

Waipori Generation Embedment Project (WGEP)

Revised 110kV Waipori Generation Embedment Proposal

Prepared for
TrustPower

WP1115

June 2013



146 Tainui Street
Greymouth, New Zealand
Ph +64 3 768 9300
Fax +64 3 768 2766

Quality Assurance Record


Project Description: Feasibility study to embed the generation output of Waipori Power Stations into the Halfway Bush GXP

Document Number: ENS – R601 Rev 04 May 2013

Project Reference: WP1115

File name: [Revised 110kV Waipori Embedment Proposal](#)

Revision Log

Rev	Date	Description		Signed	Name
01	24 April 2012	33kV Proposal Issued	Prepared		Mike McSherry
			Reviewed		Andrew Beddard
			Approved		Rodger Griffiths
02	April 2013	Revised 110kV Draft	Prepared		Mike McSherry
			Reviewed		
			Approved		
03	May 2013	110kV Issued	Prepared		Mike McSherry
			Reviewed		Peter Litchfield
			Approved		Richard Spearman
04	June 2013	Updated with comments from Transpower and other minor amendments.	Prepared		Mike McSherry
			Reviewed		Peter Litchfield
			Approved		Richard Spearman

Contents

1	Introduction	4
2	Background.....	4
3	Project Description	6
4	Costs.....	7
4.1	Substation Equipment/Work	7
4.1.1	Waipori Substation - \$3,196k	7
4.1.2	Halfway Bush Substation - \$910k.....	8
4.1.3	Associated Works - \$151k.....	8
4.2	New 110kV Line (including underground cable)	9
4.2.1	Overhead 110kV Line Works - \$12,147k	9
4.2.2	Underground 110kV Cable Works - \$1,415k	10
4.3	Survey Fees.....	11
4.4	Cost Recoveries	11
4.5	Resource Consents	12
4.6	Easement Costs	12
4.7	Operations and Maintenance Costs	12
4.8	Business Interruption Costs	12
5	Transmission Losses	13
5.1	Loss Calculation Methodology.....	13
5.2	Current Situation.....	13
5.2.1	33kV System	13
5.2.2	110kV System	14
5.2.3	Total Current Losses.....	15
5.3	Losses on Proposed 33 and 110kV system.....	15
5.4	Additional Loss Created by the Proposal	16
6	Revenue.....	17
6.1	Connection Charges.....	17
6.1.1	Berwick 110kV Substation.....	17
6.1.2	Halfway Bush 33kV Substation.....	17
6.2	Berwick HVDC Injection Charges	17
6.3	Halfway Bush Avoided Interconnection Charges	18
6.4	HVDC Injection Charges at Halfway Bush	19
6.5	Increased Losses.....	20
7	Economic Feasibility	21
7.1	Assumptions	21
7.2	Economic Assessment Results	21
8	Technical Feasibility	22
8.1	Loadflow Analysis	22
8.2	Waipori Substation	22
8.3	Halfway Bush Substation.....	22
8.4	New 110kV Transmission Line to Halfway Bush	23
9	Legal and Environmental Issues	25
10	Conclusions.....	26
	Appendix A – Conceptual Drawings	27
	Appendix B – Loss Data Tables	29
	Appendix C Revenue.....	32
	Appendix D – Interconnection Charges Data HWB.....	33
	Appendix E – Discounted Cashflow Analysis	34
	Appendix F – Extracts from the Clutha and Dunedin City District Plan.....	36
	Appendix G – Independent Opinion of the Clutha and Dunedin City District Plans....	39
	Appendix H – Estimated Injection HAMDI at Halfway Bush	41

1 Introduction

The objective of this report is to:

"Confirm the feasibility of bypassing existing grid assets to embed the Waipori Generation Station at Halfway Bush, considering the legal, commercial, environmental, operational and technical aspects of the proposed project"

2 Background

The Waipori Hydro Scheme near Dunedin was originally constructed to supply power to the City of Dunedin and was owned by the Dunedin City Council or its subsidiaries until 1999. At that time, the scheme was sold to TrustPower as a result of the Bradford reforms, which prevented a lines business from continuing to own or have an interest in, electricity generation asset.

Initially, the output from the scheme was transmitted via three 33 kV lines to Dunedin some 44 km away. As the scheme size increased over later years, the existing transmission network was unable to handle the additional demand, and rather than carry out a major upgrade of the 33 kV lines, a 110 kV line was run from Waipori Stations 3 and 4 to connect into the nearby NZED network.

As Station 2A was further developed, the 110 kV line was extended from Station 3 up to Station 2A and a 110 kV bus and substation established at that point to run alongside the existing 33 kV substation. Significantly, there is no interconnection between the two buses at this point, allowing some control of power flows at each voltage.

This means that electricity generated by the Waipori Hydro and Mahinerangi Wind Farm Schemes are connected to the national grid via a hybrid system comprising two separate transmission networks operating at different voltages. Connection to the grid occurs at the following sites: -

- Transpower's Berwick Substation approximately 30 km south of Dunedin on the Taieri plains via a single 110 kV line; and
- Transpower's Halfway Bush Substation in Dunedin via three 33 kV lines with 60MVA capacity (Summer ratings)

The connection at Halfway Bush Substation is fully embedded in the Aurora Energy network in that all of the generation delivered is consumed by the local distribution network without net injection into the grid.

On the other hand, all of the generation delivered to Berwick is directly injected into the grid, as there is no balancing local load off take.

As the scheme was originally developed, the most sensible technical solutions were employed resulting in low losses and reduced capital investment. Commercial arrangements were put in place to support this approach, most notably the application of *notional embedment* whereby the output from Waipori was treated as a single entity, whether the power flowed into Halfway Bush via the 33 kV network, or through the 110 kV line to nearby Berwick substation. In other words, Berwick and Halfway Bush were treated as a single notional GXP.

In the mid-1990's, Transpower introduced a new pricing methodology that charged South Island generators for the costs of running the inter-island HVDC link. These charges were based upon the anytime maximum injection into the grid at each GXP and removed the benefit of aggregation of load between various exit or injection points.

Nevertheless, a number of local agreements could still be negotiated with Transpower by various vertically integrated power companies that owned both generation and distribution

assets as a means of partially ameliorating the impacts of these changes. It is understood that the Waipori Scheme also benefited through such an arrangement.

In 2001, Transpower introduced its "*Connections*" contract package and this reinforced the charging methodology for HVDC charges. At the same time, however, a stronger stance was taken on standardisation of contracts and, when combined with the split of generation from distribution, there was little option for South Island generators but to bear the full brunt of these charges where there was a direct connection into the national grid.

The present pricing methodology contains two features where electricity companies look to save costs. South Island generation injection costs can be avoided if the generation is connected to a matched load via the local lines company and lines companies can avoid interconnection costs if their take-off load is reduced by interconnected generation. Generators also benefit if the latter cost savings are passed on by the lines company.

Therefore, the key drivers for WGEP are the benefits received by the avoidance of interconnection charges at Halfway Bush and the avoidance of the HVDC injection charges at the Berwick GXP.

The charges for the connection at Berwick comprise the following:

- Connection Charges based upon the substation Replacement Cost;
- Interconnection Charges based on load off-take, (although the quantum of this charge means that it has little materiality for the purposes of this study); and
- HVDC Charge which is used to recover the cost of making available the assets used to provide the inter-island link between Benmore in the South Island and Haywards in the North Island.

In 2004, Transpower supported the benefits of this project and provided TrustPower with an agreement to notionally embed the Waipori generation at Halfway Bush.

This agreement is due to expire on 23 October 2013 and TrustPower wishes to continue the arrangement under Transpower's current prudent discount policy.

This report examines the operation as it stands today and updates the data presented in the initial report. The reasons for embedment have not changed since 2004.

3 Project Description

The Waipori Generation Embedment Project (WGEP) would involve physically embedding the Waipori generation in the Aurora Energy network at Transpower's Halfway Bush substation.

Currently, the 33kV generation is fed into the 33kV bus at Halfway Bush via three 33kV transmission lines. Under this proposal, the Waipori line B would be replaced by a single circuit 110kV line, while leaving the A and C lines in service, providing transmission capacity for Waipori generation into Dunedin.

The existing Grid Exit Point at Berwick will be disestablished and the section of 110kV line from Station 4 to the Berwick GXP will be disconnected and have bolted earths applied. The remaining 110kV line will transport the generation from Stations 3 and 4 back up to Station 2A.

Specifically, the following changes are considered:

- A 60MVA 110/33kV interconnecting transformer at Waipori with typical values for impedance (12.5%);
- A single circuit 110kV line strung in Phosphorus conductor;
- Two Waipori 2A generators connected to the 110kV bus;
- 33kV Waipori A and C lines left in service from Waipori to Halfway Bush; and
- Disestablishment of the existing 110kV connection to Transpower's Berwick Substation.

This project will need to be carried out in close cooperation with Aurora Energy, as much of the line work will involve changes to their assets. On completion of construction the line will be gifted to Aurora and operated by them or their agent. Drawings in Appendix A shows the existing and proposed concepts.

4 Costs

The total expenditure for the project is estimated at \$18.7M. This expenditure is broken down as per the table below.

Capital Costs	
Item	Sum
Substation Equipment/Work	\$4,257k
110kV Line	\$12,147k
Underground Cable	\$1,415k
Survey Fees	\$255k
Scrap Recovery	-\$401k
Resource Consent	\$10k
Easement & Investigation(s)	\$1,000k
Total Capital Cost	\$18,683k

4.1 Substation Equipment/Work

The total cost for the above substation work is estimated at \$4.257M.

4.1.1 Waipori Substation - \$3,196k

The proposal at Waipori is for TrustPower to install a new 110/33kV transformer at the Waipori 2A station. The proposed 110kV line route (line B) emanates from this station. The existing and proposed configuration is shown in Appendix A.

The costs at the Waipori Substation are given below. There is sufficient space at in the existing switch yard at 2A station to accommodate the new works with spare capacity in the overhead gantry for the disconnectors for the new line and transformer connections. There will be some minor civil works for this proposal.

The prices provided in the tables include design and installation costs.

(Note: All costs indicated in the following tables are in thousands of dollars \$000's)

	Qty	Cost	Total
110 kV Equipment Waipori			\$928
Circuit Breakers	2	\$155	\$310
Disconnectors	4	\$35	\$139
VT's-3 phase single winding	1	\$63	\$63
CT's	1	\$73	\$73
Bus Extension	2	\$51	\$102
Foundation for 110 kV CBs including Stands	2	\$29	\$57
Foundation for 110 kV DIS including Stands	4	\$15	\$60
Foundation for 3 phase set CTs	1	\$9	\$9
Foundation for 3 phase set VTs	1	\$9	\$9
Protection Relays	1	\$105	\$105

	Qty	Cost	Total
33 kV Equipment Waipori			\$241
Disconnectors	2	\$26	\$52
Circuit Breakers	1	\$141	\$141
Foundation work for 33 kV GIS CB	1	\$12	\$12
CT's	1	\$29	\$29
Foundations for 3 phase set CT	1	\$7	\$7

	Qty	Cost	Total
Transformers			\$1,979
110/33 kV 60MVA	1	\$1,872	\$1,872
Transformer Protection	1	\$107	\$107

Waipori Site	Qty	Cost	Total
Civil Works	1	\$48	\$48

4.1.2 Halfway Bush Substation - \$910k

The Project would require a 110kV single line connection at the Halfway Bush Substation with the associated circuit breaker installed as per the current connections. There is a connection point available to the North Western end of the structure. The cost details are provided below. TrustPower intend to complete this work to Transpower standards and hand over ownership to Transpower on completion of commissioning.

	Qty	Cost	Total
110 kV Equipment Halfway Bush			\$862
Circuit Breakers	1	\$156	\$156
Disconnectors	2	\$35	\$70
VT's-3 phase single winding	1	\$64	\$64
CT's	1	\$73	\$73
Bus Extension	2	\$51	\$102
Foundation for 110 kV CBs including Stands	2	\$29	\$57
Foundation for 110 kV DIS including Stands	2	\$15	\$30
Foundation for 3 phase set CTs	1	\$9	\$9
Foundation for 3 phase set VTs	1	\$9	\$9
110kV metering	1	\$240	\$240
Protection Relays	1	\$53	\$53

	Qty	Cost	Total
Civil Works	1	\$48	\$48

4.1.3 Associated Works - \$151k

Associated works include SCADA, control and secondary equipment as detailed below.

	Qty	Cost	Total
SCADA			\$58
database/configuration changes to SCADA	1	\$58	\$58
Secondary Equipment			\$93
Multicore Control Cables from ODJB to relay room	4	\$20	\$82
Comms	1	\$11	\$11

The above costs provide a breakdown of material and installation costs by item. The information below breaks the total cost down into categories.

		Material Totals	Install Subtotals	Sub Total \$000	Design \$000	Management \$000	Project Support Costs	Contractor Overheads	Site Factor \$000	Total \$000
Civil Works		\$22,680	\$61,320	\$84	\$4	\$8	\$1	\$0	\$0	\$97
Waipori	110	\$431,865	\$273,210	\$705	\$42	\$67	\$8	\$0	\$0	\$823
Halfway Bush	110	\$270,480	\$216,615	\$487	\$29	\$46	\$7	\$0	\$0	\$570
	33	\$137,235	\$68,145	\$205	\$12	\$20	\$3	\$0	\$0	\$241
Transformers		\$1,475,414	\$270,652	\$1,746	\$52	\$51	\$23	\$0	\$0	\$1,872
Protection		\$58,530	\$136,570	\$195	\$49	\$19	\$1	\$0	\$0	\$264
SCADA		\$25,620	\$22,890	\$49	\$4	\$5	\$1	\$0	\$0	\$58
Secondary		\$22,050	\$43,260	\$65	\$10	\$6	\$1	\$0	\$0	\$82
Comms		\$8,400	\$0	\$8	\$1	\$1	\$0	\$0	\$0	\$11
Metering		\$53,188	\$124,106	\$177	\$44	\$17	\$1	\$0	\$1	\$240
Total		\$2,505,462	\$1,216,768	\$3,722	\$248	\$238	\$46	\$2	\$1	\$4,257

4.2 New 110kV Line (including underground cable)

The Project would require replacing one of the existing 33kV lines to Halfway Bush with a new, 110kV, single circuit, concrete pole line, using Phosphorous AAAC/1120 conductor with a thermal rating of 145 MVA. The final 1.15km of line into the Halfway Bush substation will be run as underground cable to assist with access and alleviate any resource consent issues. The cost details are provided below.

