to domestic and international steelmakers.

Alongside coal, the mainstay of its business, Solid Energy is developing some of the promising energy solutions that will help to power New Zealand's future: technologies such as biodiesel made from used cooking oil and rapeseed oil, and wood pellets from waste wood. Solid Energy is also actively investigating using the country's vast lignite resource for the production of transport fuel.

Already the largest wood pellet producer in the southern hemisphere, Solid Energy is commissioning a world-scale pellet plant in the central North Island – the heart of New Zealand's plantation forestry industry – and is investigating the potential for wood pellet exports. It has secured the long-term supply of wood residues needed to support this expansion.

From 2007 its Biodiesel New Zealand business trialled cultivation of a variety of European-sourced rapeseeds to determine which cultivars provide the greatest benefit in New Zealand conditions. In Autumn 2009 the firm completed its first commercial-scale harvest of locally grown rapeseed crops, built a facility to handle and store the crop and began a process of optimising its existing biofuel production capacity. It is now considering the timing, size and location of future biodiesel production facilities.

New Zealand has globally significant lignite deposits, much of these suited to a range of chemical processes. Solid Energy has secured access to more than 1.3 billion tonnes of lignite in Southland which the company believes can play a key role in securing the country's energy needs through a world-scale coal-to-liquid fuel plant. The company is evaluating a number of related technologies, including gasification to produce a versatile and energy-rich synthetic gas, and carbon capture and storage and biosequestration to manage the associated carbon footprints.

www.coalnz.com

There is considerable interest in developing the large resources of lignite in the South Island for use as feedstock for petrochemical processing into a range of products including liquid fuels, ammonia, and urea or dimethyl ether. However, the expectation of a carbon cost means that such production is unlikely unless carbon sequestration can be achieved; this being an area of considerable research activity by Solid Energy and other resource owners.

4. Government Energy-Related Policy

The following section covers the policy and legislative provisions relating to energy in New Zealand existing in February 2009, inclusive of the actions taken to date by the new National Government with a commentary covering prospective changes to the degree that they are understood or reasonably certain. The National Government is reviewing the Emissions Trading Scheme, the Resource Management Act and the New Zealand Energy Strategy, all of which will influence future energy developments.

While the detail of the National Government's policies is not yet clear in many areas, the policy direction of the National Government was outlined in the Minister's address of 24 February 2009 and the key points are outlined in the box below.

Key points from Energy and Resources Minister Gerry Brownlee's address to the National Power Conference, 24 February 2009:

The Minister is considering a Ministerial Working Party to reshape the regulatory functions of the electricity industry and sees the disentangling of these and the regulatory overlap between Transpower, the Electricity Commission and the Commerce Commission as a way to speed up investment in electricity transmission assets. The Minister had concerns at delays and potentially unnecessary duplication in national grid investment caused by the Electricity Commission's role in approving grid investment plans.

The National Government intends to issue a new Government Policy Statement on electricity governance along with a revamped national energy strategy. The over-riding goal of the strategy would be economic growth, with a focus on security of supply, affordability and environmental responsibility.

The Government would also be seeking a further round of seismic data to encourage hydrocarbon exploration, and would review the petroleum exploration regime to ensure it was "fit for purpose", attractive to explorers and extractors but also sensitive to environmental best practice. The existing minerals regime was also up for review.

The use of biofuels was supported by the Government. It was looking at applying a consistent tax incentive for sustainable liquid biofuels whether bioethanol or biodiesel.

Policies to encourage private investment in retro-fitting home insulation and further moves to try to maintain building industry activity during the recession would be announced later.

4.1 National Energy Strategy

The Government's overall objective with regard to energy policy is to ensure that electricity is delivered in an efficient, fair, reliable and environmentally sustainable manner to all consumers. This was set out in a Government Policy Statement on Electricity Governance, published in October 2004.

New Zealand, like the rest of the world, faces major energy challenges. One is to respond to the risks of climate change by reducing the greenhouse gases that are a by-product of the production and use of energy. A second is to deliver clean, secure, affordable energy while treating the environment responsibly.

Todd Energy

Todd Energy traces its roots back to 1929 as the first indigenous oil company in New Zealand and today remains 100% Kiwi owned and operated. It has investments in the gas, LPG, electricity and solar sectors and manages the flow of energy from exploration, production and generation through to delivery to customers via its retail brands Nova Energy and Bay of Plenty Energy.

As New Zealand's largest domestically-owned petroleum exploration and production company, Todd Energy has interests in major oil and gas fields including Maui, Kapuni, McKee, Mangahewa, Pohokura and Maari.

Since its acquisition of McKee and Mangahewa plant facilities near Tikorangi in North Taranaki in 2006, Todd Energy has expanded its gas export capability, boosted the oil recovery at McKee and drilled and completed Mangahewa 3 (MHW-3) with three more wells planned this year. Based on the results of the successful MHW-3 Well, upwards of 300 PJ of gas reserves could exist, elevating this field to the second largest in New Zealand behind Pohokura.

Todd Energy's electricity generation includes renewable hydro at Aniwhenua in Bay of Plenty, Mangahao Hydro Station and geothermal generation in Kawerau. It is the largest generator of electricity in New Zealand from efficient gas-fired co-generation facilities located in Edgecumbe, Kapuni, Whareroa and New Plymouth.

Two co-generation units at McKee were commissioned in 2008 that use waste gas to generate enough electricity and hot water to power 2000 houses annually. A further three units generate an additional 9 MW of electricity using gas sourced from the Mangahewa Field.

In conjunction with Wellington City Council, Todd Energy's retail subsidiary Nova Energy is harnessing landfill gas at Happy Valley Landfill in Wellington to generate electricity to power 1000 houses annually.

In October 2008, Nova Energy launched a solar/electricity plan whereby customers can install a SolarElite hot water heating system and pay for it over a period of five years via their energy bill. The system has been rigorously tested in Australia and is AS/NZS 2712:2007 certified.

Further renewable energy projects in progress or being evaluated include a hydro project on the upper Kaituna River and a number of potential wind-farms as well as investment in new tidal-generation technologies, smart electricity metering and energy efficiency audits.

www.toddenergy.co.nz

The "New Zealand Energy Strategy to 2050", launched in October 2007, sets out the previous Government's vision and an action plan to make that vision a reality. That vision is for a reliable and resilient system delivering New Zealand sustainable, low emissions energy services, through:

- Providing clear direction on the future of New Zealand's energy system
- Utilising markets and focused regulation to securely deliver energy services at competitive prices
- Reducing greenhouse gas emissions, including through an Emissions Trading Scheme
- Maximising the contribution of cost-effective energy efficiency and conservation of energy
- Maximising the contribution of cost-effective renewable energy resources while safeguarding our environment
- Promoting early adoption of environmentally sustainable energy technologies
- Supporting consumers through the transition

Key actions in the New Zealand Energy Strategy are:

Resilient, low carbon transport
To reduce greenhouse gas emissions overall, New Zealand must substantially cut emissions from transport. The previous Government set a target of halving domestic transport emissions per capita by 2040, and for New Zealand to be one of the first countries to widely deploy electric vehicles, this to be achieved by using more efficient and lower-impact transport modes, using alternative renewable fuels, increasing vehicle fleet efficiency, and reducing kilometres travelled through smarter planning.

Flotech

Flotech designs, manufactures, installs and services a diverse range of equipment in the energy sector, including industrial heat exchangers, gas purification drying and conditioning systems and gas compression equipment. Based in Auckland, it has operations in Sweden, Spain, Singapore and Australia. The company is ISO 9001 accredited.

Its Greenlane biogas systems are proprietary-designed solutions that deliver better than 97% pure methane for use as vehicle fuel or for supplementing pipeline gas. These use Ro-Flo vane type compressors to supply a packed column scrubber with raw gas to remove unwanted components. This is followed by a (patented) adsorber process producing a pure and bone dry gas as end product.

Unlike fossil fuels, which are in limited supply, biogas is extracted via processes that have previously consumed carbon (CO2) resulting in a naturally balanced cycle.

The company offers delivery of packaged technology solutions together with supporting installation and commissioning services to a worldwide client base backed by an applications engineering and service team.

While already exporting to many countries, Flotech sees further potential in the raft of legislation and attractive incentives to encourage faster and wider conversion to renewable energy sources in the USA and many European countries, as well as increasing demand from Asia.

www.flotech.com

Key initiatives included:

- Updating the New Zealand Transport Strategy in 2008. (This was completed in August 2008)
- Developing policies to encourage greater provision of public transport, cycling and walking
- Developing a New Zealand Domestic Sea Freight Strategy
- Developing average fuel economy standards for light vehicles at point of importation

- Establishing an expert advisory group to look at future vehicle technologies, such as biofuels and electric cars
- Introducing the Biofuels Sales Obligation on 1 April 2008. (This provision has now been repealed by the National Government which has indicated that it intends to encourage biofuel use with a tax incentive proportional to the level of biofuels in the fuel up to a maximum of 10% (refer section 3.9))

Security of electricity supply
Maintaining security of energy supply at competitive prices is essential for a modern economy. Energy efficiency, demand-side management and an increased diversity of electricity supply all contribute to high levels of security. Long term, security of supply depends on competitive markets, cost-effective demand-side response, greater use of renewables and a stronger national grid.

