HOLLAND BECKETT

17 SEPTEMBER 2025

MEMORANDUM

To The Ministry for the Environment

From Holland Beckett on behalf of King Country Energy Ltd

Response to further information request for Mangahao Hydro-electric Power Scheme referral application

1. We set out below the response from King Country Energy Ltd (**KCE**) to the request for information from the Ministry for the Environment in respect of the application for referral for Mangahao Hydro-electric Power Scheme (**Mangahao HEPS**).

Further information and data to support the assertion in the application that this project is of national significance and the economic benefits associated with this project in that context

2. KCE has provided an assessment of the national benefits of the Mangahao HEPS from the New Zealand Institute of Economic Research (**NZIER**) attached as **Appendix A**.

3. A critical national benefit of the Mangahao HEPS is by providing a controllable and dispatchable supply of electricity when wind generation in the Manawatu is not available in peak times.[1] This is known as 'firming'.

4. Put simply, when the wind farms in the Manawatu are not generating electricity the National Grid requires another electricity supply. The Mangahao HEPS is the only significant hydro-electric power scheme south of Patea in the North Island and has water storage through the multiple reservoirs. This makes the Mangahao HEPS a controllable source of renewable electricity which ensures the consistent supply of electricity to supplement the wind farms.

5. NZIER's assessment is that if the Mangahao HEPS was not present to provide this firming role, new generation would need to be constructed (likely gas-fired thermal generation as grid scale batteries are not suitable). The ongoing operation of the Mangahao HEPS avoids the capital and ongoing cost to the national electricity supply network of providing new supplementary generation, which is a national benefit.

6. Overall, NZIER's assessment is that the national benefits of the Mangahao HEPS are:

   (a) Providing controllable and dispatchable renewable electricity to supplement wind farms. The operation of the Mangahao HEPS provides this national benefit by:

      (i) Avoiding the cost of new capital construction of additional renewable electricity generation to provide 'firming' in peak times (i.e. if the Mangahao HEPS did not exist). NZIER estimates that the capital cost of constructing new coal fuelled thermal peaker generation[2] to address the mismatch between wind output and the Mangahao HEPS would be approximately $60.7M.

[1] Note NZIER note that there is solar farm pa

[2] Peaker generation is used to meet periods of high demand when other capacity is either fully committed or output from other capacity (such as wind and solar) falls below projected levels unexpectedly. Peaker generation needs to be able to go from zero to full output in a very short period and then run consistently until the gap between demand and other capacity is closed. In New Zealand this type of generation is fueled by gas.

(ii) Avoiding the ongoing costs in fuel for such thermal generation is estimated to be $5.8M per year at recent gas prices but would rise over time.

(iii) Avoiding increasing emissions would be generated from supplementary thermal generation. NZIER assesses these emissions at about 25,800 tonnes of carbon dioxide equivalent (tCO2e) per year. Avoiding these emissions is a national benefit.

(iv) Avoiding the need to pull additional generation from the national grid and other regions to provide this firming role, which avoids the resulting electricity transmission losses. This is also a national benefit.

(b) The Mangahao HEPS generates up to a maximum 39.9 MW of electricity with an average annual output of 131 GWh, which is enough to power approximately 20,000 homes.

(c) The ongoing operation of the Mangahao HEPS avoids the capital cost to replace this generation of $128.7M for a period of 25 to 30 years and operating costs estimated at $2.0M to $2.7M per year. Avoiding these costs to the national electricity network is a national benefit.

(d) The ongoing operation of the Mangahao HEPS contributes towards decarbonising New Zealand's economy. It also contributes to achieving the 90% renewable energy target by 2025 set out in the National Policy Statement for Renewable Electricity Generation 2011 (**NPS-REG**) and the aspiration to achieve 100% renewable energy by 2030.

(e) NZEIR has assessed the greenhouse gas emission reductions at the Mangahao HEPS for the total generation from the scheme of approximately 67,830 tonnes CO2-e (for gas). This helps New Zealand meet its emission reduction targets under the Paris Agreement by continuing to displace greenhouse gas emissions from thermal generation for both baseload and peak demand.