Note on costs: The information contained in both 110kV Overhead Transmission Line and 110kV Underground Cable cost tables are summaries of more detailed spread sheets. These spread sheet contain buy prices and mark up's and other commercially confidential information. The total price indicated is that which the project will deliver on.

4.2.1 Overhead 110kV Line Works - \$12,147k

Provision has been made for labour to remove B line existing conductor and poles along with required machinery of \$90,750. Conductor removed from poles at a rate of 32 poles per day and poles removed at a rate of 20 poles per day. Machinery costs included within Hiab Trucks breakdown.

The first 13 km of the line from Station 2A to Berwick is on private land. The existing lines are owned by TrustPower and are covered with easements that allow access for maintenance and other work as required, including line rebuilds up to 110kV.

This section of the line is on hill country with limited access so helicopters will be used extensively in this portion of the rebuild.

Proposed construction for Waipori is 17m, 24kN concrete "I" poles with composite post insulators and welded RHS "Tee" crossarm arrangements. Phosphorus AAAC conductor will be used, rated between 500 and 1000Amps dependent on ambient conditions, 26.3mm diameter, at a maximum operating temperature of 75°C with tension limited to 16% UTS. The maximum height of the line is 15m which is less than the 20m allowed in the utility permitted activities of the District Plans.

The majority of the remainder of line route is flat road reserve which will present no major issues in terms of access or traffic management.

110kV Overhead Transmission Line	Estimate	Qty/km	Quantity	Prize NZ
Conductor Phosphorus AAAC/1120	\$13.20	3000	43.39	\$1,761,200
Insulator Post NZI ALP33/920	\$200.00	36	43.39	\$320,218
Insulator Terminating "Verilite SML 70kN	\$185.00	6	43.39	\$49,367
Poles Stresscrete 17M	\$1,862.00	10	43.39	\$828,120
Poles Hardwood 21M	\$5,320.00	2	43.39	\$473,211
Crossarms 2.7M Spotted Gum 100x100 treated	\$200.00	12	43.39	\$106,739
Site Works	\$500.00	12	43.39	\$266,849
Utilites	\$1.50	18000	4	\$110,700
Cranes	\$350.00	500	2	\$358,750
Helicopter	\$1,500.00	1.5	43.39	\$100,068
Hiab Trucks	\$2.50	15152	4	\$155,309
Excavator 20T	\$250.00	120	2	\$61,500
Excavator 3T	\$150.00	120	2	\$36,900
Project Manager	\$175.00	960	1	\$172,200
Process Engineer	\$155.00	360	1	\$57,195
Mechanical Engineer	\$155.00	360	1	\$57,195
Electrical Engineer	\$155.00	360	1	\$57,195
Supervisor	\$100.00	600	1	\$61,500
Line Mechanic Wire Run	\$75.00	28000	1	\$2,152,500
Line Mechanic Poles	\$75.00	45000	1	\$3,459,375
Labour - Removal	\$50.00	1815	1	\$90,750
Labour - Erection	\$50.00	4185	1	\$209,250
Sub Total				\$10,946,091
Performance Bond	\$5,000.00	1	43.39	\$222,374
Insurance	\$2,000.00	1	43.39	\$88,950
Freight	\$5,000.00	1	43.39	\$222,374
Contract Design and Management	\$6,000.00	1	43.39	\$266,849
Allowance for inclement weather 10%	\$1,800.00	5	43.39	\$400,273
Total Overhead Works				\$12,146,911

The overhead line costs are comparable with recently completed projects of a similar nature and have a high degree of confidence from the proponent.

A recently completed 110kV line in Taranaki over rough terrain requiring a significant number of tie/stay poles was delivered for between \$310k to \$345k/km. The costs presented here deliver the line at \$280k/km. If say an additional 15% is added for rough terrain and tie/stay poles the price comes in at \$322k/km.

The estimate for the line works presented above is believed to be fair and reasonable, but above all achievable.

4.2.2 Underground 110kV Cable Works - \$1,415k

The underground route is well defined running in utility corridor. The cable route crosses one main road before entering into Halfway Bush Substation. Coordination will be required with Transpower for access route into appropriate bay within the Substation.

Access into the 110kV bay at Halfway Bush is via a tortuous route and an additional allowance had been made for this within the scope.

Proposal includes use of 400mm² single core copper XLPE CAS 110kV rated cable with current capacity of ~450A buried. An allowance of \$200k has been included for cable terminations and jointing.

110kV Underground Cable	Qty	Rate	Total
Site Establishment/Disestablishment	1	\$7,150.00	\$7,150
Project Management	2	\$52,800.00	\$105,600
Project Supervisor	1	\$52,800.00	\$52,800
Traffic Management	4	\$2,090.00	\$8,360
Environmental Control	4	\$550.00	\$2,200
			\$176,110
Purchase 110kV Cable and fittings	3450	\$178.17	\$614,700
Install of 110kV Cable from CTS site to cable term.	1	\$120,432.00	\$120,432
Service Locations	1	\$5,000.00	\$5,000
As Built Drawings	1	\$4,500.00	\$4,500
Bulk cut to top of cable backfill (1.2mx2.8m)	1150	\$31.63	\$36,375
Cut cable trench (0.5x0.5m)	1150	\$6.99	\$8,039
100mm cable bedding TR 0.9 ex allied	1150	\$223.30	\$256,795
Place tensar geogrid to trench subgrade	1150	\$5.50	\$6,325
Ducting for earth, cable and lay	1150	\$7.92	\$9,108
Magslab and warning tape	3450	\$5.50	\$18,975
Complete cable bedding to 200mm above soffitt	200	\$223.30	\$44,660
Place bedding over cable	1150	\$2.40	\$2,760
Backfill trench	1150	\$49.20	\$56,580
Reinstate 100mm soil to berm	1150	\$8.88	\$10,212
Hydroseed	1150	\$1.62	\$2,430
Pipe pressure testing x6	1	\$4,400.00	\$4,400
Soil testing x6	1	\$10,000.00	\$10,000
Testing backfill	1150	\$24.00	\$27,600
			\$1,238,891
Total Underground Works			\$1,415,001

The underground costs are based on recent submissions by Mitton ElectroNet to Transpower for work at Kaiapoi for 66kV underground works using 110kV cable. This proposal for TrustPower does not require the seismic requirements of Kaiapoi and is a single circuit line so adjustments to the price have been made accordingly.

4.3 Survey Fees

Provision of \$255k has been made for survey work including both overhead and underground works. This includes LIDAR Survey and for professional fees covering surveyors, which is considered adequate.

4.4 Cost Recoveries

The old hard drawn copper recovered from the B line will be sold for scrap as Copper No.2 Scrap rate.

The conductor is of twin-twist construction – 37/0.072Cu, with the second strand being added sometime after the initial construction as the load began to grow. Based on a route length of 44 km, a total conductor length of some 132km is involved. The conductor resistance, provided by Delta, suggests a copper content of 4760kg per 1000yards, meaning that a total of approximately 66 tonnes of scrap copper could be recovered.

The latest buy price for scrap copper has decreased significantly over recent months and presently lies close to \$6.08¹ per kg.

Savings to be crystallised through scrap copper sales are therefore estimated at 66,000 kg x \$6.08 per kg = \$401,280.

¹ Price taken from MetalCorp NZ Ltd website/telephone conversation for Copper No.2 dated 7th May 2013.

4.5 Resource Consents

The present line is covered by easements on private land with the remainder on road reserve. The Clutha and Dunedin City District Plans permit construction of new lines up to 110kV, with poles less than 20m high and the preferred location is within existing utility "corridors".

Visual effects are also considered in the plan and this proposal, while the poles are slightly higher than the existing poles, they will be spaced at almost double the current spacing, reducing pole numbers by up to 50%.

No new Resource Consents are necessary in the proposed upgrade of the line and professional opinion has confirmed this – see Section 9 and Appendix G for further detail. However, council and adjacent neighbours will require to be notified of works as well as traffic management plans are to be provided. An allowance of \$10,000 has been made for this which is considered adequate.

4.6 Easement Costs

The total line length is 44km of which ~36km runs in Road Reserve or Crown land for which TrustPower either holds easements or does not require easements. The balance of the line ~8km runs through private land. This is mainly around Berwick Substation and 3 Mile Hill. At this level of design, no new easements are deemed necessary but in practise there may be cause to deviate the line from its current position, requiring new or adjusted easements.

A general allowance of \$35,000 has been made for easement investigation. In addition a further allowance of \$8/m has been made for land with existing easements and \$86/m for private land/new easements. In total the provision of \$1,000,000 has been made for easement costs. TrustPower considers this a generous allowance to cover any unforeseen effects and expects little of this contingency will be required.

These figures are based on recent works carried out by TrustPower and Electronet Services Limited.

4.7 Operations and Maintenance Costs

The existing 33kV lines are around 100 years old with a mixture of wooden and concrete poles most of which have been replaced over time, and a combination of glass or ceramic insulators resulting in a regular maintenance burden.

This proposal replaces one 33kV line with a new 110kV line and disestablishes the existing 110kV line. It is envisaged the overall maintenance burden will not increase above those already experienced if not result in a slight decrease in maintenance requirement.

4.8 Business Interruption Costs

The existing scheme is either shut down or run at low outputs during the Summer months as lake storage is allowed to build up for the Winter generation season. The execution of the project is considered to have no financial impact on the station in terms of lost revenue from generation.

5 Transmission Losses

Transmission losses for the current system have been calculated at 21.172GWh based on 2011 generation data. Using the same data under the proposed system transmission losses would increase to 21.755GWh, an increase of 583MWh. These additional losses are valued at \$46,640, assuming \$80/MWh, which will be borne by the project.

The 2011 year was Waipori's highest output to date at 309.6GWh, compared with 2012 year producing 298.3GWh with 20.7GWh of losses. TrustPower has therefore used the highest years output to cover the worst case scenario. (All GWh figures include hydro and wind generation.)

5.1 Loss Calculation Methodology

Actual generation data was used to produce load duration curves for energy injected into the 33kV and 110kV networks. A further curve was produced for the combined total of generation, all curves are shown below.

Load flow analysis was used to determine actual loss in transmission lines in incremental steps of generation. Loss tables are shown in Appendix B.

In order to manage the loss calculation in ETAP model, actual loss figures were grouped into larger bands. This gave, for an injected quantity of energy, a loss in terms of megawatts. These results are tabulated and are shown below load duration curves. Some averaging was necessary but this is considered fair and reasonable.

Costing the losses requires the MW to be converted to MWh. This is achieved by allocating actual generation to a band according to the tables below. Once all half hours are allocated an overall loss figure can be established.

The table below is an example of loss calculation for the proposed 110kV transmission line project.

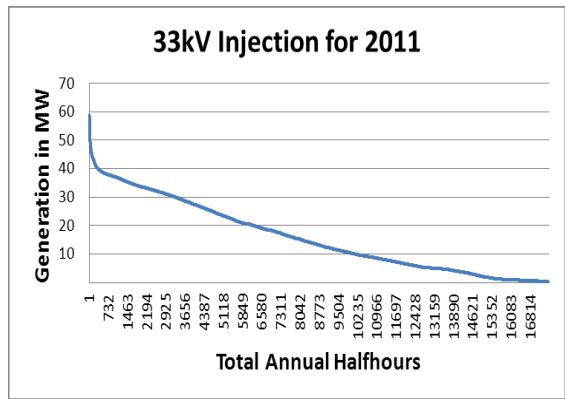
Date	halfhour	Gen onto BWK 110kV	Gen onto 33kV	Total Generation	<10	10-19	19-27	27-38	38-48	48-57	57-65	65-76	76-87	87-97	97-107	107-120	120-127	Losses
40744	20	40326	23880	64.206	0	0	0	0	0	0	2.141	0	0	0	0	0	0	2.141
40744	21	54236	13440	67.676	0	0	0	0	0	0	0	2.536	0	0	0	0	0	2.536
40744	22	53510	11910	65.420	0	0	0	0	0	0	0	2.448	0	0	0	0	0	2.448
40744	23	50176	10332	60.508	0	0	0	0	0	0	2.011	0	0	0	0	0	0	2.011
40744	24	48520	10296	58.816	0	0	0	0	0	0	1.951	0	0	0	0	0	0	1.951
40744	25	37182	11856	49.038	0	0	0	0	0	1.484	0	0	0	0	0	0	0	1.484
40744	26	35502	10566	46.068	0	0	0	0	1.369	0	0	0	0	0	0	0	0	1.369
40744	27	37170	18546	55.716	0	0	0	0	0	1.696	0	0	0	0	0	0	0	1.696

The above process was completed for 33kV and 110kV individually and then the proposed solution.

5.2 Current Situation

5.2.1 33kV System

Approximately half the generation at Waipori is injected into the 33kV circuits at Waipori Station 2. The graph below shows the load duration curve in megawatts (MW) for the 2011, 33kV injection.



