NEW ZEALAND'S ELECTRICITY DEMAND AND SUPPLY SCENARIOS AND ELCTRICTY REQUIRED TO MEET RENEWABLE ELECTRICITY TARGETS

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BACKGROUND AND ROLE

1. I was engaged by Westpower Limited (**Westpower**) in relation to its application for reconsideration under section 17ZJ of the Conservation Act 1987 of its application for a lease, licence and easement concession (**Concession**) for the Waitaha Hydro Scheme (**Scheme**).

2. I was commissioned by Westpower to provide an independent expert opinion on the reality of the electricity demand / supply scenarios in New Zealand, and what New Zealand needs to do if we are to meet renewable electricity targets (including through proposed projects such as the Scheme).

3. I am an energy industry and regulation specialist and my qualifications and experience relevant to this report are provided in **Appendix A.**

4. In preparing this report I have considered the key relevant technical information which supports Westpower's application for the Concession for the Scheme as well as the key decision documents in so far as they relate to the energy industry.[1]

SCOPE OF REPORT

5. The purpose of this report is to:

   (a) discuss the current and projected demand for electricity in New Zealand and the West Coast;

   (b) explain the Government's commitments to decarbonisation of the New Zealand economy, the Government's emissions reduction targets and other climate change objectives and the implications on projected energy demand;

   (c) explain the role of renewable electricity generation (**REG**) in meeting those targets and objectives;

   (d) discuss the existing supply base and the potential sources of new electricity in New Zealand and explain whether there will be sufficient capacity to meet the projected demand;

   (e) discuss the significance of the energy supply shortfall and the importance of hydro generation, including the Scheme, in fulfilling this demand; and

   (f) discuss why it is critical that REG schemes such as the Waitaha proceed if we are to meet the Government's emissions reductions and climate change goals and thus address the impacts of climate change.

[1] Key decision reports include:
(i) the Officer's report dated 19 August 2016 approving in principle the grant of the Concession for the Scheme;
(ii) Hearing committee report dated June 2017;
(iii) Final departmental report dated 12 June 2019; and
(iv) Final Minister's decision dated 27 August 2019.

EXECUTIVE SUMMARY

6. The Intergovernmental Panel on Climate Change's (**IPCC**) most recent report highlights that:

> *"Rapid, deep cuts to greenhouse gas emissions can still keep the world's target of holding global warming to 1.5°C within reach, but humanity's emissions must peak within just three years to avoid breaching the important limit…".*[2]

7. The IPCC also noted that the that:

> *"…the window for staving off dangerous warming has shrunk drastically due to our past failures to act."*[3]

8. To achieve the Government's 100% renewable electricity goal by 2030, 2,151 MWs of thermal generation needs to close, and significant investment in new REG will be required. There is a high probability that both Huntly coal units and the Stratford Combined Cycle Gas Turbine may close as early as 2023, taking 885 MW of capacity out of the market.

9. Transpower forecasts that growth in demand (in a large part due to decarbonisation and electrification efforts) by 2030 requires an additional 926 MWs. This means that a total generation build of 3,077MW of new capacity is required to meet the growth in demand as well as the Government's energy, emissions reduction and decarbonisation goals.

10. At present 3,673 MWs of new capacity is planned. To meet the 2030 capacity requirement, almost all the proposed projects must get built, which would be an unprecedented level of new build for New Zealand and will be challenging for those still progressing through the consenting process.

11. However, to meet 2030 forecasts, an additional 15,510 GWhs must be produced annually to meet energy requirements. The proposed projects will generate an additional total of 13,570 GWhs of additional energy. There will therefore be a shortfall of close to 2,000 GWhs from the proposed projects.

12. Given constraints that exist in delivering infrastructure projects in New Zealand and globally, there remains a real risk that the shortfall cannot be addressed in time. This means that either security of supply is put at risk or some of the existing thermal plants will need to remain operating beyond 2030.

13. Because the Waitaha generation scheme is run-of-river and not dependent on coal supply chain, it will displace thermal generation. Assuming annual generation of 100GWhs, this equates to a reduction in CO_2 emissions of 100,000 tonnes annually.

14. Electrification of process heat on the Westpower network will add approximately 50 MWs of new load to the network and require 390 GWhs of additional energy. This will require 125 MWs of new wind generation to meet this energy requirement. 20 MWs of Waitaha generation makes a significant contribution to meeting these requirements.

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[2] Vaughan, Adam. "Global emissions must peak in just three years to stay below 1.5 ºC", *New Scientist*, April 2022. Retrieved on 16 May 2022 from: https://www.newscientist.com/article/2314731-global-emissions-must-peak-in-just-three-years-to-stay-below-1-5c/

[3] As above

15. Customers on Westpower's network are supplied with electricity generated more than 550 kilometres from Greymouth. To put this into perspective, that is the same as having all of Auckland's power supplied by stations in Wellington. Consequently, the region's electricity supply is at risk from a failure at any point on the 550 kilometres of the transmission corridor.

16. South Island transmission lines supplying the region traverse the Alpine Fault. There is a high probability of a rupture of the Alpine fault, and that in an earthquake on the Alpine Fault the route of transmission lines into the region could be subject to the highest levels of ground acceleration known in New Zealand. If there is an earthquake on the Alpine Fault there is the potential for severe disruption of the region's electricity supply.

17. The Waitaha Hydro Scheme will aid in ensuring resiliency of the power system in the region following an Alpine Fault earthquake. This will support disaster recovery by providing renewable electricity to hospitals and medical centres, police and fire service stations, and emergency management centres.

18. Importantly, the Waitaha Scheme will make a significant contribution to improving the resilience and security of supply on the West Coast and reducing electricity prices on the West Coast, which will support electrification in the West Coast region, further reducing emissions and contributing to the Government's emissions reduction targets and climate change goals.

19. New Zealand's electricity system is reliant on hydro generation, but due to a limited ability to store water when compared with other countries with predominantly hydro based power systems, New Zealand is continually at risk of water shortages in dry years. Research for other hydro projects on the West Coast have highlighted that rainfall on the West Coast tends to be close to average or above average in years when there are low inflows into the Waitaki river catchment. Because of this, in dry years the Waitaha Scheme will enhance security of supply in the region and contribute to mitigation of dry year energy supply risks across New Zealand.

20. While other hydro projects may be proposed for the region, these are not mutually exclusive. On the contrary, the benefits from multiple projects are additive up to the limits imposed on the export of energy from the region because of transmission capacity limits.

GOVERNMENT'S RENEWABLE ELECTRICITY GENERATION TARGETS

21. While this report focuses on REG objectives and goals, I note that the Government has passed the Climate Change Response (Zero Carbon) Amendment Act 2019 (**Zero Carbon Act)** committing New Zealand to achieving a number of climate change targets. The key target set out in at Part 1B Emission reduction, Subpart 1—2050 target, Section 5Q, of the Zero Carbon Act is to:

> "…net accounting emissions of greenhouse gases in a calendar year, other than biogenic methane, are zero by the calendar year beginning on 1 January 2050 and for each subsequent calendar year;"[4]

[4] Climate Change Response (Zero Carbon) Amendment Act 2019

22. Further detail on the emissions reduction targets agreed to by the Government are discussed in the Boffa Miskell report.[5]

23. In terms of REG specific objectives, the Interim Climate Change Commission recommended to Government that it should set a goal of having 100% of New Zealand's electricity supply from REG by 2035. The Government accepted this goal but, has an aspirational goal of reaching 100 per cent renewable electricity by 2030.

24. This goal is part of the transition to a net-zero carbon economy by 2050 and is supported by a renewable energy work programme. In addition, the Government has established a number of funding streams and implemented initiatives to support achievement of this goal.

25. The State Sector Decarbonisation Fund and the Government Investment in Decarbonising Industry (**GIDI**) Fund provide funding for decarbonisation to the Government and private sectors respectively. For example, the Clean Car Discount Scheme is aimed at helping to reduce light vehicle fleet emissions through offering rebates for zero and low emission vehicles.

