IS Kawerau – Electricity Resource Background Study

1. Background

New Zealand's electricity sector is broken down into four main parts:

- **Generation**: Various entities generate electricity at plants throughout New Zealand. The most prevalent generation sources are hydro, gas, coal, geothermal and wind.
- **Transmission:** Electricity produced by generators is dispatched on New Zealand's national electrical grid, ready to be delivered to consumers. The national grid is the system of high voltage power lines that allows generators to deliver electricity around the country. It is owned and operated by Transpower New Zealand Limited, a state-owned enterprise
- **Distribution:** Local or regional lines companies own the power lines and networks in local areas. These connect to the national grid and deliver power to businesses and homes in their area. There are 29 lines companies in New Zealand.
- **Retail:** Retailers buy electricity from the wholesale (spot market) and sell electricity to business and residential customers. The majority of electricity consumers in New Zealand buy their electricity from a selection of 20 retail brands [1], with the five major brands being the consumer end of the five main generating companies [2] (commonly known as Gentailers) .

A limited number of large industrial users buy electricity straight from the spot market rather than through the retail channel. Spot market participants (both generators and purchasers) normally hedge their exposure to spot market price fluctuations through financial contracts that help smooth out price volatility. The spot and hedge markets are the major components of the wholesale electricity market [1].

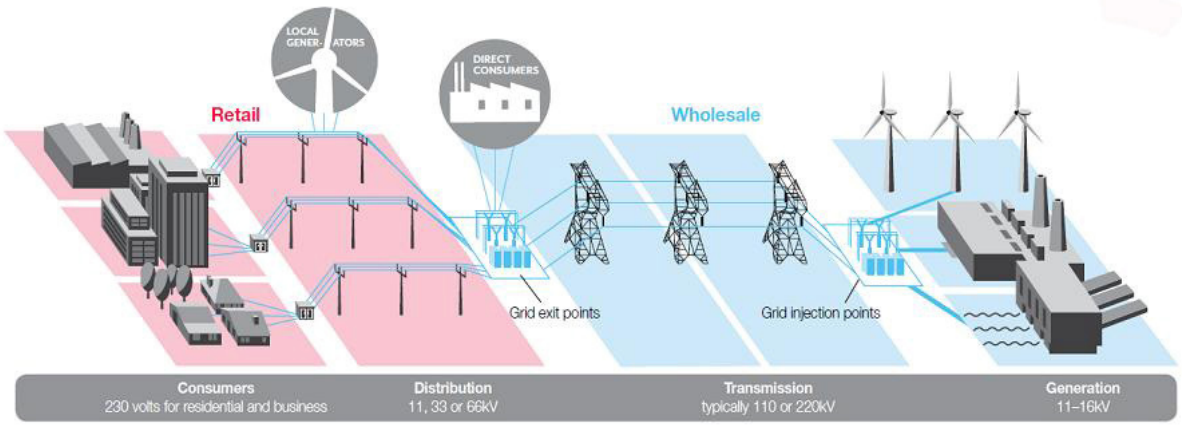

Figure 1: The New Zealand electricity supply chain [1]

2. Electricity Generation

Generators that are bigger than 10MW or are grid connected compete in the electricity spot market for the right to generate electricity to satisfy demand [1]. They submit offers through a trading system, with each offer covering a future half hour trading period. Offers detail a set quantity of electricity to be produced at a set price. Transpower, as the system operator, ranks these offers and selects the lowest cost combination to satisfy projected demand. The highest priced generation required for any trading period sets the spot price for that period [1]. In the same manner that generators bid to supply electricity, retailers and major users bid to buy electricity dispatched on the grid [1].

Electricity substations play a role in both stepping up the voltage of electricity for distribution on grid and in transforming it into lower voltages for delivery to end consumers. The Kawerau substation is one of 13 substations within the Bay of Plenty (BOP) region and is interconnected to the grid through both the 110 kV and 220 kV networks [3]. As represented below in Figure 2, three power stations in the wider region inject electricity into the substation via the 110kV network: [4]

- Mighty River Power's (MRP) 106 MW geothermal power station
- Trustpower's 80 MW Matahina hydro station
- Bay of Plenty Energy's 25 MW Aniwhenua hydro station.

Further to grid connected power stations, electricity can be distributed from generators through the following connection types [5].

- **Embedded:** Connected to the local lines network where output is consumed locally.
- **Partially Embedded:** Connected to the local lines network with some injection into the grid occurring at the grid exit point (GXP) behind which the generation is embedded. This occurs when generation is greater than consumption behind the GXP.
- **Combination of grid connected & embedded:** Connected to both the local lines network and the grid.
- **Grid Connected Co-generation:** Co-generation plant associated with a load which is connected directly to the grid.

