

IN THE MATTER of the Resource Management Act
1991

AND

IN THE MATTER of an application by Meridian
Energy Limited for resource
consents for the Mokihinui Hydro
Project

**STATEMENT OF EVIDENCE OF ANDREW DIXON ROBERTSON ON
BEHALF OF MERIDIAN ENERGY LIMITED**

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1. **QUALIFICATIONS AND EXPERIENCE**

1.1 My full name is Andrew Dixon Robertson.

1.2 I am Director of Strategy at Meridian Energy Limited (Meridian). I have worked for Meridian since February 1999 in management positions covering a wide range of generation and business expansion developments. I am currently accountable for long term planning and market forecasting for Meridian. I am authorised to give this evidence on behalf of Meridian.

1.3 From 2004 until late 2006 I managed the commercial development of Meridian's renewable electricity project options. From 1995 to 1998 I worked for The Electricity Corporation of New Zealand (ECNZ) managing the Generation Control Centre that operates and controls the eight hydro power stations on the Waikato River and the Lake Taupo control gates facility. Between 1989 and 1995 I held a variety of management roles within ECNZ in the finance area, concluding with a 3 year placement as Group Accounting Manager for ECNZ Southern Generation based in Twizel.

1.4 I have a Bachelor of Commerce in Accounting and Finance, 1989, Otago University. I am a Chartered Accountant and a member of the Institute of Chartered Accountants.

1.5 Today I will be presenting evidence on:

- a. Meridian Energy
- b. Renewable energy

- c. The role of electricity in modern day life
- d. Electricity demand growth in New Zealand
- e. Energy efficiency and demand side management
- f. The economics of energy development options currently under consideration.

1.6 In my evidence I will focus on Meridian's interests and role in the electricity system. Mr Truesdale will provide specific information on the energy situation in the South Island and the West Coast and Mr Eldred will focus on the energy options available for the West Coast. Mr Watts will give evidence on the process Meridian has gone through in selecting the Mokihinui Hydro Project and will provide specific information on design of this scheme on the Mokihinui River.

2. **EXECUTIVE SUMMARY**

2.1 Meridian is committed to the development of renewable energy sources and is committed to generating energy solely from renewable energy sources. The development of renewable energy is in-line with Government policy and reduces impacts on the environment.

2.2 Meridian has a proven track record in the development and operation of energy projects both in New Zealand and overseas.

2.3 Electricity is a necessity in modern life and over the past 20 years New Zealand's demand for electricity has grown consistently. Electricity demand is connected to economic growth and it is

important that demand is met. As well as making improvements to existing assets Meridian is involved with demand side management initiatives to reduce energy consumption. These efforts alone will not meet projected demand. It is not simply a matter of trying to meet demand but also to do so economically and in a way which accords with sustainable management.

- 2.4 Approximately 13,000GWh of new demand, and up to 8,500GWh of thermal generation replacement will be required to power New Zealand's economy by 2025. A pool of projects exists that is, on paper, capable of meeting this demand, however much of this pool will not be built because of consenting issues, transmission issues, or the commercial strength of the project or the developer themselves. In this context, quality renewable energy projects like MHP, proposed by developers with a track record of sensitive and skilful development and world-class asset management and operation like Meridian, represent opportunities that must be taken.

3. **INTRODUCTION TO MERIDIAN ENERGY**

- 3.1 Meridian is a limited liability company wholly owned by the New Zealand Government. It is one of three companies formed from the split of ECNZ on 1 April 1999.

- 3.2 Meridian's Statement of Corporate Intent states that: *"Meridian Energy's nature and scope of activities is the generation of electricity (including the ownership and operation of related assets), the management of water related infrastructure, and the marketing, trading and retailing of energy and wider complementary products, solutions and services, primarily within New Zealand."*

- 3.3 As a State Owned Enterprise, Meridian is required by statute to operate as a successful business. A component of that requirement is to be an organisation that exhibits a sense of social responsibility by having regard to the interests of the community.
- 3.4 Meridian's objectives include maximising long-term shareholder value by its commitment to sustainable management and the development of the natural, physical and human resources utilised in its business.
- 3.5 Meridian is the single largest generator of electricity in New Zealand. Its hydro generation and storage capacity accounts for approximately 30%¹ of New Zealand's electricity generating capacity and 76%² of New Zealand's hydro storage capacity.
- 3.6 When Meridian was formed on 1 April 1999 the assets associated with the Waitaki Power Scheme, the Manapouri Power Scheme and the Brooklyn wind turbine were acquired. Meridian is nearing completion of Project West Wind near Wellington, a wind farm proposal comprising 66 turbines of 2.5MW each. Meridian completed the 90 MW Te Apiti wind farm in the Manawatu in 2004 and the 58 MW White Hill wind farm in Southland in 2007. As part of its ongoing operations Meridian is continually investigating and pursuing options for new renewable generation capacity and is investigating a number of sites that have potential for wind and hydro development.