<u>Impact on energy demand</u>

26. The Ministry of Business, Innovation & Employment (**MBIE**) and Transpower have undertaken modelling of future electricity demand in New Zealand under a number of different scenarios. The Government initiatives are indicative of high electricity demand scenarios being the most likely outcome. Please see paragraphs 29 – 35 below for further discussion on the projected demand increase.

ELECTRICITY DEMAND

27. In talking about the demand for electricity, care needs to be taken in distinguishing between peak demand measured in Megawatts (**MWs**) – the demand at a point in time (typically a half hour trading period or instantaneous in New Zealand) – or the energy consumed over a period of time and measured in Megawatt hours (**MWhs**). In this section I discuss both.

<u>Current demand</u>

28. Recent demand for electricity in New Zealand has been flat for several years. Figure 1 below provides details of annual electricity generation and renewable generation between 1997 – 2021, the period New Zealand's wholesale electricity market has been operating.

[5] Boffa Miskell Limited 2022, Waitaha Hydro Scheme: Climate Change Report. Report prepared by Boffa Miskell Limited for Westpower Limited

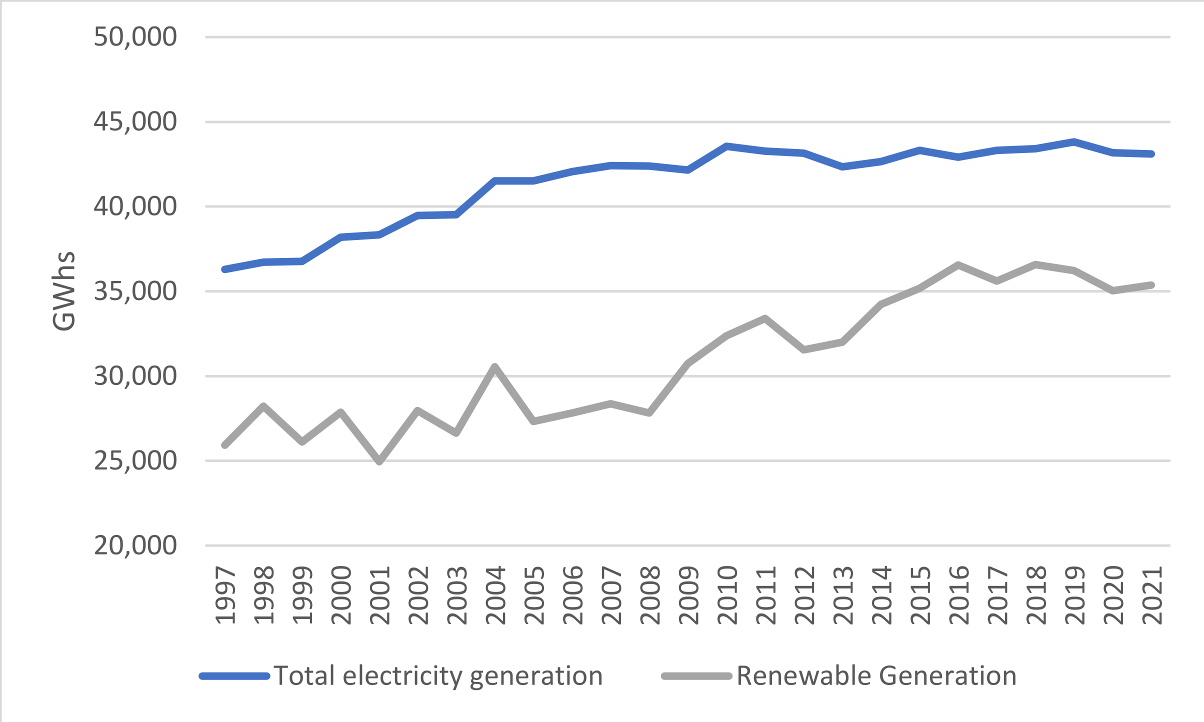

Figure 1 – Annual Electricity Production January 1997 – December 2021

29. Average growth over the period is slightly below 0.5% per year. The proportion of generation from renewable sources ranges from a low of 65% in the 2001 year of low inflow to hydro lakes to a maximum of 85% in 2016.

30. We have used electricity generation rather than electricity consumption to represent demand. This is because electricity losses in transporting energy from where it is produced to where it is consumed must be captured in analysis. Losses typically amount to approximately 7.2% of electricity generated in New Zealand, greater than that produced by the Benmore power station, the second largest renewable power station in New Zealand.

31. Peak demand is a matter of growing importance as evidenced by the power outage of 9 August 2021. On that evening there was not enough generating capacity to meet the demand for energy from customers (a new record) resulting in several thousands of having their power disconnected. This shortfall arose in part because of the absence of key thermal generating units (fuelled by gas and coal) from the market, and by the inherent variability of renewable energy – wind generation suddenly declined due to a lack of wind and a hydro plant could not operate because of blocked water intakes.

32. Peak demand has been relatively flat for an extended period. This changed in 2021 with the new record peak of 7,083 MW recorded. This is highlighted in Figure 2 below.

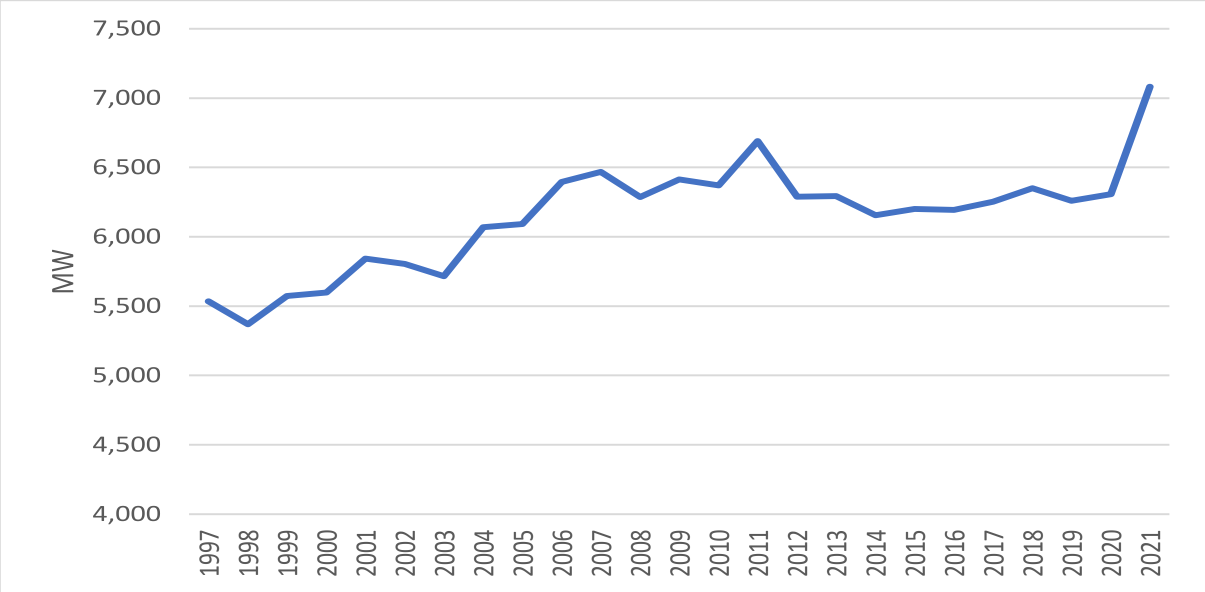

Figure 2 – Average half hour peak demand January 1997- December 2021[6]

The instantaneous peak demand on 9 August 2021 was almost 80 MW higher than this new record peak at 7,156 MW.

<u>Projected demand</u>

33. Projected demand for electricity in New Zealand is a matter of uncertainty. The two authoritative sources of electricity demand forecasts are provided by the MBIE and Transpower.

34. MBIE prepares Electricity Demand and Generation Scenarios (**EDGS**) which sets out the possible electricity demand out to 2050, and the incremental generation needing to be built to meet this forecast demand. The purpose of the EDGS is to provide the Commerce Commission with independent information to allow it to consider major capital project applications by Transpower under the Transpower Capital Expenditure Input Methodologies.[7] These are transmission expansion projects Transpower reasonably believes will be required to meet the future demand for electricity in New Zealand.

