AEMO

2018 Benchmark Reserve Capacity Price for the South West Interconnected System

November 2017

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

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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 Open Cycle Gas Turbine (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

Scope

The WEM Rules require that the Benchmark Reserve Capacity Price (BRCP) be determined each year. GHD was commissioned by AEMO to carry out a bottom up cost evaluation, for an OCGT Power Station as at April 2020 (Year 3 of the 2018 Reserve Capacity Cycle) which includes the following items:

- 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 1000 tonne capacity fuel storage tank, fuel handling facility, and initial supply of fuel sufficient for power station operation for 14 hours 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.

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 1.1 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, as was the case for last year, labour rates and indices were sourced from well-known public domains, and our analysis is therefore based on current data available at the time of compilation.

2.1 Escalation Rates

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

Table 1 Five year escalation forecast rate % change

	CPI	EGW Labour	WA Labour	Copper	Steel
Year to June 2018	2.25%	2.10%	1.42%	1.75%	-4.1%
Year to June 2019	2.50%	2.30%	1.71%	1.83%	0.0%
Year to June 2020	2.50%	2.41%	1.85%	1.04%	2.3%
Year to June 2021	2.50%	2.43%	1.88%	0.96%	1.4%
Year to June 2022	2.50%	2.44%	1.92%	0.00%	1.4%

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 Policy (SOMP) for August 2017[2]. The RBA CPI inflation figures are released twice yearly. Table 6.1 of the RBA SOMP outline the short term RBA forecast for CPI for the next two years.

[1] 6401.0 Consumer Price Index, Australia, Jun 2017, ABS, Tables 1 and 2, ID:A2325847F, http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6401.0Jun%202017?OpenDocument

[2] Statement on Monetary Policy August 2017, RBA, Table 6.1, http://www.rba.gov.au/publications/smp/2017/aug/

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

Table 2 Australian CPI % change forecast

Year to June	2017 Actual	2018 Forecast	2019 Forecast	2020 Forecast	2021 Forecast	2022 Forecast
CPI % Change	1.90%	2.25%	2.50%	2.50%	2.50%	2.50%

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

The Wage Price Index (WPI) was sourced from the Australian Bureau of Statistics (ABS) for June 2017[3].

The historical indices for Australian WPI for Electricity, Gas, Water and Waste Services is provided in the following table.

Table 3 Australian WPI for EGW

Date	Index; Electricity, gas, water and waste services	% Change
Jun-2010	103.6	
Jun-2011	107.6	3.9%
Jun-2012	111.7	3.8%
Jun-2013	116.9	4.7%
Jun-2014	120.7	3.3%
Jun-2015	124.6	3.2%
Jun-2016	127.9	2.6%
Jun-2017	130.8	2.3%

The following figure provides a graphical representation of the table above.

[3] http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6345.0Jun%202017?OpenDocument

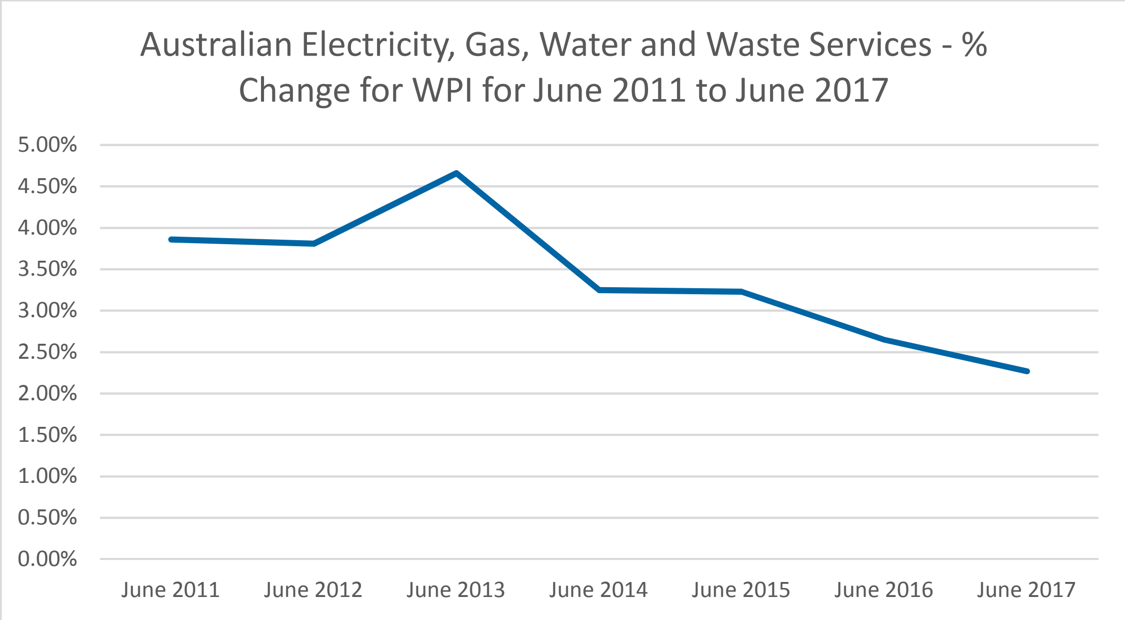

Figure 1 Australian WPI Graph for EGW

Based on historical data and trends the % change has been reducing over the past four years and we expect that the index will continue to fall through to 2018 when it is expected to stabilise and start to increase as the sector continues to recover some lost ground since 2013. GHD assumes that the recovery will be gradual and will stabilise in the range of 2.41 to 2.44 between 2020 and 2022. The forecast trend is shown by the following table and graph.