(f) Providing hydro capacity in a different climatic region from the main storage lakes in the South Island; this reduces the risk of correlated dry periods across hydro capacity.

7. The NSP-REG provides for renewable electricity generation, including its benefit of maintaining or increasing electricity generation capacity while avoiding, reducing or displacing greenhouse gas emissions, as a matter of national significance (Policy A).

8. The preamble to the NPSREG notes "*the contribution of renewable electricity generation, regardless of scale, towards addressing the effects of climate change plays a vital role in the wellbeing of New Zealand, its people and the environment*".

9. Maintaining this 'firming' role is also consistent with NPS-REG which requires decision-makers to have particular regard to even minor reductions in the generation output of existing renewable electricity generation activities, as that can cumulatively have significant adverse effects on national, regional and local renewable electricity generation output.[3] The ongoing operation of the Mangahao HEPS is entirely consistent with that national direction.

10. We also reiterate the regional benefits of the Mangahao HEPS:

(a) The provision of, and access to, secure and reliable renewable electricity is of critical importance to the social and economic wellbeing of the Horizons Region (and all New Zealanders).

[3] Policy Bb) National Policy Statement for Renewable Electricity Generation 2011

(b) The Mangahao HEPS is a run-of-river scheme with a generation capacity of 39.9MW and an annual output of approximately 131 GWh that is embedded in the Electra Lines Company distribution network (but was connected to a grid injection point (GIP) before 2010). The Mangahao HEPS generation is equal to approximately 63-64% of the electricity load met by the Mangahao GXP during the morning and evening peak loads.

(c) The operation of the Scheme results in the employment of six full-time staff who manage the day-to-day operation of the scheme. The Scheme also results in the employment of numerous support staff and the commissioning of contractors who contribute to the upkeep, maintenance, compliance and operation of the Scheme. This regularly contributes over $1M annually into the local economy depending on the maintenance work required that year.

Yours faithfully
HOLLAND BECKETT

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MEMO

To	King Country Energy Ltd
From	Mike Hensen
Date	12 September 2025
Subject	Mangahao hydro electric power scheme (HEPS) regional and national benefits

Role of Mangahao HEPS – national and regional benefits

Executive Summary - National and regional benefits of the Mangahao HEPS

The Mangahao Hydro-electric Power Scheme (Mangahao HEPS) provides both regional benefits through its role in meeting electricity demand in the Horowhenua district but also national benefits through its contribution to providing dispatchable[1] generation that can help to bridge the gap between demand and intermittent wind and solar generation. Put simply, the Mangahao HEPS acts as a reliable dispatchable[2] supply of electricity when wind generation does not meet demand in peak times. This bridging is called 'firming'. The Mangahao HEPS output is priced and allocated in the national electricity market.

If the Mangahao HEPS did not exist its generation output (annual volume and seasonal/daily timing of generation) would need to be replaced. The best replacement alternative would be a combination of wind to deliver the annual volume and gas-fired thermal to firm the wind generation. The capital, operating, fuel and emissions cost of this replacement is an avoidable national cost. We estimate the benefits of the Mangahao HEPS by assessing the avoidable cost of the best replacement alternative.

In more detail, the Mangahao HEPS provides regional and national benefits as follows:

- The Mangahao HEPS makes a substantial contribution to meeting peak demand and total output requirement for the northern part of the Electra[3] network supplied from the Mangahao grid exit point (GXP) in the Horowhenua District. Peak demand in the northern part of the Electra network cannot be reliably met by importing electricity from the grid and Electra relies on Mangahao HEPS to help cover any shortfall.[4]

[1] 'Dispatchable' is defined as being able to be controlled to increase or decrease its output, on demand in response to signals from the system operator.

[2] 'Dispatchable' in this context means electricity generation that can have its output adjusted at very short notice to accommodate variations in demand during the day.

