Review of the Maximum Reserve Capacity Price 2010 - Power Station Elements

- Final
- 16 November 2010

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Contents

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1. Introduction

As part of the establishment of the Wholesale Electricity Market (WEM) within the South West Interconnected System (SWIS), the Government of Western Australia set up the Independent Market Operator (IMO) to administer and operate the market.

The Market Rules require the IMO to conduct a review of the Maximum Reserve Capacity Price (MRCP) each year. As part of this process Sinclair Knight Merz (SKM) has been commissioned to determine the following for the year 2010:

- Capital cost (procurement, installation and commissioning, excluding land cost) of a generic, industry standard, liquid fuelled, 160 MW Open Cycle Gas Turbine (OCGT) power station.
- Fixed Operation and Maintenance (O&M) costs of the above facility with capacity factor of 2%. The cost shall be in 5 year periods covering 1 to 30 years.
- Owner's costs such as legal, approval, environmental and financing costs associated with term 'M' used in the WEM Rules.

This report should be read in conjunction with the scope of work agreed between IMO and SKM which explains the approach of this report in detail and is attached in Appendix A.

Given that this report will focus on power station elements, it should be read in conjunction with SKM report titled "Review of the Maximum Reserve Capacity Price 2010 – Non Power Station Elements".

SKM

2. Generation Plant Capital Cost

SKM has estimated the capital cost (engineering, procurement, installation and commissioning, excluding land cost) of a generic liquid fuel E-class OCGT power station. An E-class OCGT will have a nominal capacity of 160 MW for gas fuel operation. For operation on liquid fuel with water injection, for NO_X emission control, the plant may have a nominal capacity greater than this rating. The actual capacity will be dependent on the gas turbine technology, the emission level requirements and corresponding level of water injection being considered. The capital cost estimate includes all components and costs associated with a complete gas turbine project.

2.1. Methodology

In order to establish the capital costs for a generic 160 MW open cycle gas turbine plant, SKM undertook the following steps:

- Checked the table of prices developed by SKM for the 2009 MRCP review for two open cycle gas turbine plants using Version 19 (March 2009) of Thermoflow GT Pro/PEACE software and confirmed that it was relevant to use for the 2010 MRCP review;
- Normalised existing project data on recent similarly sized plant developments, (removal of non-typical costs such as significant ground preparation, piling, excessive environmental costs etc);
- Normalised existing project data, for recent plant developments, which included multiple generating units, alternative fuels or other similar scope elements, not applicable in the plant configuration under consideration;
- Correlated the Thermoflow GT Pro/PEACE derived cost data with the normalised reference data; and
- Normalised the existing Thermoflow and project data to comprise costing for a generic 160 MW open cycle gas turbine plant.

The SKM study is based on distillate (diesel) fuel oil being supplied and stored, fully in accordance with the gas turbine manufacturer's specification requirements, and used as the sole fuel source for the operation of the plant. Other potential liquid fuels or the provision of fuel treatment or conditioning facilities have not be considered in the development of any capital or operating cost estimates presented in this study.

2.2. Thermoflow GT Pro / Peace Derived Costs

SKM utilised the outputs of Thermoflow GT Pro®/PEACE® together with in-house cost data to develop capital costs for a number of single unit OCGT plants with nominal output of 160 MW (exact plant capacities are dependent on the nearest matching gas turbine) in 2009. These capital costs were multiplied with the various indices to normalize them to 2010 figures.

In developing the matrix of costs, SKM has utilised:

- knowledge and experience of generation project development;
- database for power station capital and operating costs;
- knowledge of the impact of the flow through of commodity price increases, labour costs etc on generation station capital costs and hence appropriate escalation indices; and
- knowledge and experience in generation project costing, including typical allowances for owner's costs.

In developing the cost estimates, SKM has assumed a standard green field site located in Western Power's SWIS region having no special geological, environmental, permitting or consenting peculiarities. In particular it has been assumed that there are no unusual requirements for ground preparation, such as piling or land remediation.

As a location has not been specified SKM has also assumed average annual conditions for the region of 25°C and 60% relative humidity and typical atmospheric air pressure conditions applying at an elevation of 25 m.

2.3. Project Data Price Review

In developing the end cost estimate, SKM also utilised information garnered from a number of projects that it has been involved with over the past several years, plus recent completed studies. These projects have been in varying stages of the project development lifecycle for generating plant of sizes similar to this study. However the major portion of such reference cost information was derived from projects that have been completed and are in commercial operation.

