Upper North Island Reactive Support Investigation Project

Assumptions, Approach and Options

Consultation Document

June 2009

Contents

1 Introduction

Transpower owns, operates, maintains and develops the National Grid which underpins New Zealand's electricity industry. Transpower aims to ensure sufficient investment is made in the National Grid to meet the future needs of electricity consumers and participants in the electricity industry.

Technical studies indicate that the ability of the power system to meet electricity demand in the Upper North Island (UNI), defined as the region north of and including Bombay, for the purposes of this investigation, is expected to be constrained by insufficient dynamic reactive support[1].

The UNI is a region with a large amount of load, but little generation. During peak periods, load is mostly met from generation south of Bombay. Regions like this, which rely on remote generation can be susceptible to poor voltage performance and this is the case for the UNI.

To improve voltage performance, support is provided through dynamic or static devices:

- Static devices provide voltage support during steady state conditions, but cannot react quickly enough during some contingent events. Capacitor banks are an example of a static voltage support device.
- Dynamic devices can react quickly and are required to provide support during short term voltage excursions, such as those which can be experienced during some contingent events. Synchronous condensers and generators are examples of devices which provide dynamic reactive support.

In general, dynamic voltage support devices are several times more expensive than static devices of the same capacity.

Whilst the static voltage support requirements were considered in the North Island Grid Upgrade and North Auckland and Northland projects, the dynamic reactive requirements were not. The need for more dynamic reactive support in the UNI region has been identified in separate studies which compare modelled UNI voltage with Transpower's voltage performance criteria during forecast peak demand periods, under contingencies. Both N-1 and N-G-1 contingencies were studied.

Breaching the voltage performance criteria creates the potential for the following to occur:

- loss of load;
- operation of generator and line protection;
- damage to the UNI power system (including consumer-owned equipment); and
- cascade failure.

For both the N-1 and the N-G-1 contingencies studied, the most severe breaches occurred during the "extreme summer" period, between mid January and mid March. In this period a significant percentage (64%) of the connected load is represented by induction motors. Induction motors range from large industrial scale electric motors to heat pumps, air conditioners and refrigerators. The proportion of induction motor load to total load is an important factor, as it will significantly influence voltage performance overall. Post-contingency, induction motors may stall and draw large

[1] This is in addition to the largely thermal constraints that the North Island Grid Upgrade project and the North Auckland and Northland project are being implemented to address.

amounts of reactive power while re-starting, or they may shut down and contribute to over-voltage spikes.

To improve voltage performance in the UNI, additional dynamic reactive power devices will be required.

This consultation document seeks input on the assumptions Transpower will use to determine how much dynamic reactive voltage support is required and what devices should be considered. This consultation document also serves as a Request for Information to potential providers of dynamic reactive support in the UNI.

2 Investigation Process

Transpower recovers the costs of investing in the Grid, through either a new investment contract with a customer or customers, or through the Transmission Pricing Methodology (TPM).

The TPM recovers costs from all parties connected to the Grid, and to protect the interests of those parties, Transpower is required to submit investment proposals within a Grid Upgrade Plan (GUP) to the Electricity Commission (EC) for approval under Part F of the Electricity Governance Rules 2003 (Rules).

Under the Rules, a proposal of the nature described in this document will be treated as a reliability investment and is required to pass the Grid Investment Test (GIT) to be approved. The GIT is an economic cost–benefit test.

This document describes and seeks feedback on:

- the needs assessment;
- the assumptions and approach to be used in the GIT analysis; and
- the long list of options to be considered for further analysis.

With respect to the long list of options, this document also acts as a Request for Information (RFI), in order to identify alternatives which could be added to the long list for further consideration.

The long list of options will be reduced to a short-list and analysed using the GIT, adopting the assumptions and approach that will be refined after considering the feedback received from interested parties.

Following this process, Transpower will determine whether any of the short-listed options pass the GIT and therefore whether it is appropriate to submit a Grid Upgrade Plan (GUP) to the Electricity Commission for funding approval.

2.1 Assessment of projects under the Rules

The present and forecast dynamic reactive support in the UNI is insufficient to ensure voltage in the UNI will remain in a satisfactory state following a single contingent event on the grid, and thus the Grid does not meet the Grid Reliability Standards (GRS) and the primary aim of further investment is to ensure that the GRS are met. This aim satisfies the Rule criteria for being a reliability investment.