¹ Ministry of Economic Development (2008). Energy Data File June 2008.

² Concept Consulting (2007). Annual Security and Reserve Energy Needs Assessment - October 2007 : prepared for the Electricity Commission

4. **ELECTRICITY IS A NECESSITY IN MODERN LIFE**

4.1 The electricity system from its generation to its local distribution is critical infrastructure in the New Zealand economy. Over the past 118 years electricity has reshaped how New Zealanders live and work. Electricity has also become so central to day to day life that there are frequently no substitutes, yet its availability is often taken for granted. This is due to its unique advantages over other forms of energy, specifically:

- a. flexibility – it can be transmitted over large distances instantly in the quantity required;
- b. versatility – it can be converted into three major uses of energy: heat, light and motion power;
- c. efficiency – it can be controlled and used with unparalleled precision; and
- d. availability – it can be produced from a number of different sources.

4.2 As a result, reliable and cost-effective access to electricity is fundamental to the ongoing progress of both New Zealand and its economy.

4.3 Electricity is an essential ingredient to industry. Without modern electric devices and technology New Zealand's industry would be uncompetitive in the world market. Electricity is a critical ingredient to industry and commerce in support of jobs.

- 4.4 Electricity supply is also critical to the ongoing operation of communication networks and other infrastructure, as well as the operation of banks, hospitals, schools and other public and private institutions. These make up the fabric of social, economic, and cultural wellbeing and ensure the health and safety, of people and communities.
- 4.5 The future electricity market outlook is determined by growth in demand and supply, and the design of the policy and regulatory framework. A key Government target is to restore New Zealand's per capita income to the top half of the Organisation of Economic Co-operation and Development (OECD) rankings. Another target is to embrace a sustainable future that is carbon neutral.
- 4.6 The Economic Transformation agenda is also a key corner stone of Government policy. This agenda and its component sub-themes continue to address the most important economic development issues for New Zealand; raising labour productivity and achieving environmental sustainability. Climate change is a key issue that is shaping the Government's sustainability policies. The proposed Emissions Trading Scheme will place a cost of carbon on fossil fuel emissions, raising the cost of fuel for thermal generating plant. The Climate Change (Emissions Trading and Renewable Preference) Bill proposes a 10 year restriction on new baseload thermal generation plant in an effort to minimise growth in electricity sector emissions and in support of its target that by 2025 90% of our electricity generation is from renewable sources. These policies are discussed in more detail by Mr Fraser.

5. **MERIDIAN'S COMMITMENT TO RENEWABLE ENERGY AND BEST PRACTICE**

5.1 On 22 November 2004 Meridian announced its commitment to generate energy solely from renewable sources in the future. This decision has not been made because we think it will be easy. Meridian has chosen this path because it considers it is the right thing commercially for its business and it is an environmentally responsible choice for New Zealand now, and in the future. Meridian's commitment is also aligned with Government policy. In 2007 the Government released the New Zealand Energy Strategy to 2050 which emphasises renewable energy resources to deliver a sustainable low emissions energy supply to New Zealand. Mr Fraser will discuss this in his evidence. If our collective commitment to renewables is to succeed it is important that New Zealanders engage in mature and rational debate about the impact of specific proposals.

5.2 Meridian has a proven track record in the development and operation of energy projects both in New Zealand and overseas. It also has a proven record in the development and operation of projects within sensitive areas. This includes the World Heritage listed Fiordland National Park (construction of the 10 km Manapouri Second Tailrace Tunnel), and an exemplary record of environmental compliance in new projects such as the Te Apiti wind farm and White Hill wind farm. In all the projects it is involved in Meridian has adopted a "best practice" philosophy. The Manapouri second tailrace tunnel project - New Zealand's largest energy efficiency project to date - was completed to the highest environmental standards and was a finalist in the 2002 Financial Times Global Energy Awards.

- 5.3 In the Te Apiti project Meridian's approach to best practice has been recognised by Horizons Regional Council:

Meridian Energy showed that sound planning, implementation and management of earthworks can achieve the required environmental outcomes and in doing so have set the standard for windfarm development in the Manawatu-Wanganui Region. (Letter from Ewan Robertson, Team Leader Compliance, Horizons Manawatu Regional Council).

- 5.4 Meridian will bring this approach and experience to the Mokihinui Hydro Project development and you will hear further evidence from Meridian project staff at this hearing on the approach to developing Mokihinui.

- 5.5 Meridian has demonstrated international leadership in hydro upgrading and in the operation of its hydro generation assets. For Meridian to have a mandate to develop new assets on green field sites, such as the Mokihinui River, Meridian considers it essential that we demonstrate our existing plant and resources are being used to best practice. Further, that Meridian demonstrates responsibility in its use of important natural resources.

