# Appendix A. Information Provided by Transpower, 1 February 2006

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1 February 2006

Roy Hemmingway
Chairman
Electricity Commission
PO Box 10041
WELLINGTON

Dear Roy

**Analysis and Request for Further Information Regarding 31 October 2005 GDP Application under Rule 16**

I refer to your letter dated 16 December 2005, which requests analysis and further information regarding 31 October 2005 GDP application under rule 16. Please find attached the responses to the 9 questions as requested.

If you require any further information, please do not hesitate to contact Mr Tim George on 494 6949 or Mr Dave Boyle on 495 7355.

Yours sincerely

Dr Ralph H Craven
Chief Executive

# ANALYSIS AND REQUEST FOR FURTHER INFORMATION REGARDING 31 OCTOBER 2005 GDP APPLICATION UNDER RULE 16

**1. Please will Transpower confirm that none of the IGE for which it is seeking approval has been incurred or committed?**

Transpower confirms that only the planning assessments have been completed in relation to the grid investments submitted for approval on 31 October 2005. Transpower at present is in the process of completing the conceptual design work for refining the cost and time estimates.

Transpower confirms that the interim grid expenditure for which approval has been sought under the above application has not been incurred or committed to date.

**2. Please can Transpower provide evidence that the IGE applied for in the 31 October GDP Application is additional to Transpower's normal ongoing grid expenditure?**

The grid investments, described in the 31 October 2005 application to the Electricity Commission, are required for enhancing the grid capacity for reliably supplying the anticipated future load. Consequently, they are correctly considered as expenditure additional to Transpower's normal ongoing grid expenditure.

In the "Comprehensive Plan for Asset Management and Operation of the Grid" (Vol. 1, Grid Upgrade Plan 2005) Transpower described the intended expenditure for replacement and refurbishment of the grid assets which forms a major component of the Transpower's normal ongoing expenditure. That is, normal ongoing expenditure is essentially required in order to maintain the existing capacity of the grid. On the other hand, Transmission augmentations that are required to reliably supply the future load growth have been described in the Transpower planning document "Transmission Plan Summary: Future of the National Grid 2005". The grid investment application contains a subset of these anticipated augmentations. Put simply, these augmentations are required to increase the capacity of the grid in line with the increase in load, while ensuring the Grid Reliability Standards are met.

3. **Please will Transpower provide the Commission with information on the range of quotes that it has received from SVC manufacturers? (The Commission is aware that some of this information may be commercially sensitive.)**

The cost estimates for the ±100 Mvar Static Var Compensator at Albany, as described in the Transpower proposal for providing reactive support in the Upper North Island[1], are based on the budget estimates obtained from three manufacturers.

The following table shows the possible cost range for the proposed SVC installation (excluding the cost of the Reactive Power Controller) based on three manufacturer estimates.

It should be noted that the estimates provided are only budgetary estimates, based on a high level preliminary specification. This level of accuracy in cost estimates is considered adequate for the purpose of comparing transmission options and for seeking approval from the Electricity Commission.

The costs are normally estimated by the manufacturers based on a number of assumptions and it is difficult to set a narrow common framework for accurately estimating the costs prior to calling tenders based on a well developed specification. Hence for the purpose of comparing the transmission options and for seeking approval from the Commission, the upper range budget estimates have been used.

| Item | Description | Manufacturer 1 | Manufacturer 2 | Manufacturer 3 |
|---|---|---|---|---|
| 1 | Manufacturers budget **estimate** | $ 19,250,000.00 | $16,200,000.00 | $ 14,700,000.00 |
| 2 | Design | $ 440,000.00 | $ 440,000.00 | $ 440,000.00 |
| 3 | Civil Works | $ 336,000.00 | $ 336,000.00 | $ 336,000.00 |
| 4 | Other Installation Costs | $ 230,000.00 | $ 230,000.00 | $ 230,000.00 |
| 5 | Protection/SCADA | $ 197,000.00 | $ 197,000.00 | $ 197,000.00 |
| 6 | Noise Mitigation Measures | $ 750,000.00 | $ 750,000.00 | $ 750,000.00 |
| 7 | Transpower Project Management | $ 710,000.00 | $ 710,000.00 | $ 710,000.00 |
| **Total** | | **$ 21,913,000.00** | **$18,863,000.00** | **$ 17,363,000.00** |

**Note 1:** The above cost estimates are in 2005 dollars and exclude allowances for project contingencies, financial contingencies (eg inflation) or interest during construction.

**Note 2:** Items 2 – 7 are associated with Transpower works outside the turn-key contract (manufacturers' budget estimates). These include site preparation, bay protection, 220 kV disconnector, SCADA and design reviews of the SVC.