In order to be approved under the Rules, reliability investment proposals in the core grid are required to:

- ensure an N-1 security standard can be maintained, to meet the requirements of the GRS; and
- maximise expected net market benefit or minimise expected net market cost, compared to a number of alternatives, to meet the requirements of the GIT.

The UNI region is a part of the core grid and therefore these approval requirements apply.

To determine the expected net market benefit of any option, Transpower must adopt certain input assumptions and parameters and use these to apply the GIT.

Transpower sets out later in this document, the assumptions and approach it proposes to use in applying the GIT. Transpower seeks feedback on the proposed GIT assumptions and approach in relation to this project.

The EC's core grid definition requires that "with all assets that are reasonably expected to be in service", the power system remains in a satisfactory state following a single credible contingency event (otherwise known as N-1).

Transpower considers that in the UNI, it would not be prudent to assume that all generation in the area is in service. The existing generation in the UNI is almost entirely thermal, is not always dispatched, and is subject to relatively long periods of maintenance. On average, the largest generator in the region, Otahuhu B (380 MW), is generating only around 73%[2] of the time, which in Transpower's view, does not meet the requirement to be considered "reasonably expected to be in service".[3]. For that reason, Transpower will also consider N-G-1 contingent events (i.e. N-1 contingent events while Otahuhu B is not in service).

In accordance with the Commission's view of reliability investments, as expressed in their evaluation of Transpower's North Island Grid Upgrade application, to meet N-G-1 any investment proposed will need to meet the economic limb of the GIT.

2.2 Long list of options

In order to develop a list of appropriate options for investment in dynamic reactive support for the UNI, Transpower intends this document to also act as a Request for Information (RFI).

Transpower has begun the process of identifying which alternatives might merit further investigation as possible investment options. To this end, a draft long list of options is set out in section 6. Transpower seeks feedback on this long list including any further alternatives that proponents believe Transpower might consider adding to the long list for this project.

Note that both transmission and non-transmission alternatives can be considered as options, but that (particularly) if non-transmission alternatives are to be considered, sufficient information will need to be provided with any submission to enable their inclusion on the long list of options.

2.3 Timetable for consultation

Transpower invites interested persons to provide feedback on the assumptions, approach and long list of options it proposes to adopt in the Upper North Island Reactive Support Project. Some questions have been set out in this document, in order to prompt for information which would be relevant to the project. However, respondents are not obliged to answer all of the questions and can simply comment on some of the questions, or other issues which they believe might be relevant.

We seek responses from interested persons by 7 July 2009. Responses should preferably be in electronic form in either Microsoft Word or PDF format and emailed to:

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[2] Based on historical performance.
[3] In terms of utility network availability, an 85% availability is poor. As a comparison, transmission line availability is routinely over 98%

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Please include in the Subject line: Upper North Island Reactive Support Investigation Project.

Late submissions may not be considered.

Following the close of submissions, Transpower will publish the full submissions on www.gridnewzealand.co.nz. Unless otherwise requested by a respondent, Transpower will include the name of the respondent and the entire submission on the website. If there is any aspect of the submission that is confidential, please indicate which sections you require Transpower to omit from publication and why it is regarded as confidential. Transparency in the transmission planning process is important and whilst Transpower acknowledges that there may be circumstances under which respondents do want to provide feedback confidentially, it is important to recognise that Transpower may not be able to rely on confidential information to justify an investment proposal.

Transpower also asks respondents to provide authorisation for any confidential information to be shared with the Electricity Commission in order to enable the Commission and Transpower to consider this project. If there is information which cannot be shared confidentially with the Electricity Commission, this must be clearly specified.

2.4 Process following consultation

Transpower will provide any updates on the project on the website www.gridnewzealand.co.nz.

Following consultation, Transpower will:

- consider feedback received in submissions;
- prepare a short list of options for GIT application;
- apply the GIT, and;
- prepare a GUP for submission to the Electricity Commission, if appropriate.

