AEMO

2017 Benchmark Reserve Capacity Price for the South West Interconnected System

October 2016

document.

WATER | ENERGY & RESOURCES | ENVIRONMENT | PROPERTY & BUILDINGS | TRANSPORTATION

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Abbreviations

Units	Meaning
AEMO	Australian Energy Market Operator
ABS	Australian Bureau of Statistics
ARI	Assessment by Referral Information
AUD	Australian Dollars
BOP	Balance of Plant
BRCP	Benchmark Reserve Capacity Price
°C	Degree Celsius
CE	Consensus Economics
CF	Capacity factor = (kWh/(kW rating x 8760hr)
CPI	Consumer Price Index
DLE	Dry Low Emission
EGW	Electricity, Gas, Water and Waste Water
EPA	Environment Protection Authority
EPC	Engineer, procure and construct
FEED	Front End Engineering Design
FFC	Fixed Fuel Cost
GJ	Gigajoule = 10^9 Joules
GWh	Gigawatt hours = 10^6 kilowatt hours
HHV	Higher heating value
Hr	Hours
ISO	International Standards Organisation
Kg	Kilogram (mass)
kJ	Kilojoule = 10^3 Joules
Km	Kilometre = 1000 metres
kV	Kilovolts
kW	Kilowatt = 10^3 Watts
kWh	Kilowatt hour

Units	Meaning
LHV	Lower heating value
LME	London Metal Exchange
M^3	Cubic metre
MJ	Megajoule = 10^6 Joules
MRCP	Maximum Reserve Capacity Price
MW	Megawatts = 10^6 Watts
MWh	Megawatt hours = 10^3 kWh
O&M	Operating & maintenance
OEM	Original Equipment Manufacturers
OCGT	Open Cycle Gas Turbine
PEACE	Preliminary Plant Engineering and Cost Estimation
RBA	Reserve Bank of Australia
T	Metric tonne = 1000 kg
TPA	Tonnes per annum
W	Watt (electric power)
WA	Western Australia
WACC	Weighted Average Cost of Capital
WEM	Wholesale Electricity Market
WPI	Wage Price Index
Yr	Year

1. Introduction

1.1 General

The Australian Energy Market Operator (AEMO) is required each year to determine the Benchmark Reserve Capacity Price (BRCP), as required under clause 4.16 of the Western Australian (WA) Wholesale Electricity Market (WEM) Rules. The BRCP is used to set the maximum price that may be offered in a Reserve Capacity Auction, or as an input in the determination of the administered Reserve Capacity Price if an auction is not required.

The Market Procedure outlines the methodology used to determine the BRCP, which is calculated by undertaking a technical bottom-up cost evaluation of the entry of a new 160 MW OCGT generation facility in the South West interconnected system (SWIS). The power station must:

a. Be representative of an industry standard liquid-fuelled OCGT power station.

b. Have a nominal nameplate capacity of 160 MW prior to the addition of any inlet cooling system.

c. Operate on distillate as its fuel source with distillate storage for 14 hours of continuous operation.

d. Have a capacity factor of 2 per cent.

e. Include low nitrous oxide (NOx) burners or associated technologies (for example water injection) as considered suitable and required to demonstrate good practice in power station development.

f. Include an inlet air cooling system where this would be cost effective.

g. Include water delivery and storage capability to support 14 hours of continuous operation.

h. Include the minimum level of equipment or systems required to satisfy the balancing Facility Requirements.

1.2 Scope and Limitations

1.2.1 Scope

The market rules require that a review be conducted of the Benchmark Reserve Capital Price each year. GHD was commissioned by AEMO to carry out a bottom up evaluation for the following items updated to 2019-2020:

- The power station costs for a single liquid fuelled 160 MW OCGT unit inclusive of components for the gas turbine engines, and all other costs that would normally be applicable to such a power station
- The fixed operating and maintenance costs (O&M) for the power station operating with a capacity factor of 2%.
- The fixed fuel costs (FFC) for the power station inclusive of a fuel storage and handling facility able to supply fuel for 24 hours of operation. The cost for FFC will however make provision for 14 hours of operation at maximum capacity.

- The value of Margin M, which constitutes the following costs associated with the development of the power station project:
  - Legal costs associated with the design and construction of the power station. Financing costs associated with equity raising.
  - Insurance costs associated with the project development phase.
  - Approval costs including environmental consultancies and approvals, and local, state and federal licensing, planning and approval costs.
  - Other costs reasonably incurred in the design and management of the power station construction.
  - Contingency costs.

1.2.2 Disclaimer

This report: has been prepared by GHD for AEMO and *may only be used and relied on by AEMO for the purpose agreed between GHD and AEMO as set out in section 1.2.1 of this report.*

GHD otherwise disclaims responsibility to any person other than AEMO arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared the cost estimate/prices set out in this report using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD.

2. Cost Escalation

The following sections examine the main factors that affect the cost for power plants. They are:

- Escalation rate
- Consumer price index (CPI);
- Australian Electricity, Gas, Water and Waste Water (EGW) labour Wage Price Index (WPI)
- Currency Exchange Rate
- Steel & Copper Prices

In the analysis for cost escalation rates and price indices, GHD relies on its experience of past projects and previous models for escalation rates and price indices. GHD has, in evaluating the capital cost for the OCGT plant, used GTPro software and inputted the current relevant indices for labour, materials and commodities. In order to establish trends, historic data for escalation, labour rates and indices were sourced from well-known public domains, however, our analysis is based on current data available at the time of compilation.

The following subsection provide a summary of the trends for each of the above.

2.1 Escalation Rates

Summary for the individual forecasted five year escalation rate in % change is presented in Table 1. The process for determining each escalation parameter will be described in the following sections.

Table 1 Five year escalation forecast rate % change

	CPI	EGW Labour	WA Labour	Copper	Steel
Year to June 2017	2.0%	2.0%	1.6%	-18.4%	0.69%
Year to June 2018	2.0%	2.0%	1.6%	1.81%	2.96%
Year to June 2019	2.50%	2.4%	1.9%	0.78%	1.78%
Year to June 2020	2.50%	2.4%	1.9%	0.84%	3.31%
Year to June 2021	2.50%	2.4%	1.9%	0.86%	2.05%

2.2 Australian Consumer Price Index (CPI)

Current CPI values were obtained from the Australian Bureau of Statistics (ABS) as percentage change from the corresponding quarter of the previous year[1]. Forecast data was obtained from the Reserve Bank of Australia (RBA) Statement of Monetary for June 2016[2]. The RBA projects CPI inflation figures are released twice yearly. Table in the short term RBA outline the CPI for the next two years and show a long term table for CPI for a further two and a half years.

The five year Australian CPI % change forecast is summarised in Table 2.