Table 4 Forecast for Australian WPI for EGW

Date	Index; Electricity, gas, water and waste services	% Change
Jun-2018	133.6	2.14%
Jun-2019	136.7	2.32%
Jun-2020	140.0	2.41%
Jun-2021	143.4	2.43%
Jun-2022	146.9	2.44%

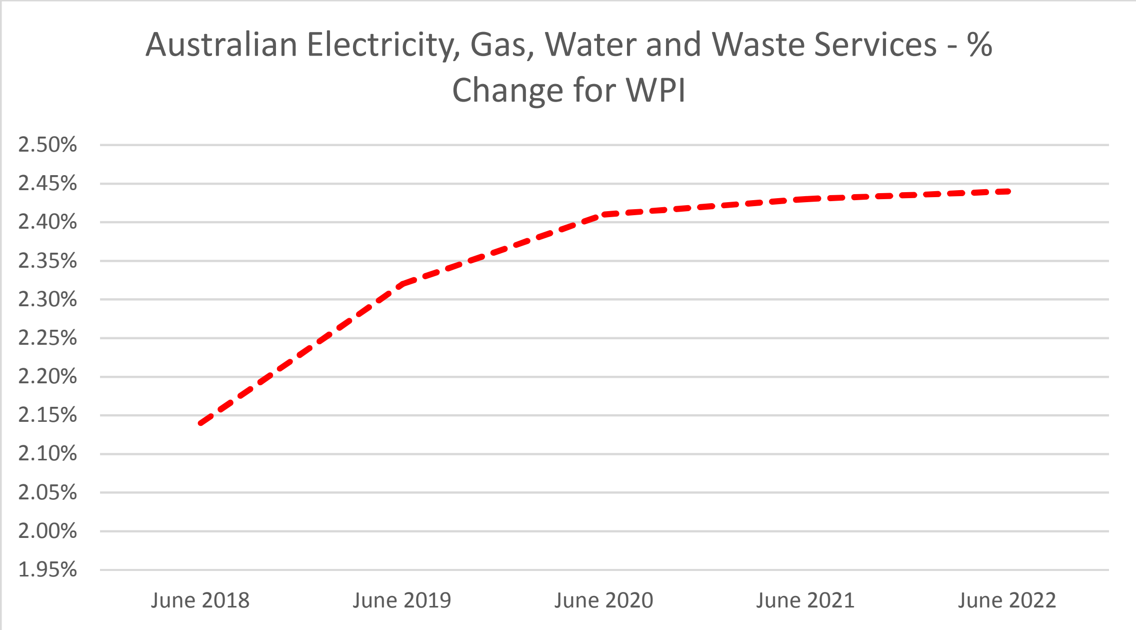

Figure 2 Graph showing forecast for Australian WPI for EGW

2.4 Western Australia Labour

This data was sourced from ABS WPI June 2017 report Table 2a[4]. These figures are not specific to the power industry however, they do apply to WA. The WA WPI figures and the corresponding % change have been summarised in Table 5.

Table 5 Annual WA WPI and % change

Year to	WA WPI	% Change
June-2013	116.5	3.9
June-2014	119.8	2.8
June-2015	122.4	2.2
June-2016	124.7	1.9
June-2017	126.5	1.44

The following figure provides a graphical representation of the table above.

[4] 6345.0 Wage Price Index, Australia, Jun 2017, ABS, Table 2a, http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6345.0Jun%202016?OpenDocument