2.5 Outline of the document

This remainder of this document provides detail as to:

- section 3 – the need for the investment;
- section 4 – the forecast demands to be used to determine future needs;
- section 5 - the relevant forecast generation in the region which needs to be considered in the analysis;
- section 6 - discussion about the long list components to be considered;
- section 7 – reducing the long list of options to a short list;
- section 8 – a proposed commensurate GIT approach
- section 9 – Summary
- Appendix A – Glossary of terms

- Appendix B – Requirements for alternatives
- Attachment A – Technical need analysis
- Attachment B – Summary of approach used in SKM motor load survey

3 Need for the investment

The UNI power system, as defined by the region shown in Figure 3-1, is an area with a large amount of load and little generation. During peak periods, the demand in the UNI is met from generation south of Bombay.

Figure 3-1: Upper North Island Region

A comparison between the local installed capacity in the UNI and the forecast prudent peak demand is shown in Table 3-1 and Table 3-2. In 2008, ignoring line losses, the UNI load demand exceeded local generation by 1,600 MW at peak; by 2018 this will increase to over 2,300 MW, assuming no new generation is built.

Table 3-1 UNI prudent peak demand (winter)

Year	Winter(regional peak, 2008 APR) MW
2009	2392
2010	2485
2011	2572
2012	2639
2013	2708
2014	2779
2015	2850
2016	2919
2017	2988
2018	3056

Table 3-2 UNI generation

UNI Generation	Capacity
Otahuhu B	380 MW
Southdown	180 MW
Glenbrook	125 MW (a 75 MW directly connected machine, and two 38 MW embedded machines with a restricted output of 25 MW each)
Ngawha	10 MW[4] (two 5 MW embedded machines)
Total	**695MW**

A region like the UNI, which relies on remote generation can be susceptible to poor voltage performance. It has been recognised[5] that transmission faults on circuits into the UNI can cause poor transient voltage performance under two scenarios:

- A fault can cause motors to partially stall. The subsequent increase current drawn by the slowed motors may result in an under-voltage dip whilst the motors reaccelerate;
- A fault can cause a large amount of connected load to disconnect. The sudden loss of load may result in an over-voltage spike or swell.

If either of these voltage excursions occurs then additional load could be lost. Furthermore for over-voltage excursions damage could occur to power system equipment. In extreme cases a cascade failure could occur.

3.1 Transient Voltage Performance Criteria

One measure of the performance of the power system is how voltage recovers after a fault. Crucial to voltage recovery is the behaviour of induction motor loads which can draw large re-accelerating currents causing lengthy voltage dips. If a dip is too long then an unnecessary loss of load can occur; to minimize the risk of prolonged under-voltage dips Transpower uses the following under-voltage criteria:

- voltage must recover to above 0.8 pu in less than four seconds following a credible fault event; and
- motor current must not be greater than six times the rated current for more than three seconds and not be greater than three times the rated current for more than eight seconds.

The aggregated load model groups the induction motor load by protection type. One protection group has been identified as being likely to disconnect motors during a fault, this group is referred to as *group one*. The disconnection of these motors is considered unavoidable and has two related effects on voltage performance:

- loss of load during a fault will reduce the length of under-voltage dips; and
- loss of load during a fault will increase the length and magnitude of post recovery over-voltage spikes and swells.

While reducing the length of under-voltage dips is advantageous and beneficial to the load that remains connected, the over-voltage spikes and swells could result in

[4] A new 25MW capable extension to Ngawha was recently commissioned. This generator was not modelled in the studies used for this consultation report, but will be included in any future analysis. As this generator is relatively small, it will not make a large impact on UNI voltage stability.

[5] Chen R; McDonald S; 2005. *Auckland Reactive Power Requirements by 2010 October 2005*. Also see Hamadani H; Wang L; 2002. *Voltage Stability Study for Transpower New Zealand Ltd* Powertech May 2002

disconnection or stress to the remaining load and power system equipment. To mitigate the risk of over-voltages Transpower uses the following over-voltage criteria:

- voltage must not be greater than 1.3 pu; and
- voltage must not be greater than 1.1 pu after 0.8 seconds.

The behaviour of motors that disconnect during a fault is crucially important to voltage recovery. However, it is not possible to predict such behaviour with certainty, because there is considerable uncertainty in the estimate of the motor load percentage and it is not possible to know accurately, how much will actually disconnect during a fault. To mitigate this uncertainty Transpower states that;

- during a fault, the group one motor load that trips should be varied between 25 and 90 percent.

The voltage performance criteria must be passed for all motor tripping percentages between 25 and 90 percent.

