SINCLAIR KNIGHT MERZ
SKM

Independent Market Operator
IMO
Wholesale Electricity Market

Review of the Maximum Reserve Capacity Price 2009 - Power Station Elements

- Rev 2
- 14 January 2010

Review of the Maximum Reserve Capacity Price 2009 - Power Station Elements

- Rev 2
- 14 January 2010

Sinclair Knight Merz
ABN 37 001 024 095
100 Christie Street
PO Box 164
St Leonards NSW
Australia 1590
Tel: +61 2 9928 2100
Fax: +61 2 9928 2500
Web: www.skmconsulting.com

Contents

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
Draft	24-09-2009	G Glazier (Term 'M') & J McEnhill (Generation)	G Glazier	24-09-2009	Technical / PD Review
0	25-09-2009	J McEnhill	G Glazier	25-09-2009	Client Issue
1	06-10-2009	J McEnhill	G Glazier	07-10-2009	Client Issue
2	14-01-2010	Alex Lambe	G Glazier	14-01-2010	Client Issue

Distribution of copies

Revision	Copy no	Quantity	Issued to
Rev 0	1	1	Ben Williams – IMO
Rev 1	1	1	Ben Williams – IMO
Rev 2	1	1	Ben Williams – IMO

Printed:	14 January 2010
Last saved:	14 January 2010 10:34 AM
File name:	I:\HARB\Projects\HA01267\Deliverables\Reports\Power Station Elements\2009 IMO MRCP Report - Power Station Elements (Rev2).docx
Authors:	Nicholas Taylor / Alex Lambe
Project manager:	Anuraag Malla
Name of organisation:	Independent Market Operator
Name of project:	Review of the Maximum Reserve Capacity Price 2009 – Power Station Elements
Name of document:	Report
Document version:	Rev 2
Project number:	HA01267

1. Introduction

As part of the Government of Western Australia's commitment to establishing a wholesale Electricity Market within the South West Interconnected System, the Government of Western Australia has set up an Independent Market Operator (IMO) to administer and operate the Wholesale Electricity Market (WEM).

The WEM 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) have been commissioned to determine the following for the year 2009:

- Capital cost (procurement, installation and commissioning, excluding land cost) of a generic, industry standard, liquid fuelled, 160MW Open Cycle Gas Turbine (OCGT) power station;
- Fixed Operation & Maintenance 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 2009 – Non Power Station Elements".

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 160MW for gas fuel operation. For operation on liquid fuel with water injection, for NO_X emission control, the plant will 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 160MW open cycle gas turbine plant, SKM undertook the following steps:

- Development of a table of prices for a number of open cycle gas turbine plant using Version 19 (March 2009) of Thermoflow GT Pro/PEACE software;
- Normalisation of existing project data on recent similar sized plant developments, (removal of non-typical costs such as significant ground preparation, pilling, excessive environmental costs etc);
- Normalisation of existing project data, for recent plant developments, which included multiple generating units, alternative fuels or other similar scope elements, not applicable in plant configuration under consideration;
- Correlation of the Thermoflow GT Pro/PEACE derived cost data with the normalised reference data; and
- Normalisation of combined Thermoflow and existing project data to comprise costing for a generic 160MW 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 has 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 has utilised Thermoflow GT Pro®/PEACE® together with its in-house cost data to develop capital costs for a number of single unit OCGT plants with nominal output of 160MW (exact plant capacities are dependent on the nearest matching gas turbine).

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 owners costs.

In developing the cost estimates, SKM has assumed a standard green field site located in Western Power's SWIS region and 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 25m.

2.3. Project Data Price Review

In developing the end cost estimate, SKM has also utilised information garnered from a number of projects that it has been involved with over the past several years. 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 has been derived from projects that have been completed and are in commercial operation or are nearing that milestone.

Capital cost of plant development in Australia has increased above that of CPI and to this end, CPI over the past few years does not provide an accurate picture of plant development escalation. To address this, SKM has developed and utilises a number of escalation factors for varying aspects of a power plant and has applied these to bring the total capital estimate to June 2009 money terms.