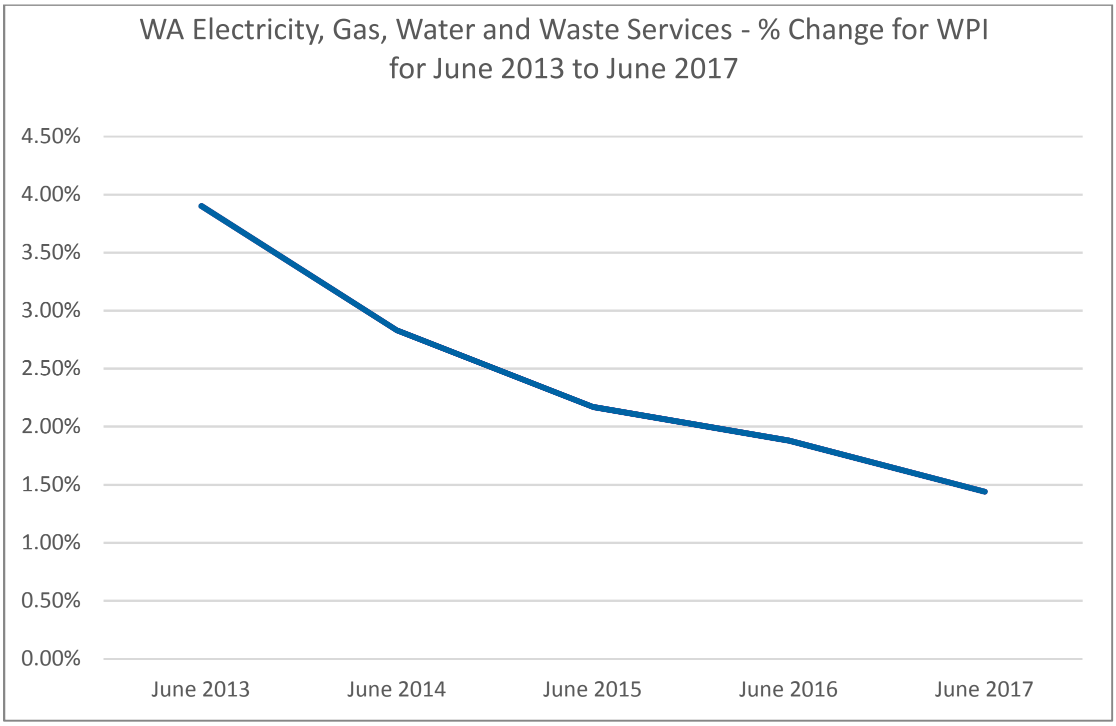

Figure 3 Western Australia WPI Graph for EGW

Based on historical data and trends the percentage change has been reducing over the past four years and we expect that the index will continue to fall and that the % change will stabilise in 2018 and start to rise as the sector continues to recover some lost ground since 2013. The following table and graph show the forecast increase.

Table 6 Forecast for Western Australia WPI for EGW

Year to	WA WPI	% Change
June 2018	128.3	1.42
June-2019	130.5	1.71
June-2020	132.9	1.85
June-2021	135.4	1.88
June-2022	138.0	1.92

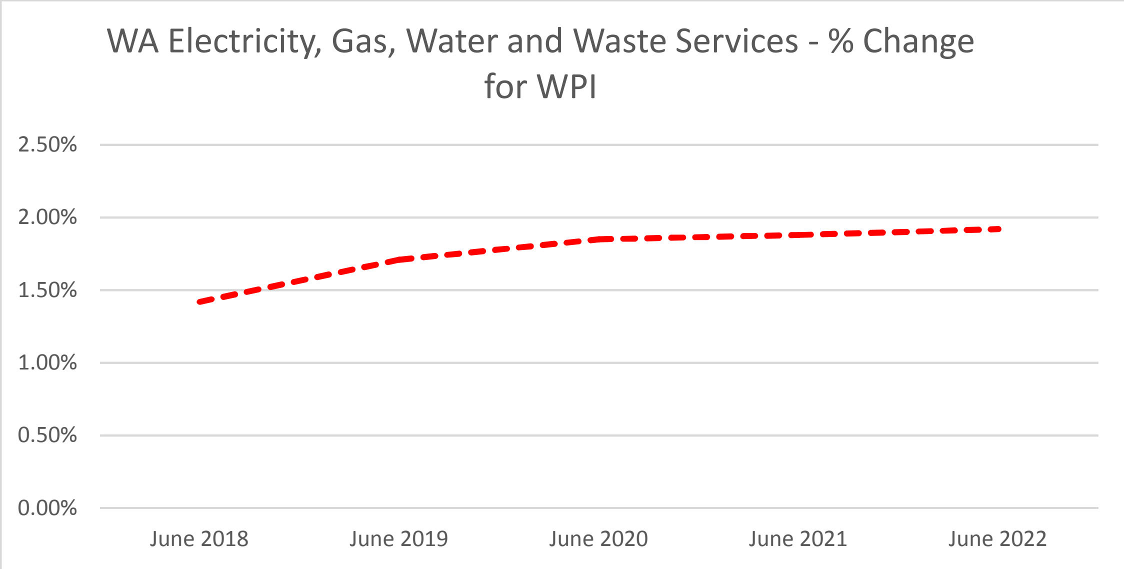

Figure 4 Graph showing forecast for Western Australia WPI for EGW

2.5 AUD to USD Exchange Rate

The output of the balance of plant from 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[5], taking the annual average year to June 2017. Forecasted figures were sourced from the CME group, Australian Dollar Futures[6]. CME figures were sourced quarterly and averaged over the year to June period for the forecasted years, these values are recorded in Table 7.

Table 7 Annual average AUD to USD exchange rate

Year to June	2017 Actual	2018 Forecast	2019 Forecast	2020 Forecast	2021 Forecast	2022 Forecast
USD/AUD Annual Average	0.7630	0.7755	0.7721	0.7673	0.7620	0.7573

2.6 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 (as of 20 October 2017) was US$7,008.00/Tonne[7]

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. This analysis is similar to what was carried out last year.

The LME figures, CE spot, 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

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

[6] Australian Dollar Futures, Accessed: 22/10/2017 http://www.cmegroup.com/trading/fx/g10/australian-dollar.html

[7] https://www.lme.com/en-GB/Metals/Non-ferrous/NASAAC

calculated and converted to AU$ using figures in Table 7 .These forecasts and % change figures are summarised in Table 8.

Table 8 Annual average copper price (AUD)

Year to June	2017 Actual	2018 Forecast	2019 Forecast	2020 Forecast	2021 Forecast	2022 Forecast
Copper Price US$ Mt	$7,008	$7,250	$7,350	$7,380	$7,400	$7,400
Copper Price AUD Mt	$9,184	$9,348	$9,519	$9,618	$9,711	$9,711
% Change (AUD)		1.75	1.83	1.04	0.96	0.00

2.7 Steel Price

Steel and steel alloys are 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 steel Rebar LME CE spot price (20th October 2017), was US$518.00/tonne. The short term price forecast predicts the price to drop to US$505.00/tonne over the next 12 months and then remain steady heading into 2019. Post 2019 GHD estimates that the price will rise slowly over 3 years to regain some of the loss made prior to 2017 as a result of reduced demand for iron ore and steel products in general.