35. The most recent version of the EDGS report was released in July 2019,[8] although much of the background work for these scenarios was undertaken in 2017/18. Accordingly, we do not consider these forecasts further as many of the assumptions made are out of date. New EDGS are anticipated to be published later in 2022.

36. In response to New Zealand's target to be net zero carbon by 2050, Transpower commenced a project - Net Zero Grid Pathways (**NZGP**). This project is based on the reasonable assumption that to achieve net zero status by 2050 significant electrification of the New Zealand economy will be required. A first report from the NZGP project was published in December 2021.[9]

[6] Source: MBIE, New Zealand Energy Dashboard
[7] Transpower-capital-expenditure-input-methodology-determination-consolidated-29-January-2020.pdf (comcom.govt.nz)
[8] Electricity demand and generation scenarios (EDGS) | Ministry of Business, Innovation & Employment (mbie.govt.nz)
[9] Transpower_NZGP_Scenarios Update_Dec2021.pdf

37. NZGP seeks to identify grid investments necessary to ensure that the transmission system is not a barrier to achievement of this goal. To identify these projects, the NZGP prepares load forecasts out to 2050 based on modified EDGS scenarios. These load forecasts are set out in Figure 3 below.

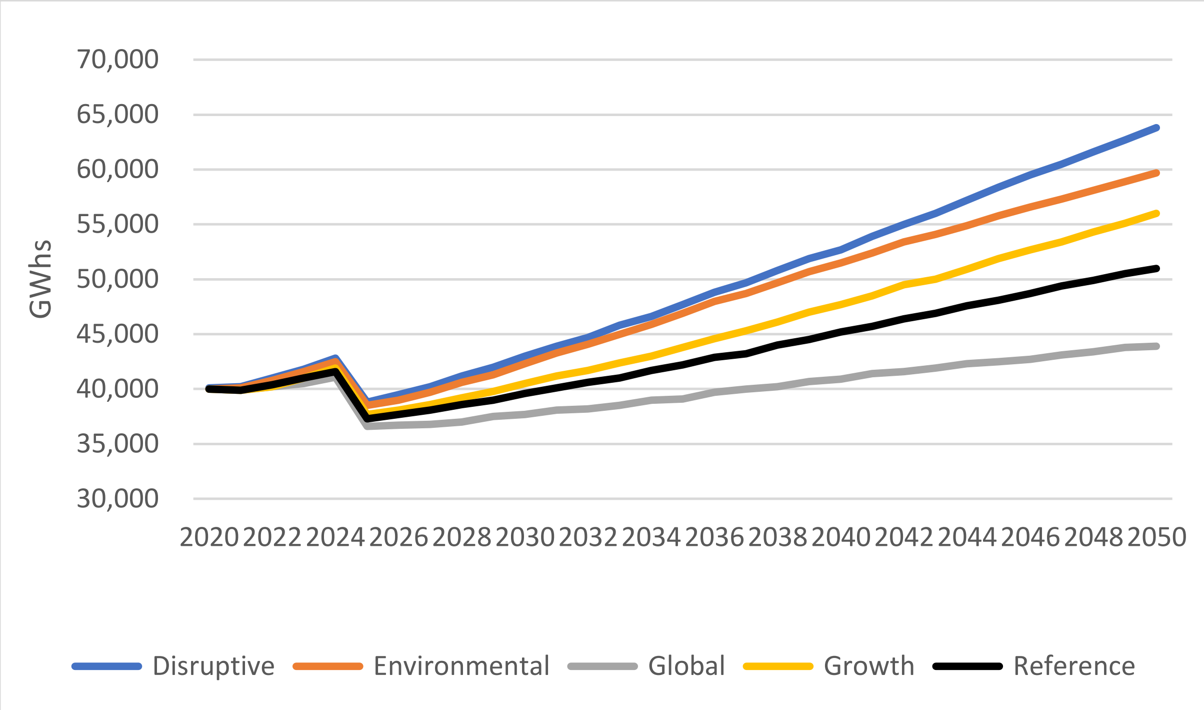

Figure 3 – Transpower NZGP load forecasts

38. For a decarbonised and electrified future, the most relevant forecasts are the 'Environmental' and 'Disruptive' scenarios. Under the Environmental scenario the Government seeks ambitious emissions reductions through incentives and regulation aimed at decarbonisation of the economy. This is achieved through support of electrification of both transport and process heat. In the Disruptive scenario, new and improved technologies accelerate the electrification process.

39. There is significant evidence both within New Zealand and internationally to confirm these scenarios as the relevant ones when considering load growth in New Zealand.

Tiwai Point Smelter

40. A key feature of the NZGP forecasts is the drop in load projected for 2025. This reflects an assumption that the Tiwai Point aluminium smelter will close in 2024. This assumption was based on the announcement in 2020 by Rio Tinto that it would close the smelter in 2024. Subsequent to this, Rio Tinto has in early February 2022 announced that:

> *" 'With a global strategy focused on decarbonisation and growth (released in October last year) Rio Tinto does see a positive pathway for New Zealand's Aluminium Smelter (NZAS) to continue operating and contributing to the local and national economies beyond 2024,' NZAS chief executive Chris Blenkiron said."*[10]

[10] Rio Tinto wants to keep Tiwai Point Smelter past 2024 closure date - NZ Herald

41. Addressing the future of the smelter is critically important to New Zealand's zero carbon initiative. The smelter consumes approximately 5,000 GWhs (13% of New Zealand's electricity demand) annually, equivalent to approximately 1,500 MWs of new wind generation – based on new wind generation plant operating a load factor of 40%.

42. We note that Transpower in the role of System Operator uses a load factor of 20% for wind when calculating the New Zealand Generation Balance (**NZGB**). The purpose of the NZGB is to:

> *"…help predict, isolate and prevent situations where available generation is insufficient to meet projected load."*[11]

Using the NZGB load factor of 20% would require a doubling of new wind capacity to 3,000 MWs to ensure the ability to generate the energy required to supply the smelter under low wind conditions.

43. With aluminium prices more than doubling since Rio Tinto's 2020 announcement, and the expected long-term challenges to the global aluminium market following sanctions imposed on Russia the world's second largest producer of aluminium, a prudent approach would be to ensure that load growth scenarios include ones where the smelter remains open.

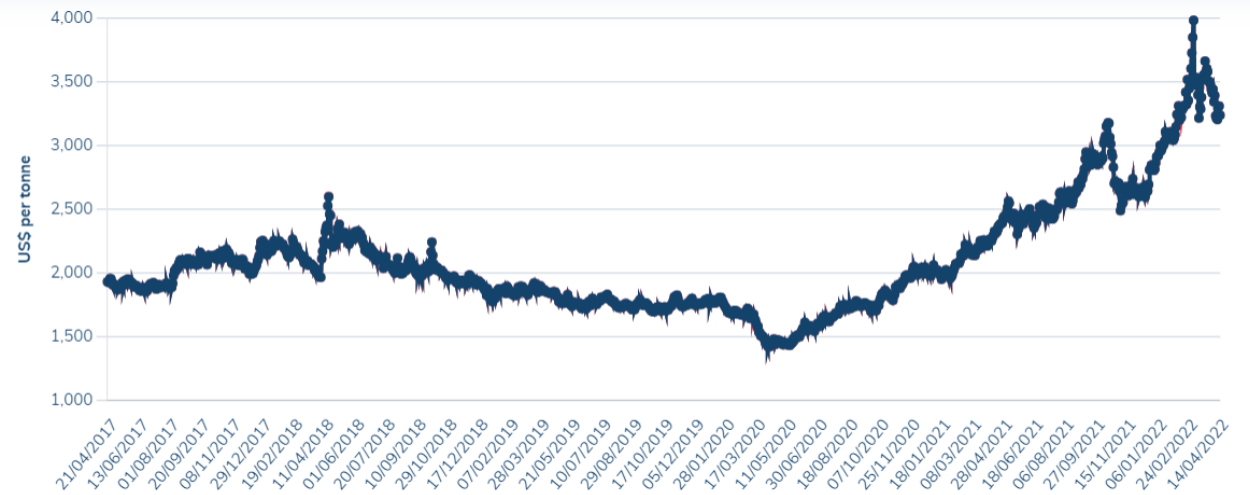

Figure 4 – Daily Close Global Aluminium Prices: April 2017 – April 2022[12]

44. To assess the impact of the smelter remaining open, load forecasts – GWhs and peak demand – for the Environmental and Disruptive scenarios with and without the smelter are set out below.