[3] Electra distributes electricity in the Horowhenua District to Levin, Shannon and Foxton and to the Kapiti District.

[4] The reliance on Mangahao HEPS to meet peak demand is referred to by both Transpower and Electra. '*Peak load at Mangahao already exceeds the n-1 capacity of the supply transformers (see Figure 11-7). … The supply transformer overload and low voltage issues are managed operationally as Mangahao generation (25 MW) is usually available during peak load periods.' See* Transpower 2023 'Transmission Planning Report, 2023' pages 208 and 209, Available at https://static.transpower.co.nz/public/uncontrolled_docs/Transmission%20Planning%20Report%202023.pdf.

'*The Mangahao hydro station is an essential generator for Electra. Its output currently supports the security of supply from the Mangahao GXP during peak demand.… The Mangahao GXP transformers (owned and operated by Transpower) are reaching end-of-life. It is an ideal time to consider options for a long-term solution for the northern region..'* See Electra 2025, 'Electra, 2025 Asset Management Plan' pages 36 and 116.

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- The Mangahao HEPS is part of the national grid and its dispatchable output is available to the national grid to 'firm' national wind and solar generation.
- If the Mangahao HEPS was not operating the loss of dispatchable generation capacity would need to be replaced by new dispatchable generation capacity. We estimate that the replacement wind generation hourly output would be lower than the expected Mangahao output over a long period, 3,890 hours which is about 45% of a year. We explain how these gaps are calculated and their nature just before Table 1 below. If these gaps are not covered by other generation Electra would have to shed demand – not supply some consumers.
- It also avoids transmission losses if generation has to be pulled from other regions to meet demand. Avoiding these costs through the ongoing operation of the Mangahao HEPS is a national benefit to the national electricity market.

National benefit - Mangahao provides controllable intraday generation

Controllable generation from low-cost non-fossil fuel is an increasingly scarce resource in the New Zealand electricity system. Total and peak electricity demand are rising more quickly than the construction of new capacity. The expansion of new wind and solar increases the system requirement for controllable generation to cover periods when wind and solar electricity output are lower than expected. The two main sources of controllable generation are hydro and gas or coal[5] fuelled thermal.

As set out above, the Mangahao HEPS plays a critical role in 'firming' the gap between demand and intermittent wind and solar generation. The Mangahao HEPS has multiple storage reservoirs which provide a reliable source of dispatchable generation, as opposed to solar and wind generation, which do not provide dispatchable generation.

If the Mangahao HEPS was not available to the national market its output and its 'firming' role would need to be replicated by new generation capacity at additional cost (capital, operating costs, fuel and greenhouse gas emissions.) These additional costs would affect the national electricity market and avoiding these costs is a national benefit. I discuss this impact below.

Regional benefit - Mangahao powers ~20,000 homes in the Horowhenua District

The Mangahao HEPS is located near Shannon in the Horowhenua District which is part of the Manawatū-Wanganui (Horizons) Regional Council area. The Mangahao HEPS is a run-of-river scheme with a generation capacity of 39.9MW and an annual output of approximately 131 GWh that is embedded in the Electra Lines Company distribution network (but was connected to a grid injection point (GIP) before 2010.) The Mangahao HEPS makes a substantial contribution to meeting peak demand and total output requirement for the northern part of the Electra network supplied from the Mangahao grid exit point (GXP). The transmission circuits to the Mangahao GXP are constrained. The Scheme generation is equal to approximately 63-64% of the electricity load met by the Mangahao GXP during the morning and evening peak loads.

Assessment of National and Regional Benefits of the Mangahao HEPS

Replacing Mangahao HEPS

This section describes the next best alternative replacement of the Mangahao HEPS and the additional cost of this capacity in order to provide both the generation output for the region and the 'firming' role for the national electricity supply.

[5] Coal-fuelled thermal generation is used by the industry as a last resort when sufficient gas is not available either due to short-term supply shocks or because New Zealand is experiencing a dry and cold winter. Investment pipeline surveys by the Electricity Authority and the investment intentions stated by the major generators do not include plans to build new coal fired generation.