Analysis was conducted under a range of contingent events, and this is presented in detail in the Need Analysis report, included with this report as Attachment A.

The results in summary are as follows:

- it was found that breaches of the transient voltage performance criteria could occur in the UNI following both credible N-1 contingencies, and N-G-1 contingencies.
- for the N-1 contingencies, the breaches occurred only in the extreme summer period (from 2009).
- for the N-G-1 contingencies, the breaches occurred both in the extreme summer period (from 2009), but also in the winter period (from 2008). The breaches in summer were more severe than the winter breaches.

As the UNI load increases, the likelihood of voltage stability issues post-contingency increases. The purpose of the investigation is therefore to consider options for providing dynamic reactive support to ensure voltage performance in such circumstances stays within Transpower's criteria for satisfactory performance.

Q1.	**Are there any other issues or considerations that Transpower should incorporate into the Upper North Island Reactive Support Investigation Project?**

4 Forecast demand

The need analysis, as reported in Attachment A, was based on the following demand input assumptions:

- the prudent peak demand forecast; and
- the motor load percentage.

The basis for these assumptions is described below.

4.1 Demand forecast

The demand forecast used for the needs analysis was determined as follows:

- In winter the load at each grid exit point (GXP) is determined by the diversity and power factors described as the prudent regional peak demand forecast in the 2008 APR[6].
- In summer, an extreme summer period is used. This period was identified by SKM as a part of their motor load survey, being where motor loads are at their peak. The period between 15 January and 16 March is used and the extreme summer diversities and power factors were developed specifically for this study. These diversity and power factors are shown in Table 4-1. The extreme summer diversities and power factors are applied to the GXP load forecasts described in the 2008 APR.

A comparison between each forecast is detailed in Table 4-2.

4.1.1 Extreme Summer Diversities and Power Factors

The extreme summer diversity and power factors have been calculated using Transpower's 2005 historical data for the combined peak of the North Isthmus and Auckland load that occurs between the 15 January and the 16 March, as shown in Table 4-1.

Table 4-1: UNI GXPs extreme summer diversity factors

Bus name and GXP name		Diversity	Power Factor
NORTH ISTHMUS			
ALB_33	Albany 33kV	64.4%	0.953
ALB_110	Albany 110 (Wairau Rd)	60.5%	0.973
BRB	Bream Bay	82.5%	0.939
DAR	Dargaville	81.6%	0.964
HEN	Henderson	56.9%	0.977
HEP	Hepburn Rd	68.1%	0.974
KEN	Kensington	87.8%	0.938
KOE	Kaikohe	67.3%	0.936
KTA	Kaitaia	77.1%	0.938
MPE	Maungatapere	56.3%	0.972
MTO	Maungaturoto	80.4%	0.970
SVL	Silverdale	50.2%	0.958
WEL	Wellsford	64.7%	0.980
AUCKLAND			
BOB_33	Bombay 33kV	78.7%	0.933
BOB_110	Bombay 110kV	73.7%	0.944
GLN_33/2	Glenbrook NZ Steel	89.4%	1.000
GLN_33/1	Glenbrook Counties	62.5%	0.924
MER	Meremere	71.9%	0.932
MNG_33	Mangere 33kV	83.0%	0.958
MNG_110/1	Mangere 110kV - 1	78.2%	0.923
MNG_110/2	Mangere 110kV - 2	78.2%	0.923
OTA	Otahuhu	79.6%	0.959
PAK	Pakuranga	67.0%	0.966
PEN_22	Penrose 22kV	91.7%	0.983
PEN_33	Penrose 33kV	76.2%	0.984
LST_110/PEN	Penrose 110kV - LST	46.7%	1.000

[6] The 2008APR diversities and power factors are contained within the file 2008 APR ADMD_080313.xls

PEN_QUAY/1	Penrose 110kV - QUAY	46.7%	1.000
PEN_QUAY/2	Penrose 110kV - QUAY	46.7%	1.000
ROS_22	Mt Roskill 22kV	52.5%	0.952
LST_110/ROS	Mt Roskill 110kV - LST	87.3%	0.937
ROS_KING/1	Mt Roskill 110kV - KING	87.3%	0.937
ROS_KING/2	Mt Roskill 110kV - KING	87.3%	0.937
TAK	Takanini	62.9%	0.981
WIR	Wiri	95.1%	0.946

4.1.2 UNI demand forecasts

The two demand forecasts, in MW, are given in Table 4-2.