[1] Section 3 of the "Grid Development Investment Proposals" submitted to the Electricity Commission on 31 October 2005

## 4. Can Transpower please further elaborate on the scope of the proposed RPC

At present Transpower has only identified the need for an RPC in the Auckland area. A significant reliance is placed on the coordinated operation of a large number of reactive power support devices in the Upper North Island for ensuring the voltage stability in the region. Manual operation of the devices is considered to be too cumbersome and prone to operating errors. Hence the development and implementation of an automated approach for selection and dispatch of the reactive devices in the area is proposed.

The primary objective of the automated reactive power controller will be to identify and dispatch the reactive needs to ensure:

- supply security to the region following an outage of a transmission element or a generating unit;
- pre and post contingency voltages at the grid nodes are maintained within acceptable levels;
- post contingent transient voltages recover to the acceptable limits within acceptable times; and
- sufficient reactive reserves are maintained for the above purposes, taking into consideration possible variations in demand and other factors.

In relation to the form and complexity of the RPC, Transpower's view is that the investigations should be started as soon as approval for the investment is received from the Electricity Commission. The functionality of RPC could range::

  - from simple coordinated control of 100 Mvar capacitors together with ±100 Mvar SVC at Albany;
  - to a complex scheme with coordinated control of the set-points of all dynamic and major static reactive resources in the region, possibly including Huntly, and the major transformer tap-changers.

However, Transpower presently envisages that the RPC would be used for the coordinated control of the proposed SVC, the synchronous condensers and the major capacitor banks connected to the transmission system in the region. The cost estimates for the development of the RPC, as indicated in the Transpower grid development investment proposal, are based on this assumption. In the event that the RPC capability is required to be extended beyond this level, a staged development is anticipated and investment approval will be sought from the Electricity Commission for second and subsequent stages.

The attached paper discusses the approach Transpower is planning to investigate the needs and specification of the functionality before calling tenders for development and implementation.

**5. Please will Transpower explain its approach to managing the reactive power resources in the Auckland and North Isthmus regions?**

Transpower endeavours to provide the most cost effective solution for the voltage related problems in the Auckland and North Isthmus regions. This is achieved by the use of a mixture of various types of reactive power devices. In planning and managing the reactive power resources, Transpower uses as many capacitors as possible and dynamic reactive devices are used only if necessary.

The 100 Mvar capacitors together with the ±100 Mvar SVC at Albany provide voltage support required for ensuring the supply reliability to the region until 2010. Through planning studies, Transpower has determined that Albany 220 kV is an appropriate location for installing capacitor banks, and that 100 Mvar is the maximum size for a single capacitor unit at this location. The decision was made based on consideration of engineering flexibility, power quality, voltage regulation and the coordination with the proposed SVC. Transpower has also evaluated options with different capacitor sizes at different locations and found that a single unit at Albany 220 kV is the most cost effective solution among the options studied.

For further detail on the technical analysis relating to comparison of development options, please refer to section 2.5.6 of the "Auckland Reactive Power Requirement by 2010". A copy of the report has been already provided to the Commission.

6. **Has Transpower investigated whether it is possible to improve power factor within distribution networks? If so, what were the cost implications of such undertakings?**

In assessing the requirement for additional reactive power compensation in the Auckland and North Isthmus regions, Transpower assumed that:

- the load power factors at the grid exit points in the Auckland and North Isthmus regions will remain at the current level (regional power factor of approximately 0.99). Power factor correcting capacitor banks (up to about 100 Mvar in total in year 2010) will be progressively installed, either within the distribution networks, or at the GXPs for maintaining this power factor; and
- up to a total of +260 / -150 Mvar of reactive power support from synchronous condensers can be procured through the System Operator ancillary service procurement contracts by 2010.

These assumptions have been stated in the investment proposal submitted to the EC.

The proposal includes installation of 2x12 Mvar binary capacitor banks at Kaitaia. Binary capacitors have the advantage that they can be switched in and out quickly and in steps of small quantities. Voltage support in the form of binary switched capacitors is required for:

a) improving the post contingency voltage recovery performance, not only in the local area, but also the entire region, and
b) limiting the switching voltages during capacitor switching.

Installation of capacitors within distribution networks to improve the power factor is helpful, but will not eliminate the need for including fast control action. Transpower believes the proposed development in the transmission system is the most cost effective upgrade for achieving the overall objective.

Transpower's assumptions in relation to power factor indicate that the proposed reactive developments are predominantly for purposes of providing transmission voltage control and covering transmission reactive losses.