Meeting total demand

If the Mangahao HEPS electricity output of 131 GWh[6] was not available it would need to be replaced by another form of generation. The most likely method of replacement generation would be wind generation.[7] The total electricity generated by Mangahao HEPS of 131 GWh would need to be replaced along with additional output to cover transmission losses estimated at 4.3 GWh (3.2 % of output[8]) as the new generation plant would most probably be located outside the region.

Assuming a capacity utilisation factor of 40% the wind farm capacity required to replace the Mangahao HEPS output (135.3 GWh[9]) would be approximately 38.6 MW[10]. The estimated construction cost for wind farms have been rising over the past three years and vary with location. For this analysis we have used an estimate of $3.33 per MW[11] which suggests a capital cost of $128.7 m to replace the output for a period of 25 to 30 years. In addition, the windfarm will incur operating cost estimated at $2.0m to $2.7M per year based on an assumption of $15 to $20 per MWh.

Meeting peak demand (wind 'firming')

Further, the additional wind generation would not be sufficient to replace the 'firming'[12] role that Mangahao HEPS plays when wind and solar output does not meet demand as the output profile of the Mangahao HEPS is much better suited to meeting the daily demand pattern at the Mangahao GXP than new wind generation.

This is illustrated in Figure 1 below which compares total electricity volumes for each half hour period:

- Mangahao demand from MHO0331.
- Electricity injected at MHO0331 – the grid injection point for the Mangahao HEPS.
- Wind generated electricity output for New Zealand scaled to the total electricity injected at MHO0331 in each quarter.

[6] This is the average output of the scheme stated by Manawa Energy and is used as the basis for the replacement cost calculations in this report.

[7] Solar generation is another alternative but its daily and seasonal output profile is a poorer match for the Mangahao HEPS than wind as solar generation is lower in winter and non-existent during the highest peaks – winter evenings. Genesis Energy is seeking consent to build a solar farm at Foxton with a capacity of 220 MWp and an expected output of 345 GWh. (See GENESIS INTEGRATED REPORT 2025,page 18.) This capacity is being built to meet future demand and as part of Genesis' 'Gen35 8by28' strategy to displace thermal generation from its portfolio by building up to 500MW of solar capacity and achieving a development pathway to 300MW of wind capacity by 2028. See GENESIS INTEGRATED REPORT 2025,page 15.) . However, Genesis also states that more firming generation will be required to ensure demand can be met. '*About 80% of announced projects are for intermittent generation (solar and wind). This will drive increased price volatility and require large amounts of firming to achieve energy security and price stability.*' See GENESIS INTEGRATED REPORT 2025, page 11

[8] MBIE , 2024, 'Electricity data tables, 2 – Annual GWh' reports Net Generation of 43,488 GWh and Total Line Losses -Transmission of 1,404 GWh or 3.2 percent of Net Generation. (This information is for the 2023 calendar year. MBIE does not include transmission losses in its quarterly data.)

[9] Reported output of 131GWh plus 4.3 GWh for transmission losses.