[1] 6401.0 Consumer Price Index, Australia, Jun 2016, ABS, Tables 1 and 2, ID:A2325847F, http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6401.0Jun%202016?OpenDocument

[2] Statement on Monetary Policy August 2016, RBA, Table 6.1, http://www.rba.gov.au/publications/smp/2016/aug/

Table 2 Australian CPI % change forecast

Year to June	2016 Actual	2017 Forecast	2018 Forecast	2019 Forecast	2020 Forecast	2021 Forecast
CPI % Change	1.0%	2.0%	2.0%	2.5%	2.5%	2.5%

2.3 Australian Electricity, Gas, Water and Waste Water (EGW) Labour

Modelling the Labour indices sourced figures from the ABS for the Wage Price Index (WPI) for June 2016.

The trend for the EGW WPI figures is a downward trend due mainly to the reduced activities in the energy and resources over the past two to three years[3]. The % change in EGW WPI has steadily reduced since 2013 to a % change to June 2016 of 2.4% and is likely to remain as such for the at least the next year. Based on this decline GHD has estimated the following 5 year forecast based on maintaining the same rate of decline for 2017 (-0.4%), remaining neutral for 2018 before increasing by the same rate as used to estimate the 2017 value (+0.4%). From 2019 onwards we assumed that the rate remains constant until 2020 as shown in the table below.

Table 3 Estimate for Annual EGW WPI % change for 2017 to 2020

Year to	% Change
June-2016 (current)	2.4
June-2017	2.0
June-2018	2.0
June-2019	2.4
June-2020	2.4
June 2021	2.4

2.4 Western Australia Labour

This data was again sourced from ABS WPI June 2016 report Table 2a[4]. These figures are not specific to the power industry however they do apply to WA.

Similarly, as for the Australian WPI figures, the trend for the annual EGW WPI for the State of WA is also on a downward trend and is likely to remain as such for the at least the next year. Based on this decline (1.9% for June 2016) GHD has estimated the following five year forecast based on maintaining the same rate of decline for 2017, remaining neutral for 2018 before increasing by the same rate as used to estimate the 2017 value. From 2019 onwards we assumed that the rate remains constant until 2020 as shown in the table below.

[3] Mining activities in WA as well as development of LNG project in Queensland has impacted significantly on the downward trend (% change) for the EGW WPI.

[4] 6345.0 Wage Price Index, Australia, Jun 2016, ABS, Table 2a, http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6345.0Jun%202016?OpenDocument

Table 4 Estimate for Annual EGW WPI % change for 2017 to 2020

Year to	% Change
June-2016 (current)	1.9
June-2017	1.6
June-2018	1.6
June-2019	1.9
June-2020	1.9
June 2021	1.9

2.5 Euro to AUD Exchange Rate

Section 3 outlines the model and variant that the OCGT power plant for this 2017 report is based upon. The largest piece of plant is the gas turbine package and being the SGT5-2000E, this package would be sourced from Siemens in Europe. Therefore, GHD has used the current Euro to AUD exchange rate of 0.6845[5] Euro/AUD to apply to cost for the gas turbine package.

2.6 AUD to USD Exchange Rate

The output of the balance of plant form GTPro cost estimates are in USD and due to the presence of internationally traded commodities being traded in USD, such as copper and steel, which is used to construct the OCGT plant, the forecasted exchange rate between the US and Australia was modelled.

The current figures were sourced from current and historical RBA data[6], taking the annual average year to June 2016. Forecasted figures were sourced from the CME group, Australian Dollar Futures[7]. CME figures were sourced quarterly and averaged over the year to June period for the forecasted years, these values are recorded in Table 5.

Table 5 Annual average AUD to USD exchange rate

Year to June	2016 Actual	2017 Forecast	2018 Forecast	2019 Forecast	2020 Forecast	2021 Forecast
USD/AUD Annual Average	0.728	0.761	0.755	0.750	0.743	0.737

2.7 Copper Prices

Copper is used in a number of areas of the OCGT plant and will influence the cost for the copper based packages as the price of copper varies. The spot price for copper is AUD $6414.52[8]

[5] This exchange rate is relevant as at 13 October 2016.

[6] Exchange Rates - Daily - 2014 - Current, RBA, http://www.rba.gov.au/statistics/historical-data.html#exchange-rates

[7] Australian Dollar Futures, Accessed: 22/09/2016 http://www.cmegroup.com/trading/fx/g10/australian-dollar.html

[8] Based on the spot price as at 17 October 2016.

The analysis carried out for the copper price was to use market forward prices for current and short term forecasts. Long term figures were then used to establish a long term approximation for the 5 year forecast.

The LME figures, short and long term figures were then linearly interpolated to establish the necessary long term figures. The average for each year to June was then calculated and converted to AU$ using figures in Table 5 .These forecasts and % change figures are summarised in Table 6.

Table 6 Annual average copper price (AUD)

Year to June	2016 Actual	2017 Forecast	2018 Forecast	2019 Forecast	2020 Forecast	2021 Forecast
Copper Price AUD Mt	$7,725.27	$6,306.23	$6,420.14	$6,469.82	$6,524.44	$6,580.21
% Change		-18.369%	1.806%	0.774%	0.844%	0.855%

2.8 Steel Price

Steel is used in a larger number of areas of the OCGT plant and will influence the cost for steel based packages as the price of steel varies. The spot price for steel is AUD $674.13

The steel forecast model extracts figures from the current spot price (17th October 2016), the short term price for 2.5 year forecast in quarterly increments and the long term forecast figures (7.5 years).

Linear interpolation was then applied to establish the value for the years in between the short term and long term forecast. The figures were averaged to year to June values and converted to AU$ again using Table 5. These figures are summarised in Table 7.

Table 7 Annual average steel price (AUD)

Year to June	2016 Actual	2017 Forecast	2018 Forecast	2019 Forecast	2020 Forecast	2021 Forecast
Steel Price AUD Mt	$595.10	$599.22	$616.94	$627.95	$648.75	$662.03
% Change		0.69%	2.96%	1.78%	3.31%	2.05%

2.9 Capital Cost Escalation Factors

The annual capital cost escalation factors determined by GHD for the forecast year to end of June for the next five years are shown in the table below.

Table 8 Annual capital cost escalation factors

Year to June	2016 Actual	2017 Forecast	2018 Forecast	2019 Forecast	2020 Forecast	2021 Forecast
Power station	1.0%	-1.01%	2.51%	1.96%	2.81%	2.12%

Based on previous work carried out by GHD our estimate for steel in an OCGT of 160 MW capacity contains 13 tonnes/MW and our estimate for copper in an OCGT of 160 MW capacity contains 1.75 tonne/MW. Using these figures and the forecasts for copper and steel prices in sections 2.7 and 2.8 respectively GHD has evaluated power station capital cost escalation as shown in the table above.

Using the escalation factors in the above table, the total capital cost estimate of the power plant on 1 April 2019 is forecasted to be $119,117,000 which equates to $802/kW[9]. This estimate is as per the Market Procedure for MRCP which requires the estimate to be as at April in year 3 of the reserve capacity cycle.

2.10 Fixed Operational & Maintenance Cost Escalation Factors

The annual operating and maintenance cost escalation factors determined by GHD for the forecast year to end of June for the next 5 years are shown in the table below.