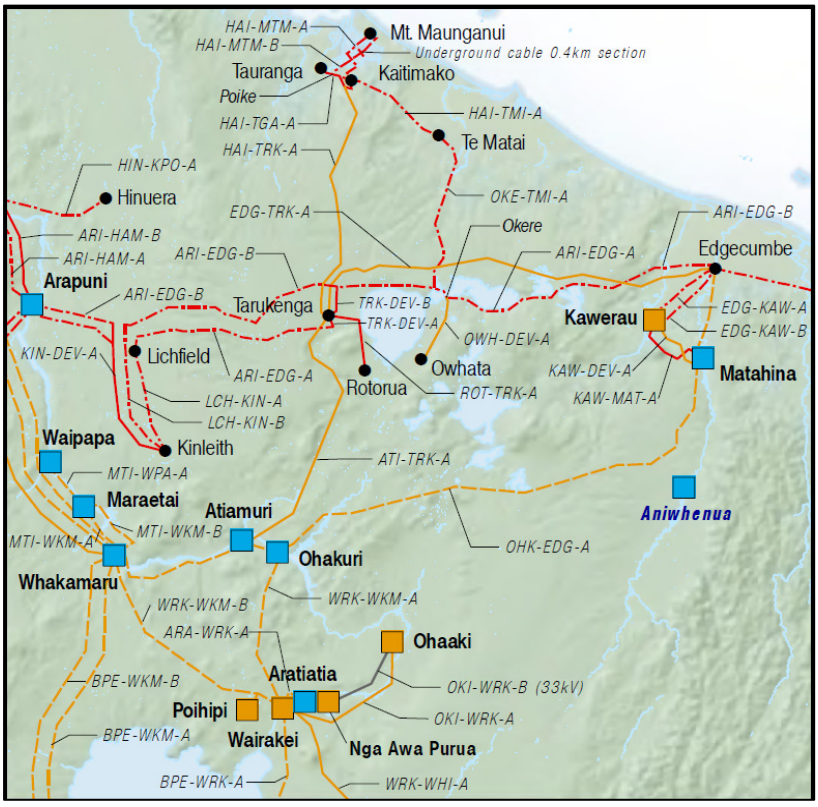

Figure 2: Transpower's Bay of Plenty transmission network [3]

Electricity generation in the Kawerau region is dominated by renewable sources. In New Zealand renewables do not receive subsidies or feed in tariffs, but compete in a free market against each other and fossil fuels.

The only non-renewable power station in the region is located nearby in Edgecumbe, at Fonterra's dairy processing factory. Owned and operated by Bay of Plenty Energy (BOPE) the embedded 10 MW co-generation plant is fuelled by natural gas and meets the factory's entire thermal and electrical energy requirements, while also supplying excess electricity to local consumers [6].

Beyond the three main stations that feed in to the Kawerau 110 kV bus and BOPE's Edgecumbe facility, other power stations in the immediate region include:

- BOPE's two Ormat binary geothermal power plants rated at 2.6 MW and 3.5 MW respectively. These stations do not connect to the Kawerau sub-station but instead provide an embedded form of generation within the local BOPE network [6].

- Norske Skog Tasman's (NST) 10 MW grid-connected embedded geothermal turbine in its mill complex, driven by steam provided by Ngati Tuwharetoa Geothermal Assets Limited (NTGA). All electricity generated is used internally by NST.
- Eastland Group's embedded 8.3 MW Ormat binary power plant which is connected directly to NST's mill complex, with electricity consumed on-site.
- Carter Holt Harvey's (CHH) 19 MW embedded co-generation plant at its Kawerau pulp mill.