The most recent available project cost information has been given higher weighting factors than similar information from older projects. The weightings of previous projects, originally contracted prior to 2005, have still been included in the overall cost comparison, but have had their respective weightings reduced in comparison to more recent projects.

Capital cost of plant development in Australia has varied from the consumer price index (CPI) and to this end the CPI over the past years does not provide an accurate picture of plant development escalation. To address this, SKM has developed and utilised a number of escalation factors for varying aspects of a power plant and has applied these to bring the total capital estimate to June 2010 money terms.

The following escalation factors, obtained from the Australian Bureau of Statistics (ABS), were used:

- Engineering design and engineering consultancy services index;

- Iron and steel index;
- Copper and brass index;
- Perth concrete cement and sand index;
- WA labour index;
- Australia labour index;
- Australia electricity, gas and water supply labour index; and
- Consumer price index.

The reference project data has then been further revised to take out non-generic project costs to produce a table of 'normalised' project data costing comparable to that obtained from the Thermoflow modelling software.

A large portion of the main equipment for an OCGT plant project comes from overseas, and so changes in foreign exchange rates can have a significant effect on the total estimated capital cost. In some instances, where possible, recent exchange rates were used to adjust the capital costs to more accurately reflect recent market conditions (AUD exchange rate of 1.41 for the Euro, 1.01 for the US dollar and 1.054 for the Swiss Franc, October 2010). This adjustment could not be carried out for all components of the cost estimate due to lack of detailed information.

These costs were normalised to ensure that they covered the same cost items as the Thermoflow software (e.g. excluding network connection costs and owners costs covered in Section 4). Much of this data has been sourced from confidential projects and so cannot be directly presented in this report.

2.4. Development of the Generic OCGT Capital Cost Estimate

SKM has compared and correlated the two sets of costing data to develop a generic OCGT capital cost estimate for a generic 160 MW open cycle gas turbine plant. Where slight inaccuracies occurred, existing project data was normalized and then used to compensate for any cost inaccuracies of the modelling software. In this manner, the anonymity of the reference project data was maintained. Escalated cost estimates for more recent projects have been weighted more heavily in this compensation than those for earlier projects.

As previously stated, the estimated capital costs from several previous projects have been based on multiple gas turbine power generation units. Normalization of the estimated capital cost of these facilities to reflect a single unit facility has been undertaken.

Previous generic capital cost estimates have been based on dual fuel (natural gas and distillate fuel oil) generating units. Adjustments have been made to reflect that in this instance the estimate is based on a single liquid fuel only machine. No cost provisions have been included in the current

capital cost estimate to reflect the inclusion of the 1000 t capacity fuel storage tank, plus fuel oil unloading and transfer systems, complete with associated civil and structural works including main storage tank containment bunds, and any initial or subsequent filling of the storage facilities with fuel. It is understood that the estimated costs for these elements of the overall works will be provided by others.

In developing the generic capital cost estimate for a liquid fuel only machine, operating at low capacity factors, one must consider whether such a machine will be required to incorporate additional exhaust gas emissions abatement provisions. Previous similar cost estimates have been based on dual fuel (natural gas and distillate fuel oil) operation for gas turbines fitted with Dry Low Emissions (DLE) combustion technology. NO_X emissions would typically be in the range of 25 ppmv dry, at 15% O_2 reference conditions when firing natural gas, with higher emissions allowed when operating on distillate fuel oil. NO_X emissions abatement while operating on distillate fuel oil, through water injection, was not taken into consideration. For a liquid fuel only fired plant the validity of this assumption needs to be reviewed and consideration made as to whether such a plant would be required to include emissions abatement technologies. It is considered that plant emission level limitations will become increasingly stronger, even for plants subject to limited capacity factors. As such the generic cost estimates assume that water injection for NO_X emissions abatement will be required and that on site water treatment and storage facilities will be included. Low NO_X burners are included in the capital cost estimate.

In addressing any need for water injection requirements, the potential source of the water; the treatment and conditioning of the water to achieve the demineralised quality required for any water injection systems; the on-site storage capacity requirements of such water; and the disposal and treatment of effluent from any treatment system, have been taken into consideration. However, these assumptions are based on sufficient potable or similar quality water supplies being available local to the facility. The requirements for extensive or complex water abstraction or treatment facilities have not been considered.