Table 9 Annual O&M cost escalation factors

Year to June	2016 Actual	2017 Forecast	2018 Forecast	2019 Forecast	2020 Forecast	2021 Forecast
Power station	1.64%	2.58%	1.85%	2.33%	2.33%	2.33%
Connection Switchyard	1.9%	1.6%	1.6%	1.9%	1.9%	1.9%
Overhead transmission line	1.9%	1.6%	1.6%	1.9%	1.9%	1.9%

The fixed operating & maintenance escalation factors for connection switchyard and overhead transmission line follow the Australian EGW WPI figures whilst the fixed operating & maintenance escalation factors for the power plant (O&M) were evaluated by applying the relevant cost indices weighted by the relevant plant cost items.

Using the escalation factors in the table above, the fixed O&M cost estimate of the OCGT 160 MW power plant in October 2019 is forecasted as $2012.2 per annum ($10,061 for a 5-year period in October 2019 dollars).

[9] Based on 148.5 MW net output as stated in section 3.5.

3. Cost for Power Plant

3.1 Methodology used to estimate cost for power plant

GHD used the current version 25 of GTPro which is part of Thermoflows software packages. This software allows the user to evaluate the performance output for any commercially available gas turbine as well as provide an updated estimate for the gas turbine as well as balance of plant which in this case is the gas turbine is configured as an open cycle GT (OCGT). The software is updated annually by Thermoflow Inc. by interviewing relevant Original Equipment Manufacturers (OEM) such as GE, Siemens, Mitsubishi, etc., to obtain up to date performance and cost detail from each OEM.

The list of available gas turbines in GTPro includes key models that are provided by OEM as well as their variants. For this reason, GTPro is considered to be a more accurate source for gas turbine performance (output, efficiency, etc.) than other sources such as the internet and websites which tends to provide performance output for a specifically configured model.

Our approach to model the 160 MW OCGT for both performance and project cost was:

- Choose a suitable gas turbine and configure the turbine with the relevant balance of plant equipment for OCGT operation and configure it to run on diesel fuel; (using assumption outlined in section 3.3).
- Adjust the labour cost and commodity factors in the software's input assumption list to reflect that the plant is to be built in WA;
- Run the model for ISO conditions and record the performance output;
- Re-run the model at assumed site conditions and record the performance output
- Obtain a cost estimate output (this is an add-on feature of Thermoflow Inc. software) from the model configured to operate at site conditions (all costs are provided in US$ and GHD used the US$/A$ currency exchange to convert these costs to A$);
- Remove the cost provided by GTPro for the supply of the gas turbine package and replace it with the current cost for the SGT5-2000E supplied from Siemens in Europe (using the Euro/A$ currency exchange to convert this cost to A$);

3.2 Overview of diesel fuelled power plant

The following sub-sections deals with the development of the capital cost estimate for a single unit, industrial type, liquid fuelled 160 MW open cycle gas turbine power plant located in the SWIS region of Western Australia.

GHD has reviewed the following gas turbines for suitability for the 160 MW OCGT power plant:

Table 10 OCGT Units considered for this cost estimate

Gas Turbine	Comments
Siemens SGT5-2000E (33MAC)	This unit was used in the last several years to develop the Benchmark Reserve Capacity Price. The nameplate rating for this unit on diesel fuel is 173 MW (gross) at ISO conditions[10]. The unit comes in 3 versions or variants; the 25MAC, 33MAC and 41MAC. For the prevailing site conditions this unit will have a net rating of 161.5 MW for the 33MAC version. Siemens suggests that for a peaking plant the 33MAC version is better suited and hence this unit was selected for the reference machine for this cost estimate.
Alstom GT13E2 (now owned by GE but still showing as Alstom GT13E2 in GTPro)	The nameplate rating for this unit on diesel fuel is 191.2 MW (gross) at ISO conditions. The unit comes in 2 versions; the GT13E2 and GT13E2 (MXL2). For a prevailing site conditions this unit will have a net rating of 172 MW and therefore is considered to be less suitable than the SGT5-2000E unit. Also it is not clear what will happen to this unit now that GE has taken over the Alstom Power business.
GE 9E.04	The nameplate rating for the 9E 04 unit on diesel fuel is 157 MW (gross) at ISO conditions with maximum water injection. The GE 9E unit comes in two versions; the GT-9E 03 and GT-9E.04. The nameplate rating for the GE 9E 04 is 144 MW @ ISO conditions and at the prevailing site conditions the GE 9E 04 unit will have a net rating of 137.2 MW and therefore is considered to be less suitable than the SGT5-2000E unit.

In developing the capital cost estimate, GHD used the latest version of GTPro (version 25) and modelled the Siemens SGT5-2000E (33MAC variant) machine for ISO conditions at a typical power plant site in the SWIS (Muja PS) and then applied the necessary inlet cooling system and water injection rate for the gas turbine operating a 41°C ambient condition and providing the lowest NOx emissions. The capital cost estimates for the reference power plant was obtained from GTPro's "Peace" output which has current estimates for 2016. A cross check with last year's estimate (2015) for the same machine was carried out to identify any significant variations. Where possible cost references were made to Australian power projects involving SGT5- 2000E machines[11]. GHD applied the relevant escalation to establish a year 2016 project cost for these projects and compared them with the project cost obtained from GTPro. The cost obtained from GTPro was found to be within the limit of accuracy[12].

[10] This is the nameplate rating provided by GTPro software.

[11] All these projects were constructed pre 2010 and the appropriate escalation was used to compare prices.

[12] For cost estimates produced by GTPro without front end engineering design (FEED) the level of accuracy is usually about +/-30%.

In Australia the SGT5-2000E has been installed for the following power pants:

- One unit in Queensland at the Townsville power plant (firing gas)
- Three units in Queensland at the Braemer 2 power plant (firing gas)
- Two units in Victoria at Laverton power plant (firing gas & diesel)
- Four units in NSW at Uranquinty PS (Siemens V94.2 (now known as SGT5-2000E))

For all evaluation of the cost for the power station, GHD has applied a cost escalator that is based on the mid-point of the forecasts of the Reserve Bank of Australia (RBA).

3.3 Assumptions

The capital cost for the liquid fuelled OCGT power plant has been estimated by GHD on the basis of an EPC contracting strategy where the capital cost is comprised of engineering, procurement and construction (inclusive of commissioning and testing). The following assumption apply to the capital cost for the power plant:

- A Siemens SGT5-2000E (33MAC) machine was used as the basis of the OCGT plant;
- Evaporative air cooling is included in the supply package for the power plant;
- The cost estimate is based on a suitably designed liquid fuelled combustor fitted with dry low emission (DLE) combustor technology;
- Water injection for NOx emission abatement is used for distillate fuel operation;
- Distillate fuel storage and handling is not included in the cost for the power plant (it is treated separately in Section 4.4;
- Site conditions having the following values:
  - A site elevation of 217 metres above sea level (based on Muja PS)
  - A net maximum ambient temperature of 41°C
  - Relative humidity of 30%
  - The power plant site is assumed to be relatively flat, requiring minimal civil works, and all foundations are of the spread footing type
  - Natural ground water table is assumed to be below the depth required for excavation
  - Plant and equipment can be transported from a nearby sea port to the site over existing roads and bridges;
  - Land cost is not included.
- A demineralised water treatment plant together with a 1200 tonne demineralised water storage tank is included in the cost estimate.
- A storage tank for potable water of 300 tonne capacity plus a fire water storage tank is included in the cost estimate;

3.4 Plant output at ISO and 41°C ambient temperature

The Siemens SGT5-2000E MAC 33 was modelled using GTPro software. The site assumptions considered are as shown in section 3.3.

