



T R A N S P O W E R

NORTH ISLAND GRID UPGRADE PROJECT

AMENDED PROPOSAL

Attachment F

Costing Report

**Cost Breakdowns for the
Four Alternative Projects**

October 2006

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1 Introduction

This report provides a cost breakdown of the four transmission options included in the economic analysis for the Amended Proposal. The four options are as follows:

- Option 1: 220 kV into Pakuranga
- Option 2: 220 kV – 400 kV staged to Pakuranga
- Option 3: 220 kV Augmentation – duplexing of the Otahuhu-Whakamaru A&B lines.
- Option 4: 220 kV Augmentation - duplexing of the Otahuhu-Whakamaru A&B lines using high temperature conductor (HTC)

Notes on the breakdown of costs for this report are provided below.

2 Costing Notes

1. All costs in this report are in 2006 dollars and exclude interest during construction (IDC).

2. Design/Procure/Build

Design/Procure/Build costs include the contractors' project management costs.

3. Investigation

The investigation costs for major lines projects includes preliminary engineering, environmental and property costs associated with establishing a preferred route and preparing designation and/or consent documentation.

4. Property

The property cost for lines comprises the cost of easements, and the property cost for substations comprises the purchase of land, where applicable.

5. Consenting

Consenting costs include all costs incurred from lodgement of consent or Notification of Requirement documents, where applicable, through to achieving the necessary approvals.

6. Project Management

The project management costs include the Transpower internal project management resources as well as Transpower contracted resources such as Owner's Engineer.

The project management costs are calculated as 8% of the Design/procure/build cost.

7. Contingencies

Contingencies have been calculated as a % of Design/procure/build + Project Management costs as follows:

Substations and cables	15% of (Design/procure/build + Project Mgmt)
Lines	24.8% of (Design/procure/build + Project Mgmt)
Ormiston Rd developments	20% of (Design/procure/build + Project Mgmt)

Desktop geotechnical assessment of the Ormiston Rd area indicates geotechnical issues are anticipated but not yet confirmed. Therefore a higher contingency has been applied to cover this uncertainty.

3 Option Costs

Year	Augmentation	Option 1: 220kV to Pakuranga							Total
		Design /Procure/ Build	Cost (\$'000)			Consenting	Contingency		
			Investigation	Property	Proj Mgmt				
2009	350 MVAR Static compensation	7,391	-	-	591	5	1,197	9,185	
2010	Decommission 110kV ARI-PAK Line	4,051	-	-	324	-	656	5,032	
	Drury Switching Station	13,065		4,750	1,045	250	2,117	21,227	
	Drury Switching Station-Lines	1,519			122	-	407	2,047	
	Upgrade OTA-WKM C	3,039		500	243	20	814	4,615	
2012	220kV Line (2 Chukar @ 75C) WKM-ORM	142,204	24,500	55,400	11,376	5,500	38,088	277,068	
	WHN 220 kV Substation	8,525	-	-	682	100	1,381	10,688	
	WKM Subs Work	2,860	-	250	229	5	463	3,807	
	OTA 2011 Subs Work	4,221	-	-	338	-	684	5,242	
	OTA Enabling Work	2,751	-	-	220	-	446	3,417	
	ORM Cable Termination Station	2,627	-	7,100	210	250	568	10,755	
	2x220kV cables ORM-PAK	91,486	-	3,863	7,319	400	14,821	117,888	
	220kV Sub Station at PAK	43,463	-	-	3,477	250	7,041	54,231	
	Shift existing OTA-PAK 110kV circuits to operate at 220kV	506	-	-	41	5	136	688	
	1st PAK-PEN cable	48,517	-	500	3,881	400	7,860	61,159	
	PEN GIS Sub	32,229	-	-	2,578	5	5,221	40,033	
2013	Reconductor ARI-HAM 1&2 to Nitrogen 75C conductor	7,596	1,000	1,065	608	20	2,035	12,324	
	BOB Interconnector	7,616	-	-	609	20	1,234	9,479	
	100 MVAr Static compensation	3,444			275	20	558	4,297	
2017	ORM Civil Works	6,584	-	-	527	-	1,422	8,532	
	100 MVAr Dynamic compensation	20,257			1,621	-	3,282	25,159	
	2nd PAK-PEN cable	48,517	-	500	3,881	400	7,860	61,159	
	PAK Subs Work	5,524	-	-	442	5	895	6,866	

