2006 Review of 160 MW OCGT Transmission Link Pricing and GT Fixed O&M

FINAL REPORT

- Transmission Line Capex, O&M and OCGT fixed O&M
- 3.0
- 16 October 2006

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Sinclair Knight Merz
ABN 37 001 024 095
369 Ann Street, Brisbane 4000
PO Box 246
Spring Hill QLD 4004 Australia
Tel: +61 7 3244 7100
Fax: +61 7 3244 7301
Web: www.skmconsulting.com

Contents

1. Introduction

As part of the Government of Western Australia's commitment to establishing a wholesale electricity market within the South West Interconnected System (SWIS), an Independent Market Operator has been established to administer and operate the Wholesale Market.

The Wholesale Electricity Market rules require the Independent Market Operator to conduct a review of the Maximum Reserve Capacity Price each year. The Independent Market Operator has asked Sinclair Knight Merz to develop costs, in June 2006 money terms, associated with:

- the capital connection cost for connecting a 160 MW generator to a 330 kV transmission line;
- operation and maintenance (O&M) costs of the transmission line connection; and
- fixed operation and maintenance costs of a 160 MW open cycle gas turbine (OCGT) power station based on a single, 160 MW net output gas turbine.

The Independent Market Operator has further requested that the OCGT fixed O&M costs be evaluated for the following operating regimes:

- 1% and 2% capacity factor;
- 4 hours running per start;
  - 22 starts per annum for a 1 % capacity factor;
  - 44 starts per annum for a 2 % capacity factor;
- no fast starts[1];
- one full time load trip to be assumed per annum.

Given no requirement for fast starts in the specified running regime, industrial gas turbines have been evaluated as being more appropriate than aero-derivative alternatives, given the applicability of industrial gas turbines to the running regime, their lower capital cost and lower O&M costs than aero-derivatives.

[1] Given that there is no balancing market in the SWIS Wholesale Electricity Market and hence the plant will be dispatched with sufficient forward notice to avoid the need for fast starts.

The Independent Market Operator has also asked that transmission line connection tie-line costs be produced for a 2km overhead line running over the following terrain types:

- base case: flat, rural, no road crossings; and
- 50% flat/50% undulating, 50% rural/50% urban, one road crossing per km.

To determine transmission line connection capital and O&M costs and OCGT plant fixed O&M costs, Sinclair Knight Merz has developed a set of indices to reflect and incorporate:

- the flow through of raw material/commodity costs (such as steel, aluminium) on equipment prices in proportion to the material element of equipment prices;
- increased labour rate costs in proportion to the labour element of equipment and installation costs, reflecting the tightening labour market in Western Australia, drawn from a range of sources:
  - Australian Bureau of Statistics (ABS) Labour Price Index (LPI);
  - Industrial Relations Commission – Electrical Contractor Award;
  - Electrical Trade Union of Australia – Employer Agree Rates;

- the increase in equipment manufacturer costs (drawn from price surveys undertaken periodically by Sinclair Knight Merz and most recently undertaken in the first quarter of 2006);
- Rawlinsons Australian Construction Handbook;
- CRU Steel Price Index – Longs Steel; and
- the ABS Consumer Price Index (CPI).

In this report, all costs presented are mean costs, cast in June 2006 money terms and have an approximate ± 10 % variation potential.

2. Transmission Connection Capital Costing

2.1 General Issues and Assumptions

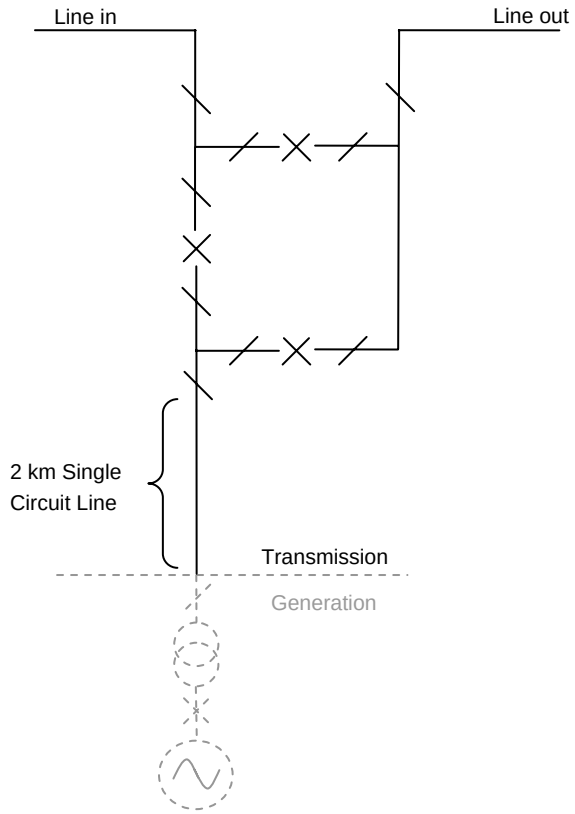
Connection costs have been based on a single 160 MW peaking OCGT generator connected to a 330 kV transmission network via a single overhead 2 km transmission tie-line utilising a turn in / turn out connection configuration. Two terrain types have been evaluated for the tie-line costs as detailed in section 1, repeated here for convenience:

- base case: flat, rural, no road crossings; and
- 50% flat/50% undulating, 50% rural/50% urban, one road crossing per km.

The assumed transmission tie-line MVA rating is 200 MVA (at 0.8 pf). All transmission connection costs have been calculated from the isolator on the high voltage side of the generator transformer and therefore do not include costs associated with the generator transformer and switchgear. Costs have been determined for an 80°C line operating temperature.

For a turn in / turn out connection, Sinclair Knight Merz has assumed a Mesh configuration. This involves locating the primary plant at the transmission connection point and running a single circuit line (transmission tie-line) to the generator substation. A simplified single line diagram of the proposed arrangement is shown in Figure 1 below.

Figure 1 Connection configuration



This arrangement will require protection modifications at the remote (generator) end substation to allow for breaker failure protection at the transmission connection point.

2.2 Cost Indexation Calculation

In order to determine the transmission line connection capex and opex in June 2006 money terms a series of indexation formulae to apply to the different cost make up elements has been developed.

2.2.1 Transmission Line Tie-line and Tee-in Capital Cost Escalation

For the transmission line connection tie-line and tee-in capital cost indexation, the follow data types[2] have been drawn on:

[2] This includes Sinclair Knight Merz cost data drawn from market surveys.

- **Table 1 Transmission Line Connection Cost Indexation Data Sources**

Escalation Sources - Transmission Line Connection - Tie-Line & Tie-in	
Source	Used for
Australian Bureau of Statistics - Consumer Price Index	Earthwire, Fittings & Insulators
Australian Bureau of Statistics - Labour Price Index (WA)	All Labour Categories
Industrial Relations Commision - Electrical Contractor Awards	All Labour Categories
Electrical Trade Union of Australia - Employer Agree Rates	All Labour Categories
SKM - Power Industry market price survey: 1st Quarter 2006	Conductor Rates
Rawlinsons Australian Construction Handbook	Foundations
CRU Steel Price Index - Longs Steel	Towers

For the construction of the tie-line, these indices have been applied to both material and construction cost and compounded in proportion to the relative mix of these costs for the different cost make up elements (Table 2):

- **Table 2 Transmission Tie-line Construction Cost Elements**

Transmission Tie-Line
Cost Item
Clearing & access
Conductor
Earthwire
Fittings
Foundations
Insulators
Survey
Towers
EPC

A number of these cost make up elements can be directly linked to published indices, such as the foundations costs. The conductor prices are escalated from Sinclair Knight Merz' most recent market surveys (undertaken first quarter 2006)[3]. These are based on market contract values and take into consideration movement in labour and commodity prices.

[3] Sinclair Knight Merz periodically undertakes power industry pricing surveys and collates capex and opex data from a range of parties. This data is used to populate a power transmission and distribution cost database. The most recent update to the cost database took place in the first quarter of 2006. Material and labour cost rates have been escalated in accordance with the escalation method outlined in this section.

The purchase cost for transmission towers has been escalated by a combination of steel, labour and consumer price indices proportionate to the ratio of these costs elements in the fabrication costs of the towers. It is important to note that these indices have been calculated for cost element escalation to June 2006 and that they do not take into consideration movement of the input indices after this date (for example resulting from recent reductions in commodity prices).

The engineering procurement and construction management (EPCM) cost element arising from costs associated with management of contractors has been taken as the mean EPCM cost for similar work drawn from Sinclair Knight Merz' most recent pricing survey. This is applied in the form of a 15% cost uplift on all other costs and hence is also represented in June 2006 money terms.