The performance data from the Siemens SGT5-2000E model is provided in The table below.

Table 11 Performance for the SGT5-2000E at site conditions

Description	Units	Value
Ambient Conditions	Deg C / % RH	41.0 / 30% RH
Gross Power	MW	161.53
Net Power	MW	159.13
Auxiliary/Losses	MW	2.40
Gross Heat Rate / Efficiency (LHV)	kJ/kWh / (%)	11,354 / 31.71%
Net Heat Rate / Efficiency (LHV)	kJ/kWh / (%)	11,525 / 31.24%
Air temperature post cooler	Deg C	27.0
Diesel Fuel Consumption	Tonnes	42.74
Water for water injection	Tonnes	59.7
Flue Gas Exhaust Temperature	Deg C	552.9

As mentioned in previous text, the plant performance for the SGT5-2000E in an OCGT configuration was derived using GTPro software. The 33MAC version was modelled first using ISO conditions to obtain the respective gross (at generator terminal) and net (export to the grid) output.

For the 160 MW (generic) power plant, GHD set the gross output for the generic power plant to 160 MW and based on the results of the SGT5-2000E power plant, the net output for ISO conditions was established using the scale down quantity of ancillary power usage. The gross and net outputs for the generic 160 MW power plant were established by scaling down from the results of the SGT5-2000E gross and net site conditions results.

The performance of the SGT5-2000E and the generic 160 MW power plant is provided in the table below:

Table 12 SGT5-2000E Performance

Case	ISO Conditions		Site Conditions	
	MW (gross)	MW (net)	MW (gross)	MW (net)
SGT5-2000E	173.0	170.5	161.5	159.1
160 MW (generic)	160.0	157.7	150.8	148.5

3.5 Capital Cost Estimate

The cost breakdown for the OCGT power plant is provided in Table 13 below

Table 13 Capital cost breakdown for the power plant

Cost Item	Based on Siemens SGT5-2000E (33MAC)*	Equivalent 160 MW Power Station
Specialised Equipment**	75,064,000	69,422,800
Other Equipment*	3,917,500	3,623,100
Civil works**	12,315,300	11,389,900
Mechanical Works**	8,739,800	8,083,100
Electrical Works**	2,913,700	2,694,750
Building & Structures	2,663,400	2,663,400
Engineering & Plant Start-up	4,258.800	4,258.800
Communications & Control Equipment**	651,200	602,300
Commissioning & Testing Cost	566,200	566,200
Contractor soft cost & Misc. Costs	13,544,700	13,544,700
Total	124,634,600	116,849,050
A$/kW (net)	783.4	786.8 (say 787)

* All costs are in 2016 dollars

** Scalable costs

The costs were established from GTPro (Peace) and were converted from US$ using an exchange rate of AU$1.00 = US$0.75. The cost for the Siemens SGT5-2000E gas turbine package was converted using an exchange rate of AU$1.00 = Euro 0.6845 From the table above, the capital cost for a 160 MW liquid fuelled OCGT is $787/kW.

The reference capital cost used to check the output of GTPro Peace estimates are based on recent power plant projects (Braemar PS and Mortlake PS – there have been more recent project completed or in the process of being completed but these projects are based on aero-derivative gas turbines not industrial turbines such as the unit assumed for this report).

Based on last year's capital cost estimate, there is a variation of -$1.87 million from this year's cost estimate. The price variation is due to manly to a decrease in the labour cost indices in Western Australia as this year WA has the lowest inflation than any other state and the effect of the mining boom collapse continues to impact on labour rates.

4. Fixed Operating & Maintenance Costs

4.1 Overview of fixed operating & maintenance costs

Once the power plant configuration was defined GHD used their internal O&M data bank to establish the fixed operating cost estimate using a bottom up approach. The fixed operating & maintenance (O&M) cost is comprised of the following items:

- Plant operator labour cost
- Corporate overhead for operating costs
- Regular and routine maintenance costs associated with OCGT substation, and balance of plant;
- Regular reporting on generator licence and environmental issues pertaining to emissions and compliance with EPA permit;
- Annual legal costs
- Travel
- Subcontractors
- Annual engineering reports/studies;
- Security
- Servicing and support for fire detection & protection system;
- Fixed O&M for associated overhead transmission line and connection at switchyard inclusive of:
  - Labour costs for routine maintenance
  - Cost for machinery, plant and tool hire for routine maintenance;
  - Overhead corporate costs (management, administration & operations)

For all evaluation of the fixed O&M cost for the power station, GHD has applied a cost escalator that is based on the mid-point of the forecasts of the Reserve Bank of Australia (RBA).

4.2 Assumptions

The fixed O&M cost for the liquid fuelled OCGT power plant has been estimated by GHD on the following basis:

- The assumed power plant capacity factor is 2% pa;
- An annualised fixed O&M cost associated with each major component has been estimated for each 5-year period for up to 60 years;
- Fixed O&M costs were determined as at 1 October in year 3 of the reserve Capacity Cycle.
- Variable costs for the OCGT plant such as schedule maintenance has not been included in the fixed O&M costs;
- One shift for operators and maintenance crew has been assumed;

4.3 Fixed O&M Costs

The fixed O&M costs have been derived using GHD's O&M data bank for OCGT plants. Where applicable a cost escalator of 2% was used to establish the fixed cost estimate for 2017 (refer Table 2). The costs are provided in the table below.

Table 14 O&M Costs

O&M Cost Component	Fixed Cost Estimate ($ pa)
Plant Operator Labour (1 x Plant Mgr @ $180K, 2 x Operators @ $140K each, 2 x Technical Assistants @ $60K each and 1 x receptionist @ $40K.	620,000
OCGT Substation (connection to tie line)	240,000
Rates (2.0% increase on last year's rates since rate generally increase in line with CPI)	65,300
Market Fee ($72.65.0/day[13] x 365 days)	26,517
Balance of Plant (service of pumps, water plant, fire system, etc., using a contract of 0.12% of capital for Mechanical and Electrical services	140,400
Consent (EPA annual Charges emission testing) Based on previous data for this a range of $30,000 to 45,000 is considered as a fee for this service. GHD has assumed a mid-point of $37,500	37,500
Legal - There are years when legal costs are negligible and some years, depending on the number of legal disputations, this cost could be as high as 40,000 or more. GHD assumes a year where there are 2 legal disputations costing $15,000 each. A total of $30,000 is therefore assumed for legal costs.	30,000
Corporate Overhead (apply 30% based on items such as superannuation contributions, work cover contributions, contribution to corporate office lease, cost for office staff in the corporate office, ongoing training of staff, employee insurance)	186,000
Travel (allow 10 domestic flights/accom @ $1200 each plus 2 International flights/accom @ $8000 each (Because there are occasions when Siemens may conduct workshops or training courses overseas GHD has allowed for 2 x international flights. This allowance could also be extended to overseas conferences that would be relevant to OCGT plant.	28,000
Subcontractors (Based on a more competitive environment among subcontractors since last year GHD deems that there would be at least a 20% saving (over last year's cost of $385,200) for services by Subcontractors. Therefore a cost of $314,320 is used for this year's value for subcontractor fees	314,320

[13] Source: AEMO Website.

