Summary of net benefit test for opening the Mangamaire bus split from May 11 to June 30 2012

Purpose
This document summarises the net benefit test applied to a temporary grid reconfiguration of implementing the Mangamaire 110 kV bus split between 11 May and 30 June 2012.

Background
Lake levels in the South Island are below average for this time of year. We can conserve water in the lakes by transmitting excess generation in the North Island to across the HVDC link to the South Island. South transfer relieves some of the need for South Island generation to meet South Island demand. The temporary grid reconfiguration at Mangamaire will allow greater amounts of south transfer.

Clauses 12.116A to 12.116C of the Electricity Industry Participation Code provide for Transpower making temporary grid configurations under certain circumstances. Transpower is required to specify the circumstances for which the grid is temporarily reconfigured and to demonstrate that there is a net benefit arising from the reconfiguration. Transpower is required to publish the circumstances and a summary of the net benefit analysis.

South transfer is limited by the capability of the 110 kV network in the lower North Island. The loss of a 220 kV circuit can cause a parallel 110 kV circuit to overload. Operational splits and special protection schemes have been used on the 110 kV network to allow greater 220 kV transfer. In the past a split has been implemented at Mangamaire which allowed increased transfer on the 220 kV circuits between Bunnythorpe and Wellington but placed the Mangamaire load on single circuit security. An automatic changeover scheme is available at Mangamaire for this situation which will automatically switch the Mangamaire load to the other in-service circuit following the loss of the single circuit supplying Mangamaire.

The reconductoring of the Masterton–Mangamaire and the Mangamaire–Woodville circuit relieved the constraint on south transfer caused by these circuits. The 110 kV constraint has shifted to the circuits between Bunnythorpe and Woodville. We are implementing a special protection scheme at Woodville to re-configure the grid when these circuits overload during south transfer. The special protection scheme is expected to be commissioned at the end of June. Once the scheme is commissioned there is no need for the 110 kV network to be split at Mangamaire.
Net benefit Methodology

Cost of implementing split
The cost of implementing the split is assumed to be negligible as the hardware is already in place and all that is required is opening the circuit breaker and arming the automatic changeover scheme.

Change in system losses
Splitting the 110 kV bus at Mangamaire increases system losses by around 2 MW on average. The number of hours over 6 weeks is 1008. Assuming a cost of marginal generation in the North Island of $50 per MWh, the upper bound on the cost of increased losses over those 6 weeks is around $100,000.

Reduction in reliability at Mangamaire
Splitting the Mangamaire 110 kV bus puts the Mangamaire load on single circuit security. That is, the Mangamaire load is supplied by a single circuit either from the north or south. The loss of the supplying circuit will cause a loss of supply at Mangamaire. Following the loss of the supplying circuit, the auto change-over scheme will switch the Mangamaire load onto the other in service.

Historic fault data indicates that the expected number of forced outages of the Mangamaire-Woodville circuit is 1.9 outages per year. The chance of a successful auto reclose operation following a fault is around 80%. The outage duration is either 1.5 seconds with successful auto reclose or 4 seconds with an unsuccessful auto reclose following the operation of the auto change-over scheme.

The probability of having a fault in the 6 weeks between 11 May and end June on the single circuit supplying Mangamaire is 1.9 faults per year x 6 weeks/52 weeks per year = 0.22.

The peak demand at Mangamaire is around 12 MW. The upper bound for energy not served for an interruption is 12 MW x 4 seconds = 0.01 MWh. The value of energy not served is around $270 with a value of lost load (VOLL) of $20,000 per MWh.

The upper bound for expected energy not served between 11 May and end June is 0.22 x $270 (around $60).

Reduction in risk of needing PCC
When lake levels fall to very low levels, the System Operator can call for a Public Conservation Campaign (PCC). Electricity consumers are requested to reduce demand for the duration of the campaign. The Electricity Authority Consultation Paper on Customer Compensation Schemes dated 7 September 2010 (http://www.ea.govt.nz/our-work/consultations/priority-projects/customer-compensation-scheme/) gives some information around the costs of a PCC:

- The cost of media advertising for the public conservation campaign in 2008 was $8 million.
- The cost of energy not served is $85 million.

The total cost is assumed to be $93 million.

Analysis by Energylink indicates the number of inflow trajectories that enter the emergency zone is

- 5 without the Mangamaire 110 kV bus split in place; and;
3 with the Mangamaire 110 kV bus split in place from 11 May.

The benefit of the reduction of the risk of entering into the emergency zone is two inflow trajectories out of 80 trajectories. The reduction in risk is around 2.5% (2/80). This is a reduction in the risk of incurring the cost of a PCC ($93 million). The potential benefit is around $2.3 million. Even if only 25% of this benefit is realised, the realised amount is more than five times the cost of increased losses.

The Energylink model takes into account other constraints on south transfer such as the amount of available South Island reserves and market security constraints. Figures 1 and 2 show the South Island Controlled Storage and Risk Curves without the grid reconfiguration and with the grid reconfiguration respectively.

![SI Actual Controlled Storage and Risk Curve](image)

**Figure 1:** South Island Controlled Storage and Risk Curve without Mangamaire split
Figure 2: South Island Controlled Storage and Risk Curve with Mangamaire split

**Outcome of Net Benefit Test**

We have identified benefits of at least $500,000 and costs at most around $100,000. There is a net benefit in implementing the Mangamaire 110 kV bus split between 11 May and 30 June.

The criterion for which the split is implemented is when one or more of the Controlled Storage and Risk Curve inflow trajectories enter the South Island emergency zone.

The criteria for removing the split are:

- when none of the Controlled Storage and Risk Curve inflow trajectories enter the South Island emergency zone; or;
- the new SPS on the Bunnythorpe-Woodville circuits is operational; or;
- there is no prospect of south transfer due to planned outages for an extended period (e.g. an outage of pole 2).

The System Operator will continue monitoring the Controlled Storage and Risk Curves on a weekly basis.