Otahuhu 110 kV bus reconfiguration

Summary
Due to a combination of generation replacements and our replacement of ageing equipment in the Auckland region we see an opportunity to increase the security of supply to consumers by closing the bus split at Otahuhu (i.e. the connection between the two electrical bussing at Otahuhu). We introduced a bus split to ensure our equipment was not damaged following certain faults on the network. With the retirement of generation and the installation of new equipment the impact of faults on the network has reduced. This means that the bus split is no longer required. By closing the bus split we can increase security of supply to our Wiri/Bombay and Mt Roskill/Mangere substations. We intend to close the bus in June 2020 following the commissioning of new equipment at Otahuhu. This action has no impact on our Bombay-Otahuhu regional major capex proposal as it has been assumed to occur in that proposal.

Background
The Otahuhu 110 kV bus is operated as normally split (i.e. with circuit breaker 48 normally open) to prevent fault currents exceeding some equipment ratings and to manage power flow on our fleet of 220/110 kV interconnecting transformers in the Auckland region.

Figure 1: existing normal operating configuration of the Otahuhu 110 kV bus (with CB48 normally open)

The split 110 kV bus results in both Bombay circuits being supplied from a single bus section. The Bombay circuits also supply the Manukau area through our Wiri substation. A fault on this bus results in both Bombay and Wiri being supplied via three 110 kV circuits from the Waikato region. This may cause voltage collapse in high load periods resulting in a loss of supply to Wiri and potentially even Bombay. The Mangere 110 kV circuits are also supplied from a single bus section and a fault on this bus section results in Mangere being supplied from Mt Roskill. During high load periods, this may overload some of the 110 kV circuits into Mt Roskill and cause low voltages on the 110 kV network.

Additionally, splitting the 110 kV bus does not allow 220/110 kV transformers on the other side of the bus to provide security of supply during outages. However, this has not been addressed historically as we could not operate the transformers in parallel anyway, due to their different impedances and ratings.
Transmission network changes
Over the last 5-years a combination of generation retirements in the Auckland region and replacements of ageing 220/110 kV transformers at Penrose (T6) and Otahuhu¹ (T4) has significantly reduced the fault currents we can expect on the Auckland 110 kV network. The new 220/110 kV transformers are also designed to load-share with the other 220/110 kV transformers at Otahuhu and Penrose. The combination of reduced fault levels and ability to load-share results in the ability to operate the Otahuhu 110 kV bus normally solid, i.e. normally close circuit breaker 48.

Intended reconfiguration of the Otahuhu 110 kV bus
With the ability to operate the Otahuhu 110 kV bus normally solid, we intend to reconfigure the 110 kV bus to improve security of supply on the Auckland 110 kV network. The reconfiguration includes changing circuit breaker 48 to normally closed and switching some disconnectors to ensure a fault on any bus section does not disconnect a parallel pair of 110 kV circuits.

The intended reconfigured Otahuhu 110 kV bus is shown in the figure below with circuit breaker 48 circled. Note that Otahuhu T2 is to be decommissioned as it is nearing its end of life and is no longer compatible with the rest of the 220/110 kV transformers following the Otahuhu T4 replacement. Security of supply can be met without Otahuhu T2 as the new Otahuhu T4 can operate in parallel with T3 and T5, as well as the Penrose 220/110 kV transformers.

Figure 2: Intended normal operating configuration of the Otahuhu 110 kV bus

Expected costs and timing of the intended bus reconfiguration
The intended bus reconfiguration does not require any new equipment to be installed or modifications to any existing equipment therefore there are no costs expected.

We are expecting to have the intended configuration in place after the commissioning of the new Otahuhu T4 which is currently forecasted for June 2020.

Expected benefits of the Intended bus reconfiguration
The benefits of the intended reconfiguration are improved security of supply to Wiri/Bombay and Mt Roskill/Mangere. Following the intended reconfiguration, a bus section fault at Otahuhu will no longer place load at risk as described in the Background section of this paper.

Although it is difficult to accurately quantify these benefits, we can estimate the benefits by using some conservative assumptions. If we assume that a bus section fault resulting in the total loss of

¹ Otahuhu T4 is currently being replaced with the new transformer expected to be commissioned in June 2020.
supply to just the Wiri load (Manukau area) occurs once every 50-years. This would result in an expected unserved energy cost of $290k - $380k over the next 30 years assuming supply is restored after 1-hour, no demand growth at Wiri, a discount rate of 7% and the value of lost load is $20,000 - $26,500 per MWh.

Effecting the intended reconfiguration would eliminate this risk, which means the benefit over the next 30-years is at least $290k (based on the assumptions used) as the reconfiguration would have no cost. There are wider security of supply benefits and other operational benefits that are difficult to quantify such as improved operational flexibility on the 110-kV network which enables easier access to equipment for maintenance and improved resilience on the Auckland 110 kV network as it becomes more interconnected (reduces the impact on the power system during equipment failures).

**How does this impact the Bombay-Otahuhu Regional Major capital proposal?**

The Bombay-Otahuhu Regional major capital proposal we have developed assumes that the Otahuhu 110 kV bus has been reconfigured (configuration assumption shown in figure 2). As the intended reconfiguration on the Otahuhu 110 kV bus was already assumed, there are no impacts on the proposal.

If the intended reconfiguration does not go ahead, we would likely have to increase the cost of the Bombay-Otahuhu major capital proposal to allow for an alternative means of providing security of supply to Wiri. The cost increase will likely be in the order of $2-3 million dollars and there is added complexity to the construction of the project as major works is required at the operational Otahuhu 110 kV switchyard.

**Contact at Transpower**

If you have any questions or feedback, please contact: communications@transpower.co.nz