O&M Cost Component	Fixed Cost Estimate ($ pa)
Engineering Support (Similarly as for the case of Subcontractors GHD has applied a 20% discount to Engineering services (on last year's cost estimate of $75,000) due to increased competition among engineering service providers to win work)	61,200
Security (Many services costs have remained the same as the previous year and security services would be one area where a service cost rise is not justified. The cost of 141,000 is considered high. GHD base the cost to be equivalent to hiring a security personnel at $120,000 pa)..	120,000
Electrical (including control & instrumentation) (This is similar to services for security. The last years cost is considered high and will be of the order of $104,000 (based on 8 hours/week for a service provider to check and report on the operation of electrical, instrumentation and controls equipment at a rate of $$2000/wk will be $104,000 pa)	104,000
Fire detection and Protection Systems (GHD has made an allowance of 2 hours /wk to check and report on the status of the fire detection and protection system. Based on a weekly rate of $750/wk the annual cost will be $39,000)	39,000
Total	**2,012,237**

The total fixed O&M cost estimate has increased by $184,763 from the 2015 reported value. The reason for this increase in value is a result of the following changes from last year's estimate:

O&M Cost Component	Variation from last year's results ($ pa)	Comments
Plant Operator Labour .	+$34,600	This year GHD has allocated number of staff, staff type and salaries for a typical OCGT plant
OCGT Substation (connection to tie line)	-$24,900	The connection cost is based on achieving a commercially acceptable return on the capital outlay for the connecting power line, protection, communications, etc. Our estimate resulted in a decrease from last year's figureand is likely due either a higher return on investmentor higher cost assumption used for last year's estimate compared with GHD's assumption in this report.
Rates	+$1,300	This is an increase in line with CPI from last year's figure which is a reasonable value for rates.
Market Fee	+$26,517	This value was not considered in last year's estimate.

O&M Cost Component	Variation from last year's results ($ pa)	Comments
Balance of Plant	-$1,200	This year GHD applied a value of 0.12% of capital for BOP O&M cost.
Consent (EPA annual Charges emission testing)	+3,000	This is an increase on last year's figure and is based upon GHD's mid-point range for this service.
Legal	+$1,600	This year GHD has based the legal fee on two legal disputations each valued at $15,000
Corporate Overhead	-$57,600	GHD has based corporate overhead on 30% of the salaries and is a reduction on previous years due to the fact that overheads such as office lease and corporate office staff has come down since the collapse of the mining boom.
Travel	-$400	This value has reduced slightly and is now based on 10 domestic flights and two international flights.
Subcontractors	-$70,880	This value has reduced significantly over last year's value and is due mainly to higher competition between subcontractors and discounting that is need to be competitive in a depressed subcontractor market.
Engineering Support	-$13,800	Similarly as for the subcontractor value, the value for engineering support has reduced significantly over last year's value and again is due mainly to higher competition between engineering service providers and the discounting that is needed to be competitive in a depressed engineering services market.
Security	-$21,000	Last year's cost was considered high and this year GHD based the cost for this service on a typical cost to employ a security staff @ $120,000 pa

O&M Cost Component	Variation from last year's results ($ pa)	Comments
Electrical (including control & instrumentation)	-$35,000	Similarly, as for the subcontractor and engineering support values, the value for electrical support has reduced over last year's value and again is due mainly to higher competition between electrical service providers. This year's cost estimate is based on 8 hrs/wk@ $2000/Wk.to carry out these services.
Fire detection and Protection Systems	-$27,000	Similarly, as for electrical services values, the value for fire detection & protection services has reduced over last year's value and is due mainly to higher competition between this type of service provider. This year's cost estimate is based on 2 hrs/wk@ $750/Wk.to carry out these services.
Total Variation	**-$184,763**	

Five yearly aggregate fixed O&M costs for the power plant are provided in Table 15 below.

Table 15 Fixed O&M cost for OCGT Power Plant ($2016)

Five Yearly Intervals	Fixed O&M Costs ($'000)
1 to 5 Years	10,061.2
6 to 10 Years	10,061.2
11 to 15 Years	10,061.2
16 to 20 Years	10,061.2
21 to 25 Years	10,061.2
26 to 30 Years	10,061.2
31 to 35 Years	10,061.2
36 to 40 Years	10,061.2
41 to 45 Years	10,061.2
46 to 50 Years	10,061.2
51 to 55 Years	10,061.2
56 to 60 Years	10,061.2
1 to 60 Years	**120,734**

4.4 Connection Switchyard and overhead transmission line

The fixed O&M costs have been calculated from the isolator on the high voltage side of the generator transformer.

The transmission line is assumed to be a single circuit 330 kV construction with 2 conductors per phase. The assumed power factor is 0.8 and for the 160 MW plant the line can facilitate the transport of up to 200 MVA.

A bottom up approach has been used to estimate the fixed O&M cost of switchyard and transmission line asset based on evaluating an annual charge for the connection infrastructure which assumes the substation and a 2 km HV connecting line to the tie-in point.

Maintenance cost for these type of assets occur irregularly and therefore GHD has assessed the costs before producing an annualised fixed cost.

The Fixed O&M cost estimate is inclusive of:

- Labour cost for routine maintenance;
- Overheads (management, administration, operations, etc.)
- Hire cost of machinery and equipment to support routine maintenance.

4.4.1 Assumptions

The following key assumptions apply to the switch yard and transmission line O&M fixed cost estimates:

- The annualised fixed O&M cost does not allow for replacement of defective asset items over the life of the assets;
- Insurance and tax costs are not included in the annualised fixed O&M costs;
- Depreciation of assets has not been included in the normalised O&M fixed costs.

4.4.2 Switchyard Fixed O&M Costs

The fixed O&M cost over the asset lifetime for the switchyard is $74,200 pa in current dollars, an increase of $9,200 pa over the value used in the 2015 report.

Table 16 shows the fixed O&M costs presented in five yearly periods over the lifetime of the switchyard assets.

Table 16 Five yearly aggregate fixed O&M costs for switchyard assets

Period	Five Year Aggregate Fixed O&M switchyard Costs (2016$)
1 to 5 years	371,000
6 to 10 years	371,000
11 to 15 years	371,000
16 to 20 years	371,000
21 to 25 years	371,000
26 to 30 years	371,000
31 to 35 years	371,000
36 to 40 years	371,000
41 to 45 years	371,000

46 to 50 years	371,000
51 to 55 years	371,000
56 to 60 years	371,000

The increase in cost of $9,200 pa is due to the assumptions taken for the bottom up approach in estimating the fixed O&M cost for the switchyard. GHD assumed that routine maintenance would take an equivalent annual period of one week and would require the hire of scissor lift and fork lift, as well as requiring project management, planning and organising by management and operations staff (this of course will change from year to year depending on what is required but essentially this cost is representative of a normalised spend over the period of the assets lifetime).