Table 4-2: UNI prudent peak demand forecasts (MW)

Year	Winter (regional Peak, 2008 APR), MW	Extreme Summer (Mid January to Mid March), MW
2009	2392	1859
2010	2485	1931
2011	2572	1999
2012	2639	2051
2013	2708	2105
2014	2779	2160
2015	2850	2215
2016	2919	2269
2017	2988	2322
2018	3056	2376
2019	3125	2429
2020	3195	2484
2021	3259	2534
2022	3324	2584
2023	3389	2635
2024	3457	2688
2025	3523	2739
2026	3588	2790
2027	3653	2840
2028	3717	2890
2029	3783	2941
2030	3850	2993
2031	3921	3048
2032	3989	3101
2033	4062	3159
2034	4131	3212
2035	4202	3267
2036	4279	3327
2037	4354	3386
2038	4430	3445
2039	4508	3506

2040	4586	3566

Q2.	**Do respondents consider that the demand assumptions are appropriate for this project?**

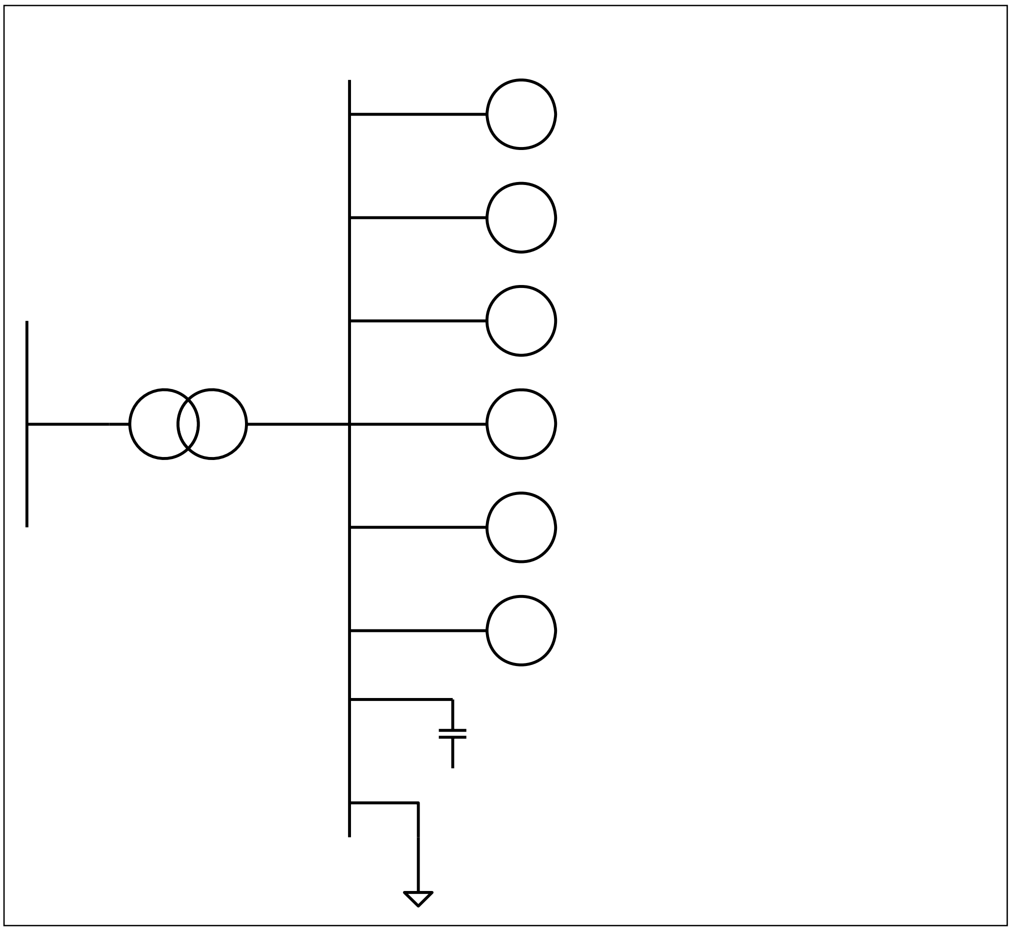
4.2 Motor load percentage

The dynamic load model used for the needs analysis comprises non-rotating "static" loads and induction motor loads.