2.5. OCGT Capital Cost Estimate

A breakdown of the capital cost estimate for a 160 MW generic OCGT plant is given in Table 2-1 below. The estimate represents a generic cost for an OCGT Plant constructed on an EPC basis. Owner's costs additional to the EPC Contract have been excluded, and are accounted for in the calculation for the term "M" in Section 4.

The total capital cost was calculated as **AUD$121,800,000**. This equates to a capital cost of **AUD$761/kW** at the assumed conditions (25°C, 60% RH, 25 m and an output of 160 MW).

- **Table 2-1 Generic 160MW OCGT capital cost estimate**

Item		Cost [$]
1	Main Plant Equipment	$ 79,000,000
2	Balance of Plant	$ 2,900,000
3	Civil Works	$ 10,700,000
4	Mechanical Works (including installation)	$ 9,000,000
5	Electrical Works (including installation)	$ 2,500,000
6	Buildings	$ 1,900,000
7	Engineering & Plant Start-up	$ 3,900,000
8	Contractor's Costs	$ 11,900,000
Total EPC Cost		$121,800,000

All costs are presented as mean values ± 10 %.

The above estimated EPC capital costs reflect the impact of the variation in the exchange rates, strengthening the Australian Dollar. In the absence of these current exchange rates variations the overall estimated EPC capital costs would be not less than 5% higher. Section 5 of the report highlights the underlying factors which continue to put upward pressure on market pricing, including limited market competition in the individual unit capacity range considered in the study.

3. Generation Fixed Operation & Maintenance Costs

3.1. Assumptions and Exclusions

An OCGT plant based on a single gas turbine capable of delivering a nominal 160 MW output operating on distillate fuel oil has been evaluated for a 30 year operating life.

SKM has developed an estimate for fixed O&M costs for the peaking power plant based on a 2% capacity factor, expected to operate infrequently solely on distillate fuel oil. Gas connection costs are therefore not considered in this estimate. Transmission line connection O&M has also been excluded.

In accordance with the September 2008 report[1] for the IMO, prepared by MMA in conjunction with SKM, the cost of scheduled maintenance overhauls based on number of starts and number of operating hours has been considered as a variable O&M cost, and is not included in this estimate. An allowance for regular balance of plant upkeep and maintenance has been included.

A generation utility owner's annual revenue entitlements will include a component for the depreciation of their assets. Depreciation relates to capital costs, distributing the loss in value of the assets over the lifetime of the plant. It is not a part of the ongoing costs to operate and maintain the assets, and as such it has not been considered in this estimate or in previous estimates.

3.2. Operation & Maintenance Cost Escalation

From July 2009 to June 2010, the CPI increased by 3.1%, the WA Labour Price Index increased by 3.4%, and the Electricity-Water-Gas Industry Price Index increased by 4.4%. 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. Also, an O&M cost item was updated to latest market cost information.

The compound escalator for the gas turbine plant fixed O&M is determined at:

- 2006-2007: 3.45%
- 2007-2008: 5.16%
- 2008-2009: 4.59%
- 2009-2010: 3.86%

The 2009-2010 escalation index was applied to the previous year's relevant values.

[1] MMA September 2009, 'Energy Price Limits for the Wholesale Electricity Market in Western Australia from October 2009', Available on the IMO website.

3.3. Expected Operation & Maintenance Costs

The fixed O&M cost elements shown below in Table 3-1 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 2010 dollar terms.

- **Table 3-1 OCGT plant fixed O&M costs**

O&M Cost Component	[$M pa]
Plant operator labour	0.496
OCGT Substation (connection to tie line)	0.236
Rates	0.057
Market Fee	0.057
Balance of plant	0.123
Consent (EPA annual charges emissions tests)	0.030
Legal	0.026
Corporate Overhead	0.217
Travel	0.025
Subcontractors	0.326
Engineering Support	0.066
Security	0.120
Electrical (Including Control & Instrumentation)	0.118
Fire	0.059
Total	**1.956**

Five yearly aggregate fixed OCGT O&M costs are provided in Table 3-2 for each five year period of the 30 year operating life.

- **Table 3-2 Fixed OCGT plant O&M costs (June 2010 dollars)**

Five yearly intervals	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	$ 9,780,000	$9,780,000	$9,780,000	$ 9,780,000	$ 9,780,000	$ 9,780,000	$ 58,680,000

All costs are presented as mean values ± 10 %.