2.2.2 Transmission Line Connection Switchyard costs Escalation

The following data types have been drawn on for the transmission line connection switch yard cost escalation determination:

- **Table 3 Transmission Line Connection Switchyard Capital Costs Escalation Sources**

Escallation Sources - Transmission Line Connection - Switchyard	
Source	Used for
Australian Bureau of Statistics - Consumer Price Index	Equipment after 2005, P&C Equipment, Misc Materials
Australian Bereau of Statistics - Labour Price Index (WA)	Installation, Commissioning, Erection
Industrial Relations Commision - Electrical Contractor Award	Installation, Commissioning, Erection
Electrical Trade Union of Australia - Employer Agree Rates	Installation, Commissioning, Erection
SKM - Power Industry Price Surveys	Electrical Equipment
Rawlinsons Australian Construction Handbook	Foundations
CRU Steel Price Index - Longs Steel	Structure

Again these indices have been compounded for each element in proportion to the ratio of the make up costs to which the indices are applicable. The composite 2005-2006 capital cost escalator determined for the transmission connection capital costs is 5.48 %.

2.2.3 Transmission Line Tie-line, Tee-in and Switchyard O&M Cost Escalation

The transmission tie-line O&M costs and Switchyard O&M costs are taken as a percentage multiplier[4] of the transmission line total construction costs and switchyard construction costs respectively. Hence the indexation applied for the transmission line and switchyard O&M cost is identical to that applied to the transmission tie-line and switchyard connection costs. As such the transmission line connection (tie-line, Tee-in and switchyard) O&M costs are medium values with a potential range of ± 10 %.

2.3 Transmission Line Costs

Based on a capacity of 200 MVA, the transmission line thermal rating needs to be approximately 350 Amps per phase. To accommodate this requirement Sinclair Knight Merz has evaluated costs for a 330 kV line with steel tower construction and 2 x Mango ACSR conductor with an 80 °C thermal operating rating.

Capital costs for a 2 km overhead transmission tie-line for:

- a base case: (flat terrain, rural, no road crossings); and
- an alternate case: (50% flat, 50% undulating terrain, 50% urban, 50% rural and one road crossing per km)

are provided in Table 4 below. These costs include an EPCM cost of 15 % of the aggregate of all other cost elements.

- **Table 4 330 kV Transmission Connection Tie-line Costs**

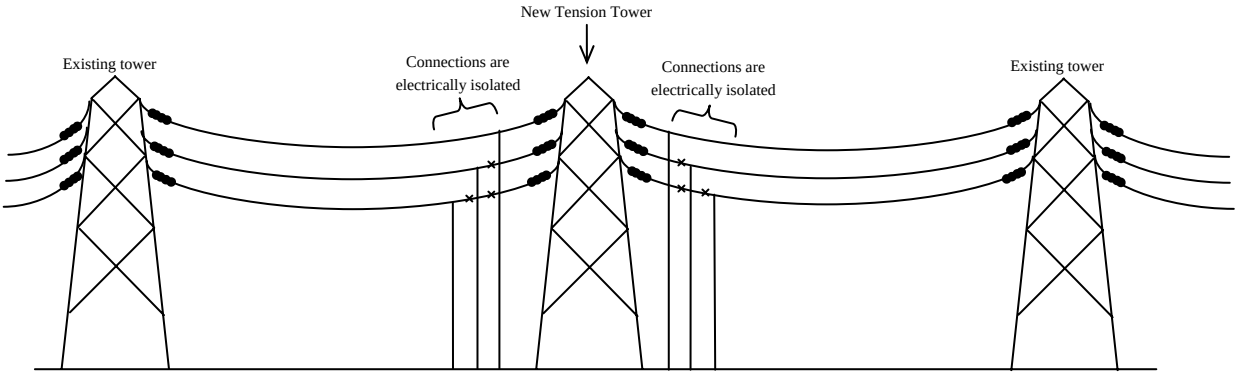
Summary of base and alternate case transmission tie-line costs June 2006		
Line Length	Base Case June 2006 Terms $(000's)	Alternate Case June 2006 Terms $(000's)
2 km	$711	$764

[4] This multiplier has been determined from operation and maintenance data gathered over a number of years by Sinclair Knight Merz and is periodically validated against known operation and maintenance costs. The multiplier varies in an increasing and approximate exponential manner with equipment age. As with the EPCM uplift determination, this multiplier takes into account recent labour and material cost data obtained from Sinclair Knight Merz' 2006 survey and hence O&M costs are cast in June 2006 money terms.