Transpower commissioned SKM to survey the various motor loads in the UNI in 2004. This survey is attached as Attachment B to this consultation report.

The motors are split into categories depending on how they might respond and what their effect might be on voltage stability, following a contingent event. Three different protection groups (groups one, two and three) were used, and each group was further subdivided into groups based on motor sizes (large and small[7]) as shown in Figure 4-1.

Figure 4-1: SKM Motor Model categories



[7] Large motors are those with ratings greater than 150 kW.

SKM surveyed the load in the peak winter period and the extreme summer period[8].

The load composition for the entire UNI is summarised in Table 4-3.

Table 4-3 Upper North Island Load motor composition summary

Period	Static Percentage	Induction motors					
		Group One		Group Two		Group Three	
		Large	Small	Large	Small	Large	Small
Winter GXP average	61.9%	3.8%	11.8%	0.9%	13.1%	1.7%	7.0%
Extreme Summer GXP average	36.0%	6.5%	20.4%	1.5%	20.3%	2.9%	12.5%

For the purposes of this investigation it is assumed that these motor load percentages do not change over time. Limited sensitivity analysis will be undertaken to test the importance of this assumption on the outcome of the analysis.

Each Grid Exit Point (GXP) equivalent distribution transformer is assumed to have an impedance of 8% on load rating.

Q3. Do respondents consider that the motor load forecast approach is appropriate for this project?

5 Forecast generation

For the purposes of this investigation project, it is assumed that existing generation in the UNI will continue to be connected to the grid and generating, for the duration of the analysis period.

The following existing generation is assumed:

Table 5-1: Existing UNI generation

UNI Generation	Capacity
Otahuhu B	380 MW
Southdown	180 MW
Glenbrook	125 MW (a 75 MW directly connected machine, and two 38 MW embedded machines with a restricted output of 25 MW each)
Ngawha	25[9] MW
Total	710MW

In addition to the forecast generation the following existing dynamic reactive support is assumed:

[8] The winter peak is between June to August 6:00pm to 8:00pm and the extreme summer peak window is between Mid January and Mid March 12:00noon to 2:00pm

[9] An extra 15MW of generation has recently been commissioned at Ngawha. This generation was not included in the need analysis, but due to its small size will not significant improve UNI voltage performance.

Table 5-2: Existing UNI dynamic reactive support

UNI Generation	Capacity (+ve capacitive, -ve inductive)
Albany SVC	+100MVAR / -100MVAR
Otahuhu A,G1,G2,G4,G5 and G6[10]	+201MVAR / -145MVAR
Total	+301MVAR / -245MVAR

No new generation is assumed specifically over the analysis period, but sensitivity analysis will be undertaken to test the effect of new thermal generation in the UNI on the need for further dynamic reactive support. The expected effect of this would be no change in the need for immediate investment, but possible deferrals in the need for future modelled projects.

Q4. Do respondents consider that the generation assumptions are appropriate for this project?

6 Long list of options

To develop a long list of options, Transpower considers all and any possibilities for meeting the identified need.

This particular investigation project is quite unique, in that the range of investments which will meet the technical need is limited. Demand side alternatives, for instance, would not help because of the short-term nature of the problem and the response time required.

The generic alternatives considered are the installation of:

- static VAR compensators (SVC)
- static compensators (Statcoms)
- the provision of dynamic reactive support from condensers connected to existing generators (if offered through this RFI).

The effect of new generation in the UNI region will also be factored in along with the effect of new transmission lines into the UNI.

Transpower's consideration of potential options for this Upper North Island Reactive Support Investigation Project will reflect development plans whereby various combinations of the generic alternatives above will be added in the UNI as required[11].

As such, Transpower does not have a long list of options, but rather a long list of potential components which will make up the long list of options.

For information, in compiling development plans, the potential need for a Reactive Power Controller/s (RPC) will also be assessed. If required, the purchase and installation of a RPC will be included in any GUP.

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[10] Through until the SO contract runs out in 2012

[11] For information, in compiling development plans, the potential need for a Reactive Power Controller/s (RPC) will also be assessed. If required, the purchase and installation of a RPC will be included in any GUP.

Q5. Do respondents agree with Transpower's approach for developing long list options?

Q6. Are there any other qualifying alternatives/components which should be considered in the exercise of compiling development plans as options?