4. Calculation of the Term 'M'

Section 1.14 of the IMO's Market Procedure for Determination of the Maximum Reserve Capacity Price version 1.1 (the Market Procedure), introduces and defines the term 'M' as; "*a margin to cover legal, approval, and financing costs and contingencies*."[2]

SKM understands that the inclusion of term 'M' within the calculation provides a means to account for specific additional indirect costs that would be expected to be incurred by the developers of the Power Station upon which the Maximum Reserve Capacity Price is based.

The indirect costs are then incorporated into the capital cost determination as a margin, i.e. a fixed percentage, added to the capital cost:

Section 1.14 of the Market Procedure identifies how the Term M fits into the MRCP calculations, being:

> *"The value of CAPCOST[t] is to be calculated as:*
>
> *CAPCOST[t] = (PC[t] x (1 + **M**) x CAP + TC[t] + FFC[t] + LC[t]) x (1+ WACC)^2*
>
> *Where:*
> *PC[t] is the capital cost of an open cycle gas turbine power station in year t, expressed in Australian dollars in year t per MW;*
> ***M is a margin to cover legal, approval, and financing costs and contingencies**;[Emphasis added]*
> *TC[t] is the cost of electricity transmission assets required to connect an open cycle gas turbine power station to the SWIS, plus an estimate of the costs of augmenting the shared network to facilitate the connection of the open cycle gas turbine power station, expressed in Australian million dollars in year t;*
> *FFC[t] is the fixed fuel costs and must represent the fixed costs associated with an on-site liquid storage tank with sufficient capacity for 24 hours of Liquid Fuel including the cost of keeping this tank half full at all times expressed in Australian million dollars in year t;*
> *LC[t] is the cost of land purchased in year [t]; and*
> *WACC is the Weighted Average Cost of Capital."*

[2] IMO 2008, "Market Procedure for Determination of the Maximum Reserve Capacity Price, 04 December, P11, Available as a download from: http://www.imowa.com.au/f711,54740/54740_Market_Procedure_for_Maximum_Reserve_Capacity_Price.pdf.

In calculating a suitable figure for 'M,' SKM has estimated the Legal, Approval and Financing costs for a generic 160 MW open cycle gas turbine plant, being the "*Power Station upon which the Maximum Reserve Capacity Price shall be based*" as defined in Section 1.5 of the Market Procedure.

The costs have been estimated from in-house data and knowledge of comparable recent developments. SKM has compared and correlated the costing data of several projects to develop a generic OCGT legal; approval and financing cost estimate for a generic 160 MW liquid fuelled open cycle gas turbine plant.

Where applicable, varying costs were each normalised and any abnormal cost variations relating to unique or unusual project factors removed. As with previous reports to the IMO, much of the original data has been sourced from confidential projects and so cannot be directly presented in this report.

The insurance cost figure presented in this section was derived from knowledge gained through undertaking a number of comparable EPC projects and due diligence reviews. In addition, SKM has sought input from recent discussions between SKM and major energy project insurers during the development and/or review of EPC project estimates.

The figure for the 'Cost of Raising Capital' has been estimated based on a fully underwritten project to build a 160 MW OCGT power station, which SKM understands to be dependent on the nature of capital markets at the time of the capital raising process.

As projects from which to gather updated data in this regard have been notably scarce in the last 12 months, due to both lack of investor confidence and the tightening of financing processes as a result of the Global Financial Crisis (GFC), the ability to refine this aspect of the calculation has been limited. The figure used in this report is therefore based on SKM's recent experience and knowledge gained through discussions with industry contacts and not on detailed analysis of actual project data.

With manufacturer's order books now beginning to recover from the affects of the GFC (see section 5), the general consensus appears to suggest that market forces have brought expected costs back in line to pre-GFC terms.

Therefore, although absolute dollar values for each of the components of the Term M will have changed, SKM deemed it reasonable to conclude that relativities between the components of the Term M and the total EPC costs would be in-line with SKM's previously established breakdown.

Table 4-1 shows SKM's estimate for the term 'M', with due consideration given to standard industry practices. These costs include:

- legal costs associated with the design and construction of the power station;
- approval costs including environmental consultancies and approvals, and local, state and federal licensing, planning and approval costs;
- Cost of Raising Capital; and
- Owners project management and engineering costs.

