BEFORE THE CENTRAL OTAGO DISTRICT COUNCIL

IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	an application made by Meridian Energy Limited for resource consent to establish, operate and maintain a wind farm and ancillary activities.

STATEMENT OF EVIDENCE BY GUY WAIPARA

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1. INTRODUCTION

Qualifications and Experience

1.1 My name is Guy Meredith Te Puka Waipara. I am an Electrical Engineer (BE Hons) and have been in working in the electricity industry for 17 years since graduating from Auckland University in 1989.

1.2 For the first 15 years of my career I was employed by Transpower NZ Limited in a range of transmission related roles including transmission planning, engineering, project construction, system operation and senior management. My last role at Transpower was Grid Development Manager, responsible for developing medium to long term plans for investment in the National Grid. This included drafting Transpower's initial submission for the proposed 400 kV transmission line into Auckland submitted in mid 2005, as well as overseeing the majority of the work on Transpower's proposal to upgrade the inter island HVDC link, also submitted in 2005.

1.3 In the last two years I have been contracted to and latterly employed by Meridian Energy Limited to assist in developing its transmission strategy and to provide expert advice on transmission issues. My recent experience includes working with international experts on assessing the impact of integrating large scale quantities of wind power into the New Zealand power system.

1.4 I have read, and agree to comply with, the Code of Conduct for Environment Court witnesses and have prepared my evidence in accordance with that code.

1.5 I have been assisted in the preparation of this evidence by Mr Ray Brown, the Meridian Growth and Development Transmission Manager. Ray has 23 years of experience in the electricity generation and transmission industry covering roles ranging from strategic planning, commercialisation and engineering to project implementation. He has been employed by Transpower NZ Ltd and predecessors, Contact Energy Ltd and Meridian. Ray is a Chartered Engineer and is available today to answer questions if required.

Scope of Evidence

1.6 In this statement of evidence, I will discuss transmission issues that are related to this project, with a particular focus on:

- The transmission planning process for new investment in the National Grid.
- Whether a new transmission line external to the site is required.
- The relevance of transmission losses associated with increasing the load on the National Grid.
- Improvements in security of supply within the Otago and Southland regions.
- Improvements in security of supply within the South Island.
- The relevance of impacts on competitor value.
- Local transmission effects associated with connection of the wind farm to the National Grid.

2. THE TRANSMISSION INVESTMENT PROCESS

Regulatory process for determining new transmission investment

2.1 Before I discuss the specific transmission effects that can be associated with Project Hayes, it is worth considering the context under which new transmission investment decisions are now made in New Zealand.

2.2 The economic aspect of all new investment in transmission is determined through the regulatory processes set out in Part F of the Electricity Governance Regulations (EGR's), administered by the Electricity Commission (the Commission). Under this framework, before any new investment is undertaken, Transpower must submit a Grid Upgrade Plan to the Commission for consideration and approval. The basis for approval of new transmission investment to support generation projects such as Project Hayes is that the transmission investment must deliver national benefits that are in excess of the transmission project costs. The detailed mechanics and processes associated with this assessment of national costs and benefits are set out in the Grid Investment Test, Schedule F4 to Part F of the EGR's.

Transpower's transmission planning process

2.3 Transpower, consistent with transmission utilities in Australia, the UK and North America, is required to operate a transparent transmission planning process overseen by an industry specific regulator. Given the overarching regulatory objective is to achieve an efficient transmission network developed at least cost to the economy as a whole, Transpower is required to demonstrate it has considered a comprehensive set of transmission augmentation alternatives before any "greenfield" construction projects can be considered.

2.4 In this context Transpower is systematically upgrading the capacity of existing assets that form the National Grid by implementing a range of well proven capacity extension projects across New Zealand. For example, Transpower has been able to achieve capacity increases in the range of 30-40% by a combination of raising the heights of existing conductors and replacing targeted substation assets.

2.5 Transpower's proposal for a new line into Auckland has received significant attention. However, over the last two to three years Transpower has upgraded the capacity of the National Grid into the North Shore in Auckland, Auckland City, the upper South Island (Nelson and Marlborough) and Christchurch. All of these projects have been implemented by incrementally upgrading the existing transmission assets; that is making modifications to existing transmission lines and substations. Each of these transmission upgrades has been made in response to constraints on the National Grid.