2.4 Substation and Transmission Line Connection Costs

A single tension tower configuration has been adopted, with the new tension tower being positioned between two existing towers. This option is considered to be the most economic. A simplified diagram is shown below in Figure 2.

- **Figure 2 Transmission Line Tee-in Arrangement**



The Mesh switchyard configuration cost has been evaluated for a three circuit breaker bay model. The total cost for breaking into the existing transmission line and for the Mesh switchyard arrangement is estimated at $ 5,017,510 including site establishment, line tee-in and EPCM costs. A summary of total capital costs for the transmission line connection consisting of the tie-line, tee-in, switchyard and EPCM costs for the base and alternate case terrain scenarios for an overhead 2 km tie-line length are provided in Table 5. A more comprehensive breakdown of each connection cost element for the base and alternate case scenarios is provided in Appendix A.

- **Table 5 Total Transmission Line Connection Capex: base and alternate case**

Transmission Tie-Line, Tie In and Switchyard Costs June-2006 2km base, and alternate case		
Item	2km Base Case June 2006 Values $	2km Alternate Case June 2006 Values $
Tie-line costs (2km)	$ 618,375	$ 664,753
Line Tee-in	$ 242,247	$ 242,247
Site Establishment	$ 1,128,545	$ 1,128,545
Switchyard	$ 2,992,259	$ 2,992,259
Subtotal	$ 4,981,427	$ 5,027,805
EPCM @ 15%	$ 747,214	$ 754,171
Total	**$ 5,728,641**	**$ 5,781,976**

3. Transmission Connection Operation and Maintenance Costs

The O&M costs for the transmission connection have been developed on an asset class basis. This has been achieved by using the unit cost developed in the capital costing exercise and applying a variable percentage value for O&M over the life of the assets[4]. It has been assumed that the average life of the 330 kV overhead transmission line is 60 years and the average life of the switchyard assets are 50 years.

Table 7 and Table 8 below show the transmission line and switchyard O&M costs over the life of the assets for the:

- base case (flat terrain, rural, no road crossings); and
- alternate case (50%flat/50% undulating terrain, 50% urban/50% rural, 1 road crossing per km)

terrain scenarios for an overhead 2km transmission tie-line length. Figures are presented for aggregated five yearly intervals.

An annual breakdown of transmission tie-line lifetime O&M costs for the base and alternate case terrain scenarios for a 2km overhead transmission tie-line length are presented in Appendix B together with an annual breakdown of the switchyard O&M costs. It should be noted that annual insurance costs have been omitted from the O&M costs figure as this will be very dependent on the ownership arrangement for the transmission tie-line.

The average annual O&M cost over the asset lifetime of 60 years for the 2 km, base case transmission line is $ 5,989 (June 2006 money terms) and $ 6,438 (June 2006 money terms) for the 2 km alternate terrain case. The average annual O&M costs for the Meshed switchyard over its 50 year life is $ 60,278 (June 2006 values). Since the lifetime of the OCGT plant is given as 30 years it is reasonable to present the lifetime O&M costs of the related assets in the same time frame. This is provided in Table 6.

- **Table 6 2 km, base case tx and switchyard O&M 2006 base case and alternate case cost comparison**

30 Year Lifetime Operation and Maintenance Costs for the Transmission Connection: 2 km Base Case and 2 km Alternate Case		
Years	Base Case 1 to 30 yrs June 2006 Values	Alternate Case 1 to 30 yrs June 2006 Values
Turn in Turn Out Connection		
Tie-line O&M Costs over the life of the GT plant (Assumed 30 years)	$ 99,202	$ 106,643
Meshed Switchyard O&M Costs over the life of the GT plant (Assumed 30 years)	$ 1,320,491	$ 1,320,491
Total Line and Switchyard O&M Costs over the life of the GT plant (Assumed 30 years)	$ 1,419,693	$ 1,427,134
Average Annual O&M cost over the life of the GT plant (Assumed 30 years)	$ 47,323	$ 47,571