Table 4-1 Estimate of term 'M'

Component of 'M'	% of Total EPC
Project Management	1.9%
Project Insurance	1.5%
Contingencies	5.0%
Cost of Raising Capital	4.0%
Environmental Approvals	0.7%
Legal Costs	1.2%
Owners Engineers - Part A (Including concept design, specification, tendering, contract negotiations)	0.4%
Owners Engineers - Part B (Including Construction Phase OE Costs, oversee project, witness tests & Commissioning)	3.0%
Initial Spares requirements	0.8%
Site Services (Provision of potable water, construction power, communications, domestic sewerage etc. at site)	0.1%
Total M as a percentage of CAPEX	**18.6%**
Multiplier in CAPEX equation 2	(1 + 0.186)

5. Changes in the Market from 2009 SKM Review

This section of the report discusses some of the changes to the Economic Environment affecting EPC projects since June 2009, which were brought into account during the determination of costs and factors in this report.

An August 2010 report by GlobalData entitled: "Global Gas Turbine Market Analysis to 2020 - Market Size, Competitive Landscape, Trends and Analysis" explained the current and future outlook for the market that determines the pricing of the Power Station upon which the MRCP has been based. GlobalData reported that:

"After the economic crisis last year, the global gas turbine market is currently in the revival phase. Very few countries were able to insulate themselves from the liquidity crunch that followed it. This resulted in a considerable decrease in the global gas turbine orders in the year 2009. The liquidity crunch that followed the subprime crisis resulted in absence of financing option for various projects. The lack of confidence of investors in projects resulted in the overall decline of the market."

The report goes on to describe how projects in the global gas turbine market retracted from $19,463.8 million in 2007 to only $10,727.4 million in 2009, clearly indicating the lower investor confidence and/or financing abilities as a result of the GFC.

However, the Diesel and Gas Turbine Worldwide publication reported that 45 gas turbine generator units in the 120 MW to 180 MW capacity range, were ordered in the Middle East, Asia and Australia region for the calendar year 2009. These regional unit orders are understood to be relatively consistent with the previous year, following the overall reduction in annual units ordered from mid-2008. This gas turbine market therefore appears to be relatively steady, unlike the European and North American markets, in which reported order numbers have substantially reduced over the same period. On this basis regional market price pressures for these units are anticipated to remain.

This indicates the market now appears to have recovered, and growth is expected in the short to medium term, with several new projects resulting in reports of increased orders from the major manufacturers in the gas turbine market.

Further, the Australian dollar is currently significantly stronger than the other major currencies. The stronger Australian dollar results in a lower comparative price for the major primary plant. The changes against the US dollar, EURO and Swiss Franc are:

- AUD/EURO exchange rate changed from 1.71 to 1.41;

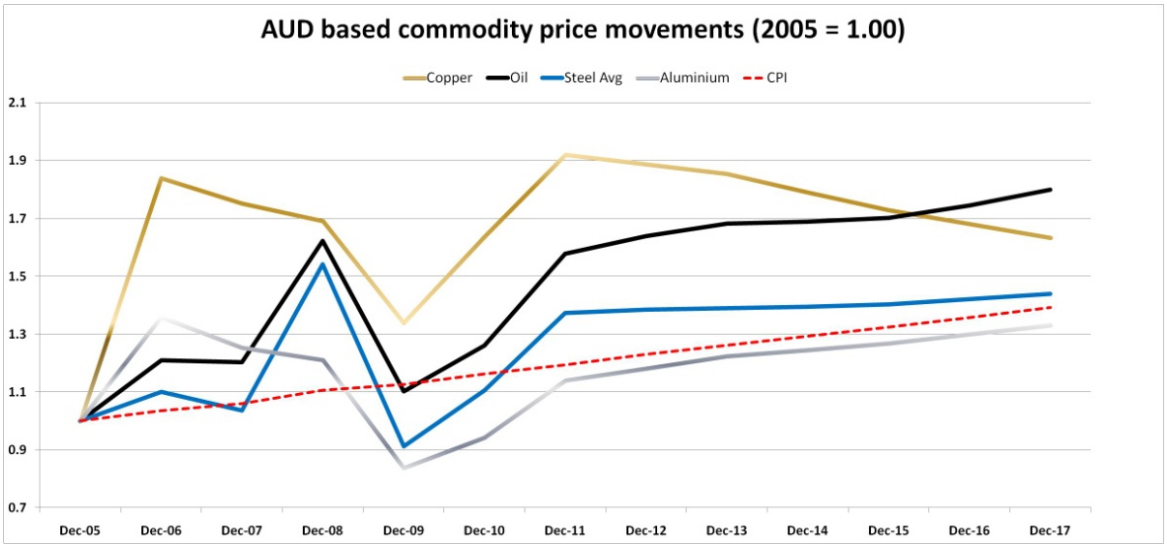
- AUD/USD exchange rate changed from 1.15 to 1.01; and
- AUD/CHF exchange rate changed from 1.113 to 1.054.