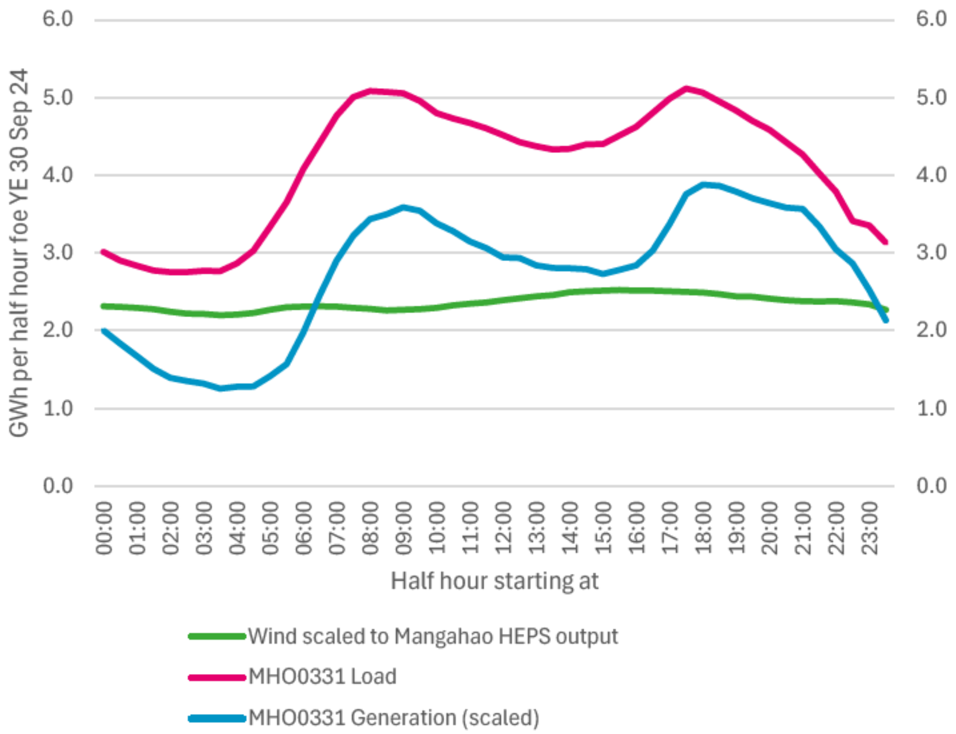
[10] The capacity of the proposed wind farm is slightly below the capacity of the Mangahao HEPS because the purpose of the wind farm is to replace the output. Wind farms are not a reliable source of generation to meet peak demand.

[11] Mercury Energy has recently announced the commencement of construction of two new wind farms:

- Kaiwera Downs Stage 2 at a cost of $486 m for an additional 155 MW of capacity – average cost of $3.14 m per MW. See https://www.mercury.co.nz/about-us/renewable-energy/new-builds-and-upgrades .
- Kaiwaikawe at a cost of $287 m for 77 MW -average cost of $3.72 m per MW. See https://www.mercury.co.nz/about-us/renewable-energy/wind-generation/kaiwaikawe-wind-farm .

[12] '*About 80% of announced projects are for intermittent generation (solar and wind). This will drive increased price volatility and require large amounts of firming to achieve energy security and price stability.*' See GENESIS INTEGRATED REPORT 2025, page 11

Figure 1 Wind replacement for Mangahao HEPS



Source: NZIER

We have estimated the task required for firming thermal generation by comparing the half hourly output from Mangahao HEPS to the half hourly output from wind generation (scaled to the reported total output as Mangahao) over the year to 30 September 2024. From this comparison we have identified continuous strings of half hour trading periods where output from Mangahao HEPS exceeds the output from the hypothetical replacement wind farm generation. We have then calculated how long these strings of consecutive under-supply are, how much electricity is required to cover them and what the peak demand is during these strings. This analysis is reported across three tables. For this short response we include one of the tables to illustrate the approach.

Table 1 Mangahao HEPS excess output – string totals by 0.1 GWh band

Using wind generation for YE 30 September 2024 scaled to Mangahao output of 131 GWh plus transmission losses

Band (GWh)	Number of excess demand strings					Total excess demand (GWh)				
	Dec 23	Mar 24	Jun 24	Sep 24	Total	Dec 23	Mar 24	Jun 24	Sep 24	Total
>0.0 to <=0.1	76	31	89	116	312	1.5	1.5	2.6	3.5	9.1
>0.1 to <=0.2	14	11	18	19	62	2.0	1.7	2.5	2.6	8.8
>0.2 to <=0.3	2	8	7	11	28	0.5	2.0	1.7	2.7	6.8
>0.3 to <=0.4	4	6	3	3	16	1.4	2.1	1.0	1.1	5.6
>0.4 to <=0.5	4	2	5	8	19	1.7	0.8	2.2	3.7	8.3
>0.5 to <=0.6	1	2	1		4	0.6	1.1	0.6		2.3
>0.6 to <=0.7	1	2	2		5	0.6	1.3	1.4		3.3
>0.7 to <=0.8	1		2		3	0.8		1.5		2.3