2.6 Incremental upgrades are always the "first port of call" for a transmission asset owner as they are low cost, low risk and create a negligible change to the landscape.

What is a transmission constraint?

2.7 Transmission constraints within power systems are a consequence of physical limitations on equipment and/or the system as a whole. Constraints arise because assets and/or systems cannot be operated beyond their capability

without risking cascade failure of the system. Cascade failures are the worst case outcome for power systems. They can cause brown outs (partial and generally controlled losses of supply) or black outs of entire regions, islands or in the worst case entire systems, such as those seen on the East Coast of the USA in 2003.

2.8 The system operator is responsible for managing the power system within these transmission constraints as part of its day to day role to co-ordinate all generation, transmission and demand for each half hour of every day for every year. Due to the long stringy nature of the New Zealand transmission system, transmission constraints do occur and there are standard processes and procedures to manage them and report on their impact. The system operator provides a monthly update on constraint activity across the country[1]. It is typical for constraint activity across the grid to follow a form of "s" curve distribution illustrated in figure 1 below.

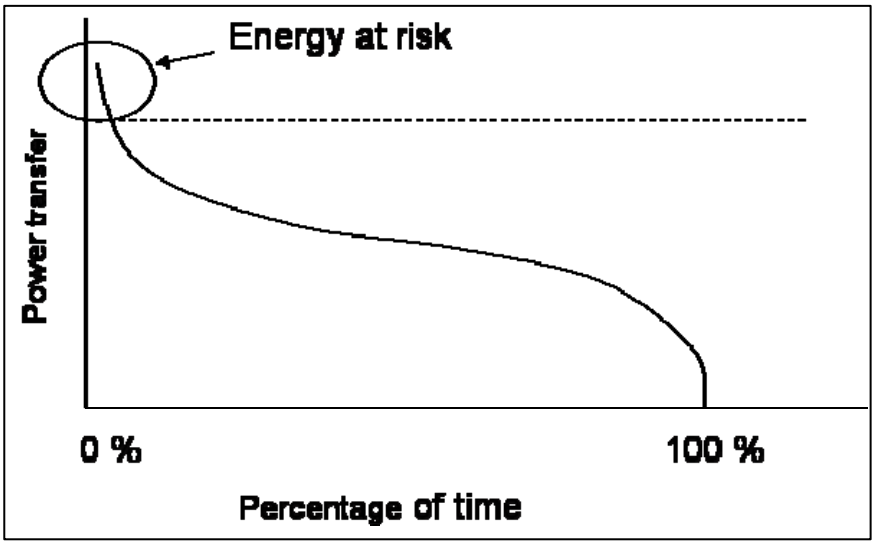

Figure 1 – Typical power flow distribution across a transmission constraint

2.9 The presence of transmission constraints does not mean that generation cannot be connected to the National Grid. However the likelihood of constraints must be taken into consideration by existing and new generators as they represent some commercial risk that generation will not be able to be dispatched to its full or desired output at specific times. This risk is represented pictorially above

[1] http://www.transpower.co.nz/?id=5978

where the energy at risk due to a transmission constraint is the difference between the desired output of a generator and its constrained output for what is typically infrequent short periods of time.

3. IS A NEW TRANSMISSION LINE REQUIRED?

3.1 All new generation projects will have an impact on power flows across the National Grid. However the impact on the transmission grid and any consideration of the need to upgrade the network must be considered in the context of the physical dynamics of the power system and the regulatory processes under which any new investment will be considered.

3.2 The National Grid in the Otago-Southland region is illustrated in figure 2. The key transmission congestion issue that Project Hayes raises is the potential for the 220 kV line between Roxburgh and Livingstone (and onto Islington in Christchurch) to become overloaded. In Meridian's assessment, some new investment in transmission will be necessary to accommodate the full output of Project Hayes.

3.3 Following Transpower's standard planning process, any transmission upgrade in this region will focus on maximising the capacity of the existing assets before any new "greenfield" lines are contemplated.