The values for 2017 and 2018 were derived from LME website[10] were averaged to year to June values and converted to AU$ again using Table 7. These figures and the values for 2019 to 2022 were derived showing a steady increase from 2020 and remaining relatively flat over the period 2020 to 2022 as summarised in Table 9.

Table 9 Annual average steel price (AUD)

Year to June	2017 Actual	2018 Forecast	2019 Forecast	2020 Forecast	2021 Forecast	2022 Forecast
Steel Price AUD Mt	$678	$651	$651	$670	$680	$690
% Change		-4.1%	0.0%	2.3%	1.4%	1.4%

2.8 Capital Cost Escalation Factors

The annual capital 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 10 Annual capital cost escalation factors

Year to June	2017 Actual	2018 Forecast	2019 Forecast	2020 Forecast	2021 Forecast	2022 Forecast
Power station	1.0%	2.7%	2.8%	1.8%	3.8%	3.7%

[10] https://www.lme.com/Metals/Ferrous/Steel-Rebar#tabIndex=0

The complete OCGT Siemens SGT5-2000E weighs approximately 236 tonnes. Based on previous work carried out by GHD our estimate for steel in an OCGT of 160 MW capacity contains 1.3 tonnes/MW[13] and our estimate for copper in an OCGT of 160 MW capacity contains 0.175 tonne/MW[14]. Using these figures and the forecasts for copper and steel prices in sections 2.6 and 2.7 respectively GHD has evaluated power station capital cost escalation as shown in the table above.

Using the escalation factors in the above table and the cost estimate in Section 3.0, the total capital cost estimate of the power plant on **1 April 2020** is forecasted to be **$128,192,560** which equates to **$847/kW**[15]. This estimate is as per the Market Procedure for BRCP, which requires the estimate to be as at April in year 3 of the Reserve Capacity Cycle.

2.9 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 11 Annual O&M cost escalation factors

Year to June	2017 Actual	2018 Forecast	2019 Forecast	2020 Forecast	2021 Forecast	2022 Forecast
Power station	1.0%	2.7%	2.8%	1.8%	3.8%	3.7%
Connection Switchyard	1.44%	1.42%	1.71%	1.85%	1.88%	1.92%
Overhead transmission line	1.44%	1.42%	1.71%	1.85%	1.88%	1.92%

The fixed operating & maintenance escalation factors for connection switchyard and overhead transmission line follow the West 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.

[13] Last year's figure was typed in error by a factor of 10 in the report. This did not affect the escalation factors.

[14] Last year's figure was typed in error by a factor of 10 in the report. This did not affect the escalation factors.

[15] Based on 151.4 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 26.1 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 configured as an open cycle GT (OCGT). The software is updated annually by Thermoflow 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 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 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$)

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 12 OCGT Units considered for this cost estimate

Gas Turbine	Comments
Siemens SGT5-2000E (33MAC)	The 33MAC variant of this unit was used in the last several years to develop the Benchmark Reserve Capacity Price. There are three variants of the SGT5-2000E (nameplate capacity at ISO conditions shown in brackets): the 25MAC (188 MW), 33MAC (175.6 MW), and 41MAC (181 MW). All variants feature dry low NOx combustion, and none are compatible with water injection for power augmentation. At the prevailing site conditions (41°C, 30% relative humidity) the 33MAC is modelled to have a net capacity of 162.0 MW (net at site conditions), and is therefore the closest of the three variants to the target 160 MW. All variants are reported by GT Pro to have almost identical CAPEX and efficiency.

Gas Turbine	Comments
Alstom GT13E2 (MXL2), now owned by GE by previously by Alstom	The nameplate rating for this unit on diesel fuel is 189 MW (gross) at ISO conditions. The unit comes in 2 versions; the GT13E2 and GT13E2 (MXL2). The MXL2 features dry low NOx combustion, but is also compatible with water injection for power augmentation. For a prevailing site conditions (41 °C, 30% relative humidity) this unit will have a net rating of 161.6 MW (net at site conditions and without water injection for power augmentation).
GE 9E.04	The nameplate rating for the 9E.04 unit is 148 MW (gross) at ISO conditions. The 9E.04 features dry low NOx combustion, but is also compatible with water injection for power augmentation. The GE 9E unit comes in two version; the GE 9E.03 and 9E.04, with the 9E.03 variant having a lower capacity than the 9E.04 at 133 MW (gross) nameplate capacity at ISO conditions. There is no larger variant of the 9E, with the next step up being the 9F.03 model with a gross capacity in excess of 260 MW. At the prevailing site conditions (41 °C, 30% relative humidity) the 9E.04 is modelled to have a net rating of 126 MW (with no water injection for power augmentation).

In addition to the single unit machines, GHD investigated the potential for a multi-unit configuration to make up the 160 MW (nominal) output at the relevant site conditions. The four options that were investigated are shown in the following table.