[11] NZGB (redspider.co.nz)
[12] LME Aluminium | London Metal Exchange

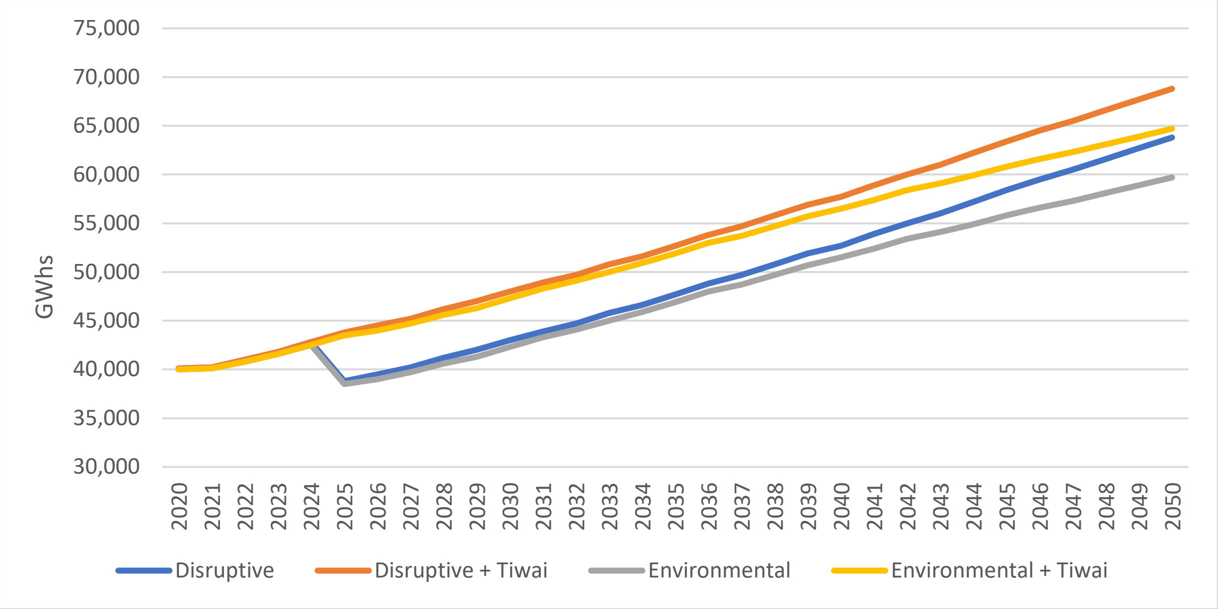

Figure 5 - Transpower Load Forecast (GWhs) 2020 – 2050

45. The forecast with the smelter remaining operational requires approximately 15,500 GWhs of additional energy annually by 2030 and 36,300 GWhs annually by 2050. In both cases this assumes that all existing thermal plant closes and the energy produced by them is replaced by renewable energy.

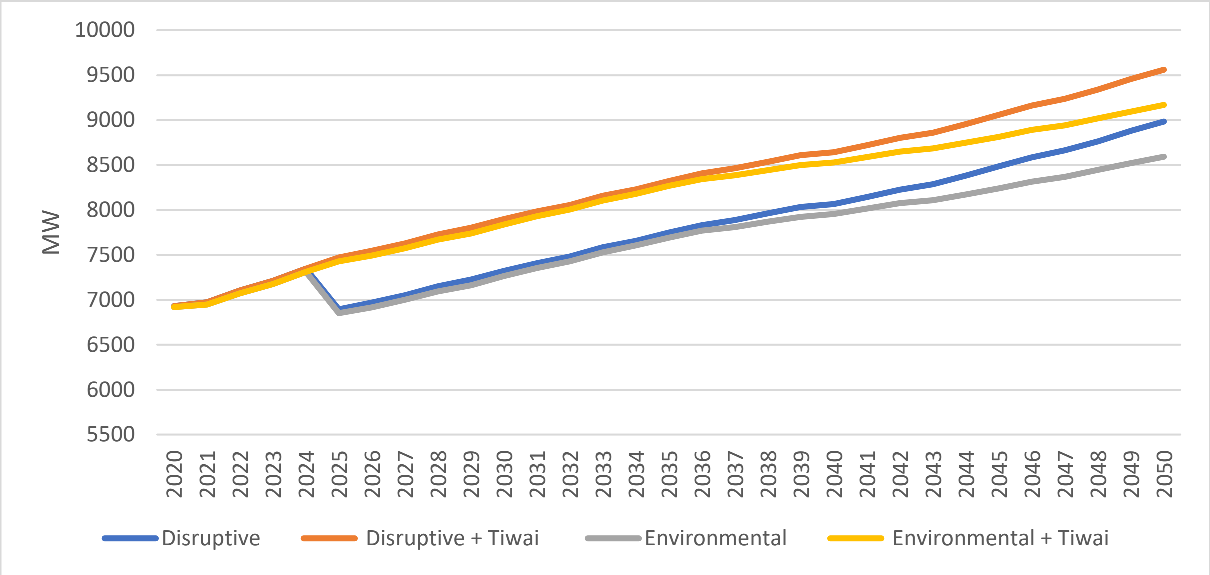

Figure 6 - Transpower Load Forecast (Peak Demand) 2020 - 2050

46. Assuming Tiwai remains open, a significant increase in capacity is also required to be commissioned by 2030 – greater than 3,050 MWs, and by 2050 this increases to approximately 4,700 MWs. In both cases there is a requirement for approximately 2,151 MWs of new capacity to replace thermal plant that are assumed to be closed.

Nature of Load Growth

47. When looking at future load forecasts, consideration also needs to be given to where and when load increases might occur. When considering decarbonisation of the New Zealand economy, three areas have special importance: process heat, transportation, and space heating/cooling.

Process Heat

48. Decarbonisation of process heat needs to be separated into North and South Island impacts. In the South Island, decarbonisation involves a substitution of coal for an alternative energy source – expected to be electricity. In the North Island decarbonisation involves a substitution from natural gas to an alternative – either electricity, or because of the existing pipeline network, green hydrogen. While some attention has been placed on biomass, it remains unclear whether sufficient resource is available to make a meaningful contribution.

49. The majority of the South Island process heat load relates to food processing, in particular in the dairy and meat processing industries. The predominant requirement for this new energy falls over the late spring through early autumn processing period.

50. Energy Efficiency and Conservation Authority's (**EECA**) Regional Heat Demand Database[13] currently provides process heat data for two regions – Canterbury and Southland (other regions are expected to be populated late 2022). Electrification of process heat in both regions will require an additional 665 MWs of capacity, with the manufacturing sector requiring an additional 528.5 MWs, equivalent to adding the capacity of a new aluminium smelter.

51. As much of this load will occur over the spring through autumn periods, in the absence of significant new generation in the South Island, this additional load will exacerbate dry year electricity supply risk in New Zealand. This will occur because storage in hydro lakes will be drawn down to meet peak demand in real-time.

52. In their document *Demand for coal and liquid fuel for industrial process heat map,* MBIE has identified 1.4 PJ annually[14] of coal-fired process heat on the West Coast, primarily at the Westland Milk Products plant and the ANZCO Foods Kokiri plant. This is equivalent to nearly 390 GWhs of electricity and is 68% more than Westpower's customers' 2021/22 electricity consumption of 232 GWhs.

53. From a peak demand perspective, Westpower expect this electrification to require an additional 50 MWs of capacity, a 125% increase on current maximum demand of 40.1 MWs.