Table 7 Lifetime O&M costs, 2km Base Case Tx Tie-line and Meshed Switchyard

Life Time O&M costs for 2 km Base Case Transmission Line and Meshed Switchyard			
5 yearly costs for periods:	Transmission Line $(June 2006)	Meshed Switch Yard $(June 2006)	Total $(June 2006)
1 to 5 years	$10,659	$151,725	$162,384
6 to 10 years	$12,516	$174,136	$186,652
11 to 15 years	$14,698	$199,856	$214,555
16 to 20 years	$17,260	$229,376	$246,636
21 to 25 years	$20,268	$263,257	$283,525
26 to 30 years	$23,801	$302,141	$325,942
31 to 35 years	$27,949	$346,769	$374,718
36 to 40 years	$32,821	$397,989	$430,810
41 to 45 years	$38,541	$456,774	$495,315
46 to 50 years	$45,259	$524,242	$569,501
51 to 55 years	$53,148	N/A	
56 to 60 years	$62,411	N/A	

- **Table 8 Lifetime O&M costs, 2 km Alternate Case Tx Tie-line and Meshed Switchyard**

Life Time O&M costs for 2 km Alternate Case Transmission Line and Meshed Switchyard			
Cost over 5 year period	Transmission Line $(June2006)	Meshed Switch Yard $(June 2006)	Total $(June2006)
1 to 5 years	$11,458	$151,725	$163,183
6 to 10 years	$13,455	$174,136	$187,591
11 to 15 years	$15,800	$199,856	$215,657
16 to 20 years	$18,554	$229,376	$247,931
21 to 25 years	$21,788	$263,257	$285,045
26 to 30 years	$25,586	$302,141	$327,727
31 to 35 years	$30,046	$346,769	$376,815
36 to 40 years	$35,282	$397,989	$433,271
41 to 45 years	$41,432	$456,774	$498,206
46 to 50 years	$48,653	$524,242	$572,896
51 to 55 years	$57,134	N/A	
56 to 60 years	$67,092	N/A	

4. Generation Operation and Maintenance Costs

4.1 Assumptions and Estimated Maintenance Costs

At the request of the Independent Market Operator, an OCGT plant, based on a single gas turbine capable of delivering a net 160 MW output fuelled predominantly with natural gas has been evaluated for a 30 year operating life. An allowance for 5 % running on distillate (light fuel oil) has been provided to allow for gas pipeline outages. Given the low capacity factor, a non-firm (i.e. interruptible) gas supply has been assumed. Sinclair Knight Merz has developed a gas turbine operation and maintenance model based on these parameters using the net output and net heat rate produced by Thermoflow GT PRO® software. Sinclair Knight Merz has assumed an ambient temperature of 35 °C, with a relative humidity of 40 % and an altitude of 15 m for the plant specification. The three turbines considered in this analysis are the:

- Alstöm 13E2;
- Siemens V94.2 (SGT5-200E); and
- General Electric GE9171E.

The running regime advised by the Independent Market Operator is as described in section 1, repeated here for convenience:

- 1 % and 2 % capacity factor;
- 4 hours running per start;
  - 22 starts per annum for a 1 % capacity factor;
  - 44 starts per annum for a 2 % capacity factor;
- no fast starts[5]; and
- one full time load trip to be assumed per annum.

[5] Given that there is no balancing market in the SWIS Wholesale Electricity Market, the Independent Market Operator has advised that there will be no requirement for fast starts in the operating regime and hence it is assumed that the plant will be dispatched with sufficient forward notice to avoid the need for fast starts.

4.1.1 Generator O&M Cost Escalation

As with the transmission line connection capital and O&M cost escalation, a range of data sources have been drawn on (Table 9) to develop appropriate costs and price escalators for the OCGT plant fixed O&M costs data. These escalators have been applied to the cost data available to Sinclair Knight Merz that is not already couched in 2006 money terms.

Table 9 Gas Turbine Plant Fixed O&M Cost Data Indexation Sources

Escallation Sources - Gas Turbine Fixed O&M	
Source	Used for
Australian Bureau of Statistics - Consumer Price Index	Market fee, gas connection fee, blance of plant, consent, legal, corporate overhead, engineering support, electrical, fire protection, rates
Australian Bereau of Statistics - Labour Price Index (WA)	Non operator blue collar labour elements 2005-2006
Industrial Relations Commision - Electrical Contractor Award	Contractor costs 2005-2006
SKM - OCGT Project Data (amalgam - 2006)	Insurance, Plant Opertor labour, OCGT substation

These indices have been compounded for each cost element in proportion to the ratio of the make up costs for which the indices are applicable. The compound 2005-2006 escalator for the gas turbine plant fixed O&M is determined at: 4.25%.