To the extent that this consultation document also serves as a RFI for proponents of transmission alternatives, information on potential alternatives should be provided in response to this Q6.

7 Reducing the long list to a short list of options

7.1 Short list of options

Once the long list of generic alternatives has been determined, Transpower will develop a series of development plans for the UNI, adding dynamic reactive support in various combinations, as required to ensure Transpower's voltage performance criteria remain to be met.

A set of high level screening criteria will initially be used to screen the long list development plans, as described below:

A. Fit for purpose
   a. Purpose – will assist meeting future energy demand growth
B. Technical feasibility
   a. Complexity of solution
   b. Reliability, availability and maintainability of the solution
   c. Future flexibility – fit with long term strategy for Grid
   d. Can solution be staged to preserve options for future changes
C. Practicality of implementation
   a. Is solution implementable by required date
   b. Implementation risks, inc potential delays due to property and environmental issues
D. Good electricity industry practice (GEIP)
   a. Consistent with good international practice
   b. Ensure safety and environmental protection
   c. Accounts for relative size, duty, age and technological status
   d. Technology risks

Given the approach taken in developing the long list development plans, it seems unlikely that any will fail on the basis of these criteria, so high level costs will also be considered in reducing the long list to a short list.

Ideally the short list of options to be considered using the GIT, will not include more than four options.

7.2 Base Case

Once the long-list is reduced to a short-list, the starting point in applying the GIT to the short-listed options is to decide on an appropriate Base Case.

The Rules define the term Base Case as being the reasonable future state of the electricity industry without the proposed investment or any alternative project.

For a reliability investment, Transpower interprets this, and in particular the word "reasonable", as meaning that the Base Case must ensure that existing load continues to be met. In other words, a "do nothing" approach is not a reasonable Base Case for a reliability investment, as it might be for an economic investment.

Transpower considers that a reasonable Base Case for this investigation would be the cheapest long-list development plan, developed using N-1. The use of a development plan using N-G-1 would not be suitable.

Other options will be considered in comparison to this Base Case.

Q7. Do respondents consider that a Base Case identified using this approach would be appropriate for this investigation project?

8 Commensurate GIT approach

Under the Rules, the rigour and comprehensiveness of the GIT analysis should be commensurate with the estimated capital expenditure of a proposed investment.

In order to ensure commensurate analysis for this investigation project, Transpower has assessed the requirements for application of the GIT and believes that only the following need to be considered in applying the GIT:

- project costs, and
- reliability cost differences

For the N-1 options, which will be justified under the reliability arm of the GIT, project costs only will be compared. This is on the basis that the options will be developed in a manner which adds dynamic reactive support to ensure Transpower's voltage performance criteria continue to be met, hence cost will be the only difference between the options.

To assess the N-G-1 options, Transpower will include reliability analysis which considers the potential cost arising from the following while G is not in service, versus the cost of providing dynamic reactive support to prevent such costs:

- possible damage to electronic equipment; and
- a higher probability of cascade failure

Q8. Do respondents consider this commensurate GIT approach to be reasonable for Transpower to apply when considering the Upper North Island Reactive Support Investigation Project?

Q9. Are there other market costs or benefits which should be reflected in the analysis?

8.1 Value of Lost Load (VoLL)

For this GIT analysis, reliability differences which reflect a different probability of cascade failure will be valued using a Value of Lost Load, (VoLL) figure.

The Rules require that the VoLL be $20,000 per MWh.[12] unless Transpower can justify a more appropriate alternative figure for the analysis in question. The $20,000

[12] Clause 8.3.4, Schedule F4 of the Rules.

per MWh was determined in December 2004 and Transpower proposes to inflate it accordingly to a June 2009 value of $22,800 per MWh.

Some industrial or other loads in the UNI may have a cost of unserved energy that differs from the $22,800 per MWh figure. For example, interruptions to Marsden Point refinery may have a higher VoLL, due to high start-up costs following a shutdown and the critical nature of that operation to the rest of New Zealand. If Transpower can substantiate a different value of lost load, the cost benefit analysis can use this revised number.

Q10. Do respondents consider this Value of Lost load is appropriate for valuing lost load in the Upper North Island Reactive Support Investigation Project?

9 Summary

The purpose of this document is to seek feedback, on the approach and inputs Transpower will use in applying the GIT to the Upper North Island Reactive Support Investigation Project.