Transportation

54. In regard to transportation, the primary source of load growth in the near term relates to light vehicles. Load forecasts generally assume that in-home EV charger load growth will be accommodated within normal load growth. This may be true when charging is based on the typical trickle charging rate of 1.8 kW, which approximately 75% of electric vehicles currently use in New Zealand, and while growth in electric vehicle numbers is small.

[13] Regional Heat Demand Database | EECA
[14] Demand for coal and liquid fuel for industrial process heat map | Ministry of Business, Innovation & Employment (mbie.govt.nz)

55. EECA is forecasting much greater use of charging rates at 7.2 kW or greater from 2023.[15] With fast charger technology allowing charge rates greater than 50 kW (300 kW and higher are being trialled), a small number of vehicles connecting during a peak period may substantially increase load on networks such as Westpower's. The need for additional fast charging capacity will also be impacted by the uptake in EVs in other regions and travel either to or through the West Coast region.

56. The Government's clean car discount scheme is already seeing significant growth in the number of electric vehicles being registered in some regions. This has had a consequent impact on the growth in peak demand on low voltage networks, consistent with in-home charging. Over time, this growth will start impacting all electricity networks.

Space heating and cooling

57. A third area driving growth is electrical space heating and cooling. While there has already been widespread electrification through the adoption of heat pumps for space heating, there is a significant potential for further uptake.

58. Globally we are seeing increasing temperatures including both maximum daily temperatures and minimum overnight temperatures. In countries with temperate climates similar to New Zealand, this has resulted in both an increased use of heat pumps for summer cooling and greater electrification with heat pumps replacing existing heating systems.

59. From a Westpower network context, initial heat pump uptake will largely replace solid fuels – wood and coal.

<u>Westpower Load Forecast</u>

60. Westpower has had an extended period of declining load, both energy and peak. This is set out in 7 below.

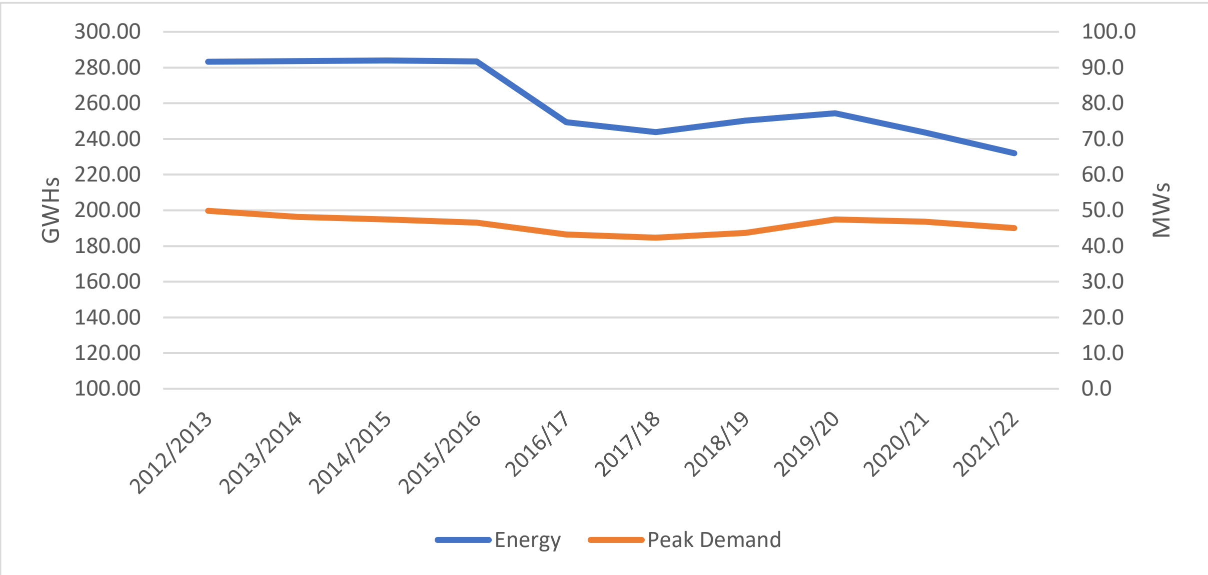

Figure 7 – Westpower energy consumption and peak demand 2012/13 – 2021/22

[15] Electric Vehicle Charging Technology: New Zealand residential charging perspective. www.eeca.govt.nz/assets/EECA-Resources/Research-papers-guides/EV-Charging-NZ.pdf

61. However, decarbonisation and electrification will cause both peak demand and the demand for energy to increase significantly. At paragraphs 34 and 35 above we identify the increases in electricity demand just from a substitution of coal for electricity in the process heat sector.

62. What is uncertain is the timing for much of this load growth. However, it is reasonable to assume that replacement of Government owned facility coal boilers on the West Coast will happen relatively quickly due to the Government's State Sector Decarbonisation Fund. To-date the only project announced on Westpower's network relates to Reefton Area school.[16]

63. Timing of the replacement of the coal boilers at the large Westland Milk Products plant is uncertain. However, we note that funding has been approved under the GIDI Fund for a demand reduction program at the site.[17] This project is seen as a precursor to future investments to enable decarbonisation at the site.

64. In addition, ANZCO has received GIDI funding to convert 2.5 MWs of coal boiler load to an electric boiler (1.6 MWs) and high temperature heat pump. It is expected that both loads will be converted late in 2022.

65. Given currently confirmed projects and underlying growth an upturn in electricity demand is expected over the next ten-year period. This is set out in 8 below.

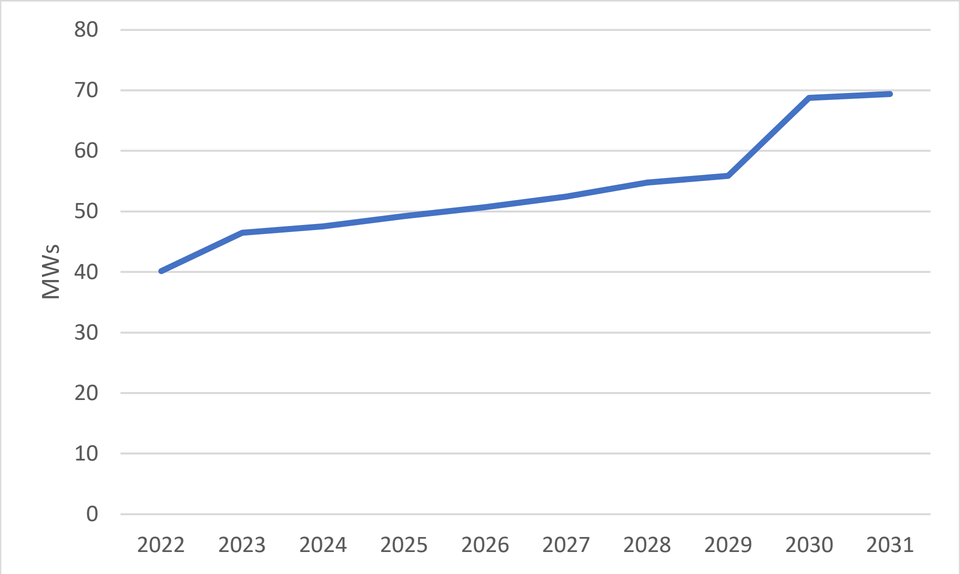

Figure 8 – Westpower Forecast Peak Load 2022 - 2031

66. Peak load is forecast to grow significantly in 2023 reflecting new load at the Reefton goldmine and additional components within the existing plant at Westland Milk Products in Hokitika. In addition, there is a 1.6 MW increase from replacement of a coal boiler at the ANZCO Kokiri plant.

67. In 2030 there is a forecast jump in load arising from Westland Milk Products commencing the decarbonisation of load at the site. The timing of this is uncertain and may be brought forward.