Similarly, consolidation in the available 50 Hz gas turbine generator unit sizes in this capacity range will also lead to maintaining market prices. For single unit capacity in this size range there are only the Alstom (13E2) and Siemens (SGT5-2000E) units available. The Mitsubishi 701DA (144 MW ISO) and the new General Electric Frame 9E and LMS100 (126 MW and 100 MW ISO respectively) have significantly lower overall unit capacities and may therefore be not directly competitive with the individual gas turbine unit capacities primarily considered in this study. As such it can be envisaged that there is likely to be limited competitive pressure on market pricing in relation to single gas turbine generator unit projects in this capacity range.

SKM therefore envisage that it is reasonable to expect that the continued growth in demand for gas turbines would drive escalation of prices for the generic 160 MW open cycle gas turbine plant.

As Figure 1 illustrates there has been a significant recovery in market prices for some of the major commodities used in the manufacture of plant and equipment for projects such as the Power Station upon which the MRCP is based, when compared to their comparative decline during the same period last year.

- **Figure 1 Commodity Price Movements**



Source: SKM Cost Escalation modelling.

Appendix A Scope of Work

Extract from SKM proposal letter WPP1105

The project shall consist of three discrete elements as follows:

1.1. Power Station Estimate

1.1.1. Estimate the capital cost (procurement, installation and commissioning, excluding land cost) of a generic, industry standard liquid fuelled 160MW Open Cycle Gas Turbine power station. The estimate will include all the components and costs associated with a complete gas turbine project; and

1.1.2. Estimate the fixed operation and maintenance costs of the liquid fuelled OCGT power station of 160MW with capacity factor of 2% to mid 2010 value. The cost shall be in 5 year periods covering 1 to 5 years; 6 to 10 years; 11 to 15 years; 16 to 20 years; 21 to 25 years; and 26 to 30 years respectively.

1.2. Connection Works Estimate

1.2.1. Estimate the capital cost (procurement, installation and commissioning, excluding land cost) of a generic, industry standard 330kV substation to a mid 2010 value that facilitates the connection of the above mentioned power station. The estimated cost will be based on a generic three breaker mesh substation configured in a breaker and a half arrangement. The substation will be located under an existing transmission line and include an allowance for 2km of 330kV overhead single circuit line to the power station that will have one road crossing. It shall be assumed that the switchyard will be located on 50% flat - 50% undulating land, 50% rural - 50% urban location and there will be no unforeseen environmental or civil costs associated with the development. The connection of the switching station into the existing transmission line will be turn-in, turn-out and will be based on the most economical (i.e. least cost) solution. It is assumed that the existing transmission line will not require modification to allow the connection with the exception of one new tower located at the substation to allow a point of connection. Shallow easement connection costs will be considered. Costs associated with any staging works will not be considered. The estimate will include all the components and costs associated with a standard substation;

1.2.2. Estimate the fixed operation and maintenance costs of this transmission line and meshed switchyard to mid 2010 value. The cost shall be in 5 year periods covering 1 to 5 years; 6 to 10 years; 11 to 15 years; 16 to 20 years; 21 to 25 years; 26 to 30 years; 31 to 35 years; 36 to 40 years; 41 to 50 years; 51 to 55 years; and 56 to 60 years respectively; and

1.2.3. Ensure the above mentioned transmission line and substation design and arrangement comply with the requirements of Western Power's technical rules for new developments.

1.3. Legal, Approval and Financing Estimate

1.3.1. Estimate a reasonable margin for the term 'M' used in the Market Procedure for: Determination of the Maximum Reserve Capacity Price (see attachment) giving due consideration to standard industry practices. It is expected that this will cover the following:

a. Legal cost associated with the design and construction of the power station;

b. Approval costs including environmental consultancies and approvals, and local, state and federal licensing, planning and approval costs;

c. Reasonable design costs associated with the power station which includes concept design, specification, tendering and contract negotiations;

d. Insurance costs required to insure the replacement of capital equipment and infrastructure; and

e. Cost of Capital raising including borrowing fees.