Transpower is not committed (except where the Rules prescribe certain factors) to any input variable or approach set out in this document.

Transpower's intention in releasing this document is also to solicit additional options (alternative projects) to those identified above. To this end, Transpower will assess any further options proposed, using the criteria outlined in Appendix B, to determine whether they could be alternative projects under the Rules and can therefore be added to the long list of alternatives.

The long list of options will then be reduced to a short list of options using the approach and criteria outlined in section 7.

A commensurate GIT will then be applied to the short list of options to determine whether any meet the requirements of the GIT and a GUP will be prepared for the Electricity Commission if appropriate.

Appendix A Glossary

Term	Description
Alternative Project	Options which are reasonable alternatives to any investment proposal as defined in clause 19, Schedule F4 of the Rules.
Economic Investment	Investments in the grid that can be justified on the basis of the Grid Investment Test set out at Schedule F4 of the Rules and are not reliability investments.
Electricity Commission	A Crown entity established under the Electricity Act 1992 to oversee New Zealand's electricity industry and markets.
Expected unserved energy	A forecast of the aggregate amount by which the demand for electricity exceeds the supply of electricity at each grid exit point as a result of likely planned or unplanned outages of primary transmission equipment.
GIT	Grid Investment Test. A test for reliability investments and economic investments in the grid developed in accordance with Rule 6. The specific rules defining the Grid Investment Test, are set out in Schedule F4 of Part F of the Rules.
GPS	Government Policy Statement on Electricity Governance.
Grid	Is the system of transmission lines, substations and other works used to connect grid injection points and grid exit points to convey electricity throughout the North and South Islands of New Zealand.
GRS	Grid Reliability Standards are standards for reliability of the grid developed in accordance with Rule 4. The standards themselves as currently developed are detailed in Schedule F3 of Part F.
GUP	Grid Upgrade Plan. A plan for grid expansions, replacements and upgrades.
MWh	Megawatt hour of electrical energy
Network	A localised portion of the Grid
Primary Transmission Equipment	Any plant or equipment forming part of the grid which enables the bulk transfer of electricity, including without limitation transmission circuits, busbars and switchgear.
Reliability investment	Investments by Transpower in the grid, or alternative arrangements by Transpower, the primary effect of which is, or would be, to reduce expected unserved energy.
RFI	Request for Information
RMA	Resource Management Act 1991
Rules	The Electricity Governance Rules 2003. Unless otherwise specified, the reference to the Rules in this document is to the rules in Part F, Section III of the Electricity Governance Rules 2003.
SDDP	A model developed by Power Systems Research in Brazil.
SoO	Statement of Opportunities developed by the Electricity Commission in accordance with Rule 9.
Transpower	Transpower New Zealand Limited, owner and operator of New Zealand's high-voltage electricity network (the national grid).
USE	Unserved Energy
VoLL	Value of Lost Load

Appendix B Requirements for alternatives

As discussed above, the GIT involves determining a number of "alternative projects," to evaluate against the Base Case so as to determine a proposed investment.

Alternative projects are defined in the Rules as meaning[13]:

> "…*any alternative transmission augmentation projects and* ***transmission alternatives*** *to the* ***proposed investment,*** *including any variant of the* ***proposed investment*** *that involves a non-negligible change in the timing of that* ***proposed*** *investment that are:*
>
> *19.1 technically feasible;*
>
> *19.2 reasonably practicable having regard to the matters set out in clauses 8.1 to 8.4 [of Schedule F4];*
>
> *19.3 reasonably likely to proceed if neither the* ***proposed investment*** *nor any other* ***alternative project*** *proceeds and unlikely to proceed if the* ***proposed investment*** *does proceed;*
>
> *19.4 reasonably expected to provide similar benefits in type but not necessarily in magnitude, to relevant nodes, as the* ***proposed investment****; and*
>
> *19.5 reasonably expected to enable the deferment of investment of the type contemplated by the* ***proposed investment*** *for a period of 12 months or more*"

The definition requires an alternative project to be a technically feasible option which could be expected to act as an alternative to an option ultimately identified as Transpower's investment proposal given:

- the grid reliability standards;
- demand growth;
- associated costs; and
- the time period in which the option could be operational.

[13] Clause 19 of Schedule F4, Part F of the Rules.