Genesis Energy

Genesis Energy is a state-owned energy company with activities in natural gas production, electricity generation and energy retailing. After a period of intensive capital investment in new gas production and electricity generation, including a highly efficient 400MW combined cycle gas turbine at Huntly, the company is now focused on new initiatives in the area of demand-side management and renewable energy.

The retail division of Genesis Energy supplies electricity, natural gas and bottled LPG to around 660,000 customers throughout New Zealand. In August 2008 the company signed an agreement with NGC Metering to bring advanced meters to the bulk of its electricity customers over the next five years and installation work commenced in February 2009. The advanced meter programme will provide a range of benefits to customers as well as to Genesis Energy. Customers will receive an accurate bill every month and will, over time, gain access to better information about their consumption and to a range of new peak and off-peak tariffs.

Genesis Energy operates four 250 MW coal and gas-fired generating units at Huntly and has annual carbon dioxide emissions of between three and five million tonnes, depending on generation volumes. Genesis Energy's primary sustainability objective is to reduce the carbon intensity of its generation portfolio to 30 per cent below 2006 levels by 2015. Apart from seeking operating efficiencies at Huntly, the company is pursuing new renewable energy development opportunities. It has concluded land use agreements in order to continue wind monitoring and feasibility studies for a potentially substantial wind farm in northern Wairarapa. It is advancing negotiations on a second wind farm development, also in the Wairarapa, and is continuing negotiations on two potential geothermal sites in the central North Island.

Genesis Energy will continue to contribute to research and development in the fields of carbon capture and storage and associated technologies as part of a long-term investment to lower the carbon intensity of its thermal generation portfolio. The principal vehicle for this is Genesis Energy's membership of the Australian Government's carbon capture and storage programme CO2CRC.

In the meantime, in response to the likely introduction of a New Zealand Emissions Trading Scheme, the company has formed a carbon trading team which is now establishing systems and acquiring carbon credits from the international marketplace.

www.genesisenergy.co.nz

Key initiatives include:

- The Electricity Commission's review of its reserve energy policy, to see whether any additional measures are required
- Developing national guidance under the Resource Management Act on electricity transmission
- Introducing amendments to the Electricity Industry Reform Amendment to relax some conditions around investment by lines companies

- Promulgation of regulations for distributed generation
- Developing gas wholesale and transmission market arrangements to make it easier to establish more flexible and secure gas supply arrangements

Low emissions power and heat
The Government has set a target for 90% of electricity to come from renewable sources by 2025 (based on delivered electricity in an average hydrological year).

Emissions pricing forms the core policy framework to support achievement of the target. The details of the Government's programmes for encouraging the use of renewable energy are set out in the New Zealand Energy Efficiency and Conservation Strategy.

Key initiatives include:

- The in-principle decision to introduce an Emissions Trading Scheme
- Development of a national policy statement for renewable energy in 2008
- Providing greater guidance on "call-in" under the Resource Management Act (note: the RMA is being reviewed by the National Government so this may change)

Using energy more efficiently
Historically New Zealand's use of energy has not been particularly efficient and the Government believes that energy savings should be made in areas where the savings are cheaper in the long run than the financial and environmental costs of supplying more energy. Such energy efficiency measures can reduce energy costs and greenhouse gas emissions, as well as providing other benefits to people, communities and the economy.

The New Zealand Energy Efficiency and Conservation Strategy (NZEECS) is the detailed action plan for whole-of-system energy efficiency. Energy efficiency initiatives are focused on reducing demand for stationary energy, which includes all forms and uses of energy services other than electricity and transport. The Government's role is in ensuring pricing and other incentives to encourage energy efficient choices, and in addressing barriers to energy efficiency.

Sustainable energy technologies and innovation
Affordable, energy efficient, low emissions technologies will be critical to improving New Zealand's security of supply and reducing greenhouse gas emissions, and ongoing technological developments will be fundamental to decarbonising the energy system over time. The Government's focus will be on supporting initiatives to build capacity and link participants from the research community, industry, and central and local government, and to bring forward adoption of low carbon, sustainable energy technologies.

Key initiatives include:

- A contestable fund (Marine Energy Deployment Fund) of $8 million over four years for the deployment of marine generation devices in New Zealand
- Establishment of a contestable fund of $12 million over three years to support new low carbon energy technologies (LCET)

Affordability and wellbeing
Historically New Zealand has enjoyed cheap and abundant energy. In recent years electricity prices have risen in response to growing demand, a re-allocation of costs between domestic and commercial customers, rising gas costs and to meet the costs of new generation facilities. Oil prices have also risen sharply, impacting on the transport sector particularly. The Government does not set prices for energy, but it can ensure that the market remains competitive to protect all customers.

Key initiatives include:

- Amending regulations for the low fixed tariff option for domestic electricity consumers to take into account regional climate variations that impact on heating costs
- Providing assistance for households to adjust to higher electricity prices arising from the introduction of emissions trading. (The nature of that assistance is under consideration)
- Supporting the provision of high-quality information to householders (including www.consumer.org.nz/powerswitch; www.smarterhomes.org.nz; www.fuelsaver.govt.nz)

Contact Energy

Contact believes that New Zealand needs to find new ways to generate electricity to meet increasing demand well into the future. It says that concern around climate change and the move towards carbon pricing will rule coal-fired generation out of the immediate mix while a lack of certainty around New Zealand's domestic gas supplies is a barrier to investment in gas-fired generation.

Contact is one of New Zealand's largest publicly listed companies, with installed generating capacity of 2,000 MW in hydro, geothermal and natural gas-fired power stations and more than 600,000 electricity, gas and LPG customers across the country.

It is the country's leading generator of renewable geothermal energy operating four geothermal power stations in the central North Island and is actively developing plans for more. Clean and with low carbon emissions, geothermal delivers baseload energy at very high levels of reliability. Alongside its current plant, Contact is currently constructing a $100 million 23 MW geothermal binary plant near Taupo and is working on developing two additional geothermal power stations in the area with a combined capacity of around 450 MW.
Contact is also developing options in wind energy. Two projects totalling more than 700 MW are in the resource consenting process and the possibility of further large-scale hydro development on the Clutha River in Central Otago is being investigated. The Clutha is already home to the company's Clyde and Roxburgh dams whose combined installed capacity is 752 MW.

While Contact continues to pursue a renewables-based strategy, there remains a role for the efficient use of thermal generation to support increasing volumes of weather-dependent renewables. It is currently constructing a 200 MW fast-start gas-fired peaking power station at Stratford to be operating by the winter of 2010 and designed to quickly respond to changing market conditions and periods of peak demand.

In order for this peaking station to run most effectively, a flexible supply of natural gas will be required. With gas supplies becoming increasingly fixed in nature, Contact is also developing the country's first underground natural gas storage facility in a depleted underground gas field near the Stratford peaking project. Costing around $250 million, the facility will be in operation around the end of 2010.

www.ContactEnergy.co.nz

4.2 Government Climate Change Policy

The Government has ratified the Kyoto Agreement and introduced a number of policy initiatives to reduce national greenhouse gas emissions. In 2002 it had been proposed that, in the first Kyoto commitment period 2008-2012, a charge on carbon dioxide emissions from fossil fuels be introduced. Late in 2005 it was announced that the proposed tax would not be introduced as it was felt that it would not cut emissions enough to justify its introduction.

In September 2008 the previous Government passed legislation setting up an Emissions Trading Scheme (ETS). The first sector to come within the scope of the ETS was forestry starting on 1 January 2008. Other sectors were to progressively come into the ETS through to 2011. The National Government has committed to Kyoto, but initiated a formal re-assessment of the whole climate change policy and there are uncertainties in how other policies linked to carbon emissions, such as Negotiated Greenhouse Agreements for major energy users and emitters, will be affected.

4.3 Emissions Trading Scheme

The aims of the Emissions Trading Scheme (ETS) are:

- Reducing New Zealand's net emissions below business-as-usual levels
- Complying with New Zealand's international obligations, including Kyoto Protocol obligations

The act is currently under review by a Climate Change Special Select Committee set up in December 2008. It is uncertain what possible changes will be made to the scheme, but it is expected that the ETS will remain in a modified form with some delays in timing to avoid exposing New Zealand businesses to costs that would damage their international competitiveness and to align the strategy with Australia's.