4.4.1 Transmission line Fixed O&M Costs

The fixed O&M cost over the asset lifetime for the transmission line is $4,600 pa in current dollars, an increase of $3,350 pa over the value used in the 2015 report.

shows the fixed O&M costs presented in five yearly periods over the lifetime of the transmission line asset.

Table 17 Five yearly aggregate fixed O&M costs for transmission line asset

Period	Five Year Aggregate Fixed O&M transmission line Costs (2016$)	
1 to 5 years	23,000	
6 to 10 years	23,000	
11 to 15 years	23,000	
16 to 20 years	23,000	
21 to 25 years	23,000	
26 to 30 years	23,000	
31 to 35 years	23,000	
36 to 40 years	23,000	
41 to 45 years	23,000	
46 to 50 years	23,000	
51 to 55 years	23,000	
56 to 60 years	23,000	

Similarly, to the switchyard fixed O&M, the increase in cost of $3,350 pa for transmission line O&M is due to the assumptions taken for the bottom up approach in estimating this fixed O&M cost. GHD assumed that the line inspection would be carried out over a 2day period and require the hire of scissor lift, as well as requiring project management, planning and organising by management and operations staff. (similarly as for the switch yard, this cost will change from year to year depending on the O&M required but essentially this cost is representative of a normalised spend over the period of the assets lifetime).

5. Fixed Fuel Costs

5.1 Overview of fixed fuel cost estimate

The fixed fuel cost component is associated with the cost for an onsite liquid fuel (diesel) storage and supply facility for the 160 MW OCGT power plant. The storage facility has sufficient capacity for 24 hours of operation on diesel fuel. The fixed fuel cost however will be based on having the storage facility filled to have sufficient capacity for the power plant to operate for 14 hours.

5.2 Assumptions

- Key assumptions for the fixed fuel cost used in GHD's report prepared in 2011[14] were used for the fixed fuel cost for the 160 MW power plant which includes:
  – A fuel tank of 1,000 tonnes (nominal) capacity including foundations and spillage bund suitable for 14 hours' operation.
  – Facilities to receive fuel from road tankers.
  – All associated pipework, pumping and control equipment.
- Land is available for use and all appropriate permits and approvals for both the power station and the use of liquid fuel have been received;
- The basis of the estimate for fuel storage and handling assets is based on GHD's report mentioned in the first dot point;
- The fuel facility concept design would be reasonably typical for storage and handling of diesel fuel for service to an open-cycle gas turbine power station.
- The facility battery limits start from the loading bay and manifold for receipt of fuel from road tankers through to storage tank, diesel transfer pumps, diesel filtration and ends at a tie-in point on the fuel transfer pipe to the gas turbine, not further than 100 m and upstream from the turbine fuel train limits.
- The facility design complies within AS 1940 and includes for spillage bund containment and fire protection accordingly;
- The concept design will be described in the report by schematic process block diagrams and schematic plot plan diagram of the facilities

5.2.1 Fuel capacity

The stored fuel is required to operate the 160 MW gas turbine power station for an equivalent period of 24 hours at full load. The working fuel quantity of 1000 tonnes is calculated using a fuel high heat value of 44.8 MJ/kg and a fuel to electrical energy efficiency of 30.7% for the chosen 160 MW open-cycle turbine.

5.3 Estimated Fixed Fuel Cost

5.3.1 Fuel facility cost

below provides a breakdown of our estimate for the liquid fuel storage and handling facility for the 160 MW OCGT.

[14] GHD Report Titled "Review of fixed fuel cost for maximum reserve capacity price in the wholesale electricity market", dated November 2011

Table 18 Cost breakdown for the diesel storage & handling facility

No.	Item Description	A$'000
1	Fuel Storage Tank – fabrication and construction of roofed vertical tank, externally coated, process nozzles, access manholes and concrete ring foundation, Spillage bund of concrete wall and floor, Stairways and access platforms, Instrumentation for level and temperature measurement, Geotechnical investigation, hydrostatic testing and cathodic protection.	1,554
2	Fuel Supply Loading Manifolds (two sets) – Loading manifolds including valves and coupling, Loading pumps and motors, Piping and electrical works.	52
3	Road Tanker Loading Bay of sealed road surface	124
4	Fuel transfer mainline piping (from pumps to the gas turbines including valves)	98
5	Fuel Transfer Pumping (duty run & standby run) – Two fuel pump runs each with motor, filters & oil separators Flow meters, Piping and basic instrumentation, including floating suction header in tank, Concrete foundation and bunded plant area.	430
6	Oily Water Treatment System Sump pump, Oil separator unit, Piping and electrical, Concrete foundation and bunded plant area.	72
7	Site preparation, civil and early works	2,150
8	Perimeter fencing (cyclone wire mesh)	38
9	Fire protection (including hose reels and fire extinguishers)	35
10	Lighting	25
11	Mobilisation and De-mobilisation	85
12	Engineering, procurement and construction management (12%)	559
13	Contractor risk, insurance and profit (15%)	700
14	Spares and consumables	75
A	Sub-total for facility installation	5,997
B	Base fuel storage of 657 m3 (552 tonne) @ A$0.661/L	434
	TOTAL	**6,431**

5.3.2 Cost of fuel

According to the Australian Institute of Petroleum, the average diesel price for diesel fuel in regional WA is 105.7[15] cent/litre.

The current excise rebate for diesel consumed in a power generation unit is 39.6 cents/litre. In addition to this rebate it is assumed that the power plant purchases of diesel do not attract GST.

Based on the above, the delivered cost for diesel is 66.1 cents/litre ($0.661 per litre). This is a 7.9 cent/litre reduction from last year's report. The reduction is price is due to the fact that oil prices have decrease since last year's report and remain low.

The estimated HHV heat rate for the 160 MW OCGT operating at the specified site conditions is 11,720 kJ/kWh (gross), therefore the hourly fuel consumption 1,767,380 MJ (for 150.8 MW gross) which based on a HHV for diesel of 44.8 MJ/kg represents a fuel consumption of 39.4 tonnes of diesel/hour. For 14 hours of operation at full load the amount of fuel required is estimated to be 552.3 tonnes of diesel or 657,500 litres of diesel.

The estimated cost for the first fill capacity (lasting 14 hours of operation at full load) is $434,.6 (0.434 mil). This figure is approximately 0.166 mil lower than last year's figure. This difference is due to the variation in efficiency when the fuel consumption was evaluated last year and the current efficiency for the gas turbine used in this report as well as this year's slightly lower gross output (approx. 2 MW higher).

[15] As at 13 October 2016.

6. Margin M Costs

6.1 Overview of margin M costs

The allowance for the M factor includes:

a. legal costs associated with the design and construction of the power station.

b. financing costs associated with equity raising.

c. insurance costs associated with the project development phase;

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

e. other costs reasonably incurred in the design and management of the power station construction; and

f. contingency costs.