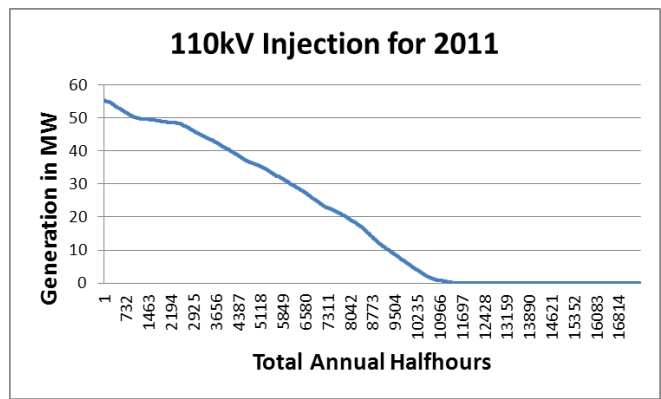
The table shows the steps (bands) for which calculations were carried out and the average loss figure for each band.

Step	Injection MW	Ave MW Loss in band	Duration in band hours	Generation in MW	Losses in MWh
1	70.00	16.80		65-70	0
2	65.00	13.77		60-65	0
3	60.00	11.47	5.5	56-60	123
4	55.00	9.05	7	51-55	127
5	50.00	7.18	25	46-50	406
6	45.00	5.89	88.5	41-45	1160
7	40.00	4.55	511.5	36-40	4482
8	35.00	3.44	835	31-35	4726
9	30.00	2.52	733	26-30	2747
10	25.00	1.77	699.5	21-25	2127
11	20.00	1.20	949.5	16-20	1587
12	15.00	0.74	4903.5	0-15	2715
			(8758hrs)	Total	20201

The total losses on the 33kV system for 2011 were 20.201GWh. (Includes approx 37 days with no injection into 33kV network)

5.2.2 110kV System

The remaining half of the generation at Waipori is injected into the 110kV circuits at Waipori Station 2. The graph below shows the load duration curve in megawatts for the 2011, 110kV injection.



The table shows the steps (bands) for which calculations were carried out and the average loss figure for each band.

Step	Injection MW	Ave MW Loss in band	Duration in band hours	Generation in MW	Losses in MWh
				60-65	0
1	60.00	0.484	0	56-60	1
2	55.00	0.402	414	51-55	9
3	50.00	0.327	1056	46-50	54
4	45.00	0.261	510	41-45	183
5	40.00	0.204	494	36-40	142
6	35.00	0.152	496.5	31-35	203
7	30.00	0.108	418	26-30	186
8	25.00	0.072	469	21-25	76
9	20.00	0.043	406	16-20	55
10	15.00	0.023	4491.5	0-15	63
			(8755hrs)	Total	971

The total losses on the 110kV system for 2011 were 0.971GWh. (Includes approx 130 days with no injection into 110kV network)

5.2.3 Total Current Losses

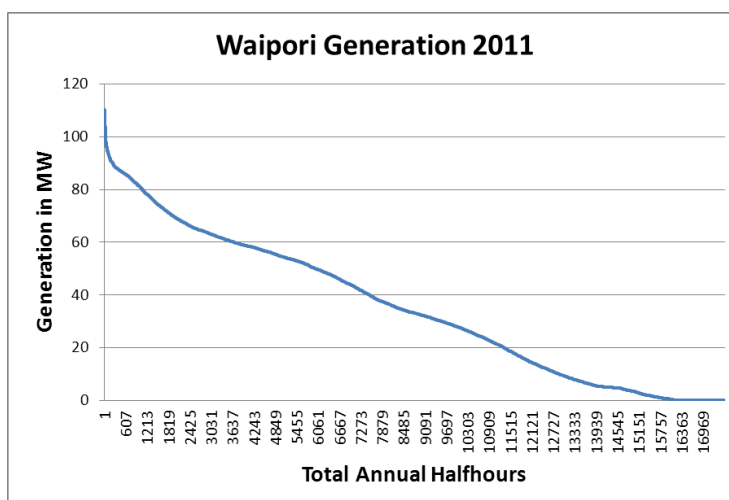
The total current losses, for 2011, are the sum of the two sets of losses.

33kV losses	20.201GWh
110kV losses	0.971GWh
Total current losses	21.172GWh

(For comparison losses for 2012 were 20.723GWh)

5.3 Losses on Proposed 33 and 110kV system

The same process for loss calculation was carried out for the proposed 110kV system. Combined generation figures were used for the load duration curve. Again 2011 generation data was used. The graph below shows the load duration curve in MW.



The table shows the steps (bands) for which calculations were carried out and the average loss figure for each band.

Step	Injection MW	Ave MW Loss in band	Duration in band hours	Generation in MW	Losses in MWh
1	127	8.01		120-127	0
2	120	7.07	8	107-120	47
3	107	5.80	70.5	97-107	196
4	97	4.70	377.5	87-97	1839
5	87	3.96	1015	76-87	2861
6	76	3.08	650.5	65-76	3253
7	65	2.44	484.5	57-65	3852
8	57	1.88	532.5	48-57	2844
9	48	1.46	589	38-48	1887
10	38	1.13	616.5	27-38	2347
11	27	0.76	467	19-27	909
12	19	0.64	586.5	10-19	966
13	10	0.51	3363	<10	754
			(8760hrs)	Total	21755

5.4 Additional Loss Created by the Proposal

The estimated losses for the proposal are 21.755GWh, representing an increase of 0.583GWh over the current estimated losses. These additional losses are valued at \$46,640, assuming \$80/MWh, which will be borne by the project.

6 Revenue

The revenue for the project is derived from the avoided transmission charges, less the additional costs brought about by the project.

Savings are available from avoiding the Berwick Connection and HVDC Charges along with the expected benefits of payment for avoided interconnection connection charges at Halfway Bush as a result of full embedment. Additional costs include the kWh losses along with any additional HVDC injection charges at Halfway Bush.

The table below summarises revenue streams.

Charge	Value (\$'000)
Net Connection Charges	\$218
BWK HVDC Injection	\$2,814
HWB Avoided Interconnection	\$4,548
Total Savings	\$7,580
Less HVDC Charges	-\$1,018
Less Increased Losses	-\$48
Net Annual Benefit	\$6,514

6.1 Connection Charges

6.1.1 Berwick 110kV Substation

As from October 2013, Transpower will require connection charges for their Berwick GXP substation. These charges will be payable if the Project is not in place by October 2013.

6.1.2 Halfway Bush 33kV Substation

These charges will be payable when the Project is commissioned.

If the Project was to proceed, TrustPower would forego the Berwick charges and pay only the Halfway Bush connection charge. Thus, an incremental saving in the Connection Charge of approximately \$217,656 would be realised by TrustPower, as summarised in the table below.

Connection Asset	Charge
Berwick	-\$255,326
Halfway Bush	\$37,670
Total Savings	-\$217,656

6.2 Berwick HVDC Injection Charges

The HVDC charge, levied across all South Island generators, is based upon a flat \$/kW HVDC rate. For the purposes of determining the kW demand on which the charge is based, Transpower define this as being *"the historical anytime maximum injection specified for the substation which is determined by either the average of the 12 highest injections during the period from 1 September to 31 August for the relevant pricing year or the average of the 12*

highest injections during any of the four immediately preceding pricing years, whichever is the highest”.

Waipori’s generation history is provided in the table below.

Peak	2007	2008	2009	2010	2011
1	52500	55044	53226	53320	55546
2	52478	54532	52380	53272	55428
3	52424	54436	51880	53248	55368
4	52418	54050	51748	53200	55368
5	52382	53734	51618	53188	55368
6	51918	53508	51522	53188	55356
7	51828	53388	51308	53182	55356
8	51770	53288	51106	53176	55356
9	51500	53050	51010	53176	55332
10	51144	53046	50748	53170	55332
11	51030	53022	50748	53160	55332
12	50698	52992	50700	53154	55332
Average	51841	53674	51500	53203	55373
Previous four year maximum				53674	

The Historic Anytime Maximum Injection for the Berwick GXP is therefore 55,373kW, given the 2011 average being greater than the previous four years.

The published rate for the 2013 year is \$50.82 per kW.

Transpower’s prudent discount policy and Rule 4 of the EGR, Part G, Section 2, Sub-rule 4.1, supports the fact that the HVDC Charge is fully avoidable if the point of injection is relinquished, provided that the previous injection can be fully embedded in a distributor’s network.

TrustPower already receives Halfway Bush GXP loading information at Waipori through the Aurora Energy SCADA system and can easily apply appropriate measures to limit generation to match load.

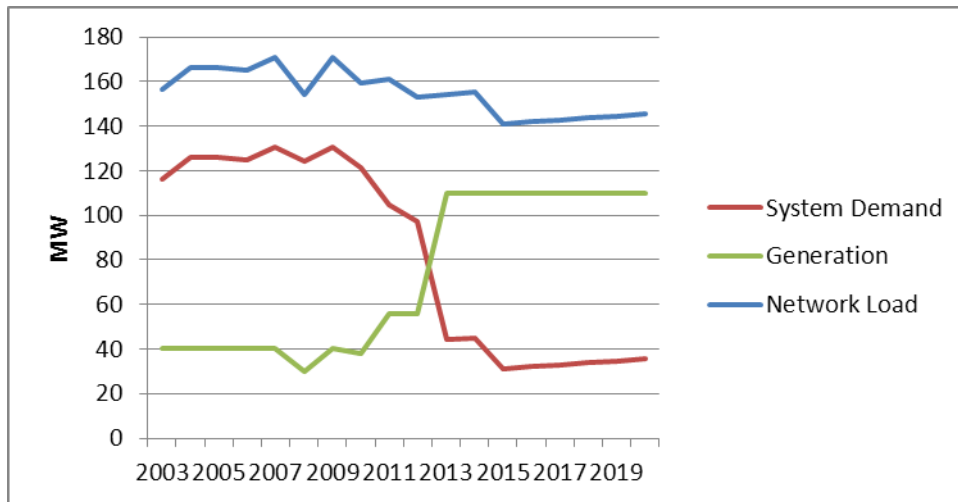
Based on the above, the full benefit of the avoided HVDC Charge should be realised at the time of disconnection.

Accordingly, a net saving \$2,814,056 is anticipated from the avoided HVDC Charge at Berwick.

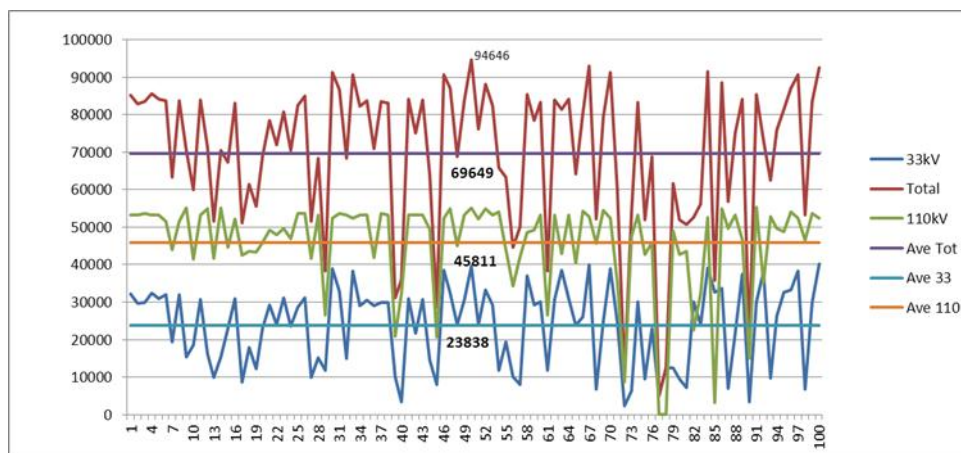
6.3 Halfway Bush Avoided Interconnection Charges

The Project will provide a significant benefit by the reduction of Aurora Energy’s Interconnection Charges at Halfway Bush through the netting of generation and demand.

The Waipori generation is capable of producing 110 MW and this maximum peak output has been achieved in recent times. The graph below shows the relationship between generation and load projections.



The generation that is coincident with the LSI RCPD for 2010/11 is 69,649kW. Details are provided in the graph below.



However, there will be a decrease in maximum peak generation available at Halfway Bush because of the additional losses incurred in transporting the energy to Halfway Bush under WGEP. This will be most pronounced at times of maximum generation when the marginal losses will be at their greatest, and the load flow analysis suggests the 100 peak average generation available for avoiding charges will reduce by 2,709kW. (Appendix D tabulates this data.)

The 2013 interconnection charge is \$99.44 per kilowatt, which implies a saving for TrustPower of \$6,656,513.

If the current agreement between TrustPower and Transpower is not renewed, TrustPower would continue to receive revenue from Aurora Energy under its avoided transmission charge agreement. On the basis of the calculations above, the 2010/11 33kV generation coincident with the 100 highest peak average is 23,838kW, reducing to 23,256 after losses. This would amount to revenue of 23,256 kW x \$90.66/kW = \$2,108,406.

The net additional avoided interconnection charge is therefore \$4,548,107.

6.4 HVDC Injection Charges at Halfway Bush

At certain times of the day, available generation may exceed the local demand at Halfway Bush and TrustPower may elect to inject into the national grid.

TrustPower has provided data on recent injection and this is provided in Appendix G. While predictions are for 17–18MW in the near future, the maximum HAMI target is 20MW.

Accordingly, a cost of $20,000\text{kW} \times \$50.88/\text{kW} = \$1,017,600$ per annum is anticipated from the HVDC Charge at Halfway Bush.

6.5 Increased Losses

The estimated losses for the proposal are 21.755GWh, representing an increase of 0.583GWh. These are valued at \$80/MWh, totalling \$46,640.

7 Economic Feasibility

A Cost-Benefit Analysis has been carried out using CAPEX® Capital Investment Appraisal Software.