Current legislation remains in place until the Government makes changes following the review that is underway. The ETS has been described as a "cap and trade" system. Features of the current ETS scheme are:

- The primary tradable unit is the "New Zealand unit" (NZU). Each NZU would be backed by a Kyoto-compliant unit, primarily an AAU. (The ETS allows both sales to and purchases from international trading markets, but with some restrictions.)
- Firms (Participants) must surrender units to match the emissions they are responsible for. (One New Zealand unit must be surrendered to the Government for each tonne of emissions in a compliance period, usually a year.)
- Firms (Participants) may either reduce emissions, receive free units from the Government, or buy/sell units in the commercial trading market. (The allocation of free units is constrained to 90% of 2005 emissions.)
- A limit on the number of emission units (sometimes referred to as carbon credits) in the market creates a cap on emissions and gives the units an economic value
- Free emission units will not be issued to emitters where they are able to pass on the cost. This includes those in the fuel supply chain, stationary energy sectors (including electricity generators) and landfill operators. It is intended to reduce the free allocation of units to zero progressively between 2013 and 2025

Under the ETS, certain businesses ("Participants") will carry specific obligations. These businesses will be "points of obligation" under the scheme and will have an obligation to surrender tradable emission units, known as New Zealand Units or NZUs, to cover their direct emissions or emissions associated with their product.

Entry of the relevant business sectors ("Participants") into the scheme is staggered under the Act. The forestry sector has retrospective obligations from 1 January 2008, stationary energy and most industrial processes from 1 January 2010, liquid fossil fuels sector from 1 January 2011, and agriculture, waste, and industrial processes involving SF6, HFCs and PFCs from 1 January 2013.

While many businesses and consumers will have no obligations under the scheme the effects will be felt indirectly, primarily in a rise in fuel prices directly related to the carbon emissions their use generates.

4.4 Resource Management Act

The Resource Management Act (RMA) is New Zealand's primary environmental legislation. It is focussed on the sustainable management of resources and managing the effects that activities have on the environment. In its current form the RMA provides a guide to what is important in the environment, but generally leaves the decisions about how to manage the environment in the hands of the local community.

A national policy statement on electricity transmission was gazetted in March 2008 and a draft NPS for renewable electricity generation has been prepared. An independent Board of Enquiry has been set up to receive submissions on the draft. Public hearings on the draft NPS are to be held in May 2009.

RMA reforms
The RMA was enacted in 1991 and one of the National Government's priorities is to review the act. The first phase of the reform is to streamline and simplify the act. The National Government plans to amend the RMA in two rounds that began in February 2009. The first round will seek to:

- Streamline and simplify (consenting) procedures
- Provide priority consenting of major projects
- Reduce costs and delays
- Speed up plan-making processes
- Restrict (anti) trade competition, vexatious and frivolous objections

The establishment of a new Environmental Protection Authority (EPA) will be the subject of legislation later in the year. The EPA is not intended to be an advocate for the environment but a neutral agency. It will incorporate the functions of the Environmental Risk Management Authority and assume responsibilities for National Policy Statements (NPS) and National Environmental Standards (NES).

4.5 Gas Market Policy

A co-regulatory model of gas governance was introduced in October 2004. The industry body, the Gas Industry Company (GIC), is charged with making recommendations to the Minister of Energy which meet the Government's objectives for the gas industry as detailed in the Gas Act (1992) and the Government Policy Statement on Gas Governance (October 2004). Areas covered by the Statement include:

- Effective governance of the gas sector
- Effective wholesale market and processing arrangements
- Effective access regimes for transmission pipelines
- Access protocols across distribution networks
- Retail and consumer arrangements (e.g. natural gas prices, information disclosures, and Electricity and Gas Complaints Commission)

GIC is owned by industry shareholders which include a mix of industry and independent directors (and an independent Chair). It has power to make recommendations on a range of gas governance matters to the Minister of Energy and also to recover its costs by way of a statutory levy.

The GIC's current work programme can be grouped into work streams which:

- Enhance access to key infrastructure
- Improve efficiency of wholesale and retail markets
- Ensure optimal outcomes for consumers

This work is required to support the industry in its transition to a fully competitive market environment.

GIC is developing gas wholesale and transmission market arrangements to make it easier to establish more flexible and secure gas supply arrangements.

4.6 Energy Sector Governance

The New Zealand Energy Strategy (NZES) sets out the previous Government's vision of a sustainable, low emissions energy system and describes the actions that will be taken to make this vision a reality.

The energy efficiency and renewable energy sections in the NZES are supported by the NZEECS. The NZEECS is an action plan to help New Zealanders increase their uptake of energy efficiency and conservation measures and renewable energy.

Responsibility for delivering the NZES and NZEECS actions is shared across a number of departments and Crown entities including the Electricity Commission (EC).

A Senior Energy Officials Group has been established to oversee the implementation of the NZES and the NZEECS, and to coordinate the development of priority energy efficiency programmes. This group is led by the Ministry of Economic Development (MED), and includes

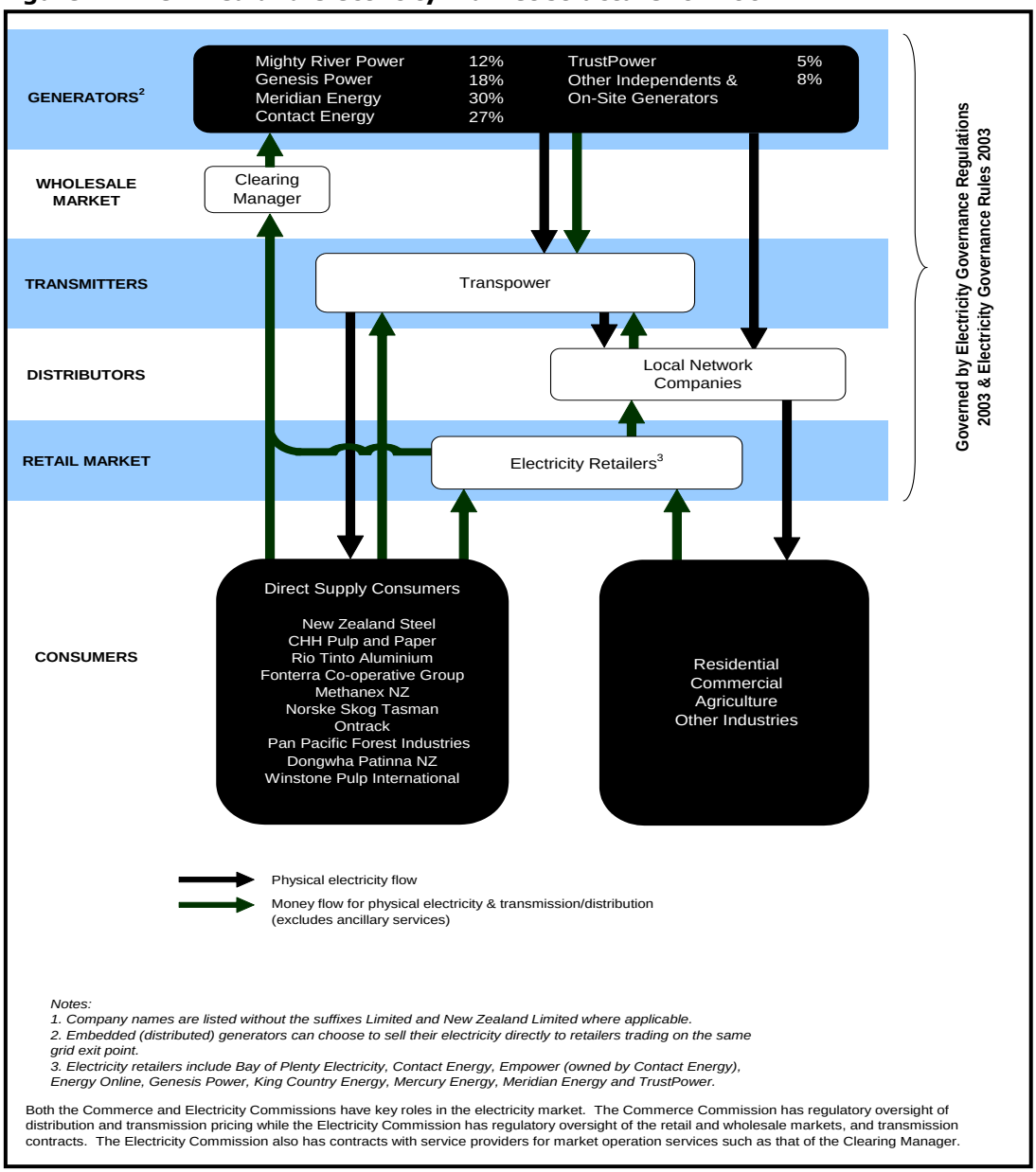
the EC as well as other relevant agencies such as the Ministry for the Environment (MfE), the Ministry of Transport (MoT), the Energy Efficiency and Conservation Authority (EECA) and the Department of Building and Housing (DBH).

EECA and the EC have a common objective: to promote the use of electricity in an efficient and environmentally sustainable manner. In November 2008 the EC and EECA reached a memorandum of understanding which sets out a framework as to how the parties will work together. The National Government has indicated an intention to review and overhaul energy sector governance.

5. The Electricity Market

The New Zealand electricity market (Figure 12) is a competitive market, being the subject of major reforms over the last 15 years. There is open entry to the market, subject only to compliance with market rules developed by the Electricity Commission.