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[16] State-sector-decarbonisation-fund-project-summary-28-October-2021-v2.xlsx (live.com)
[17] GIDI-Fund-Summary-of-Projects-Round-1.pdf (eeca.govt.nz)

68. It is difficult to forecast the energy requirements because the peak loads are seasonal in their consumption, with peak demand occurring in spring and early summer period. Despite the difficulties, due to seasonal fluctuations, once such fluctuations are accounted for the forecasts are reliable.

Generation to Meet Forecast Load

69. New Zealand is heavily dependent on the production of electricity from hydro-electric power stations, generation that requires a regular supply of fuel – water either from inflows or stored water in lakes. As shown in Figure 9 there is also a growing proportion of generation provided by both geothermal and wind resources.

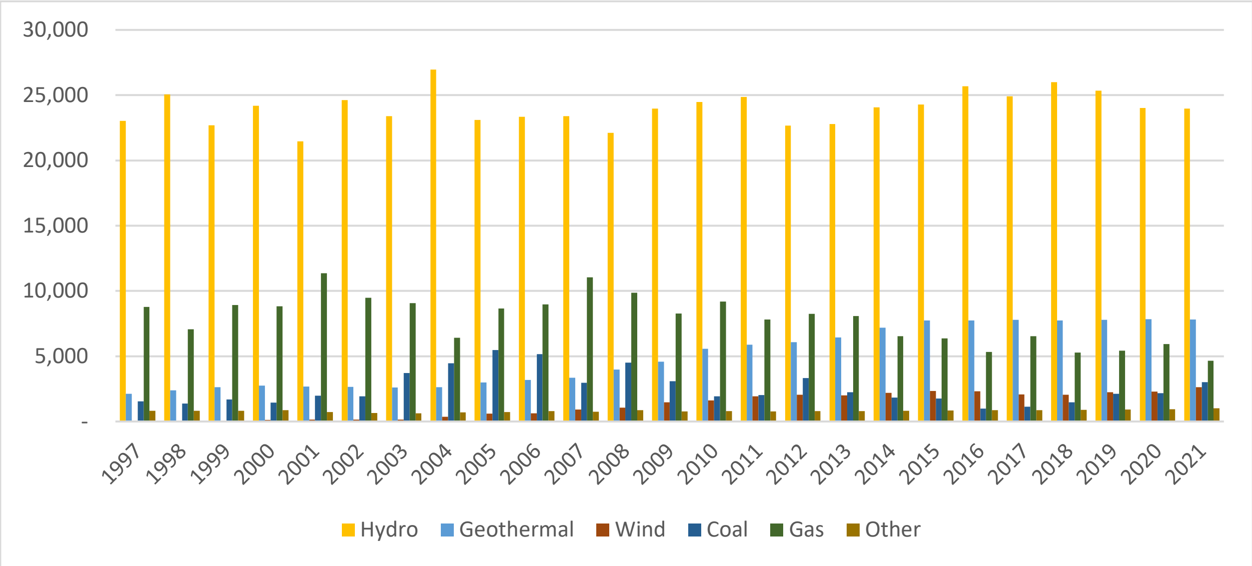

Figure 9 – Generation by plant type – 1997 - 2021[18]

70. Under normal conditions the New Zealand electricity market is considered to be energy constrained. That means that over time there may not be enough energy to meet demand. This manifests from time to time by what are referred to as dry years, or years in which there are extended periods when water flows are insufficient to maintain storage levels in hydro lakes. Accordingly, annual hydro generation in these years declines and is replaced with increased coal and/or gas generation. This is not an option if generation is 100% renewable.

Plant Closures

71. With a target of 100% renewable generation by 2030, significant investment in new generation will be critical. Starting with the replacement of existing thermal generation plant, 2,151 MWs of generation will be decommissioned. This total may be reduced if 241 MWs of co-generation remains operational to provide process heat or converts to an alternative such as biomass (woodchips). Details of plants facing closure are set out in Table 1 below.

[18] https://www.mbie.govt.nz/assets/Data-Files/Energy/nz-energy-quarterly-and-energy-in-nz/electricity.xlsx

Plant	Location	Capacity (MW)
Auckland Hospital	Auckland (Waitemata)	3.6
Bream Bay	Northland	9
Edgecumbe	BoP	10
Huntly (2 units)	Waikato	500
Huntly 5 - E3P	Waikato	400
Huntly 6	Waikato	50
Junction Road	Taranaki	100
Kapuni	South Taranaki	25
Kawerau (TPP)	BoP	37
Kinleith	South Waikato	40
Mangahewa	New Plymouth	9
McKee (recip)	New Plymouth	2
McKee (turbine)	New Plymouth	100
QE2 Park	Christchurch	4
Stratford CCGT	Taranaki	385
Stratford peaker	Taranaki	200
Te Rapa	Waikato	44
Wellington Hospital	Wellington	8
Whareroa	South Taranaki	69.6
Whirinaki	Hawkes Bay	155
Total Thermal Capacity		2151
Co-generation plant		241

Table 1 – Thermal plant closures to meet 100% renewables by 2030[19]

72. There is a high probability that both Huntly coal units and the Stratford Combined Cycle Gas Turbine (**CCGT**) may close as early as 2023, taking 885 MW of capacity out of the market.

73. It is also probable that older wind and geothermal plants may close before 2030. Although assuming existing activities are able to be re-consented, any plant will likely be replaced with the modern equivalent plant at the same site.

What New Plant Will Be Built?

74. Decisions to build new generation in New Zealand will be a commercial decision for investors. It can be expected that the plants built will have the lowest levelized cost of energy (**LCOE**).

75. LCOE provides the present value of energy from a generation project. It is a measure of the lifetime cost of the project divided by its energy production. It provides a simple manner to compare different generation technologies (wind, solar, hydro etc) which have different capital and operating costs, different expected lives, different capacity factors, and different costs of capital for their investors.

76. The International Renewable Energy Agency (**IRENA**) publishes annual data on the LCOE for new plant and the expected capacity factor for the plant.[20] The most recent data for 2020 is set out below. Average capacity factors for New Zealand plant for 2021 are also shown.

[19] List of power stations in New Zealand - Wikipedia
[20] Renewable Power Generation Costs in 2020 (irena.org)

Plant Type	LCOE $/MWh[21]	Capacity Factor	NZ Generation Plant Capacity Factor[22]
Hydro	$65.84	46%	50%
Onshore Wind	$58.42	36%	38%
Offshore Wind	$124.12	40%	
Solar	$83.95	16%	9%
Geothermal	$105.32	83%	70%

Table 2 – IRENA global average 2020 LCOE and capacity factors for new renewable generation projects

77. Based on these LCOE figures, it would be expected that New Zealand would see investment in onshore wind and hydro. While there is significant investment in wind projects, there are a limited number of new hydro and grid scale solar projects. By way of reference, Amethyst Hydro LCOE was 6.3 cents per MWh and the Waitaha Hydro Scheme is expected to be about 7-8 cents per MWh.

78. There are currently 24 projects either holding necessary consents or undertaking the consenting process (**proposed projects**). While predominantly wind projects, there is a small number of hydro, solar, and geothermal projects.

	MWs	GWhs
Required capacity and energy	11,800	36,310
Proposed Projects	3,673	13,590
Shortfall in generation	8,127	22,720

Table 3 – Required and proposed generation to meet 2050 forecasts

79. Based on the information set out in Table 3, it is clear that there is a significant shortfall in REG required to meet 2050 energy and capacity requirements. Proposed projects provide slightly more capacity than forecast as being required in 2030, but there remains an energy shortfall of close to 2,000GWhs.

80. Given constraints that exist in delivering infrastructure projects in New Zealand and globally, there remains a real risk that the shortfall cannot be addressed in time. This means that either security of supply is put at risk or some of the existing thermal plants will need to remain operating beyond 2030.

81. With the LCOE continuing to fall for wind (onshore and offshore) and solar as the technology improves and better sites are identified, further growth in market share for these generation technologies can be expected. But, they can suffer from significant short-term declines in production due to rapid changes in local weather – as happened on 9 August 2021, resulting in several thousands of customers having their power disconnected.

