TRANSPOWER

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Upper North Island Dynamic Reactive Support Investment Proposal: Attachment B – Costing Report

20 May 2010

Version control

Document Number/Version	Description	Date
001/ A	Upper North Island Dynamic Reactive Support Investment Proposal – Attachment B	May 2010

This report contains costing information which is provided to the Electricity Commission on a confidential basis.

If the Grid Upgrade Plan to which this report is attached is approved, Transpower will be tendering for services and equipment associated with projects in that Grid Upgrade Plan.

If the Electricity Commission would like to provide this report to any other party, including external resources, Transpower permission should be sought first.

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1 Introduction

This document forms attachment B to the Upper North Island Dynamic Reactive Support Investment Proposal. This report:

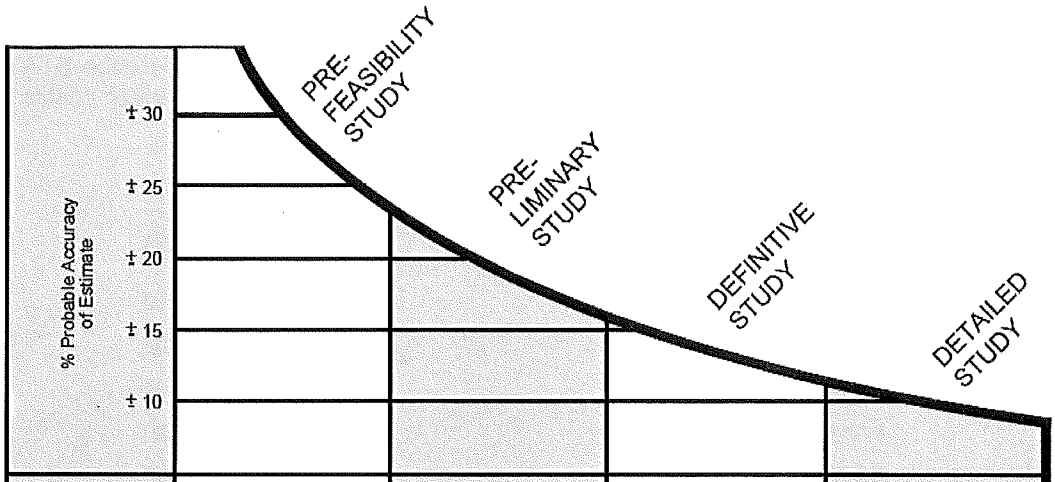
- gives the build-up of STATCOM and SVC costs
- outlines the offers received in response to our RFP for transmission alternatives
- gives costs of the additional works proposed.

2 Costs of STATCOMS and SVCs

2.1 Transmission costs

The process of costing a transmission solution is a process of refining the cost estimates over time, recognising there is a trade-off between cost accuracy and timely and efficient investment decisions. This is similar to any cost estimation process where, as more detailed design is undertaken, costs become more refined. This is illustrated in Figure 2-1 below which sets out at each stage what level of detail is undertaken.

Figure 2-1: Transmission costing process



Type of Estimate	Order of Magnitude	Preliminary	Definitive	Detailed
Provided Documentation	• Product capacity and Location • Cost Data on Similar Projects • Major Equipment List	• Preliminary Equipment List • Engineering Line Diagram • Plant Outline General Arrangement • Maps and Surveys • Bench Test Results • Nature of Facilities	• Equipment Specifications and Vendor Quotations • Construction Schedule • Electrical One Lines • Piping and Instrumentation Flow Diagrams • Soil Data and Architect Features • Site Survey and Labour Complete	• Bulk Material Specifications and Vendor Quotes • Construction Specification and Sub Contractor Quotations • Engineering Advanced Approximately 10%
Definition of Scope of Work	Conceptual	Approximate	Clearly Described Essentially Complete	Complete. Well Detailed
Estimating Procedure	Factoring	Combination of Factoring and Quantity Take-Off	Most Quantity Take-Off. Very little Factoring	Complete Quantity Take-Off
Use of Study	Comparison/ Rejection	Final Feasibility	Budget	Funding

Bottom-up asset estimation costs are generally subject to the orders of accuracy outlined above. This also demonstrates the level of information required to accurately estimate the costs associated with a particular project.