GT Model	Site Conditions		EPC Capital Cost	Comments
	Gross output (MW)	Net Output (MW)		
Pratt & Whitney FT8	165.14	162.46	182,554,000	4 unit configuration
GE 6F.03	140.68	138.41	143,625,000	2 unit configuration
GE 6F.01	182.73	179.71	190,240,000	4 unit configuration
Siemens SGT800-50	181.28	178.27	170,529,000	4 unit configuration

As shown by the table above, the multi unit options were either too expensive and/or were not suitable to comply with 160 MW nominal output at site conditions. Therefore, the multi-unit configurations were not considered further.

The SGT5-2000-33MAC was selected to develop the capital cost estimate as this unit provides good value in terms of capital and O&M costs. This unit is also close to the 160 MW nameplate and has previously been used to evaluate the BRCP.

In developing the capital cost estimate, GHD used the latest version of GTPro (version 26.1) to model the SGT5-2000E 33MAC machine at ISO conditions at a typical power plant site in the SWIS (Muja PS). We 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 2017. A cross check with last year's estimate (2016) for the same machine was carried out to identify any significant variations. Where possible cost references were made to Australian power projects involving the SGT5-2000E machines[16]. GHD applied the relevant escalation to establish a year 2017 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[17].

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

- One unit in Queensland at the Townsville power plant (firing gas) (Yabulu PS)
- Three units in Queensland at the Braemar 2 power plant (firing gas)
- Two units in Queensland at Oakey 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 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 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

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

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

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

The performance data from the SGT5-2000E-33MAC model is provided in The table below.

Table 13 Performance for the SGT5-2000E-33MAC at site conditions

Description	Units	Value
Ambient Conditions	Deg C / % RH	41.0 / 30% RH
Gross Power	MW	164.4
Net Power	MW	162.0
Auxiliary/Losses	MW	2.4
Gross Heat Rate / Efficiency (LHV)	kJ/kWh / (%)	10,581 / 34.02%
Net Heat Rate / Efficiency (LHV)	kJ/kWh / (%)	10,738 / 33.53%
Air temperature post cooler	Deg C	27.0
Diesel Fuel Consumption	Tonnes/hr	40.1

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

The ISO output for the SGT5-2000E machine is 175.6 MW (gross) and 173.3 MW (net). 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. For the SGT5-2000E machine at site conditions, with evaporative cooling, the gross and net outputs reduces to 164.4 MW and 162.0 MW respectively. For the generic 160 MW machine at site conditions, with evaporative cooling, the gross and net outputs reduces to 153.8 MW and 151.4 MW respectively.

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

Table 14 Seimens SGT5-2000E Performance

Case	ISO Conditions		Site Conditions	
	MW (gross)	MW (net)	MW (gross)	MW (net)
Siemens SGT5-2000E	175.6	173.3	164.4	162.0
160 MW (generic)	160.0	157.9	153.8	151.4

3.5 Capital Cost Estimate

The cost breakdown for the OCGT power plant is provided in Table 15 below

Table 15 Capital cost breakdown for the power plant

Cost Item	Based on Seimens SGT5-2000E *	Equivalent 160 MW Power Station
Specialised Equipment**	68,232,150	62,159,500
Other Equipment**	4,317,660	3,933,400
Civil works**	11,900,150	10,841,000
Mechanical Works**	9,301,700	8,473,830
Electrical Works**	3,045,730	2,773,750
Building & Structures	2,720,330	2,720,330
Engineering & Plant Start-up	4,905,700	4,905,700
Contractor soft cost & Misc. Costs	23,997,650	23,997,650
Total	128,421,070	119,805,160
A$/kW (net)	792.7	791.3 (say 791)

* All costs are in 2017 dollars
** Scalable costs

The costs were established from GTPro (Peace) and were converted from US$ using an exchange rate of AU$1.00 = US$0.763 (average 2016/17 exchange rate from Oct 16 to Sept 17). From the table above, the capital cost per net kW installed for a 160 MW liquid fuelled OCGT is $791/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 projects 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 for the generic 160 MW plant, there is a variation of +$2.956 million from this year’s cost estimate. The price variation is mainly due to the gas turbine upgrade that provides a larger output than last year’s model and with better efficiency.

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 have 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 established in section 2 was used to establish the fixed cost estimate for 2017 (refer Table 1.0 and 11.0). The costs are provided in the table below.

Table 16 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 * 1.0142 (1.44% escalation) = $628,928).	628,928
OCGT Substation (connection to tie line), has been escalated by 1.44% from last year's figure of $240,000.	243,456
Rates Based on a site that is 17550 m2 the Landgate gross rental value (GRV) is $438,700 (equivalent to a weekly rental of $8,436/wk or $25/m2 per annum). Local Council in Bunbury evaluates rates on the basis of GRV x $0.09087 which would result in a rate value of $39,860 per annum. Collie Shire also calculates rates on the basis of a Landgate GRV value and applies a similar cost rate to establish annual rates for any property. GHD has used the cost rate for Bunbury as we were not able to obtain the equivalent value from the shire of Collie.	39,860
Market Fee – AEMO fee for 2017/18 is based on $0.918/MWh. 151.4 MW x 8760 hrs x 2% = 26,525 MWh which works out as an annual fee of $24,350	24,350
Balance of Plant (service of pumps, water plant, fire system, etc., using a contract of 0.12% of capital for Mechanical and Electrical services	143,766
Consent (EPA annual Charges emission testing) This year's figure is based on last year's value. A range of $30,000 to $45,000 was considered a reasonable fee for this service. Similarly to what was done last year, GHD has assumed a mid-point value which resulted in a fee 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 $15,300 each. A total of $30,600 is therefore assumed for legal costs.	30,600
Corporate Overhead (apply 30% of plant operator labour to cover 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)	188,678
Travel (allow 10 domestic flights/accommodation @ $1200 each plus 2 International flights/accommodation @ $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