The following sub-section provide an overview of the cost estimate that make up the M factor.

6.2 Derivation of M factor in 2016

6.2.1 Legal Costs

The legal cost estimated for 2015 was $1,643,000. This figure represents approximately 1.4% of the 2015 reported capital cost for the 160 MW OCGT power plant.

The legal cost should as a minimum cover the following

Description	GHD's % Estimate on Project Costs (based on previous projects)	GHD's Estimate (A$)
Support for contract conditions for specifications, tender analysis, and negotiations	0.60	706,400
Legal content for diesel fuel supply contract	0.12	141,300
Legal support for PPA/Capacity/offtake contract	0.40	470,900
Legal support for financing/loan procurement	0.10	117,700
Legal support for grid connection agreement	0.12	141,300
Legal support for contracts during construction phase	0.35	412,100
Total		**1,989,700**

Based on our assessment, in the table above for a 160 MW OCGT plant, our estimate for legal cost is $1,989,700 which is significantly higher than last year's cost for legal.

The reason for this difference is due to the fact this year's analysis for legal cost was based on a bottom up approach and not based on a % of the capital.

6.2.2 Financing costs

The financing cost comprise of cost to raise capital and also to setting up the project vehicle for financing during the construction phase. Last year assumed that that the financing cost was 3%, which resulted in a value of $3,513,000.

Financing cost generally includes the fee for financing which usually includes a senior debt fee and a subordinate debt fee. Based on an equity to debt ratio of 20%/80% and a senior debt of 60% (of the total project loan – (0.8 * ((117,735,000 + 6,431,000)*0.6))) = 59,599,700) and a subordinate debt of 40% (of the total project loan - (0.8 * ((117,735,000 + 6,431,000)*0.4))) = 39,733,120), GHD's estimate for loan fees based on the loan amount (@ for a borrowing of 80% of the full project cost) is as follows;

Loan Fee	% fee for loan	Amount A$
Senior loan	2.50%	1,489,990
Subordinate loan	3.15%	1,251,590
Total		**2,741,580**

Based on our assessment, in the table above for a 160 MW OCGT plant, our estimate for financing cost is $2,741,580 which is significantly lower than last year's cost for financing. The reason for this difference is due to the fact this year's analysis for financing cost was based on a bottom up approach and not based on a % of the capital as appeared to be the cast for last year's analysis.

6.2.3 Insurance cost

The cost for insurance assumes a number of risks that may occur during the construction phase of the power plant. An OCGT of this technology is relatively simple technology when compared with other power plant technologies and therefore would attract a premium commensurate with the level of risks for this technology. Last year's allowance of 0.5% for an OCGT of this capacity and low utilisation.

Insurance for a plant of this nature generally covers the following key risks:

- Loss due to fire and irreparable damage of the major plant components; and,
- Loss of income of the power plant due to lengthy delays during the construction phase;

A loss of the key power plant component rendering it to be written off is generally about 0.5 to 0.7% of the capital cost for the project. It is understood that the capital outlay during construction will ramp up during construction to the full project value until after the plant is commissioned, tested and handed over to the owner. However, insurance is based on the value of the commitment since total loss may occur toward the end of construction when the owner has paid over 90% of the commitment. Insurance premiums take into consideration the payment schedule during construction and therefore will initially be based on the commitment or asset value insured by the owner using a figure mid-way between 0.5% and 0.7%, the insurance cost is estimated to be $707,000.

Loss of income due to delayed construction is not always a risk that power plant owners insure against, and since loss of income is very subjective between insurance companies and can usually be recovered by the owner through liquidated damages, the estimate for insurance premium for this risk is not included as part of the insurance cost for this assessment.

6.2.4 Permitting & Approvals cost

The basis of this costing assumes that the proposed power station will be constructed on land which is appropriately zoned under the relevant local government planning scheme and that the site does not contain any significant environmental constraints that would require formal assessment by the WA Environmental Protection Authority under Part 4 of the Environmental Protection Act 1986 (EP Act).

As a consequence, the power station will require a Works Approval and Licence under Part 5 of the EP Act and development approval under the relevant local government planning scheme.

Works Approval

A Works Approval issued by the Department of Environmental Regulation (DER) under the Environmental Protection Regulations 1987 will be required to allow construction of the power station.

The following assumes an Assessment by Referral Information (ARI) type level of assessment which is significantly less arduous than the level of assessment set by a Public Environmental Review (PER).

Environmental assessment by the DER will focus on air and noise emissions. We have assumed that the site will contain remnant vegetation and consequently a biological survey will be required to support a Clearing Permit, but will not require heritage clearance (given the nature of its zoning).

The Works Approval will need to provide the following information:

- General specifications of the main pieces of plant
- Proposed facility layout
- Standard emissions
- Typical operating conditions
- Storage of hazardous goods
- Details of any liquid runoff
- Fuel source and estimated consumption
- Proposed mitigation measures for any emissions, as well as any surface water runoff.

Indicative costs:

- Prepare and submit Works Approval $20,000
- Air and noise modelling $20,000
- Biological survey $20,000
- Clearing Permit $10,000
- Application fee (est.) $62,000

Development Approval

The proposed facility will require development approval under the local government planning scheme.

The Development Application will need to include:

- Appropriate application fee
- Details of the use proposed for the land or buildings

- Submission of three sets of plans consisting of:
  - site plan
  - elevations and sections of any building proposed to be erected or altered and of any building intended to be retained
  - floor plan
  - landscape plan
  - drainage plan.

Plans will need to include:

- Street names, lot number(s), north point and the dimensions/contours of the site
- The location and proposed use of any existing buildings to be retained and the location and use of buildings proposed to be erected
- The existing and proposed means of access for pedestrians and vehicles
- The location, number, dimensions and layout of all car parking spaces to be provided
- The location and dimensions of any area proposed to be provided for the loading and unloading of vehicles carrying goods or commodities and the means of access to and from those areas
- The location, dimensions and design of any landscaped or open storage areas
- Building materials, including specification of roof colours
- The location of on-site remnant vegetation, in particular mature trees
- Boundary fencing treatments
- The location of any underground services lines.

Indicative costs:

- Prepare landscape and drainage plans $30,000
- Prepare and submit Development Application $20,000 (assumes engineering and building details provided)
- Application fee (est.) $40,000

Licence

Once constructed a licence to operate will need to be sought from the DER. The licence will document the type of emissions from the facility and specify the regular (annual) testing and reporting requirements.

Indicative costs:

- Prepare and submit Licence application $15,000
- Annual licence fee dependent on type and concentration of emissions
- Annual stack monitoring $10,000
- Annual compliance report $20,000

The estimated cost for Permitting and approvals cost is **$267,000**.

6.2.5 Design & project management (Project Development)

The project development cost is comprised of project management cost, owners cost, initial spares, site services, and start-up costs. Our analysis for these costs is outlined in detail in the sub-sections below.