The transmission costs used in this project have been summarised into the following components:

- line capital costs
- substation capital costs
- property and easement costs
- environmental costs
- project management
- operating and maintenance costs.

2.2 Costs of STATCOMs

The GIT analysis shows that the preferred option is option 1, installing STATCOMs as required for dynamic reactive support in the Upper North Island.

The following tables show the itemised costs to install two Penrose STATCOMs (excluding capital costs), the Maungatapere STATCOM (excluding capital costs) and the Reactive Power Controller.

Table 2-1: Penrose substation costs

Substation Costs	Cost ($NZ)
Site Works	298,012
Civil Works	318,022
Primary Equipment	3,295,094
Protection	98,520
SCADA	74,250
Secondary Equipment	292,659
Communications	0
Freight on Materials	38,049
Transpower overheads 1st STATCOM	
Transpower Costs Investigation	100,099
Transpower Tender Evaluation	51,600
Transpower Costs Construction	1,104,400
Consultants	333,333
Other Transpower Overheads	200,000
Transpower overheads 2nd STATCOM	
Transpower Costs Investigation	100,099
Transpower Tender Evaluation	51,600
Transpower Costs Construction	1,104,400
Consultants	333,333
Other Transpower Overheads	200,000
Contractor Overheads	349,300
Switching Costs	25,000
Total	**$8,367,770**

The substation costs excluding the Transpower overheads are considered to be shared equally by the two STATCOMs. Therefore the total cost of $8,367,770 for two STATCOMs is apportioned as $4,183,885 for each. This GUP requests funding for just one of these STATCOMs. The decision on whether the second is necessary in 2015 will be made in 2011 depending on the outcome of studies on an option for series capacitors and any confirmed new generation.

Table 2-2: Maungatapere substation costs

Substation Costs	Cost ($NZ)
Site Works	272,016
Civil Works	789,362
Primary Equipment	652,403
Protection	92,270
SCADA	74,250
Secondary Equipment	81,582
Communications	0
Freight on Materials	38,018
Transpower Overheads	
Transpower Costs Investigation	100,099
Transpower Tender Evaluation	51,600
Transpower Costs Construction	1,104,400
Consultants	333,333
Other Transpower Overheads	200,000
Contractor Overheads	227,000
Switching Costs	10,100
Total	**$4,026,433**

2.3 Primary Capital Costs

The primary capital costs are for the STATCOM or SVC devices plus associated power transformer as required. Budgetary prices were sought from [redacted] for various sized STATCOMs and SVCs. The price reflected in Table 2-3 for the STATCOMs is for a unit connected at 33 kV with a continuous power rating of 40 Mvar which is capable of delivering 80 Mvar for two lots of 3 seconds. The primary capital cost for the STATCOM at Otahuhu includes a $4 million power transformer. The SVC cost is for a +150 Mvar (capacitive) / -75 Mvar (inductive) unit connected at 110 kV. The other primary equipment such as circuit breakers, disconnectors and current transformers are included in the installation costs.

The indication from [redacted], which has been converted to New Zealand dollars at [redacted] per dollar.

2.4 Property Costs

Costs for property were included where the Transpower land at a substation would not of sufficient size for the new primary plant. These costs were calculated on the amount of land required, the location of the substation and the use of the area surrounding the substation. Similarly easement costs have been included where necessary.

2.5 Installation Costs

The Penrose and Maungatepere STATCOM installation costs were investigated in two SSRs prepared by BECA. These include all associated works required when installing a STATCOM or SVC; refer Table 2-1 and Table 2-2. The installation costs also include project management costs associated with the design, construction and commissioning of

the works to be undertaken. The Maungatapere costs have been used as a reference for the other STATCOM and SVC installations. Where there are known congestion issues at a site an additional $1 million has been allowed for cable and other equipment relocation.