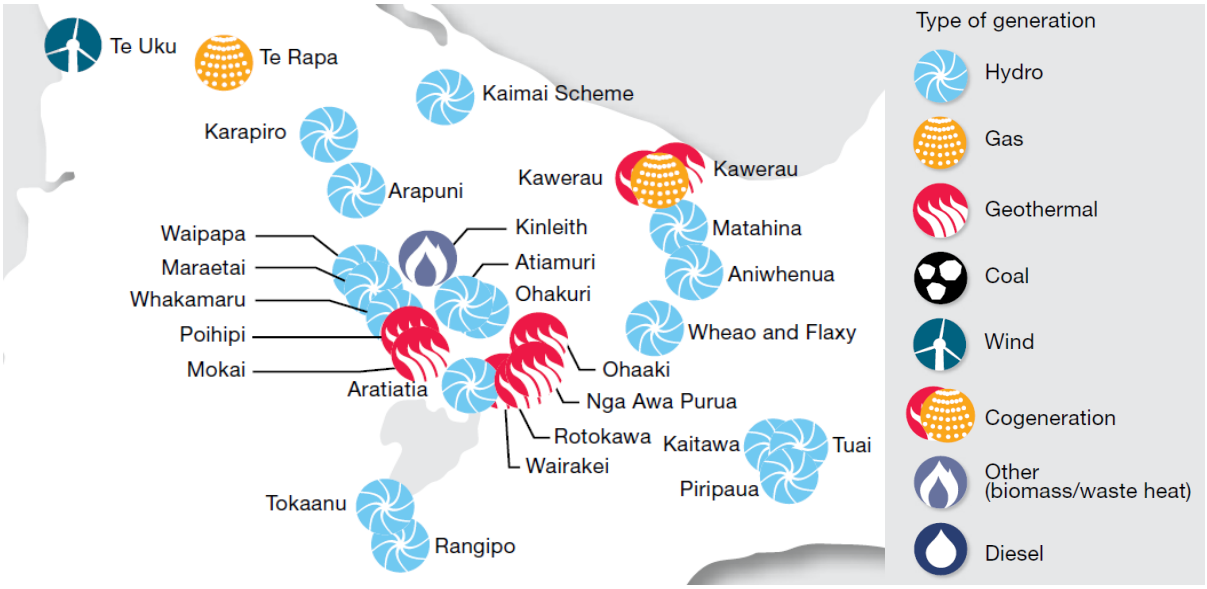

Figure 3: Generation sources in the central North Island [1]

Details of the generators most likely to make a continued contribution to industry in Kawerau are listed in Table 1. Facilities excluded from this list are:

- BOPE's 10 MW co-generation plant at the Edgecumbe dairy factory. Output of 54 GWh per year is primarily committed to Fonterra and not considered available to industrial activities at Kawerau.
- CHH's 19 MW embedded co-generation plant. Using wood waste and black liquor the plant produces around 118 GWh per year, but generation is normally restricted to around 13.5 MW by production requirements [5]. In the mid term, it is feasible that wood waste will be put to higher value uses than generating steam and/or electricity.

Plant name	Fuel Source	Commissioned	No of units	Installed Capacity-MW	Production - GWh/yr
TG1	Geothermal	1989	2	2.4	8
TG2	Geothermal	1993	1	3.5	26
NST	Geothermal	2004	1	10	43
KA24	Geothermal	2008	1	8.3	65
Kawerau	Geothermal	2008	1	106	877
Aniwhenua	Hydro	1980	2	25	135
Matahina	Hydro	1967	2	80	290
Total capacity and generation				235.2 MW	1,444 GWh/yr

Table 1: Electricity generating facilities in the wider Kawerau region

To provide an understanding of the scale of the Kawerau mill complex, NST currently consumes in excess of 1,000 GWh per year [7], equivalent to the amount of electricity consumed annually by 125,000 homes.

If NST operated its mill 24 hours a day, 360 days a year then its average electricity consumption would be around 115 MW. NST obtains its current electricity supply through 8 MW from its own generator, 6 MW from Eastland Group's plant and the remainder from the national grid, with a proportion of this being provided through a commercial off-take agreement between MRP and NST, established prior to the construction of MRP's 106 MW plant.

3. National and Regional Generation Sources

In the 2010 calendar year 74% of New Zealand's electricity supply came from renewable sources [8]. This rose to 79% for the first six months of 2011. Hydro generation typically provides a little less than 60% of New Zealand's electricity, although this fluctuates with rainfall and lake storage levels. The balance comes from a range of geothermal, wind, bio-energy, coal, gas and other thermal means.

Geothermal generation provided 12.8% of New Zealand's electricity supply in 2010 [8], having grown from 7.5% in 2006. New Zealand's geothermal resources are concentrated in the central North Island's Taupo Volcanic Zone. Geothermal power stations equate to almost half of the installed capacity in the wider Kawerau region, while contributing approximately 65% of the electricity generated. This is due to the reliable base-load nature of the resource, compared with the utilisation of hydro power stations varying with hydrology.

4. Expansion of Electricity Generation at Kawerau

The Kawerau geothermal field is recognised as a world class, high temperature resource. As such, a range of current and potential developers have been assessing further options for electricity generation.