Project management

The project management services considered in this section pertains project development by the developer which will include all costs associated with:

- Concept/prefeasibility study
- Full feasibility
- Costs for the engagement of an Owners Engineer;
- Costs for the engagement of legal and financial services;
- Cost associated for the owner to provide a project team

Owners Engineer

The owners engineer services consider the following costs:

- Front End Engineering Design (FEED) which includes all site related studies, specification, tendering, EPC contractor selection and contract negotiations up to financial close;
- Construction management services to include, design drawing and document reviews, oversee construction activities, witness testing and commissioning activities and ensure that the O&M manuals and as built drawings are correct.

The cost associated with project management and owners cost is provided in the following table.

Table 19 Cost associated with project management and owners engineer services

Description	Cost (A$)	
Project Management		
• Concept/feasibility study	$150,000	This is an average cost to produce a concept/feasibility study for an OCGT project. This normally takes 1 to 2 months to complete.
• Full Feasibility Study	$560,000	This is an average cost to produce a full feasibility study) for an OCGT project. This normally takes 3 to 4 months to complete.

Description	Cost (A$)	
• Engagement of Owners Engineer	$210,000	This is an average cost to carry out a tender process to engage an owners engineer to represent the owner for the construction of the OCGT Plant. This normally takes 2 to 3 months to complete.
• Engagement of legal & financial services	$290,000	This is the average cost to evaluate legal and financial groups to provide these support services for the OCGT plant. This normally takes 2 to 3 months to complete.
• Cost associated for the owner to provide a project team	$850,000	This is the cost associated for the owner to provide a team of staff to oversee the progress of the project from concept to commercial operation. This normally takes 2 to 3 years to complete.
Owners Engineer		
• FEED & Contractor selection up to Financial close	$1,740,000	This is an average cost to produce a front end engineering design (FEED) and for an OCGT project and a tender process to establish an EPC contractor and the necessary contract for the construction of the OCGT plant
• Construction management services	$2,320,000	This is the average cost to carry out construction management services by an Owners engineer throughout the construction period up to and including testing & commissioning.
Total	**$6,120,000**	

Based on the table above the cost associated with project management and owners engineering services is $6,120,000 which is $673,000 lower than last year's estimate of $6,793,000. The reason for this difference is that this year average cost values were used instead of taking a % of the capital cost as was done in last year's report.

6.2.6 Other costs

Initial spares

It is likely that the bare minimum of spares will be held by the power plant operators. GHD considers that spares will be held for schedule maintenance such as hot gas path inspections and minor overhauls and thereafter replacement parts will be order on an as need basis.

The following table outlines areas of concern for the Siemens gas turbine and only those items marked “Wear” under the category “Findings” are likely to be held in stock at the power station.

Table 20 Areas of Concern for Siemens V94.2 GT

Item	Component	Findings	Measures
1	Compressor Blades	Corrosion & cracks	Replacement
2	Compressor Vanes	Cracks on Hooks	Replacement
3	Flame Tube Tile Holders	Wear	Replacement
4	Burner	Corrosion & cracks	Replacement
5	Seal Ring	Wear	Replacement
6	Casing	Cracks	Repair
7	Turbine Blades	Cracks/Degradation	Life extension for one further interval
8	Inner Casing	Oxidation	Repair and life extension for one further interval
9	Rotor Disk	Oxidation	Requalification and life extension for 100,000 EOH
10	BOP plant spares for wear (filters, gaskets, hoses, bolts , nuts, spare transfer pump, fuses, control cards, etc	Wear	Replacement

Source Life Extension for Siemens Gas Turbine[16]

The cost estimate for the parts marked “Wear” is estimated to be approximately $500,000. This will of course differ from plant to plant depending on the adopted operator’s maintenance strategy. Therefore, our estimate for initial spares is $500,000.

The 2015 report allowance for initial spares of 0.8% which was $937,000. The difference from last year’s estimate and this year’s estimate (i.e. $437,000) results from using average cost estimate for the minimum spares required whereas a % rate was used for last year’s estimate.

[16] Life Extension for Siemens Gas Turbine, Guido Lipiak, Susanne Bussmann, Power-Gen Europe 2006 30 May-1 June 2006, Cologne, Germany.

Site services

The 2015 report allowance for site services of 0.1% which was $ 117,000. GHD considers last year's estimate for site services to be too low GHD's assessment for site services is considered to be between $100,000 and $200,000 as it covers the cost for landscaping, cleaning services, renewing signage, painting and upkeep of the control/administration building. Therefore, our estimate of $150,000 is assumed to be mid-way between the lower end and higher end for this service..

Start-up costs

The start-up cost for the 160 MW OCGT power plant considers the cost for recruiting and training and employing staff during commercial operations as well as the cost of fuel and consumables used for testing and commissioning the plant.

The value used in the 2015 report was 2.75%. GHD considers this value to be high. Based on the output from GTPro we estimate this percentage to be closer to 1.5%. Therefore, our estimate is $1,766,000.

6.2.7 Contingency

The contingency is an allowance for items that were not identified at the time of producing a cost estimate resulting from level of design available. The major cost for an OCGT power plant is the gas turbine package which in this case is well defined by GTPro. Costs for gas turbines are updated annually and therefore GHD considers that the level of accuracy for the gas turbine is high.

In last year's report, a contingency of 5% was used which is consistent with previous year's and therefore for this year's report GHD agrees that a contingency of 5% is reasonable. Therefore, our estimate is $5,842,000.

6.3 Overall M factor

The M factor for year 2016 is provided in below.

Table 21 Calculation of M factor for 2016

Component of "M"	2015 Cost ($)	2016 % of EPC	2016 Cost ($)
Legal Cost	1,643,000	1.63	1,989,700
Financing Cost	3,513,000	2.34	2,741,580
Insurance Cost	586,000	0.60	707,000
Permitting & Approvals Cost	1,000,000	0.22	267,000
Design & Project Management	6,554,000	5.24	6,120,000
Other Costs			
Initial Spares	937,000	0.43	500,000
Site services	117,000	0.13	150,000
Start-up cost	3,220,000	1.51	1,766,000
Contingency	5,855,000	5.00	5,842,000
Total	**23,425,000**	**17.19**	**20,083,280**

Following our assessment of the 2016 cost the overall M factor has reduced by approximately $3,341,720 due mainly to a reduction in the following:

- Permitting & approvals cost which is assumed to be based on a more likely and less complicated and arduous process whereas last year's estimate was based on significantly higher level of work to obtain the necessary permits and approvals;
- Legal cost was considered to be low. GHD has carried out a bottom up analysis for legal cost that better represents the cost for this service.
- Financing cost was considered to be high. For this year's report, GHD has carried out a bottom up analysis for financial cost that better represents the cost for this service.:
- Insurance cost has increased slightly from last year's cost and is based on the necessary construction insurance cost that covers total loss and delays in completion of the project. The reason for the increase in insurance cost is GHD's assessment of the risks and costs associated with the risk.
- Initial spares are considered to be high. This year GHD used data for spares from previous projects involving Siemens machines.
- Start-up cost

The overall M factor value is sensitive to a number of assumptions and styles of management from the specification of the plant to the operating and maintenance strategy adopted. However, the figure of $20,083,280 is considered to be within the range expected for this factor.

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