This package is specially designed to provide a robust economic analysis of capital projects, using Discounted Cash Flow techniques.

7.1 Assumptions

A number of assumptions are required to provide the seed input data for the financial modelling process and these are detailed below.

- Project Life 50 years
- Project cost \$18.7 million
- Base Revenue \$5.0 million
- Discount Rate² 7%
- Annual Cost Adjustment 1% per annum
- Load Growth 1% per annum
- Asset Lives
 - Lines 60 years
 - Switchgear 40 years
 - Transformers 60 years
 - SCADA, Comms 20 years
- Perpetuity Flat
- O&M Cost Variance No additional O&M costs are projected³.
- Taxation Rate 30%

7.2 Economic Assessment Results

Appendix E contains the detailed outputs produced by the model and the table below summarises the salient indices.

Index	Indices
Payback Period (Undiscounted)	3.37 yrs
Payback period (Discounted)	3.82 yrs
Net Present Value (\$'000)	\$50,975
Accounting Rate of Return	56.8%
Internal Rate of Return	35.8%
Benefits Cost Ratio	3.67

² This is the nominal after tax discount rate chosen as per clause 39 (\$) of the Code for a prudent discount agreement with Transpower. It does not reflect TrustPower's actual Weighted Average Cost of Capital.

³ An older 33kV line already exists, which is to be replaced with a new 110kV line. It is therefore assumed no additional maintenance burden for the change in asset configuration.

8 Technical Feasibility

There are no significant technical issues associated with Project implementation. The technical considerations are summarised below. Proposed system diagrams have been produced to enable appropriate cost estimates to be prepared.

8.1 Loadflow Analysis

A load flow study has been completed to determine the effects of the Project and no detrimental impacts to the transmission system have been identified.

8.2 Waipori Substation

The Project considers a new 110/33kV, 60MVA transformer will be installed at Waipori Station 2A where there is sufficient land for construction. The figure below shows sufficient space in the 110kV yard.



There are no major substation constructability issues.

8.3 Halfway Bush Substation

Halfway Bush is the Transpower owned GXP and consists of 110kV, 33kV and 11kV assets.

The 110kV overhead structure has spare capacity to allow a new connection.



110kV Overhead Gantry with spare capacity

8.4 New 110kV Transmission Line to Halfway Bush

From Waipori 2A Station to Aurora’s Berwick Substation: This section of line is 13.5km in length and consists of 250 poles of both wood and concrete construction. As the lines leave Berwick and before it rises into the hilly ground passing under the 220kV 3 Mile Hill/North Makarewa line. Generally speaking the lower reaches are farm land being grazed, while the upper reaches towards the station is more forestry orientated. Land ownership is a combination of crown and individual land owners. TrustPower owns this section of the line already and has easements in place. Visual impairment is considered to be minimal.



Approximate Line Route

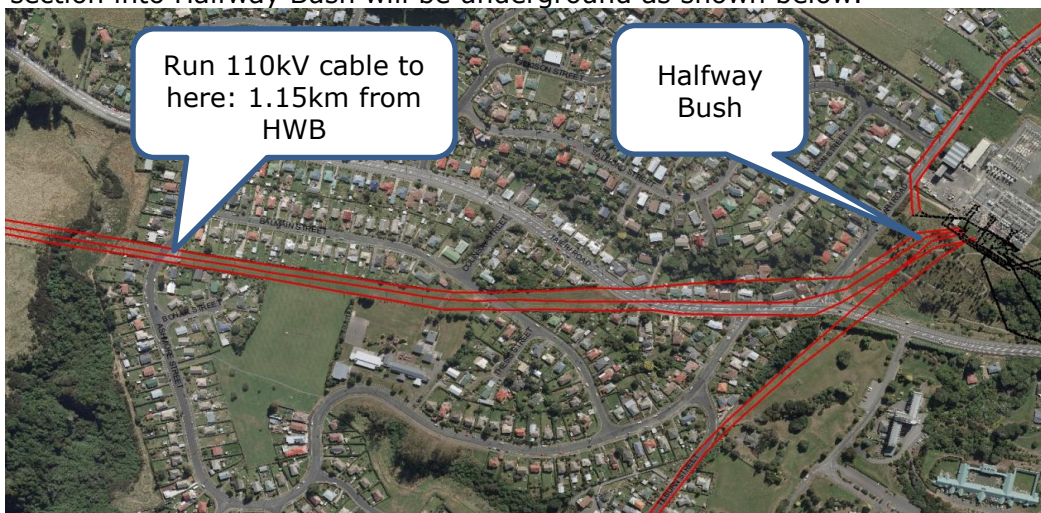
From Aurora's Berwick Substation to 3 Mile Hill: This section of line is ~25km in length consisting of 350 poles located on flat land. For ~22km of the route two of the three lines run in road reserve while the third is inset into private land. Of the two lines on road reserve there is under build on one of the lines supplying residential or small industrial/commercial properties. 'A' and 'B' line are located in road reserve either side of the road, while the 'C' line is located in private land. The lines cut across private land entering into and exiting Outram Substation. There are a couple of tee off's supplying local load.



Figure 11 - 33 kV Subtransmission Lines at Outram

3 Mile Hill to Halfway Bush Substation: This is the shortest section of line at ~6km running across 3 Mile Hill, passing under 220kV transmission line. Around 115 poles are used located mainly on private ground. Running the last 1.15km in underground cable provides both environmental and technical benefits. The existing utility corridor is extremely 'busy' with the existing cables and access into Halfway Bush difficult with respect to achieving required clearances. In addition the visual impact for local residents of the lines in the corridor will be improved by removal of one of the lines.

The final section into Halfway Bush will be underground as shown below.



9 Legal and Environmental Issues

There is no law, regulation or other impediment that would prevent the Proponents achieving total physical embedment of Waipori generation output at the Halfway Bush GXP.

The nature of the Project dictates that legal and contractual matters will necessarily involve Transpower as the owners of the existing transmission infrastructure assets and Aurora Energy as the final transmission customer contracted with Transpower at Halfway Bush.

The following documents are salient when considering Transpower's legal position with respect to the Project:

- Transpower's Statement of Corporate Intent;
- The Electricity Act;
- The Commerce Act;
- Electricity Governance Regulations;
- Electricity Industry Participation Code 2010; and
- Distributed Generation Regulations 2007.

Transpower is a State Owned Enterprise (SOE) and therefore its owner and shareholder is the Government of New Zealand. There is a considerable body of other legislation that impacts on Transpower, including the Health and Safety in Employment Act; however, this has little relevance to the project under consideration.

Transpower's Statement of Corporate Intent lays down the self-imposed framework under which Transpower operates. This includes the intended levels of return it aims to provide to its shareholder.

The Commerce Act is concerned with the abuse of monopoly market positions, particularly when this involves anti-competitive behaviour.

The Electricity Governance Regulations provide the framework by which the industry is regulated, including Transpower, distributors, purchasers and generators.

The Electricity Industry Participation Code (the Code), Part 12, Transport, Schedule 12.4, provides the framework for the Transmission Pricing Methodology.

The Distributed Generation Regulations 2007 provide the framework by which the industry is regulated when generation is connected directly to the local lines network.

The pricing methodology for the development of a case for a prudent discount agreement is contained in the Electricity Industry Participation Code 2010, Schedule 12.4, Prudent Discount Policy clauses 36 to 42 and has been taken into account in preparing this report.

There is no extension of existing sites or development of new sites required and all of the sites are appropriately zoned for their existing uses. Under the Clutha District and Dunedin City Plans, the upgrade of the 33kV Aurora line to 110kV would be considered a new construction and a Permitted Activity in the rural foothills.

Few new easements are likely to be required for the new 110kV line. Easements are not required where the route follows existing road reserves. The first section of the line will cross private land on an existing line route where easements already exist. The land adjacent to the Halfway Bush substation is already crowded with many lines so it is proposed to underground this section of the line.

Landowners alongside the route of the power line will need to be consulted prior to work beginning, especially if land access for construction purposes is required and these will need to be identified at an early stage if the project proceeds.

See Appendix F for excerpts from the Clutha District and Dunedin City Plans and Appendix G for an independent opinion of likely consenting issues involved with the Project.

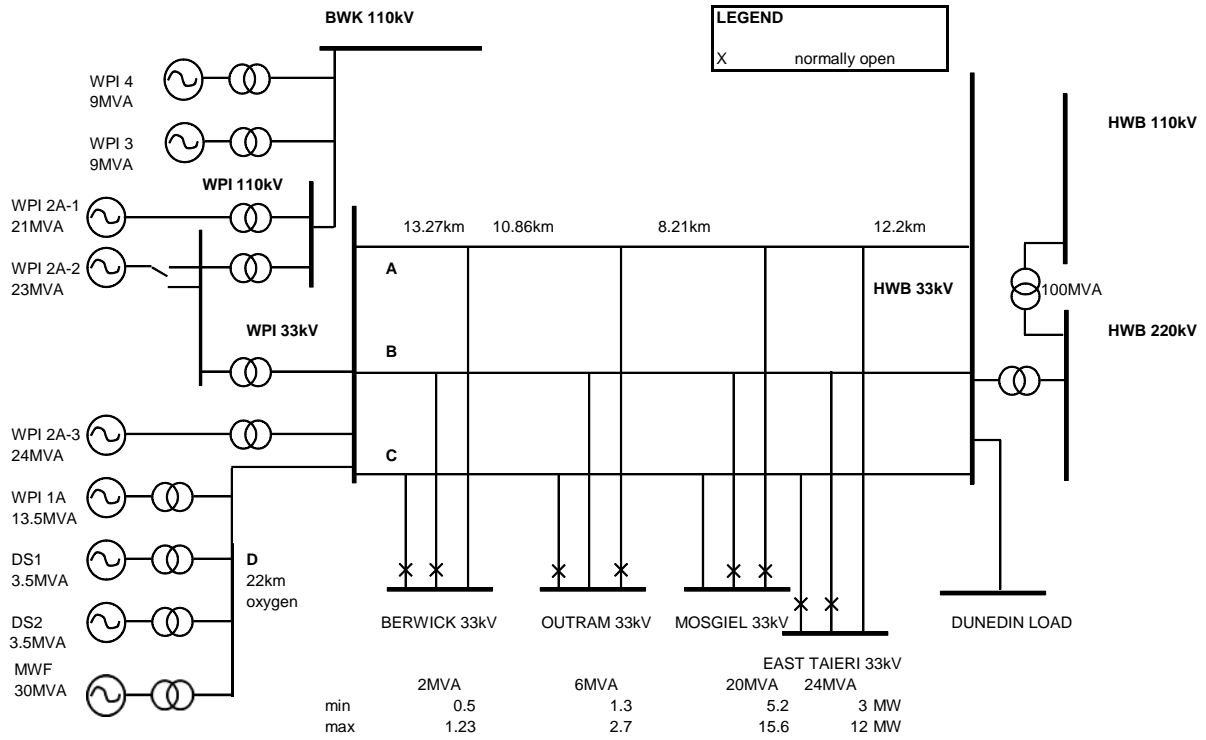
10 Conclusions

This study demonstrates the Project can be built and can be switched over on the designated date. Solid cost estimates are provided and revenues established that deem the Project economically viable. There are no material technical issues and the new line can be established without significant resource consent issues.

It is therefore concluded that TrustPower will proceed with the Project unless an economically equivalent commercial arrangement can be negotiated with Transpower in accordance with the Prudent Discount Arrangements.