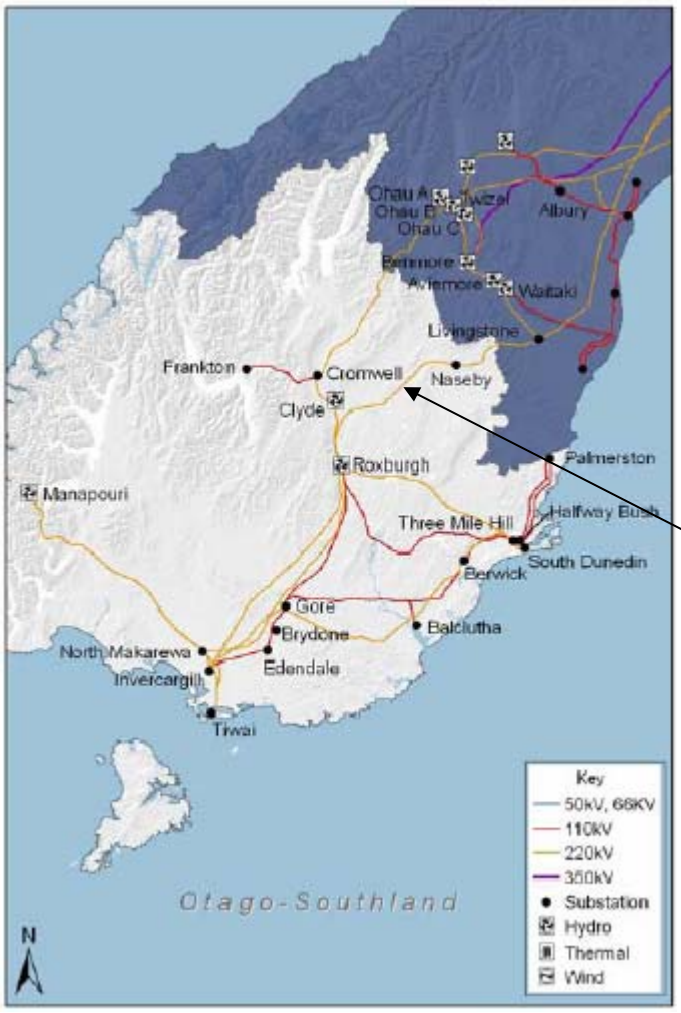

Figure 2 – Otago – Southland regional transmission grid

Independent transmission analysis

3.4 The Electricity Commission has recently released its analysis of this (Roxburgh to Livingstone) constraint in the paper "Transmission Advisory Group – Coordination of Transmission and Renewable Generation Investment".[2] Figure 3 is taken from this paper.

[2] http://www.electricitycommission.govt.nz/advisorygroups/tag/tagmeeting/19april07/index.html/view

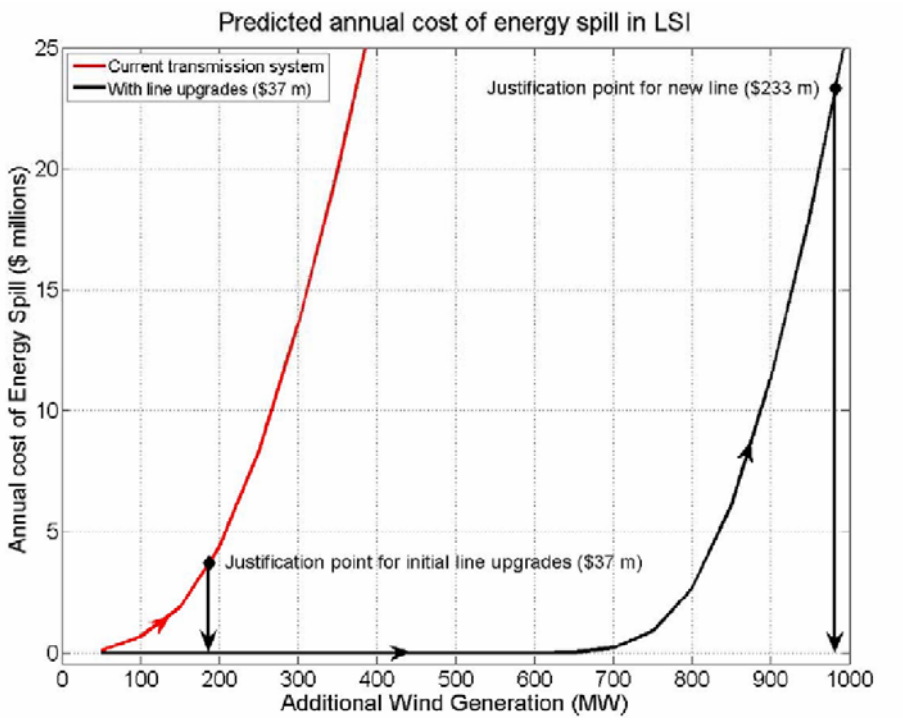

Figure 3 – Electricity Commission Analysis

3.5 The Commission's analysis suggests that upgrading the existing transmission assets could to enable a wind farm with a capacity of approximately 600 MW to be developed in the Otago Southland region.