[21] Dollar figures are NZ$ converted from US$ at the 20 year average exchange rate – NZ$1 = US$0.675
[22] Source - Electricity statistics | Ministry of Business, Innovation & Employment (mbie.govt.nz)

82. If much of the new generation is located in the same region, then this risk gets magnified. Currently much of the wind resource is located in the south of the North Island, and several of the proposed wind projects are located in the same region.

WAITAHA ROLE IN PROVIDING RESILIENCE TO THE LOCAL POWER SUPPLY

83. Modern power systems face many threats and hazards and modern economies rely increasingly on reliable and resilient power systems. The scope of these threats and hazards includes physical events such as wind storms, bushfires, earthquakes, sea level rise, and flooding, and man-made events like human error, physical attacks and cyber-attacks.

84. These events can and do have impacts a long distance from where they occur. This is certainly the case facing Westpower who are reliant on almost 550 kilometres of transmission to provide supply from Benmore. To put this into perspective, that is the same as having all of Auckland's power supplied by stations in Wellington. Consequently, Westpower's electricity supply is at risk from a failure at any point on the 550 kilometres of the transmission corridor.

85. Manifestation of any of these threats and hazards will have local impacts that vary depending on the local economy. Consequently, greater attention is being placed on how to increase the reliance of the power system.

86. To evaluate the ability of generation to provide resilience to local power systems the United States National Association of Regulatory Utility Commissioners (**NARUC**) identified the following several traits of distributed energy resources (DERS), most of which Waitaha is an example:

> *"Dispatchability* [partial for Waitaha]*: Resilient DERs can respond to a disruption at any time with little to no advance warning.*
>
> *Islanding Capability: Resilient DERs have the ability to isolate from the grid and serve load during a broader outage.*
>
> *Sitting at Critical Loads/Locations* [not applicable to Waitaha]*: Resilient DERs reside at critical loads or at critical points on the grid (e.g., areas of high residential density).Fuel Security: Resilient DERs do not rely on the availability of a limited physical fuel to provide power.*
>
> *Quick Ramping* [partial for Waitaha]*: Resilient DERs are capable of changing output quickly to match rapidly changing load.*
>
> *Grid Services: Resilient DERs can provide voltage support, frequency response, and other grid services that contribute to stabilization during disruptions.*
>
> *Decentralisation: Resilient DERs are sized and sited to support a load in the distribution system*
>
> *Flexibility: Resilient DERs can be deployed quickly and at relatively low cost, when compared to centralized generation, transmission, and/or distribution, at locations and times where resources are needed."*[23]

[23] ECD7FAA5-155D-0A36-3105-5CE60957C305 (naruc.org)

87. Waitaha meets most of these attributes, although Dispatchability and Quick Ramping are only partial – the load can always be reduced but whether it can be increased depends on the flow, and Sitting at Critical Loads/Locations does not apply. As a run of river hydro scheme embedded within the Westpower network, it is dispatchable by Westpower control room staff. It can operate islanded in the event that the network is cut off from the transmission system. It is sited close to the largest single load on the network (Westland Milk Products) and the second largest centre of population (Hokitika). As a run-of-river scheme it has security of fuel supply, no known instance of the Waitaha River flow stopping has been recorded. Being a hydro generator, Waitaha is inherently able to increase or decrease production extremely quickly. Being embedded in the distribution network, Waitaha is by definition decentralised in accordance with the above definition. Further, subject to receiving all required concessions and consents, Waitaha will be operational quicker and at lower cost than large grid connected generation.

Providing Resilience after an Alpine Fault Earthquake

88. The West Coast is facing a high probability of a large earthquake on the Alpine Fault, and for disaster planning purposes this is frequently referred to as an AF8 event – for a magnitude 8 earthquake. When this occurs, it will almost certainly cause an extended period power outage. There may be multiple locations where damage to the transmission system is sustained along its 550km route into the West Coast.

89. Current mitigation of this risk is provided by diesel generators. But this will be inadequate due to limited fuel supply in the region. Providing additional fuel storage will not help as these may rupture and spill fuel, contaminating ground and possibly waterways. As roads will likely be closed for an extended period, getting additional fuel into the region will be problematic. While barges or small tankers may provide some relief, the absence of sheltered harbours may make this option difficult especially if weather conditions are inclement for crossing sandbars at the river mouths. Further, transfer of fuel from ship to shore is fraught with risk, without having to operate from severely damaged facilities.

90. While there can be no guarantees, a well-designed Waitaha run-of-river hydro scheme can make a significant contribution to the provision of a limited power supply in the region, and avoid the need for using diesel generation. This power supply will be essential in meeting the electricity requirement of critical facilities such as hospitals and other medical facilities, police and fire service stations, disaster relief coordination centres, emergency accommodation, and essential infrastructure such as water and wastewater treatment plants.

<u>Westpower Network Region Wholesale Spot Prices and Transmission Losses</u>

91. The New Zealand wholesale electricity market creates the price at each location at which wholesale electricity is produced and consumed. There are about 280 of these locations across New Zealand. The pricing model optimises the dispatch of generation so that price and transmission losses are minimised. Simultaneously, a number of security aspects are considered, such as ensuring there is sufficient generation reserve, and the supply of this is also optimised. The development of prices at each location is referred to as nodal pricing.

92. Nodal pricing works such that the price at one of the 280 different locations represents both:

1. the marginal cost of energy supply (based on generator price-quantity offers); and

2. the marginal cost of transmission to the location of supply.

93. In this context, the marginal cost of transmission at a location is the additional losses that are incurred by supplying the extra demand at the location. Since losses are, in simple terms, related to the square of the power flowing on the line, and the length and size of the line, then marginal losses are proportional to the length of the line and the power flow along it.[24] Put simply, the longer the transmission line, and the more power that flows along it, the higher the price will be at the end of it.

Westpower Region Nodal Prices

94. The increase in losses with line length and power flow identified above is highly relevant in the case of the Westpower region and the upper South Island in general, since the transmission system to these locations is long and there is very little generation in these regions. The combination of the long transmission system, little generation in the regions, and increasing electricity demand, leads to higher prices, which, in the absence of any significant new local generation capacity, will increase over time.

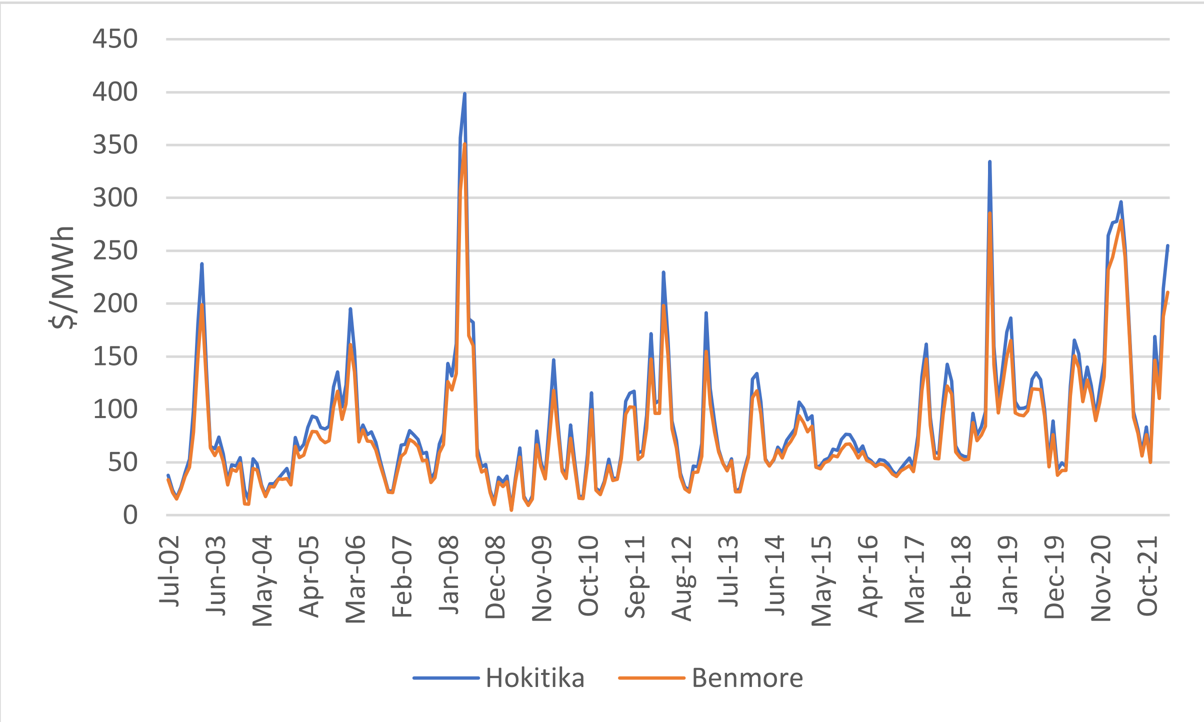

Figure 10 – Comparison of Average Monthly Spot Prices

95. The higher prices in the West Coast region make it a prime area for generation investment, when there is a suitable fuel source. Locating generation in the region will serve to lower the wholesale spot price on the Westpower network.