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	PEN Subs Work	2,629	-	-	210	5	426	3,271
2019	100MVAR Static compensation	3,444	-	-	275	5	558	4,282
2021	110kV OTA-WIR cable ; close the WIR bus breaker	28,360	-	-	2,269	-	4,594	35,223
	50% series compensation on the ORM-WKM 1&2 ccts	33,829	-	-	2,706	5	5,480	42,021
	Switching station at ORM - ORM Switching Station	9,624	-	-	770	5	2,079	12,478
	One ORM-OTA 220kV cable	52,985	-	2,810	4,239	400	8,584	69,018
	1st OTA-PEN cable	48,751	-	-	3,900	400	7,898	60,949
	PEN Subs Work	2,629	-	-	210	5	426	3,271
	OTA Subs Work	4,925	-	-	394	5	798	6,122
2022	200 MVAR Static compensation	5,267	-	-	421	-	853	6,541
2024	2nd ORM-OTA Cable	52,098	-	2,810	4,168	400	8,440	67,916
	OTA Subs Work	623	-	-	50	5	101	779
	ORM Subs Work	1,344	-	-	108	5	290	1,747
2026	100 Mvar Static compensation-	3,444			275		558	4,277
	Series current limit reactor - 20 Ohm	15,193			1,215	5	2,461	18,874
2027	100 MVAR Dynamic compensation	20,257	-	-	1,621	5	3,282	25,164
2029	100 MVAR Static compensation	3,444	-	-	275	-	558	4,277
	250 MVAR Static compensation	5,976	-	-	478	-	968	7,422
2031	2nd 220kV Double Circuit between WKM-ORM	133,088	22,500	55,400	10,647	5,500	35,646	262,782
	WHN Subs work	3,532	-	-	283	-	572	4,386
	ORM Subs Work	3,328	-	-	266	5	719	4,318
	1st 220kV cable between SAD-PAK	83,166	-	3,863	6,653	400	13,473	107,555
	PAK Subs Work	487	-	-	39	5	79	610
2032	2nd OTA-PEN cable	48,751	-	-	3,900	400	7,898	60,949
	PEN Subs Work	2,629	-	-	210	5	426	3,271
	OTA Subs Work	1,159	-	-	93	5	188	1,444
2035	250 MVAR Static compensation	5,976	-	-	478	-	968	7,422
2036	PST on ARI-BOB	7,503			600		1,215	9,318
2037	1st cable SAD-OTA Cable	77,685			6,215		12,585	96,485

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	ORM Subs Work	1,833			147	5	396	2,381
	OTA Subs Work	5,342	-	-	427	5	865	6,639
2038	150 MVAR Static compensation	4,457	-	-	357	-	722	5,535
2040	Series Compensate WKM-ORM 3&4 circuits by 50%.	33,829	-	-	2,706	-	5,480	42,016
2042	400 MVAR Static compensation	8,609	-	-	689	5	1,395	10,698

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Year	Augmentation	Option 2: 400 kV Staged to Pakuranga							Total
		Design /Procure/ Build	Investigation	Property	Proj Mgmt	Consenting	Contingency	Cost (\$'000)	
2009	350 MVAR Static compensation	7,313	-	-	585	5	1,185	9,088	
2010	Decommission 110kV ARI-PAK Line	4,009	-	-	321	0	649	4,979	
	Drury Switching Station	12,930		4,750	1,034	250	2,095	21,059	
	Drury Switching Station-Lines	1,503			120		403	2,026	
	Uprate HLE-HAM-WKM section of the OTA-WKM C line to twin Goat @ 80C	3,007		500	241	20	805	4,573	
2012	2x400kV WKM-ORM ccts operated at 220kV	168,580	22,500	80,000	13,486	5500	45,152	335,219	
	WHN 220 kV Substation	8,436	-	-	675	100	1,367	10,578	
	WKM Sub work	2,830	-	250	226	5	459	3,770	
	OTA Enabling Work	2,722	-	-	218	0	441	3,381	
	OTA Subs Work	4,176	-	-	334	5	677	5,192	
	2x220kV ORM-PAK cables	90,529	-	3,863	7,242	400	14,666	116,700	
	Cable Termination at ORM	2,600	-	7,100	208	250	562	10,719	
	220kV substation at PAK	45,880	-	-	3,670	250	7,433	57,233	
	Convert OTA-PAK 110kV ccts to 220kV	501	-	-	40	5	134	680	
	1st PAK-PEN cable	48,010	-	500	3,841	400	7,778	60,529	
	PEN GIS	31,892	-	-	2,551	5	5,166	39,615	
2013	Reconductor ARI-HAM 1&2 to Nitrogen 75C conductor	7,517	1,000	1,065	601	20	2,013	12,217	
2015	BOB Interconnector	7,536	-	-	603	20	1,221	9,380	
	100 MVAr Static compensation	3,408			273		552	4,232	
2017	ORM Civil Works	7,016	-	-	561	0	1,515	9,092	
	100 MVAr Dynamic compensation	20,045			1,604		3,247	24,896	
	2nd PAK-PEN cable	48,010	-	500	3,841	400	7,778	60,529	
	PAK Subs Work	894	-	-	72	5	145	1,115	
	PEN Subs Work	2,602	-	-	208	5	422	3,237	