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 produced by 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 1.71 for the Euro, 1.15 for the US dollar and 1.13 for the Swiss Franc, August 2009). 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 160MW 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 duel 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 1000t 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 25ppmv 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.

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.

2.5. OCGT Capital Cost Estimate

A breakdown of the capital cost estimate for a 160MW 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$119,200,000. This equates to a capital cost of **AUD$745/kW** at the assumed conditions (25°C, 60% RH, 25m and an output of 160MW).

Table 2-1 Generic 160MW OCGT capital cost estimate

Item		Cost [$]
1	Main Plant Equipment	$ 77,300,000
2	Balance of Plant	$ 2,900,000
3	Civil Works	$ 10,400,000
4	Mechanical Works (including installation)	$ 8,800,000
5	Electrical Works (including installation)	$ 2,500,000
6	Buildings	$ 1,800,000
7	Engineering & Plant Start-up	$ 3,800,000
8	Contractor's Costs	$ 11,600,000
Total EPC Cost		$119,200,000

All costs are presented as mean values ± 10 %.

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 160MW 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 2009 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

The CPI figure fell significantly during the recent economic downturn (at 1.5% year to June 2009), while the Labour Price Index for WA also decreased (at 5.1% year to June 2009), leading to a reduction in the 2008-2009 composite escalator for O&M, when compared to the 2007-2008 rate.

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

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

The 2008-2009 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 2009 dollar terms.

Table 3-1 OCGT plant fixed O&M costs

O&M Cost Component	[$M pa]
Plant operator labour	0.480
OCGT Substation (connection to tie line)	0.223
Rates	0.056
Market Fee	0.056
Balance of plant	0.119
Consent (EPA annual charges emissions tests)	0.028
Legal	0.025
Corporate Overhead	0.210
Travel	0.023
Subcontractors	0.315
Engineering Support	0.063
Security	0.116
Electrical (Including Control & Instrumentation)	0.112
Fire	0.056
Total	**1.883**

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 2009 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	$ 9,415,000	$ 9,415,000	$ 9,415,000	$ 9,415,000	$ 9,415,000	$ 9,415,000	$ 56,490,000

All costs are presented as mean values ± 10 %.

4. Calculation of the term 'M'

The IMO's market procedure for making a determination of the maximum reserve capacity price, 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' provides a means to account for additional "Owners Costs" encountered during the development of a power station and is incorporated into the capital cost determination as a margin i.e. a fixed percentage, added to the capital cost:

Page 11 of the IMO's Market Procedure for Maximum Reserve Capacity Price identifies how the Term M fits into the maximum reserve capacity price 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."*

In calculating a suitable figure for 'M,' SKM has estimated the Legal, Approval and Financing costs for a generic 160MW open cycle gas turbine plant, which is defined as the "*Power Station upon which the maximum reserve capacity price shall be based*" in Section 1.5 of the IMO's proposed methodology.

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

[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.

generic OCGT legal; approval and financing cost estimate for a generic 160 MW liquid fuelled open cycle gas turbine plant.

The varying costs were each normalised and any abnormal cost variations relating to unique or unusual project factors removed. 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 fully underwritten project to build a 160MW OCGT power station. SKM understand that this cost is dependent on the nature of capital markets at the time of the capital raising process and that over the last 12 months costs may have been higher than the long term average. The figure used is based on SKM's recent experience and knowledge gained through discussions with industry contacts and not on detailed analysis of project data.

Table 4-1 shows SKM's estimate for the term 'M' used in Appendix 4 of the WEM Rules, 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[3]	4.0%

[3] SKM note that its previous 2008 review of the calculation for Term "M" contained a separate line item cost labelled "Financing charges (IDC)". Cost related to this particular EPC line item is accounted in the determination of WACC and does not form the scope of this work. The "Cost of Raising Capital" denotes the cost incurred by the proponent to raise equity and debt to build 160MW OCGT power station in WA from the financial market.