3.6 This would be achieved by implementing two upgrade projects. The first project would be to install a second set of conductors on the existing line between Roxburgh and Livingstone. The second project would require the operating temperature of the conductors on the Cromwell to Twizel line to be raised to allow the line to operate at a higher capacity. Transpower has implemented similar projects in other parts of the country over the last few years.

3.7 The Commission's analysis suggests that with these upgrades completed, a wind farm in the order of 600 MW could be connected in the Otago – Southland region without any additional energy spill in the lower South Island than would be expected today.

3.8 Further corroborating analysis of the transmission grid in this region has been completed by the System Studies Group. Section A2.3 of their report titled "Inter-Area Transmission Capacity"[3] identifies that the existing thermal limitation between Southland and the Waitaki could be increased by approximately 600 MW. Again this would be achieved by implementing the two projects identified in the Commission's analysis.

3.9 Finally, Meridian commissioned engineering consultants Beca Carter Hollings and Ferner to study this region of the National Grid in more detail. Their report titled "Otago/Southland to Waitaki Transmission Limitations, April 2007" shows that the thermal limit of the transmission system between Southland and the Waitaki could be increased by approximately 650 MW. Again, this assumed that the upgrades identified by the Commission would be completed.

3.10 All three sets of analysis suggest that additional capacity sufficient to accommodate Project Hayes could be achieved by upgrading the existing transmission assets. The costs of these upgrades are estimated at approximately $40 million.

Meridian's review of transmission analysis

3.11 Because of the critical nature that transmission plays in the economics of Project Hayes, Meridian has conducted its own analysis of potential transmission constraints and the grid upgrades that it considers necessary to accommodate the Project Hayes wind farm.

3.12 Transmission systems are subject to two main forms of constraints, thermal constraints and stability constraints. Thermal constraints arise due to the potential for assets to over load and fail. Consequences of exceeding the thermal limits of a transmission system include equipment failure and possible system cascade failure leading to brown outs or black outs. Thermal constraints are simple to model and simple to quantify.

[3] http://www.electricitycommission.govt.nz/pdfs/opdev/modelling/GPAs/SSG-inter-regional-transmission-capacity.pdf

3.13 Meridian's own analysis agrees with that completed by the three independent parties regarding the impact of thermal constraints. Our view is that a wind farm in the order of 600 MW could be developed at in the region with the suggested modifications completed on the existing transmission system and without the need for a new transmission line.

3.14 The second type of transmission constraint are stability constraints. These arise due to the complex interactions between all of the components that form part of the power system; generation, transmission and demand. Stability constraints are inherently more difficult to model and quantify. The consequences of system instability are serious and include possible brown outs or black outs across large regions of the system.

3.15 Meridian has completed a more in depth assessment of the stability limits of the existing system than the independent analysts. Our conclusion is that with the suggested incremental upgrades to the existing transmission system completed, a wind farm of approximately 400-450 MW could be connected to the National Grid at Hayes without the need for an additional new transmission line.

3.16 Once the full range of stability mitigation options have been investigated, it is expected that this stability limit will be able to be increased further; approaching the higher system limit set by the thermal analysis. This would enable Project Hayes to be connected without the need for a new transmission line.

Other transmission mitigation strategies and issues

3.17 Two other issues must be considered when assessing the need for new transmission into the region. The first is the impact of demand growth.

3.18 Figure 4 illustrates Transpower's forecast of demand growth in the Otago and Southland region over the next 10 years. Transpower is forecasting an increase in regional demand in the order of 100 MW. This will clearly reduce the impact that Project Hayes has on transmission congestion, as the transmission system is only required to transfer the net position of generation less additional demand

growth. Furthermore, if any additional industrial or significant commercial load were to be connected in the region then this would further reduce the net transmission requirement and associated congestion concerns.

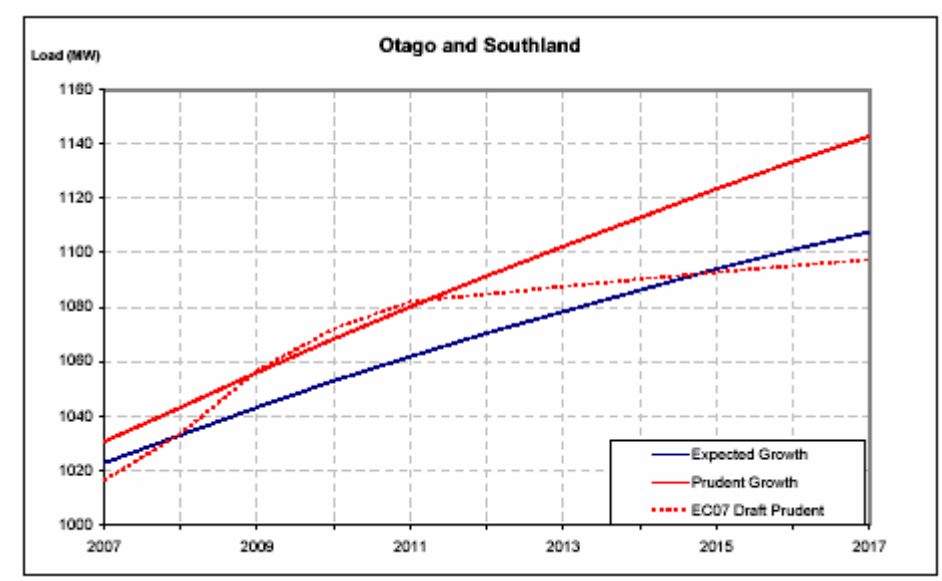

Figure 4 – Transpower demand growth forecast – Otago Southland[4]

3.19 The second factor that will mitigate transmission congestion is that Meridian has some ability to operate its hydro assets at Manapouri and Waitaki to manage the combined impact of Project Hayes and Meridian's existing hydro stations on the transmission system. While the impact is difficult to quantify, hydro and wind assets are an ideal compliment with hydro power stations. Hydro stations have a substantial degree of operating flexibility to manage the impact of wind generation variability.

Ultimate transmission requirements for the region

3.20 There is likely to be some interest in understanding the ultimate transmission requirements for the Otago and Southland regions. At this point in time there is no straightforward answer to this question. The issues that must be resolved before one can be definitive about the ultimate regional transmission requirements include:

[4] http://www.transpower.co.nz/upload/notion/sectionimages/22717_annual-planning-report-2007.pdf page 375

- How much generation is developed in the region. During my time running the Grid Planning and Grid Development teams at Transpower I was exposed to all proposals for new connection to the National Grid. Only a small subset of generation projects pass from stage to stage; conceptual to detailed investigation to consenting to construction. At each phase more and more projects are abandoned or put on hold as the economic costs of the projects are refined.

- Demand growth in the region, including domestic, commercial and industrial consumers and the future of the Rio Tinto Aluminium smelter.

- The degree to which the existing transmission network can be worked harder and harder before new transmission augmentation becomes necessary.

- The economics of transmission because as discussed earlier, all new transmission investments must pass the Electricity Commission's grid investment test.

Summary

3.21 In summary, three independent sets of transmission analysis all suggest that a wind farm of the order of magnitude of Project Hayes can be accommodated by upgrading the existing National Grid assets between Roxburgh and Livingstone and Cromwell and Twizel without the need for any new transmission lines.

3.22 In my opinion, the close corroboration of the thermal analysis and my experience with upgrades of this nature in my former role suggests that the thermal constraints of the existing network can be raised substantially by implementing low cost and risk transmission upgrades.

3.23 In my opinion, I believe that it is likely that the system stability constraints can also be increased to a level approaching this thermal limit provided that the full extent of additional mitigation options are investigated and implemented.

3.24 This outcome would be consistent with results experienced across the country, for example transmission into Auckland and Christchurch where stability and thermal constraints are set at relatively comparable levels.

3.25 The impact of demand growth combined with the flexibility offered by Meridian's existing hydro stations at Manapouri and Waitaki are additional considerations that may mitigate transmission congestion concerns.

3.26 Some submitters have suggested that a new line would be required between the Clutha and Waitaki Valleys if Project Hayes was built with a 600 MW capacity. In the early stages of Meridian's investigations the concept of a new line was raised as a means of dealing with transmission constraints between the Clutha and Waitaki Valleys if Hayes had a 1000 MW capacity. The analysis presented shows that a new line would only be required for a wind farm larger than approximately 600 MW.

3.27 On this basis, it is my opinion that that the existing transmission network upgraded to its full capacity will be sufficient to accommodate Project Hayes without the need for a new transmission line to be constructed.

4.0 TRANSMISSION LOSSES

4.1 Transmission losses are the energy lost between the point of generation and the point of consumption. All electricity generated, transmitted and distributed will incur transmission losses. In effect, losses represent the cost of transportation and can be considered in a comparable way to any transport cost for any product or service.

4.2 When a generator assesses the economics of an electricity generation project from a more remote source they must include the impact of transmission losses when they assess the economic viability of that project. For example, a power station that can generate electricity at say 7 c/kWh but incurs a transmission loss cost of 0.3 c/kWh, totalling 7.3 c/kWh, is still more economic to consumers when compared with electricity generated at 8 c/kWh with no cost of transmission losses.

4.3 The situation is directly comparable to a consumer in New Zealand seeing the benefit of purchasing a lower cost product from an overseas manufacturer,

inclusive of transport costs (comparable to transmission losses) than a higher cost locally produced product.

4.4 Therefore, transmission losses cannot be considered in isolation from the overall cost of producing each and every unit of electricity. Losses should not be considered as an adverse effect when, as demonstrated above, consumers can still clearly benefit from remotely generated and transmitted electricity over locally generated electricity. Losses are merely a small component of the overall cost of generating and transmitting electricity to the point of consumption. Furthermore, they are taken into full account by investors in new generation plant as ultimately they reflect an element of commercial risk to the developer.

4.5 Quantifying the actual losses from Project Hayes requires a detailed assessment of supply and demand including assumptions about all other generation stations across the country over the life of the project. This is inherently difficult and the results are a function of the assumptions made. However Meridian's high level assessment is that the average transmission losses from Project Hayes are likely to be within the range of 3-4%.

4.6 As a final point, the report of the Planning Consultants for the CODC section 9.2.5 states that the average loss of the Cook Strait cables is "5% rising to 15% at very high transmission rates through the Cook Strait Cable". However, Meridian's internal calculations show that the losses across the HVDC link are no more than 8% when the Cook Strait cables are transmitting at their maximum northward capacity, and in the order of 3% at average load (285 MW).

5.0 REGIONAL SUPPLY BENEFITS

5.1 The Otago-Southland area imports approximately 30% of its electricity from the Waitaki and further north during years of average hydrology. This import requirement is significantly higher during dry years when generation from Manapouri power station is limited. The average quantity of electricity imported

into the region will continue to increase as demand grows unless new generation is installed within the region.

5.2 Security of supply to the region is becoming more and more reliant on Manapouri power station. Each year, the minimum generation levels that Transpower expect from Manapouri power station are increased to match regional demand growth. This heavy and increasing reliance on Manapouri power station increases the risk that regional demand will not be able to be met during dry years if there is simply insufficient water to generate the electricity to match Transpower's minimum generation expectations. This regional security of supply situation will continue to worsen as demand grows unless generation is constructed within the region and/or upgrades to the transmission system are implemented.

5.3 Transpower's Annual Planning Report (APR) provides a comprehensive summary of the capability of the power system for all regions across the country. Section 20.5 of the 2007 APR which focuses on Otago and Southland states "Although Manapouri generation is currently used to support Southland demand, this capacity is not unlimited and at some point if load growth exceeds generation development in the area, transmission reinforcement will be necessary (to support southward power flow into the region)."

5.4 The proposed location of Project Hayes in this constrained region will improve security of supply to Otago-Southland and reduce the reliance of the region on Manapouri generation particularly during dry years. This improved security of supply will increase consumer confidence about both the availability and price of electricity in the region. It is reasonable to expect that a significant improvement in security of electricity supply and the associated reduction in electricity price volatility may encourage new industry and investment within the Otago-Southland region.

5.5 In summary, Project Hayes would provide clear benefits to the region by improving the security of electricity supply and reducing electricity price volatility particularly during dry periods. Contrary to some opinion, much of the output from Project Hayes will be consumed locally and will make a positive

contribution to improve the resilience of the greater Otago – Southland regional electricity generation and transmission system.

6.0 SOUTH ISLAND SECURITY OF SUPPLY BENEFITS

6.1 Over the last six years the South Island has faced security of supply concerns in 2001, 2003 and 2006. While brown outs or blackouts did not occur, there were significant impacts on electricity prices to consumers. Demand reductions were achieved by a combination of contractual incentives with consumers, by consumers reducing demand in response to high prices and by requests for voluntary savings.

6.2 This section addresses the positive benefits that generation in the South Island, including that proposed from Project Hayes will deliver to South Island consumers.

6.3 Figure 5 shows the historical and projected future flows across the High Voltage Direct Current (HVDC) link. This assumes no additional generation is commissioned in the South Island. As demand in the South Island continues to rise at (on average) 250 GWh per annum, South Island demand will become more and more reliant on the transmission of predominantly North Island thermally generated electricity across the HVDC link.

6.4 The lack of new generation in the South Island will only increase the dependence of the South Island on this North Island power transfer, which in itself is subject to possible transmission constraints both getting to the HVDC link terminal in Wellington and across the HVDC link.

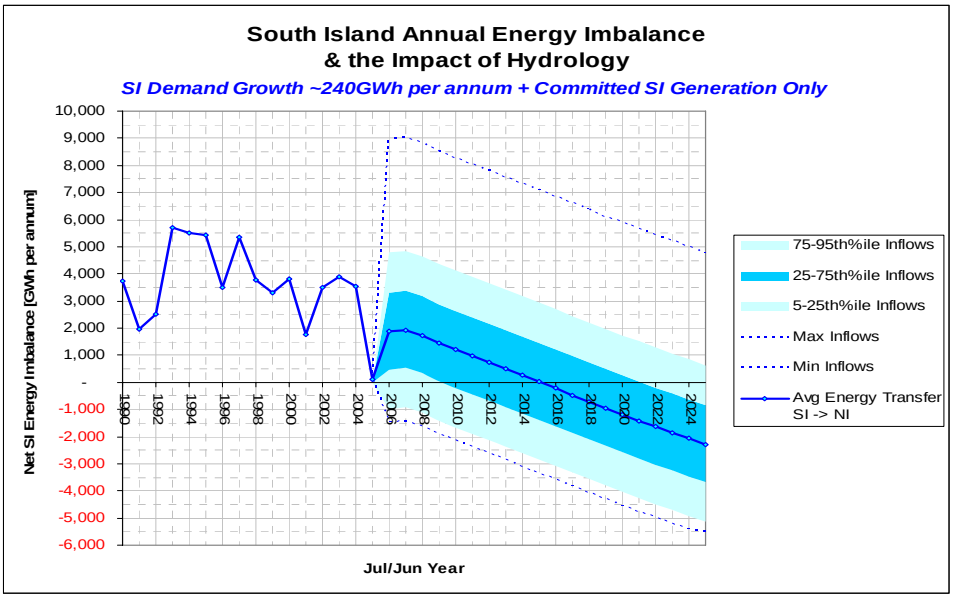

Figure 5 – HVDC transfers historical and projected

6.5 The presence of any additional electricity generation in the South Island, particularly if it is from a non-hydro source, will improve the overall South Island security of supply position as it reduces the South Island's reliance on electricity transferred from the North Island.

6.6 Project Hayes, with an estimated total output of up to 2,050 GWh per annum is equivalent to eight years of South Island demand growth. Project Hayes would therefore provide a substantial improvement in South Island security of supply. The positive benefits to South Island consumers would be a reduction in exposure to high electricity prices and possible brown outs, particularly during dry years.

7.0 COMPETITOR VALUE CONCERNS

7.1 First and foremost, Meridian believes that concerns from competitors regarding any potential impact of a new project to their competitive position in the electricity market are the consequences of economic competition.

7.2 The founding assumption of the electricity market is that competition will deliver benefits to consumers in the long run. The entry (or exit) of any new generation into the electricity market will create changes to the balance between supply and demand. It will affect market prices and the associated market value of the

entrant as well as all competitors. This is a fundamental point understood by all market participants.

7.3 The transmission grid across New Zealand is not constraint free and no participant has any property rights or priority access rights to the National Grid. Consumers, not generators, pay for the core grid transmission assets as consumers are the major beneficiaries of a transmission network. The access for generators to the transmission grid is an outcome of all competitors offering their generation into the electricity market at prices at which they are willing to generate. In this way demand for electricity from consumers can be met by selecting or "dispatching" the lowest priced generation across the National Grid so that consumers' demand for electricity can be met at least cost.

7.4 We are aware that Contact Energy has raised concerns over the impact that Hayes will have on the operation of its stations in the Clutha, particularly in relation to spill. The presence of spill merely implies that the marginal cost of generation is zero. In this case a generator such as Contact would be faced with a market price for its product of (or approaching) zero and consumers who purchase electricity from the wholesale market could acquire this energy at or approaching a zero price. Clearly this would be a negative outcome for Contact (and Meridian) from a commercial perspective and positive for consumers in the constrained Otago – Southland region.

7.5 Meridian considers the point regarding spill is really a point regarding market price outcomes and commercial value.

7.6 However, if these points are to be considered then we question the basis upon which Contact has assessed the impact of Project Hayes on its competitive position. In particular, has Contact assumed the capacity of the existing transmission grid would remain unchanged or have they assumed the low cost upgrades identified by the Electricity Commission and Meridian will be implemented. The outcomes between these two assumptions will be orders of magnitude different. With the costs for these minor upgrades to the existing transmission grid estimated at $40 million, Meridian is strongly of the view that these upgrades will occur as they are highly likely to pass the Electricity

Commission's Grid Investment Test. In this case, our view is that the impact on Contact Energy's commercial position is likely to be negligible.

8.0 TRANSMISSION INFRASTRUCTURE INTERNAL TO THE WIND FARM SITE

8.1 The transmission infrastructure internal to the wind farm site is described in the consent application.

8.2 Power generated from the individual wind turbines will be transmitted via 33 kV underground or overhead cables to one of five substations across the Hayes wind farm site. Generally the cables will be placed underground except where construction difficulties make an overhead solution preferable. The substations will convert the electricity up to the transmission voltage level (220 kV).

8.3 The existing Roxburgh to Three Mile Hill (near Dunedin) 220 kV line which runs for 14 km across the project site will have a short diversion constructed into the Sluicings substation. Two new on-site 220 kV transmission lines will connect the remaining four substations to Sluicings which will become the focal point where the wind farm sub transmission system aggregates the entire power generation output of the wind farm.

8.4 The Roxburgh (ROX) to Three Mile Hill (TMH) 220 kV transmission line provides a strong, low power loss direct connection to the load centre at Dunedin and then on through further connections to load centres in Southland and South Otago. The westerly connection of the line provides a strong connection to the wider grid at Roxburgh. Hence locally, on these circuits and the 220 kV substations at TMH and ROX, there are no constraints for a wind farm capacity in the order of Project Hayes.

9.0 CONCLUSIONS

9.1 My key conclusions are as follows:

- If the minor upgrades to the existing transmission grid between Southland and Waitaki identified in this evidence are made, it is my opinion that the proposed wind farm at Hayes will be able to be connected to the Transmission system without the need for a new transmission line. This view is consistent with

independent analysis conducted by the Commission and specialist engineering consultants.

- Regional demand growth will reduce the net energy transmitted from the Otago and Southland region from Hayes. Over time, an increasing amount of its output will be consumed locally.

- In an economic sense, transmission losses represent the transport cost component of electricity generation, which is an order of magnitude less than the cost of generating electricity from the wind farm. While difficult to quantify, average transmission losses from the wind farm are likely to be in the 3-4% range.

- Project Hayes will substantially improve security of supply to the Otago Southland region by providing another source of locally generated electricity. It will reduce the regions reliance on electricity generated from Manapouri power station, which is subject to dry year risk.

- Project Hayes will significantly improve security of supply in the South Island. Its full output is equivalent to eight years of South Island demand growth. This injection will reduce the risk of electricity shortages and the associated adverse price impacts to South Island consumers.

- It is my opinion that concerns from competitors regarding Project Hayes are founded on protecting their competitive position. Their appropriate focus should be on what incremental transmission upgrades can be achieved to integrate new and existing generation in the region. If the incremental grid upgrades identified in this evidence occur then their concerns regarding spill are unlikely to materialise.