Figure 12: New Zealand electricity market structure for 2007



Notes:
1. Company names are listed without the suffixes Limited and New Zealand Limited where applicable.
2. Embedded (distributed) generators can choose to sell their electricity directly to retailers trading on the same grid exit point.
3. Electricity retailers include Bay of Plenty Electricity, Contact Energy, Empower (owned by Contact Energy), Energy Online, Genesis Power, King Country Energy, Mercury Energy, Meridian Energy and TrustPower.

Both the Commerce and Electricity Commissions have key roles in the electricity market. The Commerce Commission has regulatory oversight of distribution and transmission pricing while the Electricity Commission has regulatory oversight of the retail and wholesale markets, and transmission contracts. The Electricity Commission also has contracts with service providers for market operation services such as that of the Clearing Manager.

Source: Ministry of Economic Development 2008

The electricity generators offer generation from their power stations in half-hourly blocks. Retailers indicate possible electricity demand requirements and the market operator determines the price to be paid for each half hour by stacking up from the lowest price offered until demand is met. The highest price then applies to all generation in that half hour period.

The market is operated under the Electricity Governance Regulations 2003 and Electricity Governance Rules 2003. Generators and purchasers of electricity can also enter into hedge contracts to manage the financial risks of trading electricity at spot prices.

The grid operator (Transpower - a Government-owned entity) coordinates with the market operator who determines the sources of generation to ensure that electricity is supplied adequately and safely. Electricity is transmitted nationally by Transpower, while local electricity distribution is by 24 network companies.

Oversight of the electricity industry is by the Commerce Commission with regard to pricing and competitive behaviour, while the Electricity Commission is responsible for supply security and other activities.

5.1 Electricity Market Regulation

The New Zealand energy market has been characterised by light-handed regulation, but since 2003 the Electricity Commission has taken a significant role in coordinating and facilitating efficient market operation.

Natural monopoly elements (the lines companies and Transpower) are free to operate under information disclosure regulations with the provision for price control if circumstances require. The generators compete with one another and are free to operate independently or combined with retail activities.

The Commerce Commission has regulatory control for the "lines business" and has a threshold regime for price control. The threshold regime requires the line companies to ensure their price paths are on a "CPI minus X" declining basis to avoid Commerce Commission scrutiny and possible control, i.e. prices should not increase by more than CPI minus an efficiency factor of "X".

5.2 Electricity Commission

The Electricity Commission was established in 2003 following concerns from the previous Government that the existing industry arrangements did not provide for the effective management of the sector and that the existing governance arrangements did not ensure security of supply in dry years. The Electricity Commission has extensive powers to regulate to achieve its aims.

The Electricity Commission must operate in a manner that is consistent with the New Zealand Government's Government Policy Statement (GPS). It regulates the operation of the electricity industry and markets (wholesale and retail) in accordance with the Electricity Act and Government energy policy.

The Electricity Commission's principal objective, as set out in the Electricity Act, is to ensure that electricity is produced and delivered to all classes of consumers in an efficient, fair, reliable and environmentally sustainable manner. It is also required to promote and facilitate the efficient use of electricity.

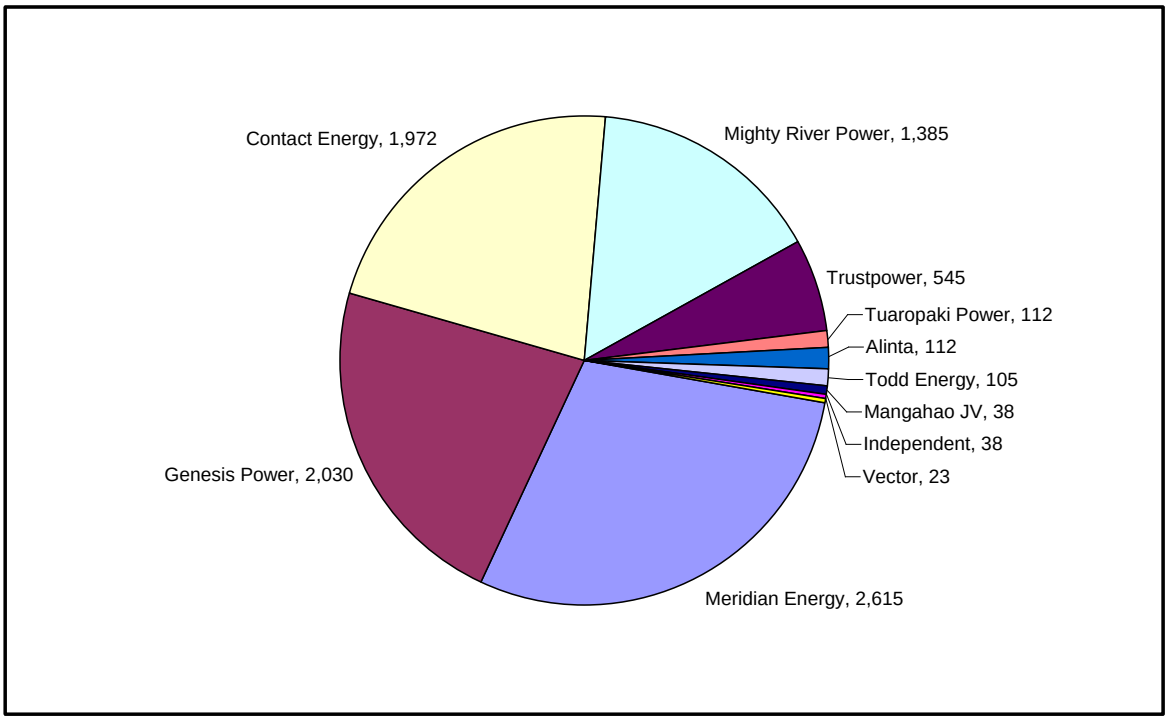
The GPS outlines the Government's expectations for the effective operation of the electricity market and identifies three priority areas:

- Security of supply and reserve generation
- Priority investment in the transmission grid
- Hedge market arrangements and demand-side participation

5.3 Electricity Generators

Anyone can be an electricity generator. If they generate only for on-site consumption there are no permitting requirements in addition to those generally required by anyone for any land use or building construction.

Figure 13: Generation capacity (MW) at December 2007



Source: Ministry of Economic Development 2008

There are five large generator companies, three of which are Government owned, and a number of smaller ones (Figure 13). In addition there are a number of industrial companies who have on-site generation. A generator is free to sell electricity to anyone directly or through the electricity market mechanism.

The growth in generation from wind energy has opened up the opportunity for other companies to become generators. While developments to date have been carried out by existing generator companies, both private and lines companies have plans for new wind farms.

Electricity generators can also act as retailers, but cannot own transmission lines unless they are directly to a customer. Although independent generators or retailers are possible, in practice the trend has been for independent retailers to be taken over by major generators as the generators try to balance their generation and retail portfolios through provision of an internal hedge on generation. As these large generators are also retailers, details of these companies are given in the Retailer section 5.4.

Distributed generation

Distributed generation is expected to play an increasingly important role in meeting electricity demand in the future. The Electricity Governance (Connection of Distributed Generation) Regulations 2007 are designed to ensure that there are no unnecessary barriers to such development and to enable connection of distributed generation where this is consistent with the required standards. A number of the distribution companies have agreements that will allow connection to their grid.

Whisper Tech Limited

Whisper Tech Limited is a developer and manufacturer of micro combined heat and power systems (microCHP) utilising Stirling engine technology. The company, formed in 1995, is based in Christchurch and owns several worldwide patents for its WhisperGen® heat and power systems. The major shareholder of Whisper Tech Limited is Meridian Energy, the largest electricity generator in New Zealand.

The company offers two innovative products for on and off-grid applications that share the same core Stirling technology.

The AC WhisperGen® is an on-grid heat-demand led microCHP system designed for domestic home use. This product is essentially a boiler replacement with the ability to supplement the electricity supply to a domestic household. The product produces between 7 and 12 kW of thermal output and 1 kW of electrical output at very high overall thermal efficiency. Where regulations permit, unused electricity can be exported back through the grid resulting in lower power bills. The result is cheaper energy costs, reduced dependence on mass energy production and a reduction in CO2 emissions overall.

A joint venture company was established in Spain at the end of 2008 to manufacture and distribute the AC WhisperGen™ microCHP product to the European market for residential applications and is expected to become available in selected parts of continental Europe and the UK from mid-to-late 2009.

The DC WhisperGen® is an electricity-demand led off-grid microCHP system that is essentially a fully automated battery manager that supplies heat in the form of hot water as a secondary function. Capable of producing 800 W of electrical output and 5.5 kW of thermal output, it is designed for marine, remote off-grid power applications and integrated solutions. This off-grid system is available via a global distributor and service network.

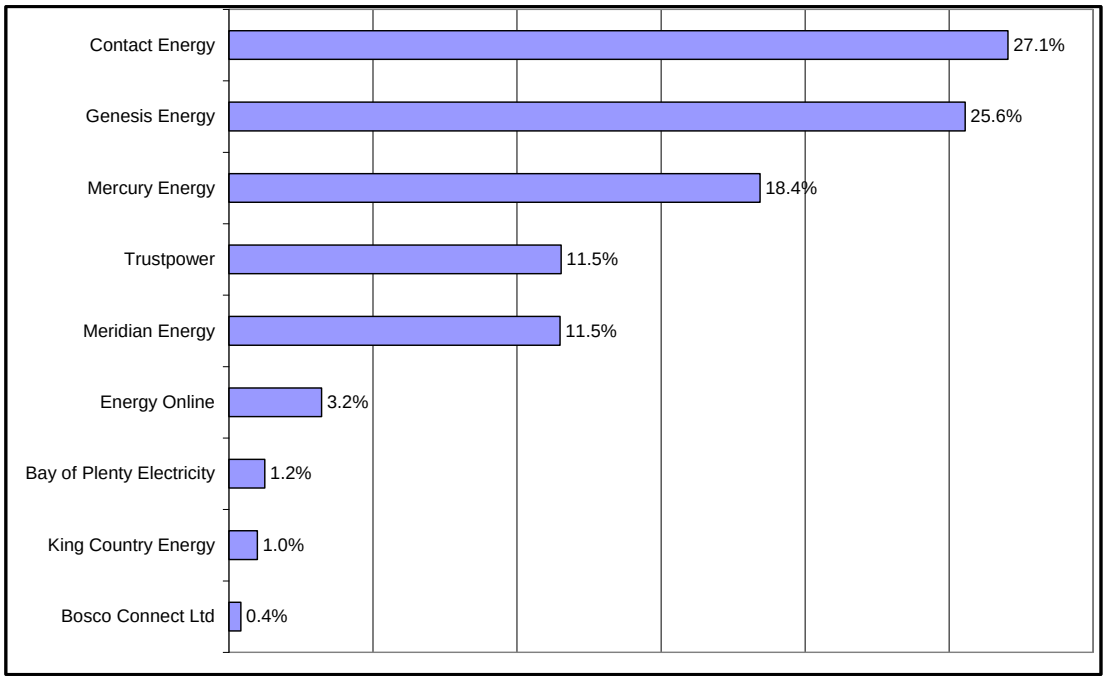
www.whispergen.com

The Government is encouraging the uptake of distributed generation through such programmes as EECA's pilot feasibility study fund. Seventeen studies have been funded by EECA so far with projects covering wind, hydro, geothermal, biomass and biogas. Details can be found at http://www.eeca.govt.nz/renewable-energy/distributed-generation/funding.html

5.4 Electricity Retailers

The 1.94 million energised Individual Connection Points (ICPs) at March 2008 were shared by the retailers as indicated in Figure 14.

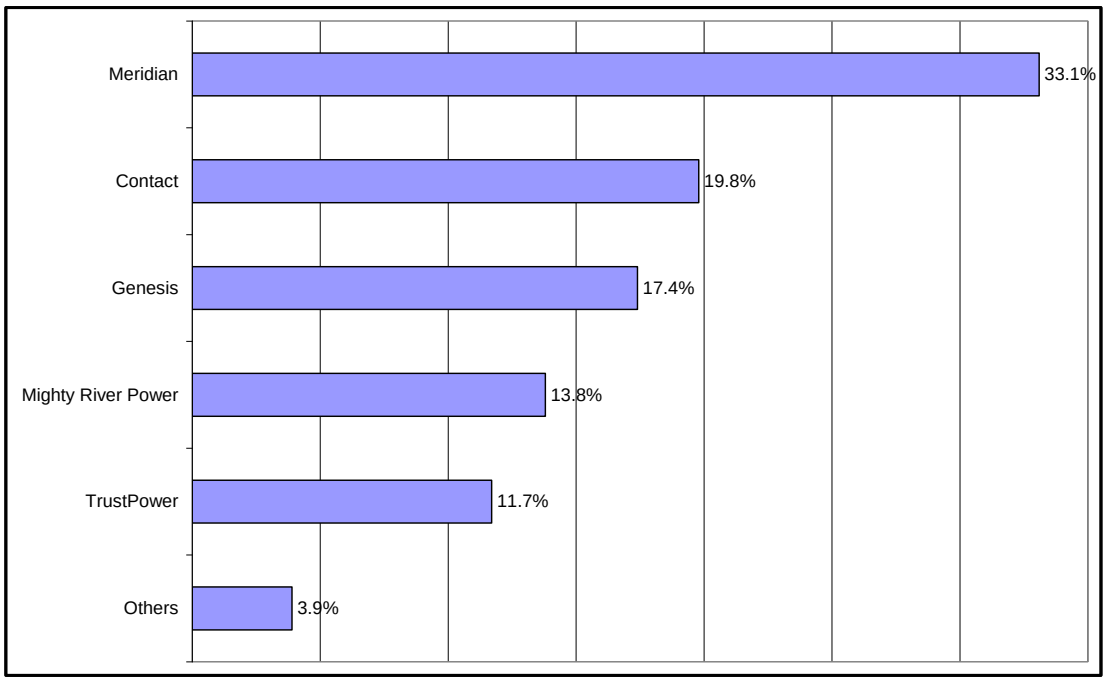
Figure 14: Electricity retail market share by total number of customers (for the month of March 2008)



Source: Electricity Commission 2008

Figure 15 shows the percentage of total electricity purchased by each retailer from the clearing manager in March 2008. Retailers with less than 1% market share are grouped together under "Others".

Figure 15: Retailer Market Share of Electricity Purchased from the Clearing Manager – March 2008



Source: Electricity Commission 2008

Details of the major electricity retailing companies are given below. The market share is based on quantity of electricity sold, as recorded by the Electricity commission at March 2008, rather than on number of customers. The generation portfolio of plant greater than 10 MW is summarised in Table 7.

Table 7: Generation Portfolio (greater than 10 MW)

Generator	**Renewable**				**Fossil**			
	Hydro	Geothermal	Wind	Other	Gas	Coal	Oil	Other
Meridian Energy	2466		149					
Contact Energy	752	281			784		155†	
Genesis	501			40	489	1000*		
Mighty River Power	1090	125			170			
TrustPower	384		161					
Todd Energy	25				80			
Other	61	137		13				112
Total	**5279**	**543**	**310**	**53**	**1523**	**1000**	**155**	**112**

* The plant can be operated on coal or gas or both
† Reserve generating plant

Meridian Energy (33% market share) – a state-owned company. Generation is predominantly from South Island hydro generation but Meridian is becoming the major developer of wind farms. All generation is from renewable sources. The company retails nationally at domestic, small to medium enterprise and industrial level. The high energy retail level in Figure 12 compared to the number of ICP in Figure 11 is due to the sale of large volumes of electricity to Comalco's aluminium smelter and to other industrial customers.

Contact Energy (20% market share) – a publicly listed company. Generation assets include some South Island hydro generation, geothermal generation in the central North Island, gas-fired generation (both simple cycle and combined cycle) in the Taranaki area and in Auckland. Also operates the state-owned standby plant at Whirinaki. The company retails nationally at the domestic, small/medium enterprise (SME) and industrial level. It has been trading on the retail gas and electricity markets using both its *Contact* and *Empower* brands.

Genesis Power (17% market share) - a state-owned company. Generation is from the 1400 MW Huntly coal and gas-fired power station (south of Auckland), and from hydro and wind power stations (all in the North Island). The company's retail activities are focussed on the North Island although commercial customers are nationwide. It retails gas and electricity under the *Genesis Energy* brand.

Mighty River Power (14% market share) – a state-owned company. Generation is from a series of hydro stations on the Waikato River (upper central North Island), with further interests in geothermal generation and landfill gas (all in the North Island). The company's retail focus has been mainly in Auckland, but offers contracts and hedges nationally to industrials. It retails under the *Mercury Energy* brand.

TrustPower (12% market share) – a publicly listed company. Generation is from small hydro plants spread nationally and wind generation from their 160 MW Tararua wind farm. The company retails nationally, with a considerably larger retail base than its generation base. It relies on purchasing hedges off other generators to be able to contract for supply to its industrial customers.

Todd Energy (4% market share) – a subsidiary of the Todd Group. Electricity generation is all North Island-based including hydro, geothermal and natural gas fired cogeneration. The company retails through *King Country Energy* and *Bay of Plenty Electricity*. Also a major player in the gas market.

5.5 Transpower

This Government-owned company owns and operates the high-voltage transmission grid (the national grid) which transmits electricity throughout New Zealand. The grid comprises approximately 12,000 km of transmission lines and 170 substations and switchyards. Transpower is responsible for the real-time co-ordination of electricity transmission throughout New Zealand.

Transpower also provides scheduling and despatch services and maintains the common elements of quality of supply for the electricity industry.

A new regulatory framework for transmission investment and pricing was established in 2004. The process requires the Electricity Commission to publish a Statement of Opportunities, which is an assessment of the future adequacy of the electricity system. The Electricity Commission also develops grid reliability standards and a grid investment test, which are used to guide grid upgrade plans. Transpower submits proposed grid upgrade plans to the Electricity Commission for assessment, which will include the consideration of alternatives to specific investments. Transpower may recover the costs of grid investment that have been approved by the Electricity Commission subject to any incentives or constraints imposed by the Commerce Commission under Part 4A of the Commerce Act.

New Zealand's HVDC Link
A high-voltage direct current (HVDC) link, first commissioned in 1965, connects the electricity supply systems of New Zealand's North and South Islands. The capacity of the link is 1040 MW and it operates at voltages of 270 kV and 350 kV.

The link generally sends electricity from the South Island to the North Island. Electricity is converted from alternating current (AC) to direct current (DC) at Benmore in the Waitaki Valley, and then transmitted over 535 km to the shores of Cook Strait, where undersea cables carry the electricity 40 km to the North Island. At Haywards in the Hutt Valley, the electricity is converted back from DC to AC and injected into the national grid.

One of the cables was unexpectedly decommissioned in 2008 because of its age and condition and potential costs of failure. Its replacement is not expected to be in service until 2012. This has added a considerable constraint to the amount of electricity which can be transferred between the North and South Islands, which had been increasing in recent years, and is likely to increase electricity costs in the South Island and lower North Island.

5.6 Grid Constraints

Wholesale prices in New Zealand are at times subject to variance due to grid operating security issues with the grid owner/operator Transpower, which dispatches electricity from generators to load centres setting constraints to maintain n-1[1] security on transmission during maintenance or fault events. These pricing signals encourage retailers to source electricity from other parts of the grid, reducing load on the constrained transmission line(s).

The Electricity Commission has been tasked with ensuring electricity supply constraints are removed under a decision-making process in relation to grid investment provided in Part F of the Electricity Governance Rules 2003 (Rules). Under the Rules the Electricity Commission is required to undertake a review and consult with interested parties on the grid investments proposed in the Grid Upgrade Plan. This process must also consider whether alternatives to transmission might defer or replace transmission investments.

There is concern that supply capacity to the Auckland region will present major constraints in the next five to 10 years. Transpower is advocating major grid upgrades or completely new supply lines into both Auckland and Christchurch to overcome predicted constraints and the Electricity Commission issued a draft decision declining Transpower's plan to build a new 400 kV line into Auckland. A revised proposal was then submitted by Transpower and approved by the Electricity Commission. Using their statutory powers under the Resource Management Act, Transpower designated a transmission corridor for the line. Because of its national significance

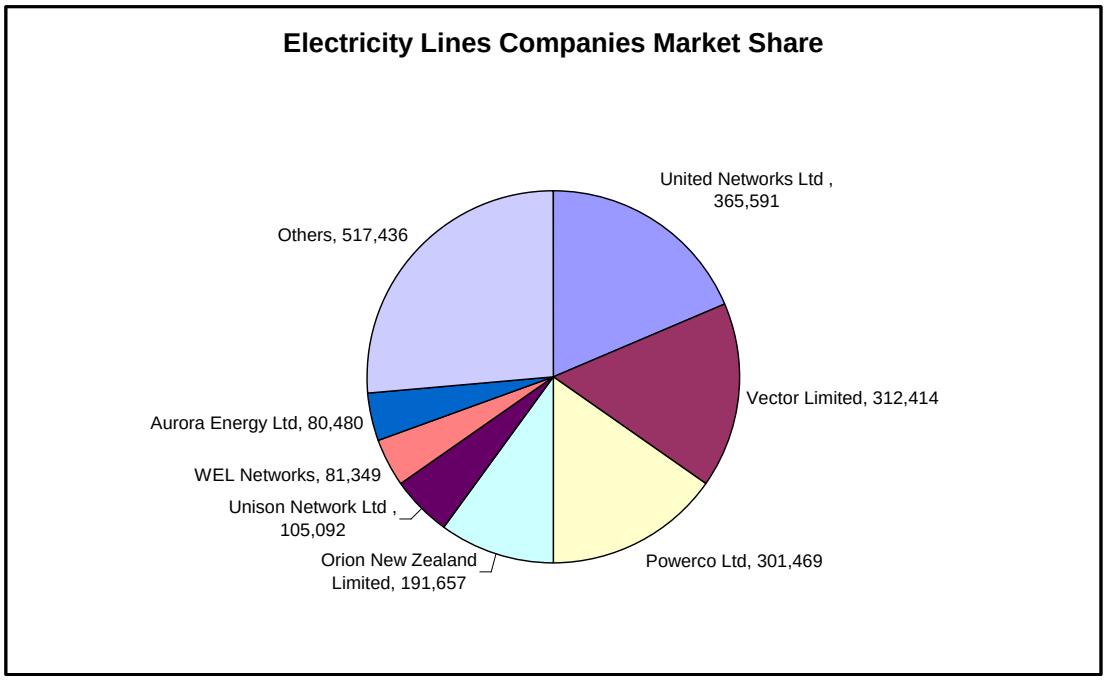
[1] n-1 security allows one line to fail with negligible impact on transmission of electricity, i.e. if one of three lines fails, the remaining two lines must be able to handle the load.

and the amount of public interest, the Government subsequently 'called-in' the proposal for a decision by an independent Board of Inquiry. The enquiry has been held but the findings have yet to be made public.

5.7 Distribution Companies (Lines Companies)

These companies purchase electricity from the grid and distribute it to consumers via their own local distribution networks. The companies cannot participate in retail activities and are constrained in terms of investment in some forms of electricity generation facilities. There are 24 line companies, although some are jointly managed.

Figure 16: Market share of main electricity lines (distribution) companies by number of customers (ICP connection)



Source: Electricity Commission 2009

The Lines Companies are owned by 30 community-based organisations of various types: 25 by community electricity trusts, 4 by local bodies and one by a community co-operative.

Smart Grid

'Smart Grid' is a generic term commonly used to describe the 'future transmission grid' which will use new technologies, tools and applications to enable a more efficient power system while also offering societal benefits. As defined by EPRI[2], the smart grid is "a system that optimizes power supply and delivery, minimizes losses, is self-healing, and enables next-generation energy efficiency and demand response applications."

The smart grid includes the installation of advanced metering infrastructure (AMI) solutions, including smart meters. These are being rolled out over the next few years by four of the five major electricity retailers: Meridian, Contact, Genesis, and Mercury (Mighty River Power). In addition, three of the major meter owners, Vector, Contact and Metrix (Mighty River Power), also plan to introduce smart metering to replace their existing meters in a similar timescale.

In total, the above companies represent over 80% of electricity meters in New Zealand and over 90% of gas meters.

[2] The Green Grid, Energy Savings and Carbon Emissions Reductions Enabled by a Smart Grid. EPRI report 1016905 Technical Update, June 2008

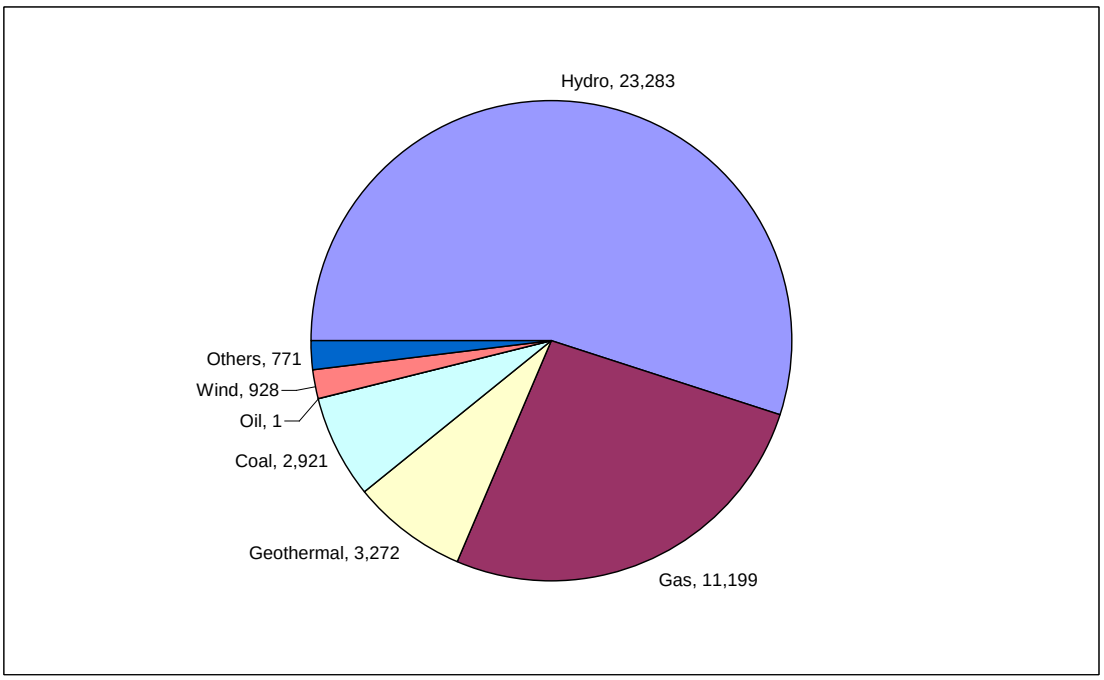
Furthermore, Transpower is looking at new and innovative technologies that are being developed worldwide around the 'Smart Grid' concept which could be applied to the New Zealand transmission system in the future.

6. Electricity Supply and Demand

6.1 Generation Capacity

New Zealand generated over 42,000GWh of electricity (including cogeneration) in the year ended December 2007. The sources of electricity generation are shown in Figure 17. It should be noted that the mix of generation varies dependent on the amount of rainfall in a year.

Figure 17: Electricity generation (GWh) in New Zealand, including cogeneration

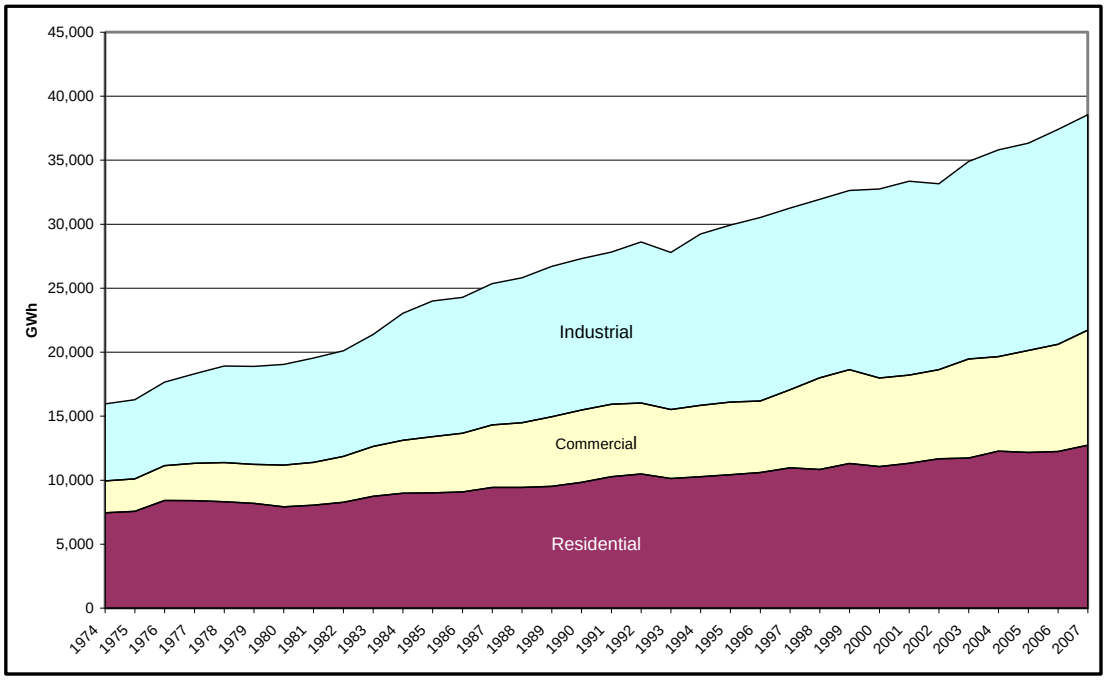


Source: Ministry of Economic Development 2008

6.2 Electricity Demand

The end-use of electricity in New Zealand by sector is given in Figure 18. It can be seen that the largest increase has been in the use of electricity by industry.

Figure 18: Electricity use by sector



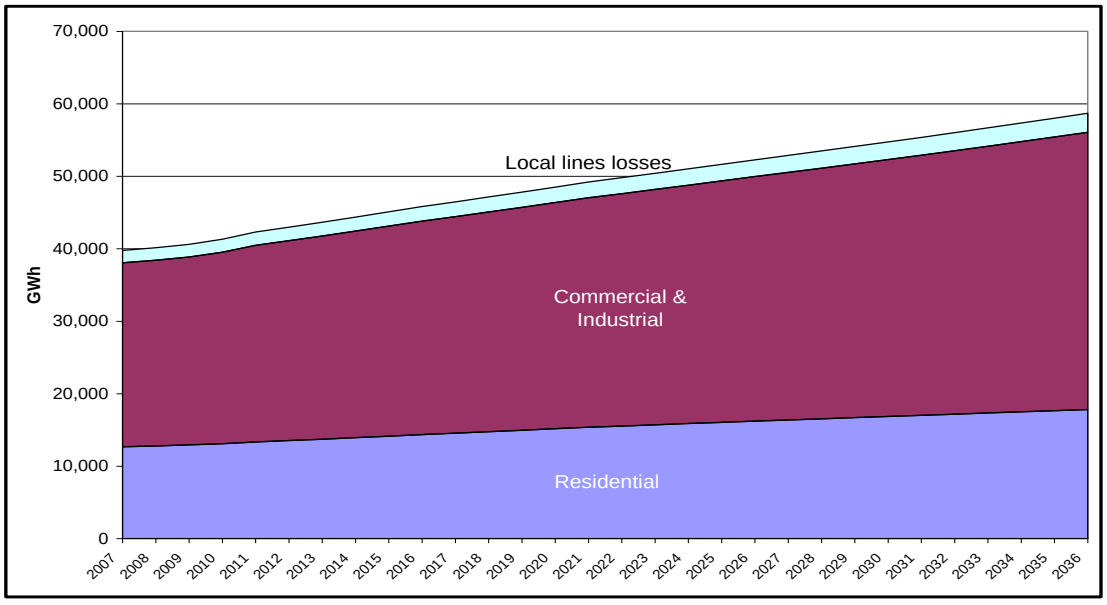
Source: Ministry of Economic Development 2008

Comalco's Tiwai Point Aluminium Smelter is the largest single consumer of electricity in New Zealand with supply being direct from the Manapouri Hydro Station. The basic non-ferrous sector, of which Comalco is the main energy user, consumed about 5,200 GWh in the year ended March 2007.

6.3 Electricity Demand Growth

A model forecasting New Zealand electricity demand for the next 30 years has been developed by the Electricity Commission. In its Initial Statement of Opportunities (SOO) August 2008, the Commission forecasts annual growth of an average 1.3% a year over that period.

Figure 19: Forecast total New Zealand electricity demand



Source: Electricity Commission 2008

The predictions are shown in Figure 19 and are based on information on socio-economic trends, national income, demographics, electricity processes and national obligations to promote greater energy efficiency. It is built around three main sectors - residential, commercial and industrial (light and heavy) - and recognises the different growth characteristics in each.

6.4 Government Reserve Generation

The Electricity Commission is required to contract for reserve generation to provide additional supply and price security beyond that achieved by the ordinary market. This is expected to extend system security to management of a 1 in 60 dry year level of hydro generation.

Prior to the establishment of the Electricity Commission, the previous Government had contracted for a reserve energy plant to provide for sufficient supply security in very dry years to be built at Whirinaki, Hawkes Bay. The 155 MW diesel fuelled open cycle gas turbine plant was opened in June 2004. While the Government has retained ownership of the plant, the station may only be operated in accordance with instructions issued by the Commission. Should hydro storage fall below a predetermined level, the plant will operate. It is also used to manage and limit electricity prices.

The cost of operating reserve generation is met through a levy across all consumers (based on wholesale purchases) on a pro rata basis.

The Electricity Commission commissioned an independent review of the operation of the electricity market throughout 2008's dry autumn and winter when the Whirinaki plant generated on a number of occasions. The report was released in January 2009 and makes eight recommendations for the improved management of dry winters:

- Ensure electricity companies face the costs of any forced cuts to consumers and are not able to shift these off to others, or implement compulsory dry year insurance
- Review the operation and cost efficiency of Whirinaki, including moving it and changing its fuel, and/or transferring the plant out of the reserve energy scheme
- As much as practicable, define and publish plans and triggers for emergency measures the Commission may take in a dry year
- Formalise the improvements to information sharing demonstrated during winter 2008
- Improve risk disclosure around suppliers' demand expectations and their ability to supply
- Improve certainty around the Commission's role when mentioned in terms of resource consent access to emergency generation capacity
- Further clarify the roles of the Minister and the Commission relating to security of supply and confirming the Commission's independent functions
- Prioritise initiatives that promote competition

Feedback from the industry on the direction of recommendations will be sought by the Electricity Commission before it implements any changes.

Appendix 1: Energy Flows

The diagram shows where energy is principally used in the New Zealand economy.

Primary energy from all sources is on the left, and to the right is the usable consumer energy. Losses are shown at each step.

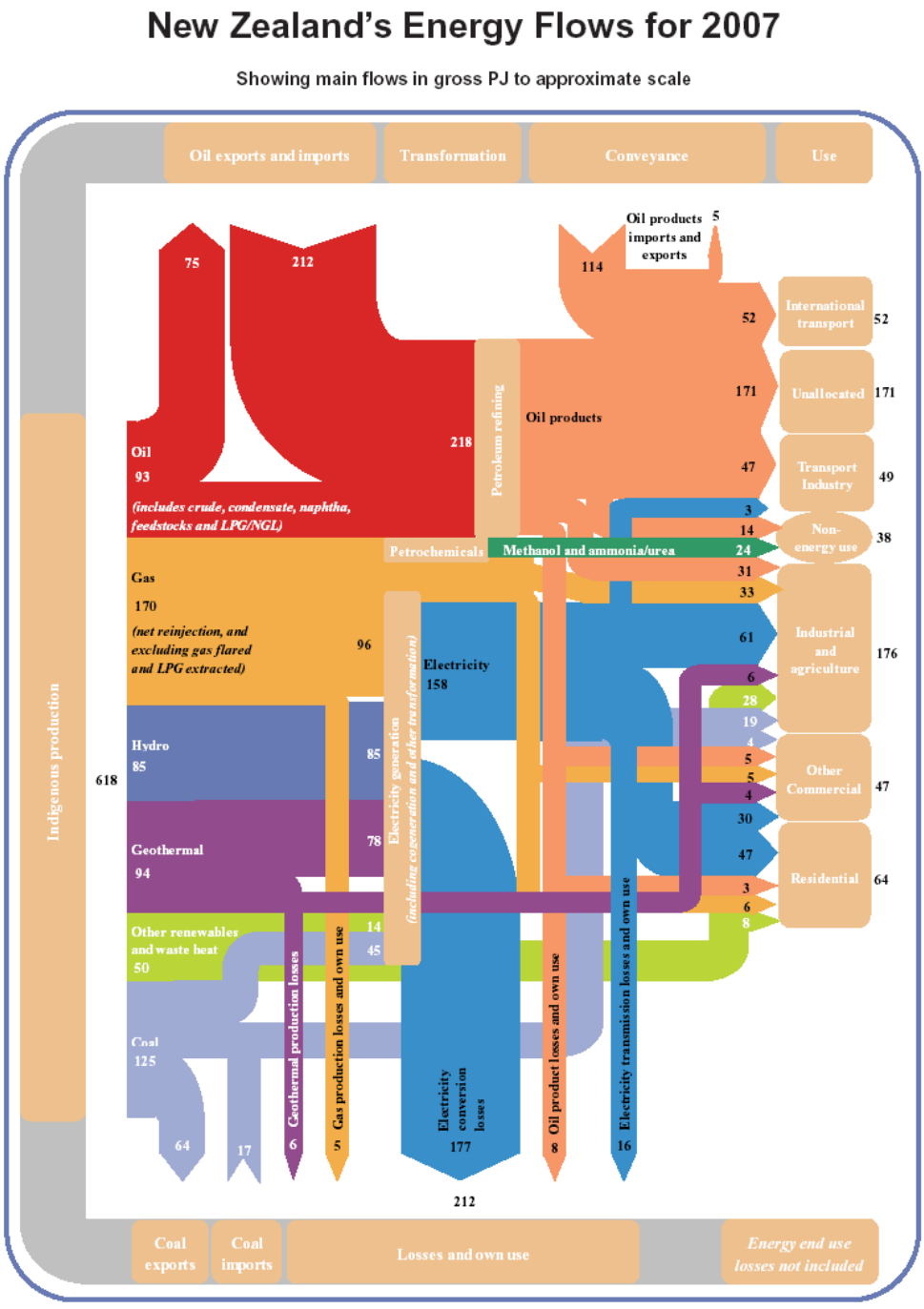


Diagram scaled approximately to nearest 10 PJ. Other uses of less than 1.0 PJ pa and stock changes are excluded (losses and own use included). In comparing this diagram with the energy balances, note that international transport is included on the demand side. "Other renewables" includes solar water heating and electricity generation from wind, biogas and wood.

Source: Ministry of Economic Development 2008

Appendix 2: Electricity Generation Projects as at November 2008

	Region	Location / Name of Project	Owned by	Capacity (MW)	Earliest commission date	Status
Diesel	Canterbury	Bromley, Belfast	Orion	23	2010	Consented
Gas	Auckland	Rodney	Genesis	480	2013	Applied for consent
	Auckland	Otahuhu C	Contact Energy	400	2012	Consented
	Taranaki	McKee - cogeneration	Todd Energy	9	2008	Under construction
	Taranaki	Stratford	Contact Energy	200	2010	Consented
Geothermal	Bay of Plenty	Rotoma	Rotoma No. 1 Corporation	35	2015	Applied for consent
	Bay of Plenty	KA24 Kawerau	Geothermal developments	10	2008	Under construction
	Northland	Ngawha	Top Energy	15	2009	Under construction
	Waikato	Centennial Drive - Tauhara	Contact Energy	20	2010	Under construction
	Waikato	Te Mihi	Contact Energy	60	2013	Consented
	Waikato	Nga Awa Purua	Mighty River Power	132	2010	Under construction
Hydro	Canterbury	North Bank Tunnel	Meridian Energy	200-280	2015	Applied for consent
	Canterbury	Rakaia River	Ashburton Com. Water Trust	16	2015	Applied for consent
	Marlborough	Wairau	TrustPower	70	2012	Consent under appeal
	Otago	Deep Stream	TrustPower	6	2008	Under construction
	Otago	Benmore refurbishment	Meridian Energy	11	2009	Under construction
	Otago	Hawea Control Gate Retrofit	Contact Energy	17	2012	Consented
	Taranaki	Mokau	King Country Energy	10	2015	Consent under appeal
	Waikato	Waipa	Hydro Energy Ltd	7	2010	Under construction
	West Coast	Arnold (Dobson)	TrustPower	46	2011	Consented
	West Coast	Mokihinui	Meridian Energy	80-100	2013	Applied for consent
	West Coast	Matiri	New Zealand Energy Ltd	5	2015	Applied for consent
	West Coast	Stockton Plateau	Hydro Developments Ltd.	25	2015	Applied for consent
Marine	Northland	Kaipara Harbour pilot	Crest Energy	1 (pilot)	2011	Consent under appeal
Marine	Wellington	Cook Strait Marine Energy pilot	Neptune Power	1 (pilot)	2009	Consented
Wind	Auckland	Awhitu	Genesis	18	2015	Consented
	Canterbury	Mt Cass	MainPower	41-69	2015	Applied for consent
	Hawkes Bay	Titiokura	Unison/Roaring 40s	48	2010	Consented
	Hawkes Bay	Te Pohue wind farm	Hawkes Bay Wind Farm Ltd	225	2011	Consented
	Hawkes Bay	Waitahora	Contact Energy	177	2013	Applied for consent
	Hawkes Bay	Te Waka	Unison/Roaring 40s	102	2010	Applied for consent
	Manawatu	Pori	Alco Wind Energy	80	2011	Applied for consent
	Manawatu	Te Rere Hau Stage 3	NZ Windfarms	17	2015	Consented
	Manawatu	Te Rere Hau Stage 4	NZ Windfarms	15	2015	Consented
	Manawatu	Central Wind (Moawhango)	Meridian Energy	130	2015	Applied for consent
	Manawatu	Turitea	Mighty River Power	360	2015	Applied for consent
	Manawatu	Te Rere Hau Stage 2	NZ Windfarms	14	2009	Under construction
	Manawatu	Motorimu	Alco Wind Energy	68	2010	Consented
	Otago	Project Hayes	Meridian Energy	630	2011	Consent under appeal
	Otago	Mahinerangi	TrustPower	200	2011	Consented
	Otago	Mt Stuart	NZ Windfarms	20	2015	Applied for consent
	Southland	Kaiwera Downs	TrustPower	240	2015	Consent under appeal
	Taranaki	Waverley	Alco Wind Energy	135	2011	Applied for consent
	Waikato	Taharoa	Taharoa C / PowerCoast	100	2015	Consent under appeal
	Waikato	Hauāuru mā raki	Contact Energy	540	2012	Applied for consent
	Waikato	Te Uku	WEL Network	84	2011	Consented
	Waikato	Taumatatorara	Ventus	44	2015	Consented
	Wellington	West Wind	Meridian Energy	143	2009	Under construction
	Wellington	Mill Creek	Meridian Energy	71	2015	Applied for consent

Source: Electricity Commission

Appendix 3: Related References

New Zealand Ministry of Economic Development, *New Zealand Energy Data File June 2008*, http://www.med.govt.nz/templates/MultipageDocumentTOC____36571.aspx

The Electricity Commission, Retail Market Statistics, *http://www.electricitycommission.govt.nz/opdev/retail/regstats/index.html* , 2008.

Energy Efficiency Conservation Authority, *Renewable Energy Industry Status Report Second Edition,* http://www.eeca.govt.nz/eeca-library/renewable-energy/report/renewable-energy-industry-status-report-05.pdf , 2005

Joint Energy Steering Group & East Harbour Management Services & Carter Holt Harvey, *Wood Processing Strategy: Energy Issues for the Wood Processing Sector in New Zealand*, 1992.

The New Zealand Energy Efficiency and Conservation Strategy (NZEECS) http://www.eeca.govt.nz/eeca-library/eeca-reports/neecs/report/nzeecs-07.pdf

New Zealand Energy Strategy to 2050 – Powering Our Future http://www.med.govt.nz/templates/MultipageDocumentTOC____31948.aspx

New Zealand's Energy Flows for 2007 http://www.med.govt.nz/upload/59482/01_flows-2007.pdf

Bioenergy Options for New Zealand - A pathways analysis of energy demand, economics & LCA http://www.scionresearch.com/bioenergy+report.aspx