O&M Cost Component	Fixed Cost Estimate ($ pa)
Subcontractors (Based on a more competitive environment among subcontractors since last year GHD deems that there would be at least a 5% saving (over last year's cost of $314,320) for services by Subcontractors. Therefore a cost of $298,620 is used for this year's value for subcontractor fees	298,620
Engineering Support (Similarly as for the case of Subcontractors GHD has applied a 5% discount to Engineering services (on last year's cost estimate of $61,200) due to increased competition among engineering service providers to win work)	58,150
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. Last year's cost of $120,000 is considered reasonable. GHD assumed 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. Last year's cost is considered reasonable and was 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. The total cost will therefore be $104,000 pa)	104,000
Fire detection and Protection Systems (GHD has made an allowance of 2 hours /week to check and report on the status of the fire detection and protection system. Based on a weekly rate of $800/week the annual cost will be $41,600)	41,600
Total	**1,987,508**

The total fixed O&M cost estimate has decreased by **$24,729** from last year's report. The reasons for this decrease in value (against last year's values) are provided in the following table:

O&M Cost Component	Variation from last year's results ($ pa)	Comments
Plant Operator Labour.	+$8,928	This year GHD has continued with the allocated number of staff, staff type and salaries for a typical OCGT plant established last year and has added 1.44% escalation (WPI EGW)
OCGT Substation (connection to tie line)	+$3,456	This year has a 1.44% escalation over last years figure.
Rates	-$25,440	This year GHD estimated a Landgate GRV figure and applied the Bunbury Council cost rate of $0.09087 for calculating Council rates. This resulted in a lower figure than last year.
Market Fee	-$2,167	This year the AEMO fee rate (($0.918/Mwh) is lower than last year and therefore resulted in a lower figure this year.
Balance of Plant	+$3,366	This year, the BOP estimate was higher than last years (due mainly to a higher equipment capital cost) and therefore resulted in a increase in this value this year.

O&M Cost Component	Variation from last year's results ($ pa)	Comments
Consent (EPA annual Charges emission testing)	$0	There is no change to last years figure.
Legal	+$600	This year GHD has based the legal fee on two legal disputations each valued at $15,300 (total of $30,600 which is a $600 increase over last years figure).
Corporate Overhead	+$2,678	GHD has based corporate overhead on 30% of the salaries and this year's value is a 1.44% increase over last year's value due to escalation.
Travel	$0	This value has remained the same as last year since GHD feels that travel costs have not risen in real terms due to the competition that exists in the travel sector.
Subcontractors	-$15,700	This value has reduced over last year's value by 5% and is due mainly to competition between subcontractors and discounting.
Engineering Support	-$3,050	Similarly as for the subcontractor value, the value for engineering support has been reduced by 5% over last year's value and again is due mainly to competition between engineering service providers and the discounting that is applied in competitive engineering services market.
Security	$0	Last year's cost was considered reasonable and the level of the security scope has not altered from last year's scope. This year GHD based the cost for this service on the basis of last year's cost for security staff.
Electrical (including control & instrumentation)	$0	This year's cost estimate is based on 8 hrs/wk@ $2000/Wk.to carry out these services (similar as per last year and therefore there is no change from last year's figure).
Fire detection and Protection Systems	$2,600	This year's cost estimate is based on 2 hrs/wk @ $800/Wk.to carry out these services (an increase of $50/Wk from the rate used last year).
Total Variation	**-$24,729**	

Five yearly aggregate fixed O&M costs for the power plant are provided in Table 17 below.

Table 17 Fixed O&M cost for OCGT Power Plant ($2017)

Five Yearly Intervals	Fixed O&M Costs ($)
1 to 5 Years	9,937,540
6 to 10 Years	9,937,540
11 to 15 Years	9,937,540
16 to 20 Years	9,937,540
21 to 25 Years	9,937,540

Five Yearly Intervals	Fixed O&M Costs ($)
26 to 30 Years	9,937,540
31 to 35 Years	9,937,540
36 to 40 Years	9,937,540
41 to 45 Years	9,937,540
46 to 50 Years	9,937,540
51 to 55 Years	9,937,540
56 to 60 Years	9,937,540
1 to 60 Years	**119,250,480**

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 that 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 switchyard 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 $75,268 pa in current dollars. This is an increase of $1,068 pa over the value used in the 2016 report.

Table 18 shows the fixed O&M costs presented in five yearly periods over the lifetime of the switchyard assets.

Table 18 Five yearly aggregate fixed O&M costs for switchyard assets

Five Yearly Intervals	Fixed O&M Costs ($)
1 to 5 Years	376,340
6 to 10 Years	376,340
11 to 15 Years	376,340
16 to 20 Years	376,340
21 to 25 Years	376,340
26 to 30 Years	376,340
31 to 35 Years	376,340
36 to 40 Years	376,340
41 to 45 Years	376,340
46 to 50 Years	376,340
51 to 55 Years	376,340
56 to 60 Years	376,340
1 to 60 Years	**4,516,080**

The increase in cost of $1,068 pa is due the escalation based on the 2016 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 forklift, 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.