NST is developing a 25 MW Ormat binary plant on its industrial site which will provide electricity directly to the NST mill, thus reducing its consumption from the grid. NTGA will supply the geothermal brine out of its current resource consent, re-routing spent brine from other activities to the NST plant. This agreement benefits both NST and NTGA, in that NST gets the resource it requires while NTGA receives an additional use for its brine. Once operational, NST will source over 90% of its electricity from geothermal, through a mix of internal generation and long term contracted supply [9].

Eastland Group is moving forward with a proposed 12–15 MW binary power plant. This is to be developed in partnership with the A8D Ahuwhenua Trust and Hawaiian owned Innovations Development Group (IDG). Further investigation has shown significant additional resource underneath the 174 hectare A8D block.

Furthermore, NTGA is currently seeking permission to extract an additional 45,000 tonnes of brine per day, having lodged resource consent with the Bay of Plenty Regional Council (BOPRC). This application has been supported by KDC and other entities, and will provide NTGA with the capacity to expand supply to both current and new customers. The increased steam supply could be used for electricity generation and/or direct heat purposes, offering significant development opportunity for either form of energy and associated downstream industrial users.

It is estimated that current installed electricity generation capacity at the Kawerau geothermal field accounts for only 30% of its 450 MWe stored heat potential [2], excluding the direct heat supply to industry. Geothermal generation capacity is expected to increase substantially over the next few decades.

5. The Electrical Grid

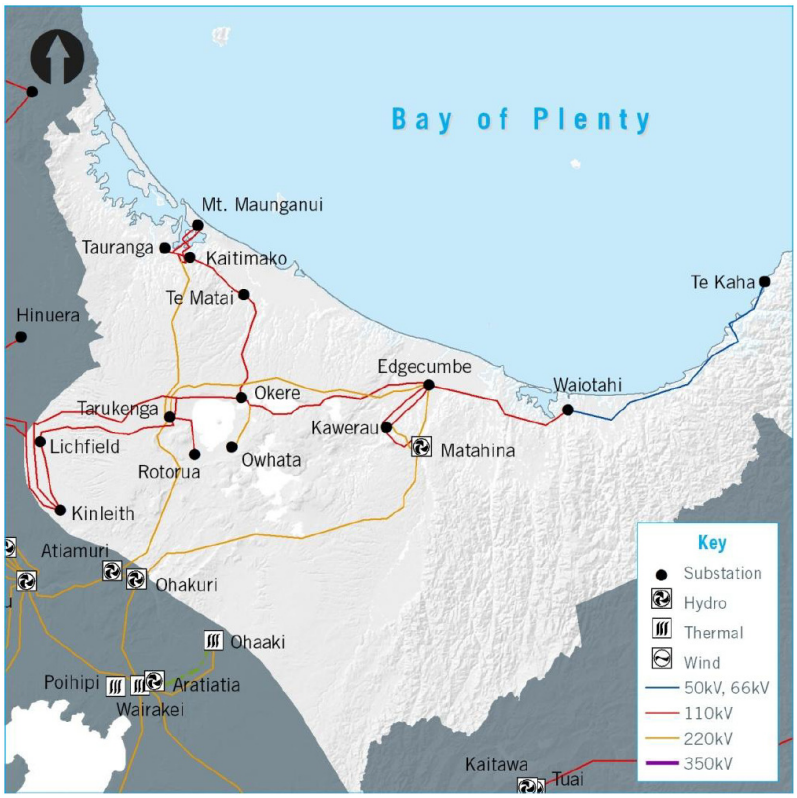

Figure 4: Bay of Plenty electrical grid network [3]

As stated, New Zealand's national high voltage electrical grid is owned, operated and maintained by Transpower New Zealand Limited. Beyond operation of the national grid, Transpower is responsible for the investment & maintenance necessary to ensure the future needs of both electricity consumers and industry participants are met [3].

Transpower also provides a coordination service, scheduling the generation of all stations and monitoring interconnected networks; and is responsible for ensuring the security of supply - evaluating planned generation, transmission constraints, forecast demand growth and fuel stockpiles [1].

The grid within the BOP region consists of 220kV, 110kV, 66kV, 50kV lines. As within the national grid, the 220kV lines act as the major distributors, linking major power stations and main cities. The 110kV, 66kV and 50kV lines help supply more provincial regions with electricity from the 220kV network, as well connecting smaller generation plants to the grid.