Band (GWh)	Number of excess demand strings					Total excess demand (GWh)				
>0.8 to <=0.9		1			1		0.8			0.8
>0.9 to <=1.0		1			1		1.0			1.0
>1.0 to <=1.1	3		1		4	3.1		1.1		4.2
>1.1 to <=1.2	1	1			2	1.1	1.1			2.3
>1.2 to <=1.3			1		1			1.2		1.2
>1.3 to <=1.4				1	1				1.4	1.4
>1.4 to <=1.5										
>1.5 to <=1.6										
>1.6 to <=1.7										
>1.7 to <=1.8										
>1.8	1				1	2.0				2.0
Total	**108**	**65**	**129**	**158**	**460**	**15.2**	**13.5**	**15.7**	**14.9**	**59.3**

Source: NZIER

The challenge is material and difficult with firming output of 59.3 GWh (45% of the Mangahao HEPS output) required over 460 separate strings with a total length of 3,890 hours which is about 45% of a year. Many of these strings (312) are relatively short – the 1,067 hours of output with an average string length less than 3.5 hours and a total energy requirement of about 9.1 GWh (shown in the first row of Table 1). However, the remaining output gaps last for long periods and have a large energy requirement. These determine the required capacity and volume output of firming generation.

The form of generation that would most probably be able to cover the output gaps shown in Figure 1 and We have estimated the task required for firming thermal generation by comparing the half hourly output from Mangahao HEPS to the half hourly output from wind generation (scaled to the reported total output as Mangahao) over the year to 30 September 2024. From this comparison we have identified continuous strings of half hour trading periods where output from Mangahao HEPS exceeds the output from the hypothetical replacement wind farm generation. We have then calculated how long these strings of consecutive under-supply are, how much electricity is required to cover them and what the peak demand is during these strings. This analysis is reported across three tables. For this short response we include one of the tables to illustrate the approach.

Table 1 would be an open cycle gas fuelled turbine (OCGT). We have estimated the cost of this 28 MW plant by scaling down modelling completed for the New Zealand Battery project[13] as:

- Plant cost of $60.7m (assuming a cost per 100MW of $216.7M prorated to a 17 MW plant).
- Fixed operations and maintenance (O&M) cost of $1.6M per year and variable O&M of $0.7m.

[13] Ministry of Business, Income and Employment - Hikina Whakatutuki, 11 May 2023, 'MODELLING ASSUMPTIONS FOR FOSSIL-FUELLED PEAKER GENERATION SUPPLEMENTARY TO NZ BATTERY OTHER TECHNOLOGIES FEASIBILITY STUDY' page 5. Available at https://www.mbie.govt.nz/dmsdocument/28355-modelling-assumptions-for-fossil-fueled-peaker-generation-may-2023 . The relevant modelling assumptions for a twelve 100MW OCGCT (total capacity 1,200MW) using the General Electric LMS100 OCGT were: start time 8 minutes from cold with a ramp rate of 50MW per minute; plant costs of $2,600m for twelve 100MW OCGT units; fixed operating and maintenance (O&M) costs of $70m per year; Variable O&M $13.8 per MWh; and asset life 30 years. The heat rate for the LMS 100 is reported at 8,400 GJ/GWh – see https://www.gevernova.com/gas-power/products/gas-turbines/lms100

- Fuel cost of $5.4m per year (assuming a gas price of $12 per GJ) plus carbon emissions costs of $1.5m per year at current prices from an increase in carbon emission of about 25,800 tonnes of carbon dioxide equivalent (tCO_2e) per year.