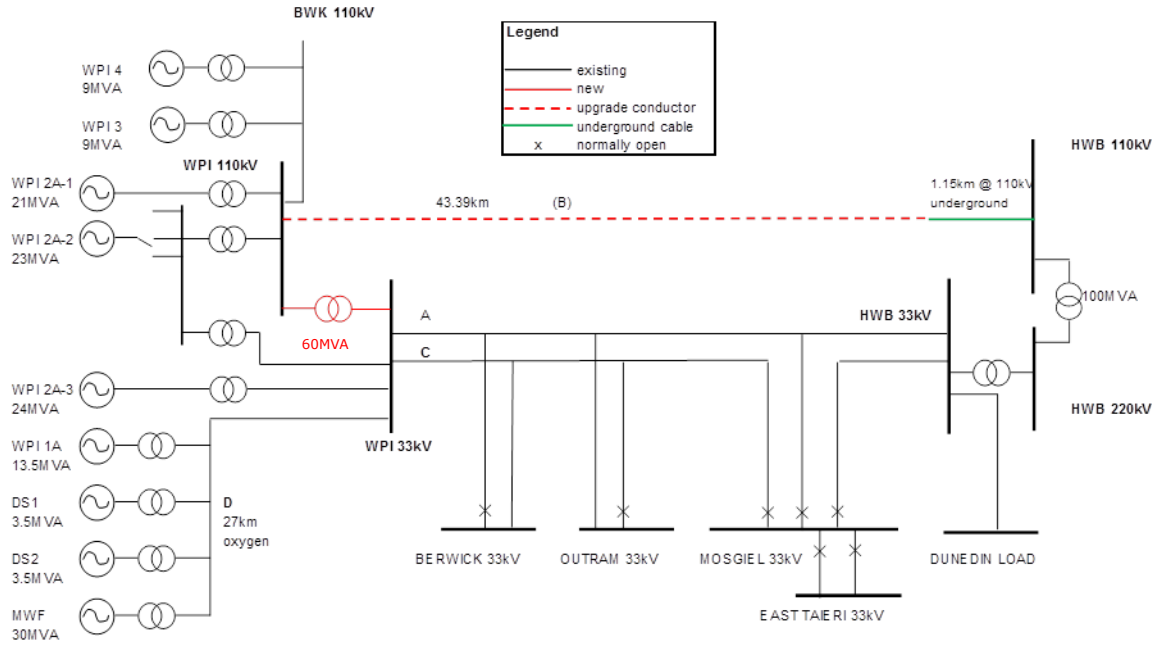
Appendix A – Conceptual Drawings

Current Waipori Configuration

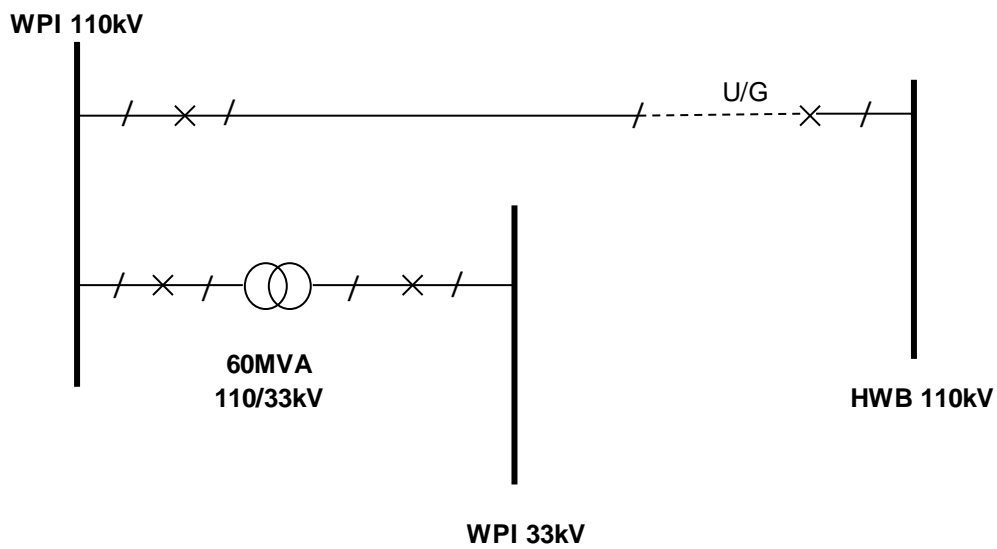


Existing Lines Ratings		
Line	Summer	Winter
A	300A/17MVA	370A/21MVA
B	300A/17MVA	370A/21MVA
C	440A/25MVA	540A/30MVA

Proposed 110kV System Configuration



Proposed Construction



Appendix B – Loss Data Tables

33kV Losses

Total Generation	A Line Waipori 2A - Berwick		B Line Waipori 2A - Berwick		C Line Waipori 2A - Berwick		A Line Berwick - Outram		B Line Berwick - Outram		C Line Berwick - Outram	
	MW	MVA	MW	MVA	MW	MVA	MW	MVA	MW	MVA	MW	MVA
72.3 MVA	2.666 MW	3.468 MVA	2.833 MW	3.686 MVA	2.704 MW	5.125 MVA	2.065 MW	2.686 MVA	2.255 MW	2.933 MVA	2.151 MW	4.077 MVA
70.0 MVA	1.833 MW	2.385 MVA	1.952 MW	2.539 MVA	1.872 MW	3.549 MVA	1.403 MW	1.825 MVA	1.552 MW	2.019 MVA	1.489 MW	2.822 MVA
65.0 MVA	1.513 MW	1.968 MVA	1.610 MW	2.095 MVA	1.549 MW	2.936 MVA	1.152 MW	1.499 MVA	1.281 MW	1.666 MVA	1.232 MW	2.335 MVA
60.0 MVA	1.268 MW	1.650 MVA	1.350 MW	1.757 MVA	1.301 MW	2.466 MVA	0.961 MW	1.250 MVA	1.074 MW	1.397 MVA	1.034 MW	1.961 MVA
55.0 MVA	1.011 MW	1.315 MVA	1.075 MW	1.398 MVA	1.040 MW	1.971 MVA	0.759 MW	0.987 MVA	0.855 MW	1.112 MVA	0.827 MW	1.567 MVA
50.0 MVA	0.809 MW	1.053 MVA	0.859 MW	1.117 MVA	0.834 MW	1.581 MVA	0.603 MW	0.784 MVA	0.683 MW	0.888 MVA	0.663 MW	1.257 MVA
45.0 MVA	0.668 MW	0.869 MVA	0.708 MW	0.921 MVA	0.691 MW	1.310 MVA	0.494 MW	0.643 MVA	0.563 MW	0.733 MVA	0.549 MW	1.041 MVA
40.0 MVA	0.521 MW	0.678 MVA	0.551 MW	0.717 MVA	0.541 MW	1.026 MVA	0.381 MW	0.496 MVA	0.438 MW	0.570 MVA	0.430 MW	0.816 MVA
35.0 MVA	0.398 MW	0.517 MVA	0.418 MW	0.544 MVA	0.414 MW	0.786 MVA	0.286 MW	0.372 MVA	0.333 MW	0.433 MVA	0.330 MW	0.625 MVA
30.0 MVA	0.293 MW	0.382 MVA	0.306 MW	0.399 MVA	0.307 MW	0.582 MVA	0.207 MW	0.269 MVA	0.244 MW	0.317 MVA	0.244 MW	0.463 MVA
25.0 MVA	0.206 MW	0.268 MVA	0.213 MW	0.277 MVA	0.217 MW	0.411 MVA	0.142 MW	0.184 MVA	0.169 MW	0.220 MVA	0.173 MW	0.327 MVA
20.0 MVA	0.139 MW	0.181 MVA	0.141 MW	0.184 MVA	0.147 MW	0.279 MVA	0.092 MW	0.120 MVA	0.112 MW	0.146 MVA	0.117 MW	0.222 MVA
15.0 MVA	0.082 MW	0.107 MVA	0.079 MW	0.103 MVA	0.087 MW	0.165 MVA	0.050 MW	0.066 MVA	0.063 MW	0.082 MVA	0.069 MW	0.131 MVA
10.0 MVA	0.040 MW	0.053 MVA	0.035 MW	0.045 MVA	0.042 MW	0.081 MVA	0.022 MW	0.028 MVA	0.028 MW	0.036 MVA	0.034 MW	0.064 MVA
5.0 MVA	0.015 MW	0.020 MVA	0.008 MW	0.010 MVA	0.015 MW	0.028 MVA	0.006 MW	0.008 MVA	0.006 MW	0.008 MVA	0.012 MW	0.022 MVA
0.0 MVA	0.007 MW	0.010 MVA	0.000 MW	0.000 MVA	0.004 MW	0.008 MVA	0.005 MW	0.007 MVA	0.000 MW	0.000 MVA	0.004 MW	0.007 MVA

A Line Outram - Mosgiel		B Line Outram - Mosgiel		C Line Outram - Mosgiel		A Line Mosgiel - HWB		B Line Mosgiel - HWB		C Line Mosgiel - HWB		MW Loss	
MW	MVA	MW	MVA	MW	MVA	MW	MVA	MW	MVA	MW	MVA	MW	MVA
1.528 MW	1.989 MVA	1.753 MW	2.281 MVA	1.673 MW	3.171 MVA	2.272 MW	2.956 MVA	1.741 MW	2.265 MVA	1.220 MW	2.312 MVA	24.861 MW	36.949 MVA
1.005 MW	1.308 MVA	1.206 MW	1.570 MVA	1.157 MW	2.194 MVA	1.494 MW	1.943 MVA	1.083 MW	1.408 MVA	0.754 MW	1.430 MVA	16.800 MW	24.992 MVA
0.813 MW	1.057 MVA	0.995 MW	1.295 MVA	0.958 MW	1.815 MVA	1.208 MW	1.571 MVA	0.857 MW	1.115 MVA	0.601 MW	1.138 MVA	13.769 MW	20.490 MVA
0.669 MW	0.870 MVA	0.835 MW	1.086 MVA	0.804 MW	1.524 MVA	0.994 MW	1.293 MVA	0.690 MW	0.898 MVA	0.491 MW	0.931 MVA	11.471 MW	17.083 MVA
0.515 MW	0.670 MVA	0.664 MW	0.864 MVA	0.643 MW	1.218 MVA	0.766 MW	0.996 MVA	0.516 MW	0.672 MVA	0.377 MW	0.715 MVA	9.048 MW	13.485 MVA
0.399 MW	0.519 MVA	0.531 MW	0.691 MVA	0.516 MW	0.977 MVA	0.593 MW	0.772 MVA	0.392 MW	0.510 MVA	0.301 MW	0.571 MVA	7.183 MW	10.720 MVA
0.320 MW	0.417 MVA	0.438 MW	0.570 MVA	0.427 MW	0.810 MVA	0.476 MW	0.619 MVA	0.309 MW	0.402 MVA	0.247 MW	0.468 MVA	5.890 MW	8.803 MVA
0.238 MW	0.310 MVA	0.341 MW	0.443 MVA	0.335 MW	0.634 MVA	0.354 MW	0.461 MVA	0.225 MW	0.293 MVA	0.198 MW	0.375 MVA	4.553 MW	6.819 MVA
0.171 MW	0.223 MVA	0.259 MW	0.336 MVA	0.256 MW	0.486 MVA	0.254 MW	0.331 MVA	0.160 MW	0.208 MVA	0.162 MW	0.307 MVA	3.441 MW	5.168 MVA
0.116 MW	0.151 MVA	0.189 MW	0.246 MVA	0.190 MW	0.360 MVA	0.173 MW	0.225 MVA	0.111 MW	0.144 MVA	0.137 MW	0.260 MVA	2.517 MW	3.798 MVA
0.073 MW	0.095 MVA	0.132 MW	0.171 MVA	0.134 MW	0.254 MVA	0.108 MW	0.141 MVA	0.076 MW	0.099 MVA	0.123 MW	0.233 MVA	1.766 MW	2.680 MVA
0.042 MW	0.054 MVA	0.087 MW	0.113 MVA	0.091 MW	0.172 MVA	0.062 MW	0.081 MVA	0.054 MW	0.070 MVA	0.113 MW	0.215 MVA	1.197 MW	1.837 MVA
0.018 MW	0.023 MVA	0.049 MW	0.064 MVA	0.054 MW	0.102 MVA	0.026 MW	0.034 MVA	0.043 MW	0.056 MVA	0.117 MW	0.221 MVA	0.737 MW	1.154 MVA
0.004 MW	0.005 MVA	0.022 MW	0.028 MVA	0.026 MW	0.050 MVA	0.006 MW	0.008 MVA	0.046 MW	0.060 MVA	0.130 MW	0.247 MVA	0.435 MW	0.705 MVA
0.001 MW	0.001 MVA	0.005 MW	0.006 MVA	0.009 MW	0.017 MVA	0.002 MW	0.002 MVA	0.063 MW	0.082 MVA	0.154 MW	0.291 MVA	0.296 MW	0.495 MVA
0.010 MW	0.013 MVA	0.000 MW	0.000 MVA	0.003 MW	0.005 MVA	0.015 MW	0.020 MVA	0.095 MW	0.123 MVA	0.189 MW	0.358 MVA	0.332 MW	0.551 MVA

110kV losses

Generation					Losses							
WPI 2A G1	WPI 2A G2	WPI 3	WPI 4	Total	WPI 2A - WPI 3 Line		WPI 3 - WPI 4 Line		WPI 4 - Berwick Line		Total	
					MW	MVA	MW	MVA	MW	MVA	MW	MVA
23.5 MVA	21.0 MVA	8.1 MVA	8.1 MVA	60.7 MVA	0.029 MW	0.088 MVA	0.141 MW	0.369 MVA	0.322 MW	0.837 MVA	0.492 MW	1.294 MVA
23.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	60.2 MVA	0.029 MW	0.086 MVA	0.138 MW	0.362 MVA	0.317 MW	0.823 MVA	0.484 MW	1.271 MVA
22.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	59.2 MVA	0.027 MW	0.082 MVA	0.133 MW	0.348 MVA	0.306 MW	0.796 MVA	0.466 MW	1.226 MVA
21.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	58.2 MVA	0.026 MW	0.078 MVA	0.128 MW	0.334 MVA	0.296 MW	0.769 MVA	0.450 MW	1.181 MVA
20.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	57.2 MVA	0.025 MW	0.075 MVA	0.123 MW	0.321 MVA	0.286 MW	0.743 MVA	0.434 MW	1.139 MVA
19.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	56.2 MVA	0.024 MW	0.071 MVA	0.118 MW	0.308 MVA	0.276 MW	0.717 MVA	0.418 MW	1.096 MVA
18.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	55.2 MVA	0.023 MW	0.068 MVA	0.113 MW	0.296 MVA	0.266 MW	0.692 MVA	0.402 MW	1.056 MVA
17.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	54.2 MVA	0.021 MW	0.064 MVA	0.108 MW	0.283 MVA	0.257 MW	0.667 MVA	0.386 MW	1.014 MVA
16.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	53.2 MVA	0.020 MW	0.061 MVA	0.104 MW	0.271 MVA	0.247 MW	0.643 MVA	0.371 MW	0.975 MVA
15.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	52.2 MVA	0.019 MW	0.058 MVA	0.099 MW	0.259 MVA	0.238 MW	0.619 MVA	0.356 MW	0.936 MVA
14.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	51.2 MVA	0.018 MW	0.054 MVA	0.095 MW	0.248 MVA	0.229 MW	0.596 MVA	0.342 MW	0.898 MVA
13.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	50.2 MVA	0.017 MW	0.051 MVA	0.090 MW	0.236 MVA	0.220 MW	0.573 MVA	0.327 MW	0.860 MVA
12.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	49.2 MVA	0.016 MW	0.048 MVA	0.086 MW	0.225 MVA	0.212 MW	0.550 MVA	0.314 MW	0.823 MVA
11.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	48.2 MVA	0.015 MW	0.046 MVA	0.082 MW	0.215 MVA	0.203 MW	0.528 MVA	0.300 MW	0.789 MVA
10.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	47.2 MVA	0.014 MW	0.043 MVA	0.078 MW	0.204 MVA	0.195 MW	0.507 MVA	0.287 MW	0.754 MVA
9.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	46.2 MVA	0.013 MW	0.040 MVA	0.074 MW	0.194 MVA	0.187 MW	0.486 MVA	0.274 MW	0.720 MVA
8.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	45.2 MVA	0.012 MW	0.037 MVA	0.070 MW	0.184 MVA	0.179 MW	0.465 MVA	0.261 MW	0.686 MVA
7.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	44.2 MVA	0.012 MW	0.035 MVA	0.067 MW	0.174 MVA	0.171 MW	0.445 MVA	0.250 MW	0.654 MVA
6.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	43.2 MVA	0.011 MW	0.033 MVA	0.063 MW	0.165 MVA	0.164 MW	0.425 MVA	0.238 MW	0.623 MVA
5.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	42.2 MVA	0.010 MW	0.030 MVA	0.059 MW	0.156 MVA	0.156 MW	0.406 MVA	0.225 MW	0.592 MVA
4.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	41.2 MVA	0.009 MW	0.028 MVA	0.056 MW	0.147 MVA	0.149 MW	0.387 MVA	0.214 MW	0.562 MVA
3.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	40.2 MVA	0.009 MW	0.026 MVA	0.053 MW	0.138 MVA	0.142 MW	0.369 MVA	0.204 MW	0.533 MVA
2.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	39.2 MVA	0.008 MW	0.024 MVA	0.050 MW	0.130 MVA	0.135 MW	0.351 MVA	0.193 MW	0.505 MVA
1.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	38.2 MVA	0.007 MW	0.022 MVA	0.046 MW	0.121 MVA	0.128 MW	0.333 MVA	0.181 MW	0.476 MVA
0.0 MVA	21.0 MVA	8.1 MVA	8.1 MVA	37.2 MVA	0.007 MW	0.020 MVA	0.043 MW	0.114 MVA	0.122 MW	0.316 MVA	0.172 MW	0.450 MVA
0.0 MVA	20.0 MVA	8.1 MVA	8.1 MVA	36.2 MVA	0.006 MW	0.018 MVA	0.040 MW	0.106 MVA	0.115 MW	0.299 MVA	0.161 MW	0.423 MVA
0.0 MVA	19.0 MVA	8.1 MVA	8.1 MVA	35.2 MVA	0.005 MW	0.016 MVA	0.038 MW	0.098 MVA	0.109 MW	0.283 MVA	0.152 MW	0.397 MVA
0.0 MVA	18.0 MVA	8.1 MVA	8.1 MVA	34.2 MVA	0.005 MW	0.014 MVA	0.035 MW	0.091 MVA	0.103 MW	0.267 MVA	0.143 MW	0.372 MVA
0.0 MVA	17.0 MVA	8.1 MVA	8.1 MVA	33.2 MVA	0.004 MW	0.013 MVA	0.032 MW	0.084 MVA	0.097 MW	0.252 MVA	0.133 MW	0.349 MVA
0.0 MVA	16.0 MVA	8.1 MVA	8.1 MVA	32.2 MVA	0.004 MW	0.011 MVA	0.030 MW	0.078 MVA	0.091 MW	0.237 MVA	0.125 MW	0.326 MVA
0.0 MVA	15.0 MVA	8.1 MVA	8.1 MVA	31.2 MVA	0.003 MW	0.010 MVA	0.027 MW	0.071 MVA	0.085 MW	0.222 MVA	0.115 MW	0.303 MVA
0.0 MVA	14.0 MVA	8.1 MVA	8.1 MVA	30.2 MVA	0.003 MW	0.009 MVA	0.025 MW	0.065 MVA	0.080 MW	0.208 MVA	0.108 MW	0.282 MVA
0.0 MVA	13.0 MVA	8.1 MVA	8.1 MVA	29.2 MVA	0.003 MW	0.008 MVA	0.023 MW	0.060 MVA	0.075 MW	0.194 MVA	0.101 MW	0.262 MVA
0.0 MVA	12.0 MVA	8.1 MVA	8.1 MVA	28.2 MVA	0.002 MW	0.006 MVA	0.021 MW	0.054 MVA	0.070 MW	0.181 MVA	0.093 MW	0.241 MVA
0.0 MVA	11.0 MVA	8.1 MVA	8.1 MVA	27.2 MVA	0.002 MW	0.005 MVA	0.019 MW	0.049 MVA	0.065 MW	0.169 MVA	0.086 MW	0.223 MVA
0.0 MVA	10.0 MVA	8.1 MVA	8.1 MVA	26.2 MVA	0.001 MW	0.004 MVA	0.017 MW	0.044 MVA	0.060 MW	0.157 MVA	0.078 MW	0.205 MVA
0.0 MVA	9.0 MVA	8.1 MVA	8.1 MVA	25.2 MVA	0.001 MW	0.004 MVA	0.015 MW	0.039 MVA	0.056 MW	0.145 MVA	0.072 MW	0.188 MVA
0.0 MVA	8.0 MVA	8.1 MVA	8.1 MVA	24.2 MVA	0.001 MW	0.003 MVA	0.013 MW	0.035 MVA	0.051 MW	0.134 MVA	0.065 MW	0.172 MVA
0.0 MVA	7.0 MVA	8.1 MVA	8.1 MVA	23.2 MVA	0.001 MW	0.002 MVA	0.012 MW	0.031 MVA	0.047 MW	0.123 MVA	0.060 MW	0.156 MVA
0.0 MVA	6.0 MVA	8.1 MVA	8.1 MVA	22.2 MVA	0.001 MW	0.002 MVA	0.010 MW	0.027 MVA	0.043 MW	0.112 MVA	0.054 MW	0.141 MVA
0.0 MVA	5.0 MVA	8.1 MVA	8.1 MVA	21.2 MVA	0.000 MW	0.001 MVA	0.009 MW	0.023 MVA	0.039 MW	0.103 MVA	0.048 MW	0.127 MVA
0.0 MVA	4.0 MVA	8.1 MVA	8.1 MVA	20.2 MVA	0.000 MW	0.001 MVA	0.007 MW	0.020 MVA	0.036 MW	0.093 MVA	0.043 MW	0.114 MVA
0.0 MVA	3.0 MVA	8.1 MVA	8.1 MVA	19.2 MVA	0.000 MW	0.000 MVA	0.006 MW	0.017 MVA	0.032 MW	0.084 MVA	0.038 MW	0.101 MVA
0.0 MVA	2.0 MVA	8.1 MVA	8.1 MVA	18.2 MVA	0.000 MW	0.000 MVA	0.005 MW	0.014 MVA	0.029 MW	0.076 MVA	0.034 MW	0.090 MVA
0.0 MVA	1.0 MVA	8.1 MVA	8.1 MVA	17.2 MVA	0.000 MW	0.000 MVA	0.004 MW	0.011 MVA	0.026 MW	0.068 MVA	0.030 MW	0.079 MVA
0.0 MVA	0.0 MVA	8.1 MVA	8.1 MVA	16.2 MVA	0.000 MW	0.000 MVA	0.003 MW	0.009 MVA	0.023 MW	0.060 MVA	0.026 MW	0.069 MVA
0.0 MVA	0.0 MVA	8.0 MVA	8.1 MVA	16.1 MVA	0.000 MW	0.000 MVA	0.003 MW	0.009 MVA	0.023 MW	0.059 MVA	0.026 MW	0.068 MVA
0.0 MVA	0.0 MVA	7.0 MVA	8.1 MVA	15.1 MVA	0.000 MW	0.000 MVA	0.003 MW	0.007 MVA	0.020 MW	0.052 MVA	0.023 MW	0.059 MVA
0.0 MVA	0.0 MVA	6.0 MVA	8.1 MVA	14.1 MVA	0.000 MW	0.000 MVA	0.002 MW	0.005 MVA	0.017 MW	0.045 MVA	0.019 MW	0.050 MVA
0.0 MVA	0.0 MVA	5.0 MVA	8.1 MVA	13.1 MVA	0.000 MW	0.000 MVA	0.001 MW	0.003 MVA	0.015 MW	0.039 MVA	0.016 MW	0.042 MVA
0.0 MVA	0.0 MVA	4.0 MVA	8.1 MVA	12.1 MVA	0.000 MW	0.000 MVA	0.001 MW	0.002 MVA	0.013 MW	0.033 MVA	0.014 MW	0.035 MVA
0.0 MVA	0.0 MVA	3.0 MVA	8.1 MVA	11.1 MVA	0.000 MW	0.000 MVA	0.000 MW	0.001 MVA	0.011 MW	0.028 MVA	0.011 MW	0.029 MVA
0.0 MVA	0.0 MVA	2.0 MVA	8.1 MVA	10.1 MVA	0.000 MW	0.000 MVA	0.000 MW	0.001 MVA	0.009 MW	0.023 MVA	0.009 MW	0.024 MVA
0.0 MVA	0.0 MVA	1.0 MVA	8.1 MVA	9.1 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA	0.007 MW	0.019 MVA	0.007 MW	0.019 MVA
0.0 MVA	0.0 MVA	0.0 MVA	8.1 MVA	8.1 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA	0.006 MW	0.015 MVA	0.006 MW	0.015 MVA
0.0 MVA	0.0 MVA	0.0 MVA	8.0 MVA	8.0 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA	0.006 MW	0.015 MVA	0.006 MW	0.015 MVA
0.0 MVA	0.0 MVA	0.0 MVA	7.0 MVA	7.0 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA	0.004 MW	0.011 MVA	0.004 MW	0.011 MVA
0.0 MVA	0.0 MVA	0.0 MVA	6.0 MVA	6.0 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA	0.003 MW	0.008 MVA	0.003 MW	0.008 MVA
0.0 MVA	0.0 MVA	0.0 MVA	5.0 MVA	5.0 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA	0.002 MW	0.006 MVA	0.002 MW	0.006 MVA
0.0 MVA	0.0 MVA	0.0 MVA	4.0 MVA	4.0 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA	0.001 MW	0.004 MVA	0.001 MW	0.004 MVA
0.0 MVA	0.0 MVA	0.0 MVA	3.0 MVA	3.0 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA	0.001 MW	0.002 MVA	0.001 MW	0.002 MVA
0.0 MVA	0.0 MVA	0.0 MVA	2.0 MVA	2.0 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA	0.000 MW	0.001 MVA	0.000 MW	0.001 MVA
0.0 MVA	0.0 MVA	0.0 MVA	1.0 MVA	1.0 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA
0.0 MVA	0.0 MVA	0.0 MVA	0.0 MVA	0.0 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA	0.000 MW	0.000 MVA

Proposed System losses

33 kV A & C Line CBs Closed						
Total Generation	110 kV Generation	33 kV Generation	Tie Transformer	A Line Load	C Line Load	110 KV Line Load
127.20 MVA	60.00 MVA	67.20 MVA	33.50 MVA	13.50 MVA	20.20 MVA	93.50 MVA
120.30 MVA	60.00 MVA	60.30 MVA	28.50 MVA	12.60 MVA	19.20 MVA	88.50 MVA
106.70 MVA	46.50 MVA	60.20 MVA	30.80 MVA	11.50 MVA	17.90 MVA	77.30 MVA
96.70 MVA	46.40 MVA	50.30 MVA	23.70 MVA	10.20 MVA	16.40 MVA	70.10 MVA
86.70 MVA	36.40 MVA	50.30 MVA	25.40 MVA	9.40 MVA	15.50 MVA	61.80 MVA
76.20 MVA	35.80 MVA	40.40 MVA	18.60 MVA	8.00 MVA	13.80 MVA	54.40 MVA
65.10 MVA	24.60 MVA	40.50 MVA	20.60 MVA	7.10 MVA	12.80 MVA	45.20 MVA
56.80 MVA	24.70 MVA	32.10 MVA	14.40 MVA	6.10 MVA	11.60 MVA	39.10 MVA
48.40 MVA	26.20 MVA	22.20 MVA	6.60 MVA	5.30 MVA	10.30 MVA	32.80 MVA
38.20 MVA	15.80 MVA	22.40 MVA	8.50 MVA	4.50 MVA	9.40 MVA	24.30 MVA
26.50 MVA	17.80 MVA	8.70 MVA	-2.10 MVA	3.20 MVA	7.60 MVA	15.70 MVA
18.90 MVA	7.40 MVA	11.50 MVA	2.00 MVA	2.70 MVA	6.80 MVA	9.40 MVA
10.00 MVA	9.50 MVA	0.50 MVA	-6.40 MVA	1.70 MVA	5.20 MVA	3.10 MVA
0.40 MVA	-0.50 MVA	0.90 MVA	-4.90 MVA	1.30 MVA	4.50 MVA	-5.40 MVA

A Line Losses					C Line Losses					110 kV Line Losses			Tie Transfor
WPI2A - Berw	Berwick-Out	Outram-Mo	Mosgiel-HV	Total	WPI2A - B	Berwick-C	Outram-M	Mosgiel-H	Total	Overhead	Cable	Total	Total
0.73 MW	0.58 MW	0.45 MW	0.67 MW	2.42 MW	1.08 MW	0.82 MW	0.58 MW	0.10 MW	2.58 MW	2.88 MW	0.08 MW	2.96 MW	0.06 MW
0.63 MW	0.50 MW	0.39 MW	0.58 MW	2.10 MW	0.96 MW	0.73 MW	0.52 MW	0.08 MW	2.29 MW	2.57 MW	0.07 MW	2.64 MW	0.04 MW
0.53 MW	0.42 MW	0.33 MW	0.48 MW	1.75 MW	0.84 MW	0.64 MW	0.45 MW	0.06 MW	1.99 MW	1.95 MW	0.06 MW	2.00 MW	0.05 MW
0.41 MW	0.33 MW	0.26 MW	0.38 MW	1.37 MW	0.70 MW	0.53 MW	0.37 MW	0.05 MW	1.66 MW	1.60 MW	0.05 MW	1.64 MW	0.03 MW
0.35 MW	0.28 MW	0.22 MW	0.32 MW	1.17 MW	0.63 MW	0.47 MW	0.33 MW	0.05 MW	1.48 MW	1.24 MW	0.04 MW	1.28 MW	0.03 MW
0.26 MW	0.21 MW	0.16 MW	0.24 MW	0.86 MW	0.51 MW	0.38 MW	0.26 MW	0.05 MW	1.20 MW	0.97 MW	0.03 MW	0.99 MW	0.02 MW
0.21 MW	0.16 MW	0.13 MW	0.19 MW	0.69 MW	0.44 MW	0.33 MW	0.22 MW	0.06 MW	1.05 MW	0.66 MW	0.02 MW	0.68 MW	0.02 MW
0.15 MW	0.12 MW	0.09 MW	0.14 MW	0.49 MW	0.35 MW	0.26 MW	0.17 MW	0.09 MW	0.87 MW	0.50 MW	0.01 MW	0.51 MW	0.01 MW
0.11 MW	0.09 MW	0.07 MW	0.10 MW	0.36 MW	0.27 MW	0.19 MW	0.12 MW	0.17 MW	0.75 MW	0.34 MW	0.01 MW	0.35 MW	0.00 MW
0.08 MW	0.06 MW	0.05 MW	0.07 MW	0.26 MW	0.22 MW	0.16 MW	0.10 MW	0.18 MW	0.67 MW	0.19 MW	0.01 MW	0.20 MW	0.00 MW
0.04 MW	0.03 MW	0.02 MW	0.04 MW	0.13 MW	0.14 MW	0.10 MW	0.06 MW	0.24 MW	0.55 MW	0.08 MW	0.00 MW	0.08 MW	0.00 MW
0.03 MW	0.02 MW	0.02 MW	0.03 MW	0.09 MW	0.12 MW	0.08 MW	0.05 MW	0.27 MW	0.52 MW	0.03 MW	0.00 MW	0.03 MW	0.00 MW
0.01 MW	0.01 MW	0.01 MW	0.01 MW	0.04 MW	0.07 MW	0.05 MW	0.02 MW	0.32 MW	0.47 MW	0.01 MW	0.00 MW	0.01 MW	0.00 MW
0.01 MW	0.01 MW	0.00 MW	0.01 MW	0.02 MW	0.05 MW	0.03 MW	0.02 MW	0.34 MW	0.45 MW	0.01 MW	0.00 MW	0.01 MW	0.00 MW

Total loss table

Total Generation	Total Losses
127.20MVA	8.01MW
120.3MVA	7.07MW
106.7MVA	5.80MW
96.7MVA	4.70MW
86.7MVA	3.96MW
76.2MVA	3.08MW
65.1MVA	2.44MW
56.8MVA	1.88MW
48.4MVA	1.46MW
38.2MVA	1.13MW
26.5MVA	0.76MW
18.9MVA	0.64MW
10.0MVA	0.51MW
0.4MVA	0.48MW

Appendix C Revenue

Connection Charges

Waipori

April 2012_30 June 2011 – ID: 6855			0.0221	0.0668	\$1,134	0.0398
Switches	Customer Allocation %	Asset Value \$	Maintenance Charge	Asset Charge	Operating Charge	Injection Charge
0	100	1,142,931.92	\$25,259	\$76,348		\$45,489
4	100	387,504.01	\$8,564	\$25,885	\$1,134	\$15,423
4	100	387,504.01	\$8,564	\$25,885	\$1,134	\$15,423
0	100	0	\$0	\$0		\$0
1	0	0.04	\$0	\$0		\$0
1	0	0.04	\$0	\$0		\$0
0	100	48,322.23	\$1,068	\$3,228		\$1,923
0	100					\$255,326

Halfway Bush

							Rate				
							0.0755	0.0221	\$992		
Recovery							Asset Component	Maintenance Component	Operating Component	Customer Allocation	Connection Charge
Asset	Asset Id	Physical Location	A	M	O	Asset Value	Asset Component	Maintenance Component	Operating Component	Customer Allocation	Connection Charge
Substation	Edgecumbe	HWB	TPM	TPM		1,896,404.86	143,178.57	41,910.55		10.00%	18,508.91
Switchgear	132	HWB	NEA	NEA	NEA	509,625.72		11,262.73	992.00	100.00%	12,254.73
Switchgear	42	HWB	NEA	NEA	NEA	132,564.41		2,929.67	992.00	100.00%	3,921.67
Switchgear	47-48	HWB	NEA	NEA	NEA	21,624.21		477.89	992.00	100.00%	1,469.89
Switchgear	VT1	HWB	NEA	NEA	NEA	49,288.68		1,089.28		100.00%	1,089.28
							Total Connection Charge				37,244.49

Appendix D – Interconnection Charges Data HWB

LSI Rank	Date	Period	Generation kW	Losses kW	LSI Rank	Date	Period	Generation kW	Losses kW
1	16 Aug 2011	27	85294	3.467	50	15 Aug 2011	34	94646	4.330
2	16 Aug 2011	30	82942	3.366	51	19 Aug 2011	16	76260	3.079
3	16 Aug 2011	34	83516	3.391	52	18 Aug 2011	37	88156	4.025
4	16 Aug 2011	31	85660	3.483	53	17 Aug 2011	38	82492	3.347
5	16 Aug 2011	29	84226	3.421	54	17 Aug 2011	19	65932	2.468
6	16 Aug 2011	24	83668	3.397	55	19 Aug 2011	18	63428	2.114
7	18 Aug 2011	18	63428	2.114	56	12 Aug 2011	16	44566	1.324
8	16 Aug 2011	26	83668	3.397	57	18 Aug 2011	15	50112	1.518
9	16 Aug 2011	23	70478	2.645	58	16 Aug 2011	39	85474	3.475
10	19 Aug 2011	21	59938	1.991	59	17 Aug 2011	27	78460	3.173
11	16 Aug 2011	33	83944	3.409	60	18 Aug 2011	26	83296	3.381
12	17 Aug 2011	24	71234	2.675	61	16 Aug 2011	17	38372	1.138
13	16 Aug 2011	22	51632	1.566	62	17 Aug 2011	36	83944	3.409
14	16 Aug 2011	28	70478	2.645	63	15 Aug 2011	36	81444	3.301
15	19 Aug 2011	20	67426	2.526	64	17 Aug 2011	40	84226	3.421
16	16 Aug 2011	35	83124	3.374	65	21 Jul 2011	36	64206	2.141
17	17 Aug 2011	25	51206	1.553	66	19 Aug 2011	39	80404	3.257
18	18 Aug 2011	22	61338	2.040	67	16 Aug 2011	40	92948	4.250
19	16 Aug 2011	25	55466	1.688	68	11 Aug 2011	19	52244	1.586
20	18 Aug 2011	16	68826	2.581	69	08 Jun 2011	36	79410	3.214
21	16 Aug 2011	37	78460	3.173	70	17 Aug 2011	16	91344	4.175
22	19 Aug 2011	17	71996	2.704	71	19 Aug 2011	40	59566	1.978
23	19 Aug 2011	22	80888	3.278	72	4/05/11	36	10980	0.550
24	18 Aug 2011	21	70552	2.648	73	18 Aug 2011	27	53838	1.636
25	18 Aug 2011	19	82434	3.344	74	18 Aug 2011	40	83296	3.381
26	18 Aug 2011	17	84936	3.452	75	18 Aug 2011	36	52038	1.579
27	16 Aug 2011	36	51632	1.566	76	19 Aug 2011	24	68826	2.581
28	17 Aug 2011	26	68314	2.561	77	09 Jun 2011	36	4974	0.253
29	15 Aug 2011	33	38372	1.138	78	21 Jun 2011	34	12390	0.610
30	16 Aug 2011	20	91218	4.169	79	17 Aug 2011	42	61572	2.048
31	18 Aug 2011	20	86616	3.524	80	18 Aug 2011	41	52038	1.579
32	16 Aug 2011	32	68290	2.560	81	18 Aug 2011	38	50712	1.537
33	16 Aug 2011	21	90624	4.141	82	15 Aug 2011	35	52564	1.596
34	17 Aug 2011	23	82312	3.339	83	11 Aug 2011	16	56084	1.707
35	17 Aug 2011	21	83734	3.400	84	16 Aug 2011	19	91618	4.188
36	19 Aug 2011	37	70926	2.663	85	15 Aug 2011	32	35802	1.030
37	17 Aug 2011	20	83516	3.391	86	19 Aug 2011	15	88492	4.040
38	17 Aug 2011	22	83038	3.370	87	11 Aug 2011	37	56742	1.728
39	19 Aug 2011	19	31054	0.892	88	17 Aug 2011	39	75064	2.824
40	11 Aug 2011	18	35898	1.033	89	16 Aug 2011	16	84132	3.417
41	17 Aug 2011	18	84118	3.416	90	3/05/11	36	18360	0.863
42	16 Aug 2011	41	75064	2.824	91	15 Aug 2011	28	85476	3.475
43	17 Aug 2011	17	83944	3.409	92	16 Aug 2011	42	73300	2.755
44	19 Aug 2011	38	63934	2.132	93	18 Aug 2011	42	62540	2.082
45	19 Aug 2011	23	28716	0.824	94	19 Aug 2011	41	75932	2.857
46	16 Aug 2011	38	90756	4.147	95	19 Jul 2011	36	81434	3.301
47	18 Aug 2011	23	87178	3.979	96	18 Jul 2011	36	87124	3.976
48	11 Aug 2011	17	68888	2.583	97	17 Aug 2011	37	90624	4.141
49	17 Aug 2011	35	83734	3.400	98	11/08/11	36	53274	1.618
					99	18/08/11	34	83516	3.391
					100	17 Aug 2011	41	92550	4.232
					AVERAGE			69,649	2,709

Appendix E – Discounted Cashflow Analysis

A Cost-Benefit Analysis has been carried out using CAPEX® Capital Investment Appraisal Software. The results are provided below:

PROJECT DESCRIPTION: Waipori Generation Embedment Project																						
Consider entering future years' must-do capital expenditure estimates for this major project																						
CAPITAL INVESTMENT WORKSHEET																						
Project	\$000																				\$000	
Start Date	(Enter as mm/yyyy)																				TOTAL	
(Enter Year-End Capital Investment values.)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
05/2013	05/2014	05/2015	05/2016	05/2017	05/2018	05/2019	05/2020	05/2021	05/2022	05/2023	05/2024	05/2025	05/2026	05/2027	05/2028	05/2029	05/2030	05/2031	05/2032	05/2033		
Existing Assets:																						
New Assets:																						
Transformer	1,872																					1,872
Buildings	260																					260
Switchgear	1,071																					1,071
Lines	14,907																					14,907
Control and Protection	956																					956
	0		0	0																		
Include these costs in above amounts where applicable:																						
Capitalised Interest	49																					49
Checklist of other capex items																						
In-house labour costs																						
Less Disposals at start																						
Opening Working Capital																						
= TOTAL CAPITAL COST	19,115																					19,115
Working capital increases																						
Deduct Residual values																						
Total Cash Outflow	19,115																					19,115
ENTER PROJECT LIFE, COST OF CAPITAL AND TAX RATE																						
PROJECT LIFE	50 YEARS			COST OF CAPITAL	7.0%			TAXATION RATE	30.0%													
FINANCIAL COSTS AND BENEFITS WORKSHEET																						
Consider taking working capital movements into account																						
First Fiscal Year	\$000																				\$000	
(Enter as YYYY/YYYY)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
2012/2013	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025	2025/2026	2026/2027	2027/2028	2028/2029	2029/2030	2030/2031	2031/2032		
Revenues/Savings																						
HVDC Injection	2,814	2,870	2,928	2,986	3,046	3,107	3,169	3,232	3,297	3,363	3,430	3,499	3,569	3,640	3,713	3,787	3,863	3,940	4,019	4,099		68,373
45.261143 Connection Charge	218	222	227	231	236	241	246	250	255	261	266	271	276	282	288	293	299	305	311	318		5,297
94% Interconnection Charge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
2 Avoided Maintenance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Avoided transmission	4,558	4,649	4,742	4,837	4,934	5,032	5,133	5,236	5,340	5,447	5,556	5,667	5,781	5,896	6,014	6,134	6,257	6,382	6,510	6,640		110,747
Base Data																						
Total Revenues/Savings	7,590	7,742	7,897	8,055	8,216	8,380	8,548	8,719	8,893	9,071	9,252	9,437	9,626	9,818	10,015	10,215	10,419	10,628	10,840	11,057		184,417
(Costs)																						
Losses	48																					48
Injection Charge	1,018																					1,018
Base Data																						
Total Costs excl Depr	1,066																					1,066
E.B.I.T.D.A	6,524	7,742	7,897	8,055	8,216	8,380	8,548	8,719	8,893	9,071	9,252	9,437	9,626	9,818	10,015	10,215	10,419	10,628	10,840	11,057		183,351
Other non-cash adjustments																						
-(Accounting Depr)	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357		-7,135
Accounting Profit/Loss on Disposal																						
E.B.I.T.	6,167	7,385	7,540	7,698	7,859	8,023	8,191	8,362	8,536	8,714	8,895	9,080	9,269	9,462	9,658	9,858	10,063	10,271	10,484	10,700		176,216
Accounting Depreciation	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357		7,135
Accounting Profit/Loss on Disposal																						
Tax Depreciation	-1,675	-1,501	-1,350	-1,220	-1,106	-1,005	-915	-835	-763	-698	-640	-586	-538	-494	-454	-417	-383	-352	-324	-298		-15,553
Taxable Profit	4,849	6,241	6,546	6,835	7,110	7,375	7,633	7,884	8,130	8,373	8,613	8,851	9,088	9,325	9,561	9,798	10,036	10,275	10,516	10,759		167,798
Tax	-1,455	-1,872	-1,964	-2,050	-2,133	-2,213	-2,290	-2,365	-2,439	-2,512	-2,584	-2,655	-2,726	-2,797	-2,868	-2,939	-3,011	-3,083	-3,155	-3,228		-50,339
Tax on Depr. Recovered on sale																						
Add back Tax Depreciation	1,675	1,501	1,350	1,220	1,106	1,005	915	835	763	698	640	586	538	494	454	417	383	352	324	298		15,553
Deduct Accounting Depreciation	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357	-357		-7,135
NOPAT (before interest)	4,712	5,513	5,576	5,647	5,726	5,811	5,901	5,997	6,097	6,202	6,312	6,425	6,543	6,664	6,790	6,919	7,052	7,188	7,329	7,473		125,877
Accounting Depreciation	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357	357		7,135
Cash Inflow	5,069	5,869	5,933	6,004	6,083	6,167	6,258	6,353	6,454	6,559	6,668	6,782	6,900	7,021	7,147	7,276	7,409	7,545	7,686	7,830		133,012
Net Cashflow	-19,115	5,069	5,869	5,933	6,004	6,083	6,167	6,258	6,353	6,454	6,559	6,668	6,782	6,900	7,021	7,147	7,276	7,409	7,545	7,686	7,830	113,897
Cumulative	-19,115	-14,046	-8,176	-2,244	3,761	9,843	16,011	22,268	28,622	35,076	41,635	48,303	55,085	61,985	69,006	76,152	83,428	90,836	98,382	106,067	113,897	227,793
Funds Employed	19,066	18,888	18,531	18,174	17,817	17,461	17,104	16,747	16,390	16,034	15,677	15,320	14,963	14,607	14,250	13,893	13,536	13,179	12,823	12,466	12,109	
EBIT / Total Funds %age	32.7%	39.9%	41.5%	43.2%	45.0%	46.9%	48.9%	51.0%	53.2%	55.6%	58.1%	60.7%	63.5%	66.4%	69.5%	72.8%	76.4%	80.1%	84.1%	88.4%		

ECONOMIC AND FINANCIAL ASSESSMENT:

UNDISCOUNTED PAYBACK 3.37 YEARS

DISCOUNTED PAYBACK PERIOD 3.82 YEARS

NET PRESENT VALUE (\$000) 50,975

INTERNAL RATE OF RETURN 35.8%

ACCOUNTING RATE OF RETURN 56.8%

BENEFITS COST RATIO (BCR) 3.67

EQUIVALENT ANNUAL VALUE (\$000) 0

Appendix F – Extracts from the Clutha and Dunedin City District Plan

Clutha District Plan

3.14.3 OBJECTIVES AND POLICIES

Objective PWN.1

To provide for the development and operation of network utilities within the District while minimising, as far as practicable, the adverse effects those activities can have on the amenity values of the District.

Policy PWN.1

To ensure that the adverse effects public works and network utilities can have on the amenity values of the District, in particular outstanding natural features and landscapes, are avoided, remedied or mitigated.

Explanation

Effects arise from structures built to distribute services such as electricity, water, telecommunication and sewerage reticulation. The most significant effects are the visual impacts associated with electricity and telecommunications transmission and land disturbance due to water, sewerage and stormwater reticulation. In some instances, noise can be generated and there may be localised effects such as flood lighting of sites. There is also a risk to public safety through the potential hazard of falling lines etc. These are the principal effects which the District Plan seeks to control through appropriate policies, rules and assessment criteria.

(Refer [Rules PWN.1](#) to [7](#))

Policy PWN.2

To reduce the adverse visual effects of public works by encouraging the use of network utility "corridors" and the co-siting of telecommunication equipment.

Explanation

The main effect of telecommunication equipment and network utilities such as electricity transmission is the visual impact on the landscape. By co-siting equipment, this effect is centralised and reduced. Not only does this apply to above ground services but it can also apply to below ground services.

Rule PWN.4 Industrial and Rural Resource Areas

(a) Permitted Activities

Except as provided for in [Rule PWN.4\(c\)](#) the following are permitted activities in the Industrial and Rural Resource Areas;

- (i) Telecommunication masts not exceeding 25 metres in height, ancillary structures, antennae, microwave dishes not exceeding 5 metres in diameter.
- (ii) Structures and associated lines for conveyance of electricity not exceeding 20 metres in height

(iii) Substations exceeding 22KV except as provided for in [Rule PWN.4\(c\)](#) provided that where they adjoin or face across a road, any land occupied for residential, commercial, health, educational or recreation activity in which case they shall be considered as a discretionary activity.

Provided that the following standards are complied with;
Dunedin City District Plan

Policy 22.3.3 Explanation

Encourage the grouping of utilities.

Objective: 22.2.2

Method: 22.4.1

To minimise adverse visual effects the Council will encourage, where technically and operationally feasible, the grouping together of new utility structures as an alternative to having utility structures dispersed throughout the environment.

Policy 22.3.4 Explanation

Encourage location of utilities in corridors.

Objective: 22.2.2

Method: 22.4.1

Where utilities are required to have a high frequency of occurrence in the environment, for example pylons, poles and lines for conveying electricity, the Council will encourage the siting of these utilities in corridors, where technically and operationally feasible, to avoid, remedy or mitigate the adverse effects on visual amenity. Often these corridors are most appropriately located along roads.

Rule 22.5.1 Permitted Activities

The construction, operation and upgrading of the following utilities are permitted activities provided that they comply with the conditions in Rule 22.5.2:

(i) Substations.

(ii) Lines and any necessary incidental equipment associated with the transmission and distribution of electricity and with telecommunications.

Rule 22.5.2 Conditions Attaching to Permitted Activities

(i) **Substations permitted by Rule 22.5.1(i):**

Substations that are located above ground shall be:

- (a) No greater than 4 m² in area and 2 m in height if ground mounted; or.
- (b) Mounted on a single pole and no greater than 0.3 m³ in volume.

(ii) **Lines for telecommunication and the conveyance of electricity permitted by Rule 22.5.1(ii):**

(a) Above-ground lines shall not carry a voltage greater than 110 kV or, where there are existing lines on existing support structures which exceed 110 kV, new lines shall not exceed the voltage of the existing lines. The diameter of any above-ground line or bundle of lines shall not exceed 30mm except:

as provided for in Rules 22.5.2(ii)(e)(ii) or

22.5.2(ii)(e)(x) below; or where there are existing electricity transmission lines on existing support structures which exceed a diameter of 30mm, the diameter of any new above-ground electricity transmission line or bundle of lines shall not exceed the diameter of existing lines.

(b) In all zones except Rural and Rural Residential Zones all lines shall be either located underground, connected to existing support structures or connected to structures permitted in Rule 22.5.2(ii)(e) below.

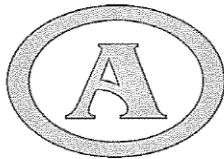
(c) All incidental equipment located above ground shall be:

(i) No greater than 0.4 m³ in volume if ground mounted; or

(ii) Mounted on a single pole and no greater than 0.3 m³ in volume.

(d) Where a line crosses a navigable water body, the line at its lowest point shall have a minimum clearance of 10 m above the level connecting the highest points of the bed of the water body.

Appendix G – Independent Opinion of the Clutha and Dunedin City District Plans



Paterson Pitts Resource Management Limited
Trading As **Anderson & Co**
Advising on Planning & Resource Management

9 May 2013

Mr Mike McSherry
Milton Electronet
12 The Pheasant Tail
Nukuhau
Taupo

Ref:\SQ2590\L080513.doc

Dear Mike

Re: Trust Power: Replacement line at Waipori to Halfway Bush

Thank you for your email of 6 May 2013 concerning the above.

The relevant district plans provisions of Clutha District and Dunedin City have not changed since our earlier advice dated 27 April 2012.

In respect to the conversion of the 33kV line to a 110kV line, our advice is as follows:

- Clutha District Plan

The Clutha District Plan has been amended in respect to the definitions of various parts of the electricity system. There are now separate definitions of "Distribution Network", "Distribution Network", "Distributor", "Electricity Generation Facility", "National Grid", "Network Utility", "Renewable Electricity Generation Activity", "Small and Community-scale Distributed Renewable Electricity Generation", "Substation", "Zone Substation", "Distribution Substation" and "Utility Service line".

The mind boggles as to the purpose of such dissection of the electricity industry but it is apparently the result of your industry's submission to the Clutha District Council.

Thankfully, the Clutha District Council has confirmed that the line is a "Electricity Generation Facility" which is a permitted activity without any conditions (Rule ELG.1(b)).

- Dunedin City District Plan

As noted previously, the existing 33kV line beyond Generation 3 and 4 where it passes through Dunedin City is not designated or shown. However Rule 22.5.1(ii) provides for lines and any necessary incidental equipment as a permitted activity subject to five performance standards. Performance standard 22.5.2(ii)(e) requires that the effects of the activity are the same or similar in character, intensity, and scale. However, it specifically allows reconductoring, replacement of lines, replacement of support structure cross arms, longer and more efficient insulators and pole replacement. Those specific conditions relating to the

Cnr Moray Place & Filleul Street, PO Box 5933 Dunedin 9058 Tel: 03 479 0005

permitted activity provides even greater certainty than the effects of the upgrading will be the same or similar in character and scale.

There is only one condition in Rule 22.5.2(ii) that we are unsure about. This restricts the diameter of any above ground line or bundle of lines to a maximum of 30mm. We assume, but don't know that the individual 110kV line will not exceed 30mm diameter.

Summary

To summarise the above, in our professional opinion, the replacement of the existing 33kV line with a 110kV line within both the Clutha District and the Dunedin City is a permitted activity.

Given the likely capital cost of this work, we recommend that our professional opinion be certified via an application for a Certificate of Compliance from both Councils.

Further to the above, we again note that physical access to carry out the work is not a matter covered by the RMA.

We trust that the above is sufficient for your purpose.

Yours faithfully



Don Anderson
T/A Anderson & Co

Appendix H – Estimated Injection HAMI at Halfway Bush

Capacity Measurement Period: 01 September 2011 to 31 August 2012

Historical Anytime Maximum Injection (HAMI) by Connection Location

Connection Location **HalfwayBush**

1 01 Apr 2009 to 31 Mar 2010			
	Date	Period	Injection
1	27/09/2009	5	0
2	27/09/2009	6	0
3	20/03/2010	47	1408
4	12/05/2009	48	1936.2
5	22/03/2010	15	2454.1
6	29/01/2010	7	3020.4
7	04/04/2009	1	3208.3
8	04/04/2009	9	3297.1
9	29/01/2010	8	3682
10	04/04/2009	10	3883.8
11	06/02/2010	16	3925.8
12	20/03/2010	48	4160.8
Average			0

2 01 Apr 2010 to 31 Mar 2011			
	Date	Period	Injection
1	19/03/2011	38	-6766.2
2	21/03/2011	16	-6425.7
3	18/03/2011	32	-4951.2
4	18/03/2011	37	-4930.2
5	13/03/2011	14	-3971
6	18/03/2011	33	-3490.9
7	18/03/2011	28	-3462.9
8	21/03/2011	15	-3226.3
9	19/03/2011	39	-2678.1
10	18/03/2011	29	-2302.5
11	19/03/2011	40	-2211.3
12	19/03/2011	37	-1974.2
Average			-3699

3 01 Apr 2011 to 31 Mar 2012			
	Date	Period	Injection
1	24/12/2011	3	-17887.1
2	29/12/2011	7	-17706.6
3	29/12/2011	8	-17526.5
4	29/11/2011	6	-17414
5	24/12/2011	2	-17335.6
6	07/10/2011	4	-17254
7	07/02/2012	31	-17156
8	24/12/2011	14	-17022.6
9	29/11/2011	5	-16907.2
10	24/12/2011	29	-16508.7
11	06/10/2011	5	-16443.5
12	08/10/2011	2	-16363.7
Average			-17127

4 01 Sep 2011 to 31 Aug 2012			
	Date	Period	Injection
1	24/12/2011	3	-17887.1
2	29/12/2011	7	-17706.6
3	29/12/2011	8	-17526.5
4	29/11/2011	6	-17414
5	24/12/2011	2	-17335.6
6	07/10/2011	4	-17254
7	07/02/2012	31	-17156
8	24/12/2011	14	-17022.6
9	29/11/2011	5	-16907.2
10	24/12/2011	29	-16508.7
11	06/10/2011	5	-16443.5
12	08/10/2011	2	-16363.7
Average			-17127

5 01 Apr 2012 to 31 Aug 2012			
	Date	Period	Injection
1	09/04/2012	7	-10334.9
2	10/04/2012	10	-8813.1
3	09/04/2012	8	-5799.2
4	05/04/2012	48	-5342.7
5	10/04/2012	4	-5089.6
6	10/04/2012	9	-4922.9
7	10/04/2012	3	-4571.8
8	05/04/2012	5	-3148
9	05/04/2012	6	-1537.3
10	05/04/2012	3	-1065.4
11	05/04/2012	8	-1036.9
12	05/04/2012	7	-939.1
Average			-4383

HAMI ■ highest in any of the five periods		
1	01 Apr 2009 to 31 Mar 2010	0
2	01 Apr 2010 to 31 Mar 2011	-3699
3	01 Apr 2011 to 31 Mar 2012	-17127
4	01 Sep 2011 to 31 Aug 2012	-17127
5	01 Apr 2012 to 31 Aug 2012	-4383
HAMI (kW) ■		-17127