- 5.6 We continue to upgrade and enhance our existing hydro generation assets on the Waitaki River and at Manapouri. This programme of existing and future work ensures that the existing system is operating as efficiently as possible and generation capacity is optimised. Planned, ongoing and completed works include:

- a. Turbine replacement of the Aviemore power station resulting in a 5% gain in efficiency for this asset (completed in 2000);

- b. The second Manapouri tailrace project completed in 2001 increased the annual energy output of New Zealand's largest hydro station by over 10%, and was followed by turbine replacement that increased output by a further 3%;
- c. Benmore power station is currently undergoing a major refurbishment that is likely to result in a 3% efficiency gain and an approximate increase in energy output of 65 GWh per annum;
- d. Proposed future refurbishment of the Tekapo A, Tekapo B, Ohau A and Ohau B and Ohau C hydro power stations to maintain the existing assets plus realise potential efficiency and energy gains.

5.7 In addition we are also actively seeking consents for further generation around these existing assets. This includes:

- a. The North Bank Tunnel scheme located on the lower Waitaki River. Currently this project is working through the resource consent process. If consented and built it would result in a net gain of between 1,100 and 1,400 GWh per year of energy. This would be an increase in generation on the Waitaki power scheme of between 13% and 18% based on an average of 8,000 GWh per annum being generated from the existing scheme.
- b. The Manapouri Tailrace Amended Discharge Project proposes to increase the maximum tailrace discharge limit for the Manapouri Hydro Powerstation from 510 to 550 cumecs. This does not require any alteration to the existing power station but simply allows better utilisation of the asset following completion of the second tailrace in 2001 and the turbine replacement in 2007. The proposal will further increase generation by 89 GWh per annum on average.

- 5.8 This programme of existing and future works demonstrates how Meridian has, and will continue to, focus on maximising generation from its existing assets. Where possible, we have focused on investigating and developing enhancements to these assets on existing river and lake systems which are already modified, before considering new developments such as Mokihinui.

Renewable generation

- 5.9 Meridian's Sustainability Policy is a cornerstone of our operating philosophy. It means we balance every decision we make according to the social and environmental as well as financial impacts it will have on our communities, our country and our planet. Sustainability is about being in business for the long haul and Meridian has been committed to sustainability since its inception in 1999. Meridian is extremely committed to renewable generation and sustainability as it is consistent with a philosophy of leaving this country a better place for future generations to come.
- 5.10 From a sustainability perspective, the localised environmental impacts of MHP need to be weighed up against the local and national environmental and economic benefits of the project. You will hear further evidence from Mr Eldred and Mr Watts on the investigation and selection process for this project and why Meridian believes it is the best option for the West Coast.
- 5.11 It is also important to note that Meridian's economic analysis suggests that the best of New Zealand's renewable generation opportunities are also the lowest-cost new electricity options at this time. New Zealand has benefited from half a century of low-cost electricity from the nation's hydro stations. We can build on that

heritage for another 50 years with innovative development of new hydro, large-scale wind, geothermal, solar and eventually marine generation. We believe that with skilful site selection and development, we can achieve the environmental benefits of renewables and the market and consumer benefits of power at lowest cost.

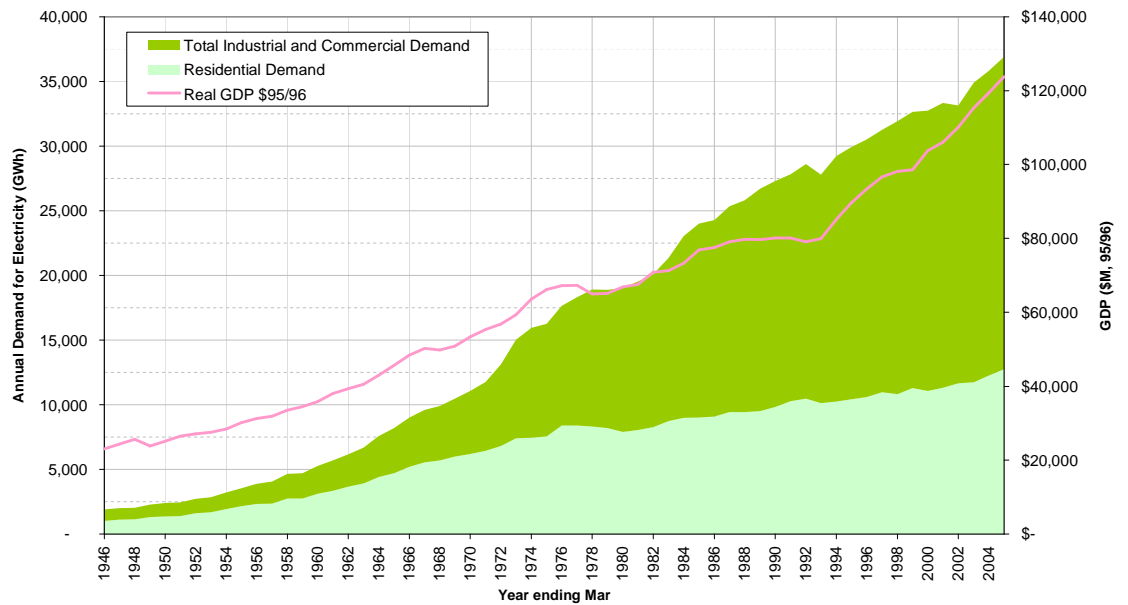
- 5.12 The trump card for renewables is that they are an indigenous resource. The development of renewable options will help to strengthen the country's capacity to compete on the world stage by producing cost effective energy supply that is less exposed to international energy prices than forms of electricity generation that rely on oil or oil substitutes like gas and coal. As we see currently with our transport sector, it is undesirable to have a major component of the economy saddled with the burden of internationally priced fossil fuels. Indigenous and naturally replenishing energy is vital in this respect.