All costs are presented as mean values ± 10 %.

4.1.2 Expected fixed Maintenance Costs

The fixed O&M cost elements shown below in Table 10 have been developed from cost data derived from a range of sources including an amalgam of data from current and recent similar OCGT projects. These costs have been escalated, where appropriate, to June 2006 money terms. As with the transmission line connection, O&M plant insurance has been omitted from the figures. However, Sinclair Knight Merz would estimate this at 0.5% of replacement capex (June 2006).

- **Table 10 Generator fixed O&M costs**

Generator Fixed O & M costs breakdown	
O & M Cost Component	**$M pa June (2006)**
Plant operator labour	0.400
OCGT Substation (connection to tie-line)	0.020
Rates	0.052
Market Fee	0.052
Gas Connection (excludes amortised gas pipeline connection costs)	0.052
Balance of Plant	0.104
Consent (EPA annual charges, emissions tests)	0.026
Legal	0.021
Corporate Overhead	0.187
Travel	0.021
Subcontractors	0.261
Engineering Support	0.052
Security	0.104
Electrical (Including Control & Instrumentation)	0.100
Fire	0.052
Total	**1.504**

Five yearly aggregate fixed OCGT O&M costs (mean values ± 10 %) are provided in Table 11 for each five year period of the 30 year operating life.

Table 11 Combined Generator O&M costs

Fixed Operation and Maintenance costs for 160 MW OCGT $(June 2006)							Total
Cumulative five yearly costs: Years:	**1 to 5**	**6 to 10**	**11 to 15**	**16 to 20**	**21 to 25**	**26 to 30**	**1 to 30**
Fixed O&M Costs $(June2006)	$7,178,665	$7,178,665	$7,178,665	$7,178,665	$7,178,665	$7,178,665	$43,071,990

Appendix A Connection Cost Estimates 2 km, 10 km, 20 km, base & high case

Table 12 Connection Cost Breakdown for 2 km, base case transmission line connection

Connection Cost Estimate for Independent Market Operator
2km base case: Flat, Rural, no Road Crossings

Assumptions	*Site establishment costs estimated* *Single-circuit steel tower construction* *Based on standard 1 1/2 breaker 3CB configuration* *Demarcation at Generator is the site fence* *Includes additional tension tower and terminations associated with turn in and out*
Exclusions	*No switching costs associated with breaking existing transmission line* *No land or easement acquisition included* *No additional costs allowed for remote locations*

Estimate

Item	Details	Qty	Cost Estimate
Site Establishment	Earthworks, Gravel, Fencing, Earthgrid, Building, Auxillaries etc	1 lot	1,128,545
Line Tee-in	Tension tower, conductor and connection to landing spans	1 lot	242,247
Switchyard			
	Supply & Delivery of 3 CB, 3 sets of CT, 1 set of VT, 6 Isolators, 3 Isolators with		
Equipment	Earth switch, station posts and PLC set	1 lot	1,815,663
Structure	Bus, gantry and support structures for HV equipment	1 lot	248,866
Foundations	Construction of foundations for HV equipment	1 lot	183,326
Protection & control	Standard protection schemes	1 lot	305,969
Electrical erection	Erection of equipment	1 lot	260,728
Miscellaneous	Minor construction & materials, commissioning	1 lot	177,708
Sub-total			*2,992,259*
Tie-line			
Line Construction	330kV SCST, 2 x Mango, Flat, Rural, No Road Crossings	2 km	475,673
Ajustment Factor	Short line ajustment factor (0.3)	1 lot	142,702
Sub-total			*618,375*
Sub-total			*4,981,427*
EPCM @ 15%			*747,214*
Total (AUD)			**5,728,641**

Table 13 Connection Cost Breakdown for 2 km, alternate case transmission line connection

Connection Cost Estimate for Independent Market Operator
2km alternate case: 50% Flat/50% Undulating, 50%Urban/50% Rural, one Road Crossing per km

Assumptions	*Site establishment costs estimated* *Single-circuit steel tower construction* *Based on standard 1 1/2 breaker 3CB configuration* *Demarcation at Generator is the site fence* *Includes additional tension tower and terminations associated with turn in and out*
Exclusions	*No switching costs associated with breaking existing transmission line* *No land or easement acquisition included* *No additional costs allowed for remote locations*