Avoided additional national electricity generation costs
In summary, the ongoing operation of the Mangahao HEPS avoids the additional cost of replacement generation including to meet the generation capacity and the 'firming' role through:

- Avoiding the substantial capital cost (around $190.6M) of constructing both new generation (probably wind outside the area at a cost of $129.9M) and new peaker generation[14] (probably gas fuelled thermal at a cost of $60.7M) to address the mismatch between wind output and the Mangahao HEPS. Our analysis finds that grid scale batteries are not suitable for covering this mismatch.
- Avoiding the potential increase in cost of fuel used for generation for the thermal component of the replacement generation. We estimate this would be about $5.8M per year at recent gas prices but would rise over time.
- Avoiding the cost of transmission losses that would be required if electricity had to be imported from outside the region to meet peak demand.
- Helping New Zealand meet its emission reduction targets under the Paris Agreement by continuing to displace greenhouse gas emissions from thermal generation for either baseload or peak demand. The supplementary thermal generation for the peak would increase emission by about 25,800 tonnes of carbon dioxide equivalent (tCO_2e) per year. Greenhouse gas emission reductions at the Mangahao HEPS for the total generation would be approximately 67,830 tCO2-e (for gas). If coal had to be used to cover any of the generation shortfall (due to temporary gas shortages caused by either supply shocks or a dry cold winter), the greenhouse gas emissions would be more than double those for gas.

The avoidance of these costs is a benefit to the national electricity market.

14 Peaker generation is used to meet periods of high demand when other capacity is either fully committed or output from other capacity (such as wind and solar) falls below projected levels unexpectedly. Peaker generation needs to be able to go from zero to full output in a very short period and then run consistently until the gap between demand and other capacity is closed. In New Zealand this type of generation is fueled by gas.

Appendix A Intraday volatility of wind generation

To compare the intraday volatility of wind generation and generation at Mangahao we have compared the change in generation output from one trading period to the next for each quarter of the year ended 30 September 2024. The generation output data is provided in for half hourly intervals (trading periods). The calculation steps for are:

- Calculate the average output for all trading periods that cover the same time of day. The output from this calculation is 48 averages that are used the comparator for a 'normal' level at that time of day for that quarter.
- Calculate the change in output from the 'current' trading period (starting at time 'hh:mm') to the 'next' trading period starting half an hour later and then divide this difference by the average output for all the trading periods starting at the same time. as the 'current' trading period. This restates the absolute difference as percentage change and is used to group the differences in bands.
- Table 2is the proportion of the count of all 'next' trading periods where the percentage change in output falls within the band under the heading 'Change in output band'

Table 2 Change in output – share of total number of trading periods

Number of trading periods with output change in each band as percentage of trading periods per quarter

Change in output	Wind				Mangahao			
	Dec 23	Mar 24	Jun 24	Sep 24	Dec-23	Mar24	Jun 24	Sep 24
<= -20%	1%	1%	2%	1%	3%	4%	4%	4%
-20% < & <= -10%	6%	6%	7%	6%	4%	3%	3%	4%
-10% < & <= -5%	12%	12%	12%	12%	1%	1%	1%	2%
-5% < & <= 0%	33%	33%	30%	32%	84%	84%	84%	80%
0% < & <= 5%	29%	28%	27%	30%	0%	0%	0%	0%
5% < & <= 10%	12%	13%	13%	11%	1%	1%	1%	1%
10% < & <= 20%	6%	7%	7%	5%	4%	2%	2%	3%
> 20%	1%	1%	2%	2%	3%	4%	4%	5%

Source: NZIER

The wind generation data shows approximately symmetric variation around the average output. Around 60 percent of the fluctuations are within plus or minus 5 percent of the average output and a further 24 percent are either 5 percent to 10 percent above or below the average.

The Mangahao output shows a pattern of dispatchable generation. Output is constant for most periods with a small number of periods of large change. There almost no changes in the intermediate bands either 5 percent to 10 percent above or below the average. This pattern is consistent with intra-day generation that is a series of low and high plateaux connected by short rapid ramping up and down of generation between the plateaux.