Electricity is distributed from the national grid to Horizon Energy (Horizon, the regional lines company) and large industrial users directly. Load customers supplied directly from the Kawerau substation are the CHH pulp mill, NST Pulp and Paper Mill and Horizon [3]. The two main customers supplied from the 110 kV bus are NST, New Zealand's second largest electricity user behind the Tiwai Point aluminium smelter, and Horizon for its local distribution needs [3].

The size and scale of customers such as NST mean their consumption patterns have a large bearing on the performance and efficiency of the grid.

6. Local Distribution

Horizon is a publicly listed company based in Whakatane. It owns, manages and operates the electricity distribution network of overhead and underground power lines responsible for transporting energy from generators through to approximately 25,000 domestic and commercial consumers in the Eastern Bay of Plenty [11]. Horizon's consumers have a combined maximum demand of 90 MW [11], further illustrating the scale of demand at the Kawerau industrial site.

Distribution assets consist of 33kV, 11kV and 400V lines and cables, along with substation assets [11]. Horizon takes supply from Transpower at GXP's in Edgecumbe, Kawerau, Waiotahi and Te Kaha.

Supply from all GXP's, except Edgecumbe, is taken at 11kV and fed in to Horizon's network, while at Edgecumbe it is taken at 33kV and distributed to 33/11kV substations owned by Horizon [11].

Beyond and within Horizon's distribution network there are a number of embedded networks which supply electricity to consumers [1]. Across New Zealand, numerous embedded generators connect directly to distribution networks rather than the national grid, and as has been mentioned, two small geothermal generators are embedded in Horizon's network at Kawerau.

7. Distribution Constraints and Resolutions

Due to the current nature of the local 110kV network, generation in the Kawerau region is constrained during periods of low load and/or high generation. This occurs with load reduction at NST and/or high hydro inflows [3]. The constraint limits the amount of generation that may be dispatched on the grid and can be due to either a significant drop in demand or a surge in supply from regular patterns.

Kawerau has significant additional geothermal potential, with a number of generation investors planning further connections to the Kawerau 110 kV bus. These new connections will further constrain generation export from the region [3], causing low cost and low carbon generation from hydro and geothermal to be replaced with more expensive generation from elsewhere, potentially using less environmentally friendly fuel sources [4]. The constraint also acts as a disincentive to development.

The most advanced geothermal investment at Kawerau is NST's 25 MW Ormat binary plant. This is intended to connect to the Kawerau 110 kV bus in late 2012 [3], leaving a total of 235 MW of generation connected to the Kawerau substation. The grid at current does not have the capacity to accept all this generation during times of low demand at Kawerau, which means some generation would need to be constrained off in order to manage loading on the grid and transmission equipment [4].

This is a negative scenario for Transpower, electricity generators and electricity consumers. As such, Transpower identified several investments which could be made to relieve the generation constraint and enable further generation development, of the geothermal resource in particular.

Transpower consulted with a range of stakeholders in May 2011 to get feedback on options to increase the transmission capacity of the Kawerau 110 kV network. All options short listed after consultation involved replacing a 220/110 kV transformer at Kawerau with a higher rated unit. Transpower's preferred option was to replace an interconnecting transformer with a 250 MVA transformer [4]. This larger transformer will allow further generation to connect to the 110kV network in the future, offering considerable benefit given the potential for low-cost renewable generation in the region [4].

Replacement of the transformer however, will not be possible until 2014 due to procurement and installation lead times [4]. To avoid constraint between the commissioning of NST's 25 MW plant and the installation of the replacement transformer, Transpower is likely to reconfigure a particular network circuit which will result in it bypassing the Kawerau substation. Through this interim measure one of the Matahina hydro generating units will be connected to this circuit, removing approximately 40 MW of generation from the Kawerau 110 kV bus [4].

It is Transpower's intention to implement the reconfiguration as soon as possible, following with the transformer replacement in 2014 [4]. As with all grid investments, Transpower first needed to gain permission from the Commerce Commission for the projected expenditure and the recovery of this investment. Transpower has estimated the cost of the investment at NZ$6.8 million and sought

approval for maximum expenditure of $9.5 million. After receiving feedback on its investment proposal from stakeholders, Transpower submitted its funding application to the Commerce Commission in December 2011 [4].

On 19 April 2012 the Commerce Commission issued a notice of intention to approve Transpower's application, with its decision for approval being finalised in May 2012 [12].

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[5] Transpower New Zealand Limited. New Zealand generating station list, October 2011 – www.transpower.co.nz

[6] Bay of Plenty Energy website – www.bope.co.nz

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[12] New Zealand Commerce Commission website. See www.comcom.govt.nz/kawerau-generation-export-enhancement-investment-proposal

June 2012
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