7. **Grid Development Proposal 5: Bay of Plenty Upgrades**

**Please will Transpower:**

**a. provide a cost breakdown of each project;**

**b. provide some discussion regarding contingent circuit overloads on the 110kV network in the Bay of Plenty subsequent to GDP 5, and how these overloads are to be managed; and,**

**c. advise whether it is possible and cost effective to improve the power factor within the local distribution network?**

a). The cost breakdown of the proposed development is as follows:

| Investment Item | Costs |
|---|---|
| Lines: | |
| Reconductoring TGA-HAI 110 kV | $2.0 m |
| Substations: | |
| Switching station at HAI | $9.9m |
| Capacitor bank at TGA | $1.0m |
| Property (Note 1) | $0.1m |
| Project Management (Note 1) | $0.5m |
| ***Total (excluding allowance for financial (eg inflation) contingencies or Interest During Construction)*** | ***$13.5m*** |
| Note 1: As these projects are to be managed as a single project the costs have been consolidated for the overall project. | |

**b).** A discussion of the circuit overloads on the 110 kV network in the Bay of Plenty subsequent to GDP 5 follows.

GDP 5 creates a switching station at Hairini, which divides the 110 kV network into a Hairini to Tauranga / Mount Maunganui section, and a Hairini / Te Matai to Tarukenga section. These are discussed below.

Hairini to Tauranga / Mount Maunganui:

With the Hairini switching station, there is a direct Hairini to Tauranga circuit, a direct Hairini to Mount Maunganui circuit, and a shared Hairini - Tauranga - Mount Maunganui three terminal circuit with the tee point at Poike.

The rating of both circuits to Tauranga must be increased (reconductored) to meet load growth at Tauranga. Even after reconductoring, eventually load growth means that an outage of the direct Hairini - Tauranga circuit will overload the Hairini- Poike section of the three terminal circuit. This overload is removed by opening the circuit breaker on the three terminal circuit at Mount Maunganui. This leaves Tauranga on the single three terminal circuit and Mount Maunganui on the single direct circuit.

The firm capacity of the two circuits to Mount Maunganui is 77 MVA. It is not technically possible to increase the rating of these circuits. To prevent overloading of these circuits due to load growth, the options are to install a third circuit to Mount Maunganui from Hairini (which would need to be largely cable because of the lack of transmission line corridors), or to limit the Mount Maunganui load and transfer the load growth to Te Matai (or a new GXP), supplied from Hairini. Transpower has begun the investigation to determine the most viable and cost effective development option, in conjunction with the local lines company (Powerco). This investigation is not yet complete. Eventually, load growth may also require the opening of the circuit breaker on the three terminal circuit at Tauranga for the outage of the direct circuit to Mount Maunganui.

The Hairini switching station is a necessary pre-requisite for any of the above developments.

Hairini / Te Matai to Tarukenga:

With the Hairini switching station, supply to the Bay of Plenty 110 kV area is through two direct Hairini - Tarukenga circuits and an indirect Hairini - Te Matai - Okere - Tarukenga circuit (with a small infeed at Okere from Edgecumbe). From 2009, an outage of a Hairini - Tarukenga circuit could overload the Okere - Tarukenga circuit (followed closely by the overloading of the Okere - Te Matai circuit). This overload can be relieved by automatically splitting the system between Hairini and Te Matai, but this will overload the remaining in-service Hairini - Tarukenga circuit.

Other issues that will arise at or soon after 2009 due to load growth are the overloading of the Tarukenga interconnecting transformers, and the increasing voltage / reactive power support required due to supplying the Bay of Plenty 110 kV load over long simplex circuits from the Wairakei / Whakamaru area.

Ultimately, load growth will require Hairini to be supplied at 220 kV from Tarukenga, with interconnecting transformers at Hairini. Extra reactive support will also be required in the Bay of Plenty area. This will address all of the above issues. Conversion to 220 kV will also reduce system losses. (The Hairini - Tarukenga double circuit line is constructed at 220 kV but is presently operated at 110 kV. To convert it to 220 kV operation will require some line work.)

A detailed investigation may show that it is economic to defer conversion of Hairini to 220 kV operation by thermally upgrading the Hairini - Tarukenga circuits (and possibly the Okere - Tarukenga circuits), plus extra reactive support in the Bay of Plenty area. This investigation is yet to be completed. However, the Hairini switching station is required as a pre-requisite for possible interim operation at 110 kV or conversion to 220 kV to supply the Bay of Plenty 110 kV area.

**c).** A discussion on the possibility and cost effectiveness of improving the power factor within the distribution network is as follows. Note that after the proposed 25 Mvar capacitor is installed at Tauranga, additional voltage support will not be required before 2009.

The proposed Tauranga 25 Mvar capacitor, and the existing Mount Maunganui 25 Mvar capacitor, can be switched as required to manage the voltage / reactive power requirements in the area. It is necessary that the System Operator has enough voltage / reactive power equipment under their control to manage the power system in real time. This real time control is not available by installing capacitors within the distribution network (improving the load power factor).