4.4.3 Transmission line Fixed O&M Costs

The fixed O&M cost over the asset lifetime for the transmission line is $4,666 pa in current dollars. This cost represents an increase of $66 pa over the value used in the 2016 report.

Table 19 shows the fixed O&M costs presented in five yearly periods over the lifetime of the transmission line asset.

Table 19 Five yearly aggregate fixed O&M costs for transmission line asset

Five Yearly Intervals	Fixed O&M Costs ($)
1 to 5 Years	23,330
6 to 10 Years	23,330
11 to 15 Years	23,330
16 to 20 Years	23,330
21 to 25 Years	23,330
26 to 30 Years	23,330
31 to 35 Years	23,330
36 to 40 Years	23,330

Five Yearly Intervals	Fixed O&M Costs ($)
41 to 45 Years	23,330
46 to 50 Years	23,330
51 to 55 Years	23,330
56 to 60 Years	23,330
1 to 60 Years	**279,960**

Similarly, for the switchyard fixed O&M, the increase in cost of $66 pa for transmission line O&M is due to escalation which was based on the 2016 transmission line fixed O&M cost. GHD assumed that the line inspection would be carried out over a 2 day 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[18], and as specified in section 2.6 of the Market Procedure, 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

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

5.3 Estimated Fixed Fuel Cost

Fuel facility cost

Table 20 below provides a breakdown of our estimate for the liquid fuel storage and handling facility for the 160 MW OCGT.

Table 20 Cost breakdown for the diesel storage & handling facility

No.	Item Description	A$
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.	1,583,000
2	Fuel Supply Loading Manifolds (two sets) – Loading manifolds including valves and coupling, Loading pumps and motors, Piping and electrical works.	53,000
3	Road Tanker Loading Bay of sealed road surface	126,000
4	Fuel transfer mainline piping (from pumps to the gas turbines including valves)	100,000
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.	438,000
6	Oily Water Treatment System Sump pump, Oil separator unit, Piping and electrical, Concrete foundation and bunded plant area.	73,000
7	Site preparation, civil and early works	2,190,000
8	Perimeter fencing (cyclone wire mesh)	39,000
9	Fire protection (including hose reels and fire extinguishers)	36,000
10	Lighting	25,000
11	Mobilisation and De-mobilisation	87,000
12	Engineering, procurement and construction management (12%)	569,000
13	Contractor risk, insurance and profit (15%)	713,000
14	Spares and consumables	76,000
A	Sub-total for facility installation	6,108,000
B	Base fuel storage of 646.666 m3 (543.2 tonne) @ A$0.707/L	457,192
	TOTAL	**$6,565,192**

Cost of fuel

The reference cost for diesel was obtained from the Jacobs report for AEMO titled “Energy Price Limits for the Wholesale Electricity Market in Western Australia”, dated 31 August 2017. The wholesale price quoted in the report was $1.043/litre. A transport cost was evaluated to be approximately $0.065/litre (based on a 24 tonne tanker load at $1855/load from Freight Metrics Website[19]). This results in a delivered price of $1.108/litre.

The current excise rebate for diesel consumed in a power generation unit is 40.1 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 70.7 cents/litre ($0.707 per litre). This is a 4.7 cent/litre increase from last year’s report. The increase in price is due to the fact that oil prices have increased since last year’s report.

The estimated HHV heat rate for the 160 MW OCGT operating at the specified site conditions is 11,320 kJ/kWh (gross), therefore the hourly fuel consumption 1,741,016 MJ (for 153.8 MW gross) which based on a HHV for diesel of 44.8 MJ/kg represents a fuel consumption of 38.8 tonnes of diesel/hour. For 14 hours of operation at full load, the amount of fuel required is estimated to be 543.2 tonnes of diesel or 646,666[20] litres of diesel.

The estimated cost for the first fill capacity (lasting 14 hours of operation at full load) is $457,192. This figure is approximately $22,592 higher than last year’s figure. This difference is mainly due to the higher price for diesel this year. Although this year’s fuel consumption is lower than last year, due to an upgraded and more efficient gas turbine unit, the savings that were possible for this year’s more efficient turbine were eroded by the fact that this year’s gas turbine output capacity was 153.8 MW compared with last year’s 150.8 MW.

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19 http://www.freightmetrics.com.au/FuelLevyCalculator/tabid/114/Default.aspx

20 Based on density of Diesel of 840 kg/m3

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 2017

Legal Costs

The legal cost estimated for 2016 was $1,989,700. This figure is approximately 1.7% of the 2016 reported capital cost applicable for a 160 MW OCGT power plant.

GHD have, for this year, maintained the bottom up approach used last year to determine the Legal cost and has updated the table below. The evaluation for the legal cost is therefore shown in the following table.

Table 21 Legal Costs

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	718,800
Legal content for diesel fuel supply contract	0.12	143,800
Legal support for PPA/Capacity/offtake contract	0.40	479,200
Legal support for financing/loan procurement	0.10	119,800
Legal support for grid connection agreement	0.12	143,800
Legal support for contracts during construction phase	0.35	419,300
Total		**2,024,700**

Based on our assessment, in the table above for a 160 MW OCGT plant, our estimate for legal cost is $2,024,500 which is slightly higher than last year's cost for legal (due to this year's higher capital cost for the 160 MW unit.