Demand growth

- 5.13 New Zealand's demand for electricity has grown consistently over the past 20 years. Electricity consumption has increased from approximately 27.7 TWh in 1985 to 41.5 TWh in 2005, an average growth rate of 2.2 percent year on year.
- 5.14 The growth in electricity consumption has been driven primarily by a combination of two factors:
- a. economic growth measured by Gross Domestic Product (GDP). Electricity is an important factor of production in energy-intensive industries such as dairy farming, forestry, metal smelting and agricultural-based products. Income is also an important driver of electricity demand; and
 - b. population growth.

5.15 The relationship between electricity demand and GDP is shown in Figure 1:

Figure 1: New Zealand Electricity Demand and Real GDP, 1946-2005



5.16 Electricity price is also an important factor affecting electricity demand. Up until 2001 price has not had a significant impact in New Zealand. There are three main reasons for this:

- a. price has been historically low by world standards. Until the last few years, changes in price have been modest;
- b. residential consumers are on fixed-price contracts; these are usually reviewed annually. This lack of price information limits demand responses; and
- c. there are no energy substitutes in many applications.

5.17 However, since 2001 wholesale electricity prices have increased significantly. There are two main reasons for this. First, the gas contracted under the Maui Gas Contract is running out. The

period of low gas prices driven by this contract is ending and gas-fired generation is using gas supplied at a much higher market price. Secondly, New Zealand's cheapest generation options have already been built. New generation plant will inevitably be more costly.

5.18 It is generally anticipated that there will continue to be upward pressure on the wholesale electricity price in the medium term, unless a significant, low-cost gas discovery is made (although the ability of such a discovery to impact the forward price path has also been diminished as a consequence of the Government target of 90% renewable energy generation by 2025). As the wholesale electricity price increases, we expect it to have a greater impact on electricity demand. Amongst other things, higher prices should encourage improvements in energy efficiency, a topic I will return to shortly.

5.19 Demand growth rates in recent years have been at a higher rate in the South Island than the North, mostly as a result of rural and forestry development. In 2006 and this year the southward transfers on the HVDC link across Cook Strait have reached the maximum possible, and during the winter of 2006 and this winter the South Island has been a net importer of electricity from the North Island. Mr Truesdale will discuss this issue further in his evidence.

Energy Efficiency

5.20 Looking into the future a range of projections have been made by a number of different parties regarding the likely continued growth in demand. Net demand growth is a combination of increased demand, due to the reasons described earlier in my evidence, tempered by Demand Side Management (DSM) measures. DSM

initiatives range from measures to reduce energy consumption by employing more efficient technologies and the use of alternative energy sources at a consumer level, including solar and gas, through to reducing energy consumption.

- 5.21 Energy efficiency is defined, in simple terms, as doing something that enables the consumer to use less input energy to achieve the same outputs. Making better use of electricity is part of our sustainable practice and Meridian is strongly in favour of this objective. We work with our customers to develop, sell and promote energy efficient practices and products. For example:
- a. In October last year we launched a new business (Right House) aimed at providing comprehensive advice for building energy efficient homes. It focuses on passive measures, such as designing to maximise solar gain, and on the installation of energy efficient systems such as heat pumps and solar water heating³.
 - b. The initiative between the Electricity Commission, Meridian Energy and Orion to distribute energy efficient light bulbs in Christchurch and central Canterbury;
 - c. Co-marketing and development of energy efficient pumping and cooling systems for on-farm milking;
 - d. Intelligent systems to improve efficiency of irrigation systems by optimising for moisture, climate and power prices;
 - e. Intelligent demand response in commercial and industrial processes or premises;

³ Solar hot water heating is also increasingly being installed by home owners. Recent installation rates have risen from 1,000 to more than 3,000 units per annum. If the rate of installation reaches 5,000 units per annum the energy savings would be approximately 15 GWh per annum.

- 5.22 The Government has also recently announced an initiative to replace all incandescent light bulbs in the near future with fluorescent bulbs. This has the potential to reduce annual energy demand by 500 to 600 GWh.
- 5.23 Energy efficiency is important to Meridian but, as I will describe shortly, it is not nearly enough to offset the need for new generation. Meridian will continue to promote energy efficiency as it makes commercial and social sense for us and our customers to explore this fully.
- 5.24 It is anticipated that DSM measures will make a contribution to meeting New Zealand's energy requirements into the future. However, there will be a substantial energy balance gap that needs to be met from new large scale power generation sources. A range of estimates are available regarding likely future demand scenarios and Mr Truesdale discusses these further in his evidence. One of the most frequently used examples is the Electricity Commission study⁴ which estimated that the likely contribution of DSM is around 1,800 GWh by 2026. Based on this estimate and a 1.5 percent demand growth rate used in the report, (significantly less than the recent growth rate of 2.2%), additional generation of approximately 13,000 GWh would still be required by 2025.
- 5.25 The Electricity Commission estimate was made prior to the Government initiative to achieve 90% renewable energy

⁴ Electricity Commission (2006). *Scenarios for electricity demand: the next 25 years*.

generation by 2025. Replacement of some of the existing thermal plant contribution by renewable generation will require a further 8,500 GWh per annum of new generation by 2025.

Generation Options Currently under Investigation

- 5.26 A range of new generation proposals have been put forward by both established participants and new entrants to the industry as electricity supply conditions have tightened. These proposals are at various stages, from initial pre-feasibility proposals through to committed projects.
- 5.27 There have been public announcements relating to over 30 wind farm proposals at different stages of evaluation, planning or construction. There are also around 15 hydro, 8 geothermal and 12 natural gas, coal, cogeneration or landfill gas options at various stages. These projects have a combined potential production of over 25,000 GWh. In addition to these projects, there are others that are not in the public arena. In Meridian's view, many of these projects are unlikely to proceed, at least in the short to medium term due to a number of factors including project economics, technology, transmission and consentability. Given this expected project mortality, it is Meridian's view that quality proposals being put forward by credible developers with strong track records like Meridian are very important opportunities for New Zealand in sustainably meeting new demand.

Economics of New Generation

- 5.28 The two key issues for new generation options are the availability and price of fuel sources, and consentability. Of the projects that can be consented, from an economic perspective the projects that should proceed are those with the lowest cost. A more detailed discussion of the main fuel sources to meet new generation is

provided in Appendix A. However, I wish to emphasise the salient points.

- a. Unless there is a large gas discovery, current contract gas prices make gas fired generation more expensive than many renewable projects. Such a gas discovery is highly uncertain. In addition, the Government's proposed moratorium on new thermal baseload generation will limit the amount of new gas fired generation that may be built in the next ten years.
- b. The importation of liquefied natural gas (LNG) is under investigation by some parties. However, at current delivered prices it is very likely to be uneconomic. In addition, this option also faces the issues associated with the Government's renewable energy targets and, as I have already discussed, has the disadvantage of further exposing New Zealand to global energy market prices.
- c. Most coal options, because of their infrastructural requirements, are very expensive and also face the Government's renewable energy target issues.
- d. Geothermal development appears economic in proven brownfield sites but these are limited in their potential output, and will not contribute meaningfully to meeting demand growth in the South Island. Nonetheless, geothermal will be an important part of the new generation mix.
- e. Wind energy is a corner stone of Meridian's future energy development plans and is expected to supply an increasing proportion of New Zealand's energy over the next few decades. The uptake of wind is constrained in some power systems because it is an intermittent source of energy (which means that generation is entirely dependant on the instantaneous wind speed at the point of generation). However, in New Zealand we are able to develop

significant amounts of wind energy with low system costs because of the existing flexible hydro plant. Hydro and particularly hydro with operational flexibility such as the proposed MHP, has the ability to work well with wind energy, ramping up and down as required. As well as offering a number of operational benefits that wind does not, further hydro development is important to allow the ongoing development of wind resources in the future.

- f. Marine energy is still at a very early phase of its development cycle. For it to become a feasible option considerable time is needed to establish the technologies and the necessary understanding of our marine resources. Marine energy will not make a significant contribution to the 2025 90% renewables target.
- g. Biomass, because of its very limited output, and solar energy, because of its high costs, are unlikely to make any significant contribution to new generation in the near future.
- h. Aside from its prohibited status under New Zealand legislation, there are major economic and technical issues that render nuclear power an unlikely option.

5.29 In summary, hydro, wind and geothermal are economic propositions now, and in the future, depending on the site and the resource. Economies of scale are important to hydro projects because of their capital intensive nature. The intermittent nature of wind generation means that as our wind portfolio grows operation of the power system will increasingly rely on the flexibility of existing and new hydro.

5.30 There are other emergent technologies on the horizon. Though some of them are tested none are economically feasible to pursue

at this stage. As demonstrated above with demand increasing action needs to be taken now to get new projects on-line.

- 5.31 Against this backdrop and the specific issues associated with the West Coast which will be described by Mr Truesdale and Mr Eldred, the MHP is considered the best option for renewable hydro development on the West Coast.

Transmission grid and new generation

- 5.32 The location of new renewable generation is determined by the location of the natural resources. Renewable generation is very site specific, with project economics hinging on the specific development costs for each individual location.
- 5.33 Connection of new generation to the national transmission grid is a critical component of any new development, but is even more so for renewable developments, which are typically located away from demand or load centres. Mr Truesdale will further discuss transmission and associated security of supply from a generation and transmission perspective in his evidence.

6. SUMMARY

- 6.1 Meridian is committed to the development of renewable energy sources and is committed to generating energy solely from renewable energy sources. The development of renewable energy is well aligned with Government energy and climate change policy, unlike thermal power generation from coal and gas,

renewable forms of energy production do not produce environmentally damaging carbon emissions (greenhouse gases).

- 6.2 Meridian has a proven track record in the development and operation of energy projects both in New Zealand and overseas. This includes a strong commitment to continued investment and enhancement of its existing hydro assets.
- 6.3 Electricity is a necessity in modern life. Over the past 20 years New Zealand's demand for electricity has grown consistently. Electricity demand is connected to economic and population growth. Both these factors are expected to continue to drive demand growth in the future and it is important that this future demand is met. Meridian is supportive of, and directly involved in many demand side management initiatives to reduce energy consumption. However, these efforts alone will not meet projected demand. It is not simply a matter of trying to meet demand, but also meeting it in a way which is economic and accords with sustainable management practice.
- 6.4 Approximately 13,000GWh of new demand, and up to 8,500GWh of thermal generation replacement will be required to power New Zealand's economy by 2025. A pool of projects exists that is, on paper, capable of meeting this demand, however much of this pool will not be built because of consenting issues, transmission issues, or the commercial strength of the project or the developer themselves. In this context, quality renewable energy projects like MHP, proposed by developers with a track record of sensitive and skilful development and world-class asset management and operation like Meridian, represent opportunities that must be taken.

APPENDIX A

The Government has introduced the Climate Change (Emissions Trading and Renewable Preference) Bill. If this legislation is successfully passed the Emissions Trading Scheme (ETS) is likely to increase the cost of new thermal generation by approximately \$10-\$12/MWh from 2010, based on an assumed carbon price of \$25/tonne. The Bill also includes a restriction on new thermal baseload generation being built in the next ten years.

1. Gas

1.1 If a large gas discovery is made in a location with supporting infrastructure, for example on the west coast of the North Island, the wholesale gas price could be at the lower end of the scale – perhaps \$4.50/GJ, depending on field economics. At this price, gas-fired new generation would be preferable to many other generation options. New generation would tend to be gas-fired, though there would be some renewable investment. There would be no new coal-fired stations. Given the lack of success in this region over the past seven years, this scenario is unlikely. Further, a price on carbon will alter this conclusion.

1.2 Alternatively, if current gas contract price expectations persist, at around \$6-7/GJ, then the Combined Cycle GasTurbine (CCGT), Long Run Marginal Cost (LRMC)⁵ would be approximately \$75 - 88/MWh, excluding any carbon price. A greater range of renewable projects is economic under this scenario, as well as some coal options. There would be a mix of new generation forms. Again, a price on carbon alters this conclusion.

⁵ Long Run Marginal Cost (LRMC) The LRMC of a new power station is the total marginal cost of producing electricity from the plant. It includes short run marginal cost (SRMC); this marginal cost comprises fuel (including the option value of fuel such as the value of water storage and coal stockpiles) and other variable operating costs – costs that can be avoided in the short term. It also includes fixed costs, in particular the capital investment cost of the station.

- 1.3 A new CCGT plant running on LNG gas at delivered prices of \$10-12/GJ is uneconomic, at least in the medium term. Importation of LNG in this price range only appears to be economic for re-firing existing gas-fired plant where the capital cost is already sunk.

Coal

- 1.1 The economics of new coal generation plant are much more site specific than CCGT gas plant – even when running on imported coal. The key difference is the specific infrastructure that needs to be developed to service particular coal plant options.
- 1.2 The cheapest greenfields coal generation option in New Zealand appears to be a large Southland lignite plant located next to the lignite coal fields at approximately \$82/MWh, excluding the cost of carbon. Other coal options are significantly more expensive than this. New North Island coal generation using imported coal is likely to sit somewhere between \$95-115/MWh – mostly depending on the proximity to an existing large port. Solid Energy has investigated and put on hold a coal fired power station on the West Coast which has an estimated LRMC of \$89.7/MWh⁶. A carbon price of \$25 per tonne CO₂e would give it a unit cost of \$109.7/MWh. This project will not be feasible in the next ten years if the Government's moratorium on thermal generation is passed.
- 1.3 Coal is likely to be particularly affected by the introduction of a carbon regime. In a scenario where there is a price on carbon emissions, most new coal-fired generation projects are uneconomic.

⁶ PB Associates (2006). Electricity generation database : statement of opportunities update 2006 / a report prepared for the Electricity Commission

Hydro

- 1.1 Similar to wind, the costs of hydro are driven by the local resource and the ease or difficulty of particular sites. As such, the LRMC of hydro is highly project specific.
- 1.2 Hydro projects are capital intensive and take a number of years to develop. As such, economies of scale are important for project economics. The LRMC of possible “economic” hydro generation options ranges from \$65 to \$100/MWh. Meridian is pursuing its investigations into a number of hydro options including the North Bank Tunnel concept on the Lower Waitaki and Mokihinui on the West Coast.

Wind

- 1.1 New Zealand has a high intensity wind resource by international standards. There is a large potential for wind generation development between \$77 and \$112 /MW depending on the site, its wind speed and its proximity to the transmission network. Wind generation tends to have a lower capacity factor (meaning it produces less energy per installed megawatt) than hydro or thermal generation. When wind generation is low, reserved hydro capacity can make up for the shortfall. Wind variability tends to be over a few days, while hydro storage varies over a longer timeframe (typically six months) so wind and hydro together make an excellent combination for a secure supply.
- 1.2 Wind energy has matured as a technology over the past 25 years and is now a mainstream option for electricity generation. Large multi-national companies such as General Electric and Siemens have entered the wind energy business, resulting in efficiency gains, better durability and more affordable equipment.
- 1.3 Despite the clearly identified wind resource that exists in New Zealand, development has not been widespread. The New Zealand Government – unlike many overseas countries – has not offered subsidies to developers of wind generation to meet the cost difference. In addition, thermal generators are not presently

required to pay for the effects of their carbon emissions, including on climate change. This requirement that wind farms pay their way as standalone projects is the main reason that, despite the very considerable potential of the wind resource, at present wind generation contributes around 2% of New Zealand's total generation.

Geothermal

- 1.1 While the geothermal fuel resource is "free", finding and maintaining the resource for the life-time of the plant can be difficult and expensive. Sites and fields that have a proven track record are therefore more attractive than completely untested resources. Given this, a brownfields expansion of an existing project is typically the cheapest and most successful type of geothermal project. The Mokai extension project is an example of a brownfields expansion. These brownfields sites are possibly the cheapest of all of the new generation options with a LRMC estimated to be around \$55-75/MWh. However such developments are limited largely to the eight key existing geothermal generation fields – up to about 2,500 GWh potential.
- 1.2 A new geothermal project on top of a good reliable resource could have a LRMC in the range of \$75- 90/MWh depending on the technology selected. Beyond this, if the geothermal resource is either not ideal or deteriorates over time, then the unit cost can climb rapidly.

Other technologies

- 1.1 There is a range of other generation options. For various reasons, these options are unlikely to be a significant part of New Zealand's electricity industry over the next 20 years. They are:

Marine

- 1.2 The marine industry is at a similar stage now to the wind industry 25 years ago. It may be able to speed up the development cycle to achieve comparable performance and LRMC to wind. This is

dependent, however, on a number of factors including technology improvements.

1.3 Marine power generation refers to a range of methods and related technologies for capturing the energy potential of the ocean. These can be grouped into three main areas:

- (a) tidal barrages;
- (b) ocean current; and
- (c) wave power.

1.4 A large number of issues will need to be resolved before ocean current or wave power technologies can be deployed successfully in New Zealand. These issues include the potential effects on marine life, technology robustness, integration with the electricity system, visual and noise effects and potential conflicts with other users of marine resources. Consentability of large-scale projects has not been tested in New Zealand.

1.5 In the early years of commercial production, wave and ocean current generation will be very costly relative to established renewable technologies such as wind, hydro and geothermal. Unless developers wish to be at the leading edge of technology adoption, the next several years may be limited to trying to better understand New Zealand's marine resources.

Biomass

1.6 Biomass can be used either as a source of energy or for its chemical components. It includes trees, crops, algae and other plants, as well as agricultural and forest residues. The definition also includes materials found in waste dumps.

1.7 In the energy sector, there are three relevant biomass resources:

- a. woody biomass – wood (including residue and by-products) and trees and bushes planted specifically for harvest;
- b. landfill gas – from municipal solid waste; and

- c. sewerage, animal effluents and agricultural biomass (residues and dedicated crops).
- 1.8 These resources are mainly used as a fuel for heat. They are relatively expensive to transport. Some woody and landfill gas heat plants are cogeneration plants that produce limited amounts of electricity.
- a. The East Harbour report “Availabilities and Costs of Renewable Sources of Energy for Generating Electricity and Heat” discusses biomass in detail (East Harbour, 2005). East Harbour has estimated there could be around 100 GWh per annum of electricity generation from landfill gas (10 percent cost of capital; medium confidence estimate) in the \$40 – 60/MWh range.
- 1.9 At around 100 GWh, biomass does not have the ability to make a major contribution to new generation.

Nuclear

- 1.10 Globally, there are 442 nuclear power plants in 30 countries providing 16 percent of the world’s electricity. Most are in developed countries, although the industry has stagnated in Western countries in recent years. Nuclear power has been growing in Asia, with 24 of the last 34 nuclear plants commissioned in the region (International Atomic Energy Agency (IAEA), 2006).
- 1.11 There has been increasing publicity about a revival in the nuclear energy industry. This has stemmed partly from the greenhouse debate over alternative options to thermal electricity generation. For example, President Bush said earlier this year: *“[The] United States of America must aggressively move forward with the construction of nuclear power plants.”*
- 1.12 The main impediment to nuclear power in New Zealand is its social acceptance. However, there are also significant economic

and technical issues that make nuclear power an unlikely option for this country. These issues include:

- a. the use of nuclear energy for electricity generation in New Zealand is prohibited by legislation;
- b. significant debate about the costs of nuclear power plants, including issues around insurance, capital costs, operating costs and decommissioning costs. Nuclear plant is generally regarded as being around twice as expensive as gas-fired plant. Given the other generation options available, nuclear energy is a relatively uneconomic option for New Zealand;
- c. nuclear power plants are run at full capacity, and cannot follow demand up or down. This would have significant implications for the way in which other generation plant is operated;
- d. the minimum economic scale would be about 600 MW compared with New Zealand's current largest single generation units, which are 385 MW. The cost of providing an additional 200 MW or more of instantaneous spinning reserve or load shedding would be excessive;
- e. New Zealand would have to purchase fuel overseas, and would find it very difficult to store waste for any significant period of time due to the lack of a stable geological structure; and
- f. substantial infrastructure would be required to construct, operate and run a nuclear power station as well as handle fuel and waste. In addition to the physical structures, the associated industry that goes along with nuclear energy would be required - including the training of specialist engineers, management systems and operating expertise in aspects such as fuel transport and waste handling.

- 1.13 Significant research is being conducted into ways of overcoming the issues of scale, safety and waste management with nuclear power plants. I believe that it will be at least 20 years before these technologies could become viable in New Zealand.

Solar

- 1.14 Solar water heating has an estimated unit cost of between \$80 and \$160 /MWh and will only be attractive to some domestic users. Based on its high cost, solar water heating is unlikely to make a significant contribution to meeting electricity demand on a large-scale in the near to medium term.

Distributed generation

- 1.15 Distributed generation has long been mentioned as a replacement to mainstream electricity generation and transmission. The most commercial opportunities rely on matching energy needs within a host business. Meridian has an associated business unit, Energy for Industry (EFI), which provides a service to industrial and large scale commercial businesses in order to maximise the energy conversion and minimise costs for customers. The most economic large-scale projects which have the potential of deferring expenditure in mainstream electricity supply have already been implemented. There is the opportunity for this contribution to grow as technology costs decline, but no major new opportunities are expected to arise that would replace the need for a reliable and sustainable supply of electricity from the grid.
- 1.16 Emerging technologies in this category include photovoltaics (PV) fuel cells, small-scale combined heat and power and micro-scale wind and hydro options. While the costs of all of these technologies are falling over time, Meridian's analysis suggests that none offer a clear economic alternative in New Zealand conditions at this time. Micro-scale projects can also require an increase in transmission infrastructure, maintenance and monitoring.

- 1.17 Meridian is the majority owner of WhisperTech (a producer of gas-fired, small-scale combined heat and power (CHP) units for home use) and has supported the development of this technology over many years. There is market readiness for this solution – but not in New Zealand. WhisperTech’s business is replacing central heating system boilers in the United Kingdom and European market where consumers have higher heat loads in their homes which can be served by CHP units and the energy prices are generally higher. Even then, only approximately 30% (less in the New Zealand environment) of a home’s electricity need is met by a Whispergen unit, still necessitating a significant purchase of energy from the grid. Uptake of Whispergen units is not expected to significantly impact on demand for grid services within planning horizons.