Estimate

Item	Details	Qty	Cost Estimate
Site Establishment	Earthworks, Gravel, Fencing, Earthgrid, Building, Auxillaries etc	1 lot	1,128,545
Line Tee-in	Tension tower, conductor and connection to landing spans	1 lot	242,247
Switchyard			
Equipment	Supply & Delivery of 3 CB, 3 sets of CT, 1 set of VT, 6 Isolators, 3 Isolators with Earth switch, station posts and PLC set	1 lot	1,815,663
Structure	Bus, gantry and support structures for HV equipment	1 lot	248,866
Foundations	Construction of foundations for HV equipment	1 lot	183,326
Protection & control	Standard protection schemes	1 lot	305,969
Electrical erection	Erection of equipment	1 lot	260,728
Miscellaneous	Minor construction & materials, commissioning	1 lot	177,708
Sub-total			*2,992,259*
Tie-line			
Line Construction	330kV SCST, 2 x Mango, 50%Flat/50% Undulating, 50% Rural/50% Urban, 1 Road Crossing per km	2 km	511,349
Ajustment Factor	Short line ajustment factor (0.3)	1 lot	153,405
Sub-total			*664,753*
Sub-total			*5,027,805*
EPCM @ 15%			*754,171*
Total (AUD)			**5,781,976**

Note (EPCM) Engineering, Procurement and Contract Management

Appendix B Lifetime costs for transmission line and Mesh switchyard O&M

- **Table 14 Operation and Maintenance Costs for 2 km Transmission Connection Line and Switchyard (Base Case Terrain Scenario)**

Operation and Maintenance Costs for the Transmission Connection: 2km Base Case (Flat, Rural, no Road Crossings)													
Five yearly period costs for:	Years	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	56 to 60
Turn in Turn Out Connection													
Line O&M Costs	$(June 2006)	$ 10,659	$ 12,516	$ 14,698	$ 17,260	$ 20,268	$ 23,801	$ 27,949	$ 32,821	$ 38,541	$ 45,259	$ 53,148	$ 62,411
Meshed Switchyard O&M Costs	$(June 2006)	$ 151,725	$ 174,136	$ 199,856	$ 229,376	$ 263,257	$ 302,141	$ 346,769	$ 397,989	$ 456,774	$ 524,242	N/A	N/A
Total Spend in Period	$(June 2006)	$ 162,384	$ 186,652	$ 214,555	$ 246,636	$ 283,525	$ 325,942	$ 374,718	$ 430,810	$ 495,315	$ 569,501		
Average Annual spend in period	$(June 2006)	$ 32,477	$ 37,330	$ 42,911	$ 49,327	$ 56,705	$ 65,188	$ 74,944	$ 86,162	$ 99,063	$ 113,900		
Average Annual O&M cost over the life of the GT plant (Assumed 30 years)	$(June 2006)	$ 47,323											

- **Table 15 Operation and Maintenance Costs for 2 km Transmission Connection Line and Switchyard (Alternate Case Terrain Scenario)**

Operation and Maintenance Costs for the Transmission Connection: 2 km Alternate Case (50% Flat/50% Undulating, 50%Rural/50%Urban, 1 Road Crossing per km)													
Five yearly period costs for:	Years	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	56 to 60
Turn in Turn Out Connection													
Line O&M Costs	$(June 2006)	$ 11,458	$ 13,455	$ 15,800	$ 18,554	$ 21,788	$ 25,586	$ 30,046	$ 35,282	$ 41,432	$ 48,653	$ 57,134	$ 67,092
Meshed Switchyard O&M Costs	$(June 2006)	$ 151,725	$ 174,136	$ 199,856	$ 229,376	$ 263,257	$ 302,141	$ 346,769	$ 397,989	$ 456,774	$ 524,242	N/A	N/A
Total Spend in Period	$(June 2006)	$ 163,183	$ 187,591	$ 215,657	$ 247,931	$ 285,045	$ 327,727	$ 376,815	$ 433,271	$ 498,206	$ 572,896		
Average Annual spend in period	$(June 2006)	$ 32,637	$ 37,518	$ 43,131	$ 49,586	$ 57,009	$ 65,545	$ 75,363	$ 86,654	$ 99,641	$ 114,579		
Average Annual O&M cost over the life of the GT plant (Assumed 30 years)	$(June 2006)	$ 47,571											