2.6 Line Work Costs

A sum of $1 million for the line work has been included where STATCOM installations necessitate line deviations. New transmission line costs are based on indicative costing corridors only. The $1 million figure includes dismantling costs as required. At Maungatepere, $200,000 has been allowed for the minor line deviation required for the installation of the first STATCOM as investigated in the SSR.

2.7 Other Work Costs

These costs are associated with major site works that are required to install a STATCOM at that particular substation. At Mangere, $7 million has been allowed to upgrade the substation from AIS to GIS to accommodate the STATCOM. Mount Roskill is a particularly steep site, therefore $1 million has been allowed for earth works.

2.8 Consenting

Transpower's environment group estimated costs for consenting the primary plant based on the size and location of the primary equipment. They include the RMA and other relevant environmental approvals and range from $8,000 to $100,000 depending on the process required.

2.9 Investigation Costs

A nominal sum of $200,000 was allowed for the expensed investigation costs associated with the installation of a new STATCOM or SVC. To date, the expensed investigation project responsible for submitting this GUP has spent approximately $500,000 which can be split over the ~~three~~ two STATCOMs in the proposal.

2.10 Community Care Fund Costs

The development of Transpower's CommunityCare Fund arose from the recognition that Transpower needs to offset the impact on communities of major grid investment projects and contribute to communities where we operate, particularly those communities which accommodate Transpower assets which benefit the whole country. The Fund has been developed along similar models used by other power companies in New Zealand and overseas. Through the fund, Transpower supports projects that benefit the community as a whole.

Transpower's community funding approach is aligned with project approval and is based on a funding formula derived from an impact. The visual impact of the line is dealt with through environmental mitigation.

Once a Grid Upgrade Proposal is approved by the Electricity Commission, community organisations may apply to the CommunityCare Fund for nominated projects that meet specific funding criteria. The CommunityCare Fund is managed in accordance with the guidelines established by the Office of the Auditor General (OAG).

2.11 Operating and maintenance costs

Operating, maintenance and dismantling costs over the operating life of each short-listed option are included in the analysis.

2.12 Scope Allowance

A scope allowance is added to the Estimated Cost, to cover two distinct categories of costs:

(a) costs of works which are planned but which have not been included in the estimated capital costs except through this general allowance, and

(b) costs for works not anticipated at the time costs were estimated.

The Scope Allowance is calculated as a fixed percentage of Estimated Costs and is added to the Estimated Cost. The Estimated Cost plus Scope Allowance equals the Expected Cost of the project – or various components of it – and this is the cost used in GIT analyses.