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2019	100MVAR Static compensation - reactive plan of 25/9	3,408	-	-	273		552	4,232
2021	1x220kV ORM-OTA cable	52,431	-	2,810	4,194	400	8,494	68,329
	ORM Subs Work	10,266	-	-	821	0	2,217	13,305
	2x55% compensation on WKM-ORM ccts	36,783	-	-	2,943	0	5,959	45,684
	Install 110kV OTA-WIR cable - close the WIR bus breaker	28,063	-	-	2,245	0	4,546	34,855
	1x220kV PEN-OTA cable	48,242	-	-	3,859	400	7,815	60,316
	PEN Subs Work	2,602	-	-	208	5	422	3,237
	OTA Subs Work	4,874	-	-	390	5	790	6,058
2022	200 MVAR Static compensation	5,212			417		844	6,473
2023	100 MVAR Dynamic compensation	20,045			1,604		3,247	24,896
	2nd 220kV OTA-ORM cable	51,553		2,810	4,124	400	8,352	67,239
	OTA Subs Work	616			49	5	100	771
	ORM Subs Work	1,330			106		287	1,724
2026	100 Mvar Static compensation	3,408			273		552	4,232
2027	150 MVAR Static compensation - reactive plan of 25/9	4,410	-	-	353	0	714	5,477
2028	Install 20 Ohm reactor on OTA-WKM A&B line	15,034	-	-	1,203	0	2,435	18,672
2029	ORM Civil Works	8,018	-	-	641	0	1,732	10,391
	100 MVAR Static compensation	3,408			273		552	4,232
2030	300 MVAR Dynamic compensation	38,787	-	-	3,103	5	6,284	48,179
2031	150 MVAR Static compensation	4,410	-	-	353	0	714	5,477
	Install cable cooling ORM-PAK cables	6,815	-	-	545	0	1,104	8,465
2033	400kV sub at WKM	86,993	1,000	3,000	6,959	250	14,093	112,295
	400kV sub at ORM	89,267	-	-	7,141	0	19,282	115,690
	2nd PEN-OTA cable	48,242	-	-	3,859	400	7,815	60,316
	PEN Subs Work	2,602	-	-	208	5	422	3,237
	Install cable cooling ORM-OTA cables	6,815			545		1,104	8,465
2037	PST on ARI-BOB	7,424	-	-	594	0	1,203	9,221
2040	300 MVAR Static compensation	6,615	-	-	529	0	1,072	8,216
2042	300 MVAR Static compensation	6,615	-	-	529	0	1,072	8,216