However, beyond 2009 there will be an increasing need for voltage / reactive power support in the Bay of Plenty 110 kV area, due to supplying the Bay of Plenty 110 kV load over long simplex circuits from the Wairakei / Whakamaru area. It is expected that the best solution will be to have a staged program to improve the load to near unity power factor at all GXP's in the bay of Plenty. The two 25 Mvar capacitors would be used for voltage / reactive power management. In addition, by 2009 it is expected that the existing Tauranga (and Mount Maunganui and Te Matai) 110/33 kV supply transformers, which have no OLTC, will be replaced due to capacity and security requirements under Service Change contracts. The new supply transformers will have OLTC, which decouples the supply bus voltage and reactive power flows, which makes it very much easier to improve the load power factor (up to unity or even slightly leading) and have a power system which is technically viable to manage.

Auckland has capacitors embedded within the distribution network (improved load power factor) to support the transmission network, and it works well. However, Auckland also has supply transformers with OLTC, several capacitor banks at the transmission level and synchronous condensers, which can all be operated as required to manage the power system voltage profile in real time.

The embedded capacitors were installed after the transmission level capacitors and supply transformers with OLTC were installed. Transpower's view is that the same development path should be used in the Bay of Plenty area.

**8. Please will Transpower confirm whether the total cost for GDP projects 6 and 8 collectively is $9.2 million (i.e. two times $4.6 million) or $4.6 million?**

Transpower confirms $9.2 million is the total project cost which includes the new interconnecting transformers at both KIK and STK. The estimate includes allowance for financial (eg inflation) contingencies and interest during construction.

**9. Please will Transpower provide a further breakdown of the contingency calculations for each project?**

Grid investment proposals contain several cost estimates, the purpose of which are to provide transparency over what has been approved, and what may be recovered in relation to any particular project.

Three cost estimates are directly relevant to the calculation of contingencies:

- the Estimated Cost is a mid-range cost estimate in real ($2005) terms. It incorporates project contingencies (scope and quantity) only;
- the Expected Cost is the nominal equivalent of the Estimated Cost, incorporating adjustments for inflation, exchange rate (where available) and interest during construction. It is also a mid-range estimate; and
- the Approval Requested from EC estimate is an upper-bound estimate incorporating potential inaccuracies in the underlying cost estimates.

Transpower expects to recover actual project costs reasonably incurred on approved projects. The Expected Cost estimate represents a good faith estimate of the amount that may need to be recovered. However, given the uncertainty over the treatment of cost overruns, Transpower considers it prudent to seek approval for an upper-bound estimate. This would avoid the potential delays, costs and, system and commercial risks, associated with having to seek approval for additional project expenditures in the event the project costs exceed the expected costs estimate.

Allowances for project contingencies, included in the Estimated Cost and Expected Cost estimates are shown in the table below:

| Project | Project Contingency Range |
|---|---|
| Hairini Switching Station and Tauranga Capacitor Banks (GDP: Section 5) | +/- 10% |
| Upper South Island (GDP: Sections 6 & 8) | +/- 30% |
| Kikiwa Bus Security (GDP: Section 7) | +/- 30% |
| OTA-WKM A&B (GDP: Section 4) | +/- 25% |
| AVI-WTK-LIV (Lines) (GDP: Section 9) | +/- 15% |
| AVI-WTK-LIV (Subs) (GDP: Section 9) | +/- 15% |

Differences in the scope and complexity of the projects are a major source of variation in the contingency estimates. Furthermore, uncertainty over project cost reduces as projects progress, with preliminary design costs subject to a high degree of uncertainty. Cost estimates have been prepared based on the best information available at the time, so variation in the level of contingency for proposed projects also reflects the fact that projects are at different stages.

In addition to the estimated project scope and quantity variations, the risks associated with the variability in market cost of equipment and services, inflation, exchange rates and interest rates needs to be acknowledged and managed. The potential uncertainty in the above variables are taken into account in deriving a reasonable upper bound for cost estimates, approval for which is sought from the Commission under each project. Accuracy bounds used for the cost estimates are shown in the table below.

| Project | Distribution | Cost Contingency Range |
|---|---|---|
| Hairini Switching Station and Tauranga Capacitor Banks (GDP: Section 5) | Uniform | +/- 10% |
| Upper South Island (GDP: Sections 6 & 8) | Normal | +/- 15% (2 standard deviations) |
| Kikiwa Bus Security (GDP: Section 7) | Normal | +/- 10% (2 standard deviations) |
| OTA-WKM A&B (GDP: Section 4) | Normal | +/- 30% (2 standard deviations) |
| AVI-WTK-LIV (Lines) (GDP: Section 9) | Normal | +/- 25% (2 standard deviations) |
| AVI-WTK-LIV (Subs) (GDP: Section 9) | Normal | +/- 10% (2 standard deviations) |