Component of 'M'	% of Total EPC
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)[4]	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)

[4] SKM note that its previous 2008 review of the calculation for Term "M" contained a separate line item cost labelled "Owners Engineering Costs to Oversee, Witness Tests etc." Cost related to this particular EPC line item have now been included within the cost component entitled "Owners Engineers - Part B (Including Construction Phase OE Costs, oversee project, witness tests & Commissioning)".

5. Changes from 2008 SKM review

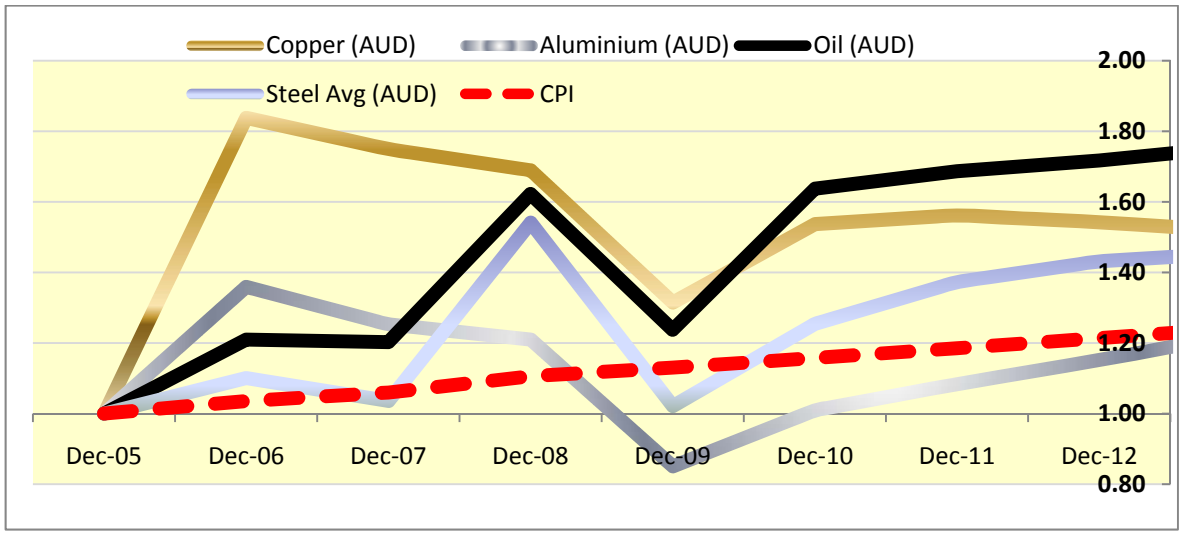
This section of the report discusses some of the changes to the Economic Environment affecting EPC projects since June 2008, which were brought into account during the determination of costs and factors in this report.

A World Bank June 2008 report entitled "*Study of Equipment Prices in the Energy Sector*", which focused on power generation projects, stated that;

"*In the past four years, global demand has led to substantial increases in equipment and material prices in the power sector. This is mainly due to significant increases in the escalation of raw materials and labor associated with the manufacture and fabrication of equipment*"[5]

However, it was widely expected that the onset of the Global Financial Crisis (GFC) would affect EPC and Gas Turbine prices through the knock on effect of falls in prices of commodities used in manufacturing and construction processes.

Figure 5-1 below shows the historic and forecast movements of a number of commodities (in AUD equivalent prices)