2.13 Build-up of STATCOM and SVC Costs

Table 2-3: STATCOM and SVC Costs Breakdown

- $ million -	Capital	Property	Installation	Line-work	Other work	Consenting	Investigations	Community Care fund	Scope allowance	TOTAL
PENSTAT1	[redacted]	0.0	4.2	0.0	0.0	0.008	0.2	[redacted]	[redacted]	[redacted]
PENSTAT2	[redacted]	0.0	4.2	0.0	0.0	0.008	0.2	[redacted]	[redacted]	[redacted]
PENSTAT3	[redacted]	0.0	4.0	0.0	0.0	0.100	0.2	[redacted]	[redacted]	[redacted]
PENSTAT4	[redacted]	0.0	4.0	0.0	0.0	0.100	0.2	[redacted]	[redacted]	[redacted]
MPESTAT1	[redacted]	0.0	4.0	0.2	0.0	0.020	0.2	[redacted]	[redacted]	[redacted]
MPESTAT2	[redacted]	0.2	4.0	1.0	0.0	0.026	0.2	[redacted]	[redacted]	[redacted]
HEPSTAT1	[redacted]	0.0	4.0	1.0	0.0	0.008	0.2	[redacted]	[redacted]	[redacted]
MNGSTAT1	[redacted]	0.0	4.0	1.0	7.0	0.008	0.2	[redacted]	[redacted]	[redacted]
MNGSTAT2	[redacted]	0.0	5.0	0.0	0.0	0.050	0.2	[redacted]	[redacted]	[redacted]
GLNSTAT1	[redacted]	0.0	4.0	0.0	0.0	0.008	0.2	[redacted]	[redacted]	[redacted]
ROSSTAT1	[redacted]	0.0	4.0	1.0	1.0	0.008	0.2	[redacted]	[redacted]	[redacted]
MDNSTAT1	[redacted]	0.0	4.0	0.0	0.0	0.008	0.2	[redacted]	[redacted]	[redacted]
MDNSTAT2	[redacted]	0.0	4.0	0.0	0.0	0.008	0.2	[redacted]	[redacted]	[redacted]
WRUSTAT1	[redacted]	1.0	4.0	0.0	0.0	0.050	0.2	[redacted]	[redacted]	[redacted]
OTASTAT1	[redacted]	0.0	4.0	0.0	0.0	0.008	0.2	[redacted]	[redacted]	[redacted]
PAKSTAT1	[redacted]	0.0	4.0	0.0	0.0	0.008	0.2	[redacted]	[redacted]	[redacted]
PENSVC1	[redacted]	0.0	4.0	0.0	0.0	0.008	0.2	[redacted]	[redacted]	[redacted]
MPESVC1	[redacted]	0.0	4.0	0.0	0.0	0.026	0.2	[redacted]	[redacted]	[redacted]
HEPSVC1	[redacted]	0.0	4.0	0.0	0.0	0.008	0.2	[redacted]	[redacted]	[redacted]
ROSSVC1	[redacted]	0.0	4.0	0.0	0.0	0.008	0.2	[redacted]	[redacted]	[redacted]
OTASVC1	[redacted]	0.0	4.0	0.0	0.0	0.008	0.2	[redacted]	[redacted]	[redacted]
OTASVC2	[redacted]	0.0	4.0	0.0	0.0	0.008	0.2	[redacted]	[redacted]	[redacted]

3 RFP for Transmission Alternatives

In September 2009, Transpower issued an RFP seeking proposals for non-transmission alternatives. In response, three parties submitted proposals in forms Transpower could accept and evaluate – Contact Energy Ltd ("Contact"), Mighty River Power Ltd ("Mighty River Power" or "MRP") and Power Consultants Ltd ("Power Consultants").

The discussion below summarises those offers and includes the reasoning used in determining the proportion of their offer to include in our GIT analysis.

3.1.1 Power Consultants Proposal

The Power Consultants proposal was to install distributed Dvars which are essentially smaller versions of the STATCOMs evaluated by Transpower in other development plans. The capital cost of the Power Consultants equipment was included in the GIT as tendered.

Distributed proposal

Power Consultants' offer of 30 October 2009 included installing their Dvar units at a range of locations. Their 40 Mvar proposal for a 10 year contract was:

Exchange Rate USD/NZD	0.8	0.75	0.7	0.65	0.6
40 MVAR 10 year option	$[redacted]	$[redacted]	$[redacted]	$[redacted]	$[redacted]

However, this was uneconomic compared with STATCOMs.

Penrose proposal

Power Consultants then offered a cheaper option with all units on the Penrose substation site and a wider range of contract terms. It included [redacted] Mvar (including [redacted] reserve capacity) connected to the 33kV Bus. The monthly costs assuming an exchange rate of 0.75 were as follows:

Contract term	Monthly cost
10 year contract	$[redacted]
15 year contract	$[redacted]
20 year contract	$[redacted]

Correcting the 15 year offer to the 1 Feb US:NZ exchange rate of 0.7046 gives $[redacted]k/month or $[redacted]m per year. This is conservative because although the rental component may decrease marginally for a 20-30 year contract, we have now confirmed that the offer did not include full energy costs or other minor costs, totalling around $[redacted]m/year. As this offer was still relatively uneconomic we did not evaluate these other items in detail as they would have made this offer even more uneconomic.

3.1.2 Contact Energy Proposal

Contact Energy offered their five Otahuhu synchronous condensers when the current contract expires at the end of November 2010. They made two offers.

The first was for five machines for five years. However, [redacted] and so this option was superseded by a second offer in which [redacted] This second, more attractive offer was for [redacted] as shown in Table 3-1 below.

Table 3-1: Contact Energy's Synchronous Condensers Proposal

Contact Energy Proposals

	Option 4A	Option 4B
Description	Units 1 & 2	Units 4, 5 & 6
Mvar Each Unit	+50/-27	+32/-27
Mvar firm	+50/-27, > 95%	+64/-58, > 98%
MVAR maximum	+100/-54, > 80%	+96/-87, > 95%
Term	[redacted]	[redacted]
Annual Fee	$[redacted]	$[redacted]
Fee per month	$[redacted]	$[redacted]

In summary, the cost of Option 4 was $[redacted]m per year for [redacted] and these costs were used in evaluating the development plans.

As the development plans including the Contact Energy proposal were uneconomic compared with the base case, we did not assess the economic cost of the following issues as these would have simply made this option even less attractive.

[redacted]

3.1.3 Mighty River Proposal

Mighty River Power's offer was for the synchronous condenser at Marsden A power station available within [redacted] of agreement. Connection issues at substation needed to be resolved and contractual differences needed to be agreed. The offer allowed for some refurbishment and for operation and maintenance costs.

For a 15 year contract the cost was $[redacted]k per month = $[redacted]m pa (Additional costs of $[redacted] per test).

For a 5 year contract the cost was indicated as likely to be in the range of $[redacted]m to $[redacted]m pa.

None of the development plans including this proposal were competitive with the base case. We did not consider the implications of plant failure as that would have made this option even less attractive.

3.2 Demand Side Initiatives

No demand side options were offered as alternatives in the RFP process. However, the ability to call on demand side response to reduce demand at peak times or during outages is an effective alternative to additional dynamic reactive support devices. It would also help manage any delay in the delivery of this project or other key upgrade projects such as NIGUP.

For these two reasons, we are including in the Grid Upgrade Plan, funding for demand-side participation. We will seek the equivalent of one year's load growth in the region (60MW).

The two initiatives are a Demand Response Initiative and an upper North Island Load Controller. They are expected to be [redacted].

3.2.1 Demand Response Initiative

The South Island DSP Trials in 2007 and 2008 demonstrated that load reductions could be achieved when required subject to certain conditions.

[redacted]

The estimate of project cost is necessarily based on subjective judgements of the contractual costs of demand response and preliminary assessments of software and hardware systems to manage and call for demand-side reductions. The estimates should be kept strictly confidential.

Table 3-2: Demand Response Estimates

Assessed Demand Response Costs	Cost ($NZ000)
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
Total	$[redacted]

3.2.2 UNI Load Controller

[redacted]. It will assist distributors to better co-ordinate distributor ripple control loads at system peak demand periods or during planned outages.

[redacted]

4 Reactive Power Controller (RPC)

Coordinating the reactive devices across the Auckland region is a significant operational challenge. As more reactive support – both static and dynamic is added – a control system, a Reactive Power Controller (RPC) is required. An RPC is necessary to ensure the devices act in a coordinated manner which will allow more optimal dispatch of the power system. A special challenge in Auckland is that the reactive devices are spread over a number of substations and the generation in the region has a significant impact on reactive power management by the System Operator.

The installation and commission of the Reactive Power Controller is planned for 2012. The design will build on experience gained in developing and implementing a regional RPC for Christchurch. The Christchurch RPC has a modular design and is intended to be able to operate over multiple sites and control both grid reactive devices as well as generating units in future. The following table of costs is based on the costs of the Christchurch RPC modified to reflect the complexity of the Auckland Region requirements.

Table 4-1: Reactive Power Controller Costs

Substation Costs	**Cost ($NZ)**
Site Works	0
Civil Works	0
Primary Equipment	[redacted]
Protection	0
SCADA	4,725,000
Secondary Equipment	0
Communications	362,500
Transpower Overheads	
Transpower Costs Investigation	131,200
Transpower Tender Evaluation	79,200
Transpower Costs Construction	1,251,200
Other Transpower Overheads	200,000
Consultants	[redacted]
Contractor Overheads	[redacted]
Switching Costs	0
Total	$[redacted]

5 Software for System Operator

The current Upper South Island reactive support implementation has identified that the dispatch of dynamic reactive support devices will require improved and enhanced tools for the System Operator to manage and calculate dynamic reactive support requirements in real time. The same requirement applies to the Upper North Island. Thus this proposal includes the necessary funds to enhance the dynamic stability

assessment software used by our System Co-ordinators so that the reactive devices can be fully utilised.

Purchase, installation and integration of this software will be targeted to coincide with the RPC and has an expected cost of $1.1m.

6 Load Monitoring Equipment

Our ability to identify a requirement for dynamic reactive support is dependent on our modelling of the way the power system responds to severe faults. The assumptions in the modelling used for this evaluation err on the side of caution where we have incomplete information.

To better inform our analysis on the future need for dynamic reactive support, including under N-G-1 scenarios we have included funding for additional instrumentation to better understand how the regional power system responds dynamically to severe power system faults. We will install this enhanced monitoring instrumentation at selected GXPs jointly with the System Operator. Our improved understanding may in turn lead to reduction or deferment of later stage investments.

Some load monitoring equipment has already been installed. Installation and commissioning of the equipment included in this GUP will be targeted for 2011 at an expected cost of $770,000.

7 Capacitor Banks

The cost of a 100 Mvar capacitor bank was assumed as $2.5m installed.

8 Expected Total Project Cost

The breakdown of the MAC and comparison with P90 estimates is in Table 8-1 below.

Table 8-1: Breakdown of MAC

	Estimated Cost	Expected Cost	Price contingency	Exchange rate variability	Exchange rate hedge	Inflation	IDC	TOTAL	P90
Auckland STATCOM 1	*(2012)*								
Expected Cost	[redacted]	[redacted]						[redacted]	
Expected End Cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Maximum Approved Cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Northland STATCOM	*(2013)*								
Expected Cost	[redacted]	[redacted]						[redacted]	
Expected End Cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Maximum Approved Cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Total for 2 STATCOMs								[redacted]	[redacted]
Reactive Power Controller	*(2013)*								
Expected Cost	[redacted]	[redacted]						[redacted]	
Expected End Cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Maximum Approved Cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
System Operator Software	*(2012)*								
Expected Cost	1.0	1.1						1.1	
Expected End Cost	1.0	1.1	0.0	0.0	0.0	0.0	0.1	1.2	
Maximum Approved Cost	1.0	1.1	0.0	0.0	0.0	0.0	0.1	1.3	1.3
Load Monitoring Equipment	*(2011)*								
Expected Cost	0.7	0.8						0.8	
Expected End Cost	0.7	0.8	0.0	0.0	0.0	0.0	0.0	0.8	
Maximum Approved Cost	0.7	0.8	0.0	0.0	0.0	0.0	0.0	0.8	0.9
Demand-side Management	*(2011)*								
Expected Cost	[redacted]	[redacted]						[redacted]	
Expected End Cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Maximum Approved Cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total GUP									
Expected Cost	82.1	90.1	0.0					90.1	
Expected End Cost	82.1	90.1	0.0	3.0	0.6	4.7	5.1	103.4	
Maximum Approved Cost	**82.1**	90.1	**3.1**	**5.8**	**0.6**	**5.3**	**5.3**	**110.2**	**110.0**

In the above table, amounts have been rounded to one decimal place but totals are correct.

Table 8-2: Summary of MAC

Component Costs	Cost ($NZ)
Auckland STATCOM (2012)	[redacted]
Northland STATCOM (2013)	[redacted]
Reactive Power Controller (2013)	[redacted]
Software for System Operator (2012)	1.3
Load Monitoring Equipment (2011)	0.8
Demand-side Management Trial (2011)	[redacted]
Total	**$110.2**