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Option 3: 220 kV Augmentation-duplexing of the Otahuhu-Whakamaru A&B		Cost (\$'000)						
Year	Augmentation	Design /Procure/ Build	Investigation	Property	Proj Mgmt	Consenting	Contingency	Total
2009	300 MVAR Static compensation	6,675	-	-	534	-	1,081	8,290
	100 MVAR Dynamic compensation	20,228	-	-	1,618	-	3,277	25,123
2010	BOB Interconnector	7,605	-	-	608	20	1,232	9,465
	Drury Switching Station	13,047		4,750	1,044	250	2,114	21,204
	Drury Switching Station-Lines	1,517			121		406	2,045
2011	Uprate HLE-HAM-WKM section of OTA-WKM C line to 2xGoat 80C	2,933	-	500	235	20	786	4,473
2012	PAK 220kV sub station	46,692	-	-	3,735	250	7,564	58,242
	Convert existing OTA-PAK 110kV to 220kV	506	-	-	40	5	135	687
	OTA Enabling Work	2,747	-	-	220	-	445	3,412
	OTA Subs Work	3,307	-	-	265	100	536	4,208
	1st PAK-PEN cables	48,447	-	500	3,876	400	7,848	61,071
2014	PEN GIS Sub	32,174	-	-	2,574	5	5,212	39,965
	Duplex OTA-WKM A&B ccts, deviate line from Sth Auckland to PAK.	97,587	3,000	83,134	7,807	4,000	26,138	221,666
	PAK Subs Work	1,805	-	-	144	5	292	2,247
	South Auck Sub	1,535	-	1,100	123	350	249	3,357
	Redoubt Rd - PAK cables	106,351	-	4,000	8,508	400	17,229	136,488
2015	100 MVAR Static compensation	3,439	-	-	275	-	557	4,271
2016	Second PAK-PEN cable	48,447	-	500	3,876	400	7,848	61,071
	PAK Subs Work	5,516	-	-	441	5	894	6,856
	PEN Subs Work	2,674	-	-	214	5	433	3,326
	200 MVAR Static compensation	5,259	-	-	421	5	852	6,537
	Reconductor ARI-HAM 1&c ccts to Nitrogen 75C	7,585	1,000	1,065	607	20	2,032	12,309
2017	Bussing of OTA-WKM A&B lines at HLE	5,709	-	3,100	457	350	925	10,541

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2019	OTA-WIR 110kV Cable	28,319	-	-	2,265	-	4,588	35,172
	110kV ARI-PAK line decommissioned	4,046	-	-	324	-	655	5,025
2020	220kV D/C WKM-ORM line (twin chukar 75C)	141,998	22,500	55,400	11,360	5,500	38,033	274,791
	WKM Subs Work	2,102	-	250	168	5	340	2,865
	2x220kV cables from ORM-PAK	114,647	-	3,863	9,172	400	18,573	146,655
	PAK Subs Work	486	-	-	39	5	79	609
	3rd PAK-PEN cable	48,447	-	500	3,876	400	7,848	61,071
	PEN Subs Work	2,626	-	-	210	5	425	3,266
	Cable transition at ORM	2,624	-	7,100	210	100	567	10,600
2025	200 MVAR Static compensation	5,259	-	-	421	-	852	6,532
	PST on ARI-BOB	7,492	-	-	599	-	1,214	9,305
2027	100 MVAR Static compensation	3,439	-	-	275	-	557	4,271
2029	250 MVAR Static compensation	5,967	-	-	477	-	967	7,411
2031	50% Series Compensation on ORM-WKM 1&2 ccts	33,780	-	-	2,702	5	5,472	41,960
	Switching Station at ORM	12,267	-	-	981	-	2,650	15,898
	1st and 2nd ORM-OTA cables	98,997	-	5,620	7,920	400	16,038	128,974
	OTA Subs work	6,424	-	-	514	5	1,041	7,984
2033	50 MVAR Dynamic compensation	13,350	-	-	1,068	-	2,163	16,581
2035	220kV Double Circuit between WKM-SthAKL	140,582	22,500	55,400	11,247	5,500	37,653	272,882
	WKM Subs Work	2,101	-	-	168	-	340	2,609
	ORM Subs Work	3,463	-	-	277	-	748	4,488
	1st OTA-PEN cable	48,681	-	-	3,894	400	7,886	60,862
	OTA Subs work	5,819	-	-	466	5	943	7,233
	PEN Subs Work	2,626	-	-	210	5	425	3,266
	3rd OTA-Sth Akl cable-	82,933	-	2,810	6,635	400	13,435	106,213
2042	450 MVAR Static compensation	8,597	-	-	688	5	1,393	10,682