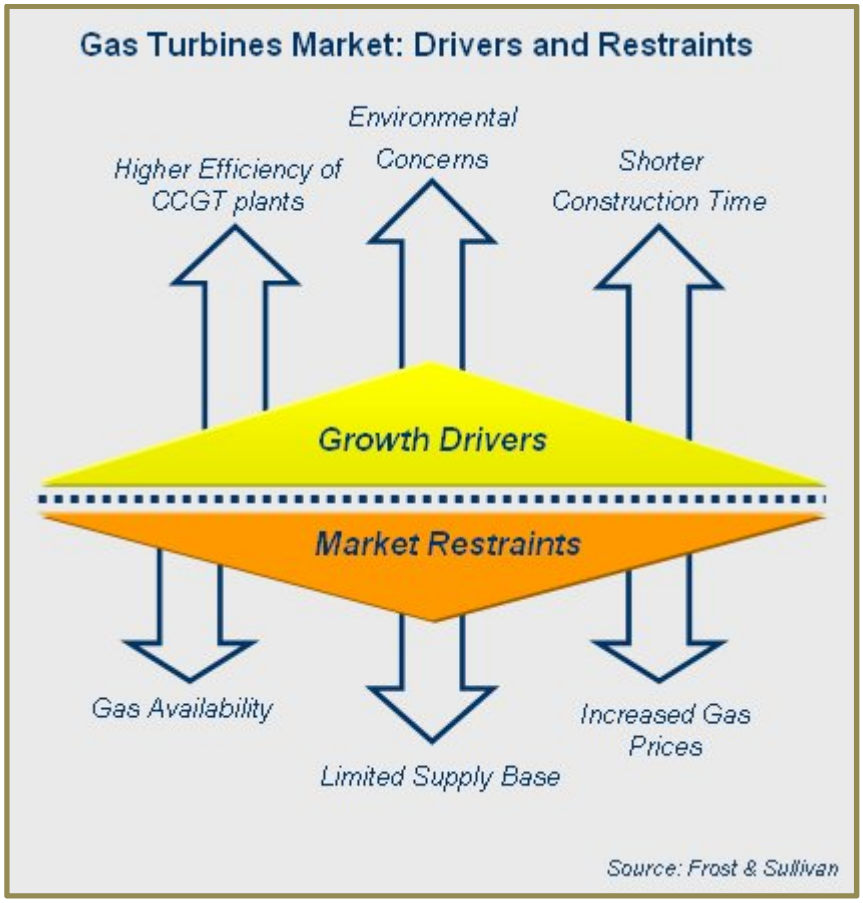


- **Figure 5-1 Historic and forecast commodity price movements. Source: SKM analysis.**

[5] Available as a download from: http://esmap.org/filez/pubs/724200833229_power_prices.pdf

Despite these commodity price corrections, a recent report by market analysts Frost & Sullivan suggested that the market for gas turbines will remain resilient. The research highlighted that the main drivers of the market are not expected to be materially affected by the recent downturn of the global economy.

An excerpt from the Frost & Sullivan report below[6] discusses some of the major forces shaping the market price of Gas Turbines.



- **Figure 5-2 Drivers and restraints of the global gas turbine market.**

"*A look at the main drivers for the gas turbine industry – as given above - reveals that most of these are not significantly affected by the slowdown. CCGT plants will remain the technology of choice for new power stations as they are more efficient and cleaner than alternative modes of generation*

[6] Available as a download from: http://www.frost.com/prod/servlet/market-insight-top.pag?docid=155528289

such as coal-fired power stations. They are also much quicker to build than other options such as coal and nuclear. On the market restraints side, the current financial and economic situation is making the restraints less important".[7]

In addition to these general drivers, it is the following specific factors that will support the gas turbines market during this time of financial and economic uncertainty:

- Comparatively lower capital cost with respect to alternative forms of power generation;
- Lower construction and operational risk;
- Public concern with alternative coal fired power generation;
- Established technology; and
- Consolidation in the manufacturing and supply base, particularly in the capacity range under consideration in this study.

SKM concluded that the continued escalation of prices for the generic 160MW open cycle gas turbine plant, as obtained through its analysis and research, were reasonable.

[7] Available as a download from: http://www.frost.com/prod/servlet/market-insight-top.pag?docid=155528289

Appendix A Scope of Work

Extract from proposal letter HAP0214

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 2009 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 2009 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 2009 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 cost including environmental consultancies and approvals, and local, state and federal licensing, planning and approval costs

c. Reasonable design costs associated with the power station; and

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

SKM proposes to apply a range of internally built escalation indices to bring the costs up to 2009 financial terms. Such indices incorporate the impact of the worldwide movement in commodity prices, foreign exchange, labour rate indices, factory gate indices and the consumer price index.