[24] This is a highly simplified analysis that does not take into account the complexities of AC power flow. However it is directly analogous to the New Zealand market pricing model and my intention is to illustrate the relationship between line length, power flow, and losses, and therefore price.

96. This will be particularly so in the case of Waitaha, which will run almost continuously when there are sufficient inflows from its catchment. Lowering of the wholesale spot price should have a beneficial effect on industry and consumers in the region. Importantly, lower prices will encourage greater electrification in the region, reducing CO_2 emissions.

Transmission Losses

97. In the previous sub-section I discussed the relationship between transmission losses and nodal electricity price, showing that price increases relative to distance of transmission with increasing transmission losses. In this section I discuss the energy savings that would result from reduced transmission losses, through locating new generation facilities in the West Coast region.

98. The total losses on Transpower's network in the 2021/22 year was 3.17% of energy entering the network. However, much higher transmission losses are experienced for electricity transmitted into the West Coast region. Analysis based on average location factors (explained below) indicate that for electricity transmitted into the West Coast region, marginal transmission losses of approximately 11.4% have been recorded since the electricity market was formed. High electricity prices on the Westpower network reflect those high transmission losses.

99. If the Waitaha Scheme is constructed, there will be a decrease in transmission losses for the West Coast region and across the whole upper South Island. Evidence of this is provided by the reduction in location factors following the commissioning of the Amethyst power station by Westpower in 2013. Location factors prior to Amethyst commissioning averaged 1.142 and they have dropped to 1.092 since it started operating. This represents a significant reduction in location factor and a further significant drop can be expected following commissioning of Waitaha.

BENEFITS OF THE WAITAHA SCHEME

Electricity benefits

100. The Waitaha hydro Scheme is proposed as a 20 MW run-of-river scheme. It is expected to generate between 100 and 120 GWhs of energy,[25] giving an average capacity factor of approximately 63%. This contrasts with the near to 80% capacity factor of Westpower's Amethyst power scheme – also run of river, over its first nine years of operation.

101. The New Zealand electricity market requires generators to make price quantity offers to the System Operator. This allows the System Operator to create a merit order of generation which ranks generators by their offers, allowing the dispatch of the lowest cost generation to meet demand. Much of the generation in New Zealand has a zero offer price ($0/MWh) reflecting the fact that they provide renewable generation that must be produced or lost – either because it cannot be stored, or in the case of hydro generation minimum water flows must be maintained.

102. As Waitaha generation is run-of-river it will typically be offered at $0/MWh. As a result, it will be dispatched ahead of more expensive generation, in the current market either thermal

[25] Communication from Westpower

generation or hydro generation with storage. If thermal generation is displaced, CO_2 emissions will be reduced. If hydro is displaced, energy security is improved because hydro storage increases.

103. Being located on the West Coast, weather patterns affecting inflows differ from those faced by the Waitaki River system, the primary location of hydro storage. Prior work done for West Coast hydro projects has identified that the generation from a scheme such as Waitaha will be higher in years when inflows and production on the Waitaki River are lower. Therefore, the Waitaha Scheme will enhance security of supply in New Zealand when it is commissioned.

<u>Climate Change benefits</u>

104. There are two potential benefits arising from construction of the Waitaha Scheme. The key benefit is that it will displace thermal generation in New Zealand. The Genesis Energy Huntly plant emits approximately one tonne of CO_2 for each MWh of electricity produced.[26] The average offer price of this generation is believed to be above $130/MWh and continues to increase with rising coal and carbon prices.

105. Assuming Waitaha production of 100 GWhs (100,000MWhs), this is equivalent to a reduction in CO_2 emissions of 100,000 tonnes of CO_2 from electricity production. CO_2 emissions will also be reduced in the coal supply chain. Information was not available to estimate this reduction.

106. The second key benefit is that because the Waitaha Scheme reduces the price differential between the Benmore generation hub and the West Coast ,and improves regional security of supply, it may encourage greater uptake in electric vehicles and increase electrification of space heating. Both of these will lead to a reduction in CO_2 emissions.

CONCLUSION

107. The IPCC has identified that urgent and dramatic cuts in emissions are required to keep the global temperature increase below 1.5 degrees Celsius. They also note that there has been a failure to act.

108. The Government's target of 100% renewable energy by 2030 requires the closure of 2,151 MWs of thermal generation. Planned renewable generation projects are insufficient to meet the forecast energy required in 2030 creating a shortfall in generation.

109. The Waitaha Scheme (not currently included in the proposed generation plant list) will make a positive contribution to decarbonisation.

110. IRENA research highlights that hydro generation such as Waitaha, has the second lowest average LCOE. If the Government wishes to ensure electricity prices do not increase unnecessarily during the decarbonisation and electrification process, actions need to be taken to ensure that the lowest cost projects are encouraged.

[26] Calculated based on publicly available information in the Genesis Energy 2021 Annual Report and Electricity Authority statistics.

111. Importantly, construction of the Waitaha Scheme will displace thermal generation in New Zealand reducing CO_2 emissions and will aid in reducing electricity prices on the West Coast and improve security of supply, which will support electrification in the region reducing emissions even further.

Erik Westergaard

23 May 2022

APPENDIX A: QUALIFICATIONS AND EXPERIENCE

112. My name is Erik Cameron Westergaard. I am an independent consulting regulatory economist and electricity market expert.

113. I graduated with a Bachelor of Commerce (Honours) Degree with majors in Accounting and Economics from Otago University.

114. I have more than thirty years' experience working in the electricity industry as both an employee of companies operating in the industry and as a management consultant providing services to governments, regulators, and corporations advising in many countries including Australia, Canada, Malaysia, New Zealand, South Africa, and the United States.

115. My relevant work experience includes:

(a) Preparation of Energy Policy for Governments;

(b) Design and operation of electricity markets;

(c) Addressing short-term and long-term issues impacting on security and reliability of supply;

(d) Developing financial transmission rights to manage risk associated with transmission congestion;

(e) Assisting utility companies assess and develop risk mitigation strategies for the risks facing their business;

(f) Investigating the potential for run-of-river hydro developments for international and New Zealand domiciled generation firms.

116. Recent projects include:

(a) Appointed by the Minister of Energy and Resources to act as the technical expert on a review commissioned by the Minister to investigate the causes of power supply interruptions on the evening of 9 August 2021, to identify and recommend improvements to ensure similar circumstances are better managed in future.

(b) Supported a New Zealand distribution business evaluate options to meet rapidly growing electricity growth arising in large part from electrification of process heat on their network. This project evaluated a range of options including both distributed generation and transmission solutions.

(c) Undertaking a project to calculate the value of lost load faced by customers of a New Zealand distribution business following power outages. The results of the project will support further investment in the network and generation options embedded in the local distribution network to minimise the need for customers to use diesel generation to meet electricity requirements following outages.

(d) Undertook an investigation into options for reducing carbon emissions associated with the commissioning of new ferries for KiwiRail. The project demonstrated that partial electrification of ferries through the adoption of battery storage was viable but not a complete solution.