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Option 4: 220 kV Augmentation – duplexing of the Otahuhu-Whakamaru A&B lines using high temperature conductor (HTC)		Costs (\$'000)						
Year	Augmentation	Design/ Procure/ Build	Investigation	Property	Proj Mgmt	Consenting	Contingency	Total
2009	250 MVAR Static compensation	6,030	-	-	482	-	977	7,489
	100 MVAR Dynamic compensation	20,228	-	-	1,618	-	3,277	25,123
2010	BOB Interconnector	7,605	-	-	608	20	1,232	9,465
2011	Drury Switching Station	13,047	-	4,750	1,044	250	2,114	21,204
	Drury Switching Station-Lines	1,517			121		406	2,045
	Uprate HLE-HAM-WKM section of OTA-WKM C line to 2xGoat 80C	3,034	-	500	243	20	813	4,610
	150 MVAR Static compensation	4,439	-	-	355	-	719	5,513
2012	PAK 220kV sub station	46,298	-	-	3,704	250	7,500	57,752
	1st PAK-PEN cables	48,447	-	500	3,876	400	7,848	61,071
	Convert existing OTA-PAK 110kV to 220kV	506	-	-	40	5	135	687
	OTA Enabling Work	2,747	-	-	220	-	445	3,412
	OTA Subs Work	3,307	-	-	265	-	536	4,108
2014	OTA_WKM A and B lines- HTC Duplex	261,948	-	83,134	20,956	4,000	70,160	440,198
	SAK Cable transition station	1,535	-	1,100	123	350	249	3,357
	2x220 cable SAK-PAK	106,351	-	4,000	8,508	400	17,229	136,488
2015	Second PAK-PEN cable	48,447	-	500	3,876	400	7,848	61,071
	PAK Subs Work	5,516	-	-	441	-	894	6,851
	PEN Subs Work	2,674	-	-	214	-	433	3,321
2016	Reconductor ARI-HAM 1&c ccts to Nitrogen 75C	7,585	1,000	1,065	607	20	2,032	12,309
	100 MVAR Static compensation	3,480	-	-	278	-	564	4,322
2017	OTA-WKM A and B lines 40% Series Capacitance	37,118	-	-	2,969	185	6,013	46,285
2019	110kV cable from OTA to WIR; Switching station at WIR	28,319	-	-	2,265	-	4,588	35,172
	Reconnect the lines from SAK to OTA; Switching station at SAK	10,360	-	-	829	-	1,678	12,867

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	150 MVAR Static compensation	4,439	-	-	355	-	719	5,513
2021	200 MVAR Static compensation	5,274	-	-	422	-	854	6,551
2022	350 MVAR Static compensation	7,380	-	-	590	-	1,196	9,166
2023	200 MVAR Static compensation	5,274	-	-	422	-	854	6,551
	OTA_WKM C - Duplex HTC	206,253	-	500	16,500	20	55,243	278,516
	OTA_WKM C installed with series capacitance	65,740	-	-	5,259	-	10,650	81,649
	OTA_WKM A and B bussed at HLE	5,709	-	3,100	457	350	925	10,541
	1st Cable from OTA to PEN	48,681	-	-	3,894	400	7,886	60,862
	OTA Subs work	5,819	-	-	466	-	943	7,228
	PEN Subs Work	2,626	-	-	210	-	425	3,261
2025	PST on ARI-BOB	7,492	-	-	599	-	1,214	9,305
2027	450 MVAR Static compensation	8,581	-	-	686	-	1,390	10,657
2028	Decommission ARI_PAK 110kV line	4,046	-	-	324	-	655	5,025
	1 Ohm series reactor on OTA_SAK bonded pair	2,023	-	-	162	-	328	2,512
2029	Construction new 2 duplex Chukar circuits from WKM to ORM	141,998	22,500	55,400	11,360	5,500	38,033	274,791
2030	2nd Cable from OTA to PEN	48,681	-	-	3,894	500	7,886	60,962
2032	Cable transition Station at ORM	2,624	-	7,100	210	250	567	10,750
	New cable from ORM to OTA	52,908	-	2,810	4,233	400	8,571	68,922
	OTA Subs work	5,819	-	-	466	-	943	7,228
	PEN Subs Work	2,626	-	-	210	-	425	3,261
2035	150 MVAR Static compensation	4,439	-	-	355	-	719	5,513
2039	2nd cable from ORM to OTA	52,908	-	2,810	4,233	400	8,571	68,922
	OTA Subs work	5,819	-	-	466	-	943	7,228
	450 MVAR Static compensation	8,581	-	-	686	-	1,390	10,657
	150 MVAR Dynamic compensation	25,285	-	-	2,023	-	4,096	31,403
2040	30% series compensation on ORM_WKM circuits	37,118	-	-	2,969	-	6,013	46,100
	3rd Cable from PAK to PEN	48,447	-	500	3,876	400	7,848	61,071
	PAK Subs Work	5,587	-	-	447	-	905	6,939
	PEN Subs Work	2,659	-	-	213	-	431	3,302

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2041	250 MVAR Dynamic compensation	35,398	-	-	2,832	-	5,735	43,965
	500 MVAR Dynamic compensation	9,102	-	-	728	-	1,475	11,305