Financing costs

The financing cost comprise of cost to raise capital and also setting up the project vehicle for financing during the construction phase. Last year's assessment involved a bottom up approach to evaluate the financing cost, which is comprised of a Senior debt loan and a Subordinate loan. Last year's financing cost was evaluated to be $2,741,580.

Based on an equity to debt ratio of 20%/80% and a senior debt of 60% (of the total project loan – (0.8 * ((119,805,160 + 6,565,192)*0.6))) = 60,657,769) and a subordinate debt of 40% (of the total project loan - (0.8 * ((119,805,160 + 6,565,192)*0.4))) = 40,438,513), GHD's estimate for loan fees based on the loan amount (@ for a borrowing of 80% of the full project cost) is as follows;

Table 22 Finance Cost

Loan Fee	% fee for loan	Amount A$
Senior loan	2.50%	1,516,444
Subordinate loan	3.15%	1,273,813
Total		**2,790,257**

*Note the % split and magnitude for Senior and Sub-ordinate loans were derived from a previous project and is indicative of a project of this capacity.

Based on our assessment, in the table above for a 160 MW OCGT plant, our estimate for financing cost is $2,790,257 and is slightly higher 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 for a slightly higher cost 160 MW generic unit.

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.

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. Similarly, as was done last year, GHD has used a figure mid-way between 0.5% and 0.7% and therefore the insurance cost is estimated to be $718,800.

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. As was the case in last year's assessment, the estimate for insurance premium for delayed construction risk is not included as part of the insurance cost for this assessment.

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 are based on last year's assessment with an increase in cost due to current hourly rates:

- Prepare and submit Works Approval $20,400
- Air and noise modelling $20,400
- Biological survey $20,400
- Clearing Permit $10,200
- Application fee (est.) $63,300

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 are based on last year's estimates with an increase in cost due to current hourly rates:

- Prepare landscape and drainage plans $30,600
- Prepare and submit Development Application $20,400 (assumes engineering and building details provided)
- Application fee (est.) $40,800

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 are based on last year's estimates with an increase in cost due to current hourly rates for consultancy services:

- Prepare and submit Licence application $15,300
- Annual licence fee $5840[21]
- Annual stack monitoring $10,200
- Annual compliance report $20,400

The estimated cost for Permitting and approvals cost is **$278,240**.

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, over-see construction activities, witness testing and commissioning activities and ensure that the O&M manuals and as built drawings are correct.

Last year's methodology used to establish project management and owners engineering services was re-examined this year and was found to be sound and consistent with current practice.

[21] http://www.wmaa.asn.au/lib/pdf/04_b/wa/publications/130709_Fees_guide_V4_-_July_2013_Ext_Draft.pdf

The cost associated with project management and owners cost is therefore based on last year's assessment with consideration to the current applicable hourly rate and is provided in the following table.

Table 23 Cost associated with project management and owners engineer services.

Description	Cost (A$)	
Project Management		
Concept/feasibility study	$153,000	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	$571,200	This is an average cost to produce a full feasibility study) for an OCGT project. This normally takes 3 to 4 months to complete.
Engagement of Owners Engineer	$214,200	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	$295,800	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	$867,000	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 (tender process) up to Financial close	$1,774,800	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	$2,366,400	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	**$6,242,400**	

Based on the table above the cost associated with project management and owners engineering services is $6,242,400 which is $122,400 higher than last year's estimate of $6,120,000. The reason for this difference is the increase in hourly rate over last year's assessment.

Other costs

Initial spares

As was the case in last year's assessment, it was assumed that a 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 24 Areas of Concern for Siemens SGT5-2000E-33MAC

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[22]

The cost estimate for the parts marked "Wear" was estimated to be approximately $500,000 in last year's assessment. This will of course differ from plant to plant depending on the adopted operator's maintenance strategy. For this year's assessment, GHD has added the applicable CPI increase since last year. Therefore, our estimate for initial spares is $511,250.

Site services

The 2016 report allowance for site services was $150,000. GHD considers last year's estimate for site services to be reasonable (based on the site services required for this technology power plant). GHD's assessment for site services for this year is based on last year's estimate with an allowance for an increase in hourly rates for labour. Therefore, our estimate of $152,250 is assumed to cater for the cost of site services for this year.

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

Start-up costs

The start-up cost for the 160 MW OCGT power plant considers the cost for recruiting, 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 2016 report was 1.5%. GHD considers this value to be reasonable, as it was based on the output from GTPro. Therefore, based on using 1.5% of the capital value for the 160 MW OCGT plant, our estimate is $1,797,080.

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 maintains that a contingency of 5% is reasonable. Therefore, our estimate is $5,990,260.

6.3 Overall M factor

The M factor for year 2017 is provided in Table 25 below.

Table 25 Calculation of M factor for 2017

Component of "M"	2016 Cost ($)	2017 Cost ($)	Difference ($)
Legal Cost	1,989,700	2,024,700	35,000
Financing Cost	2,741,580	2,790,257	48,677
Insurance Cost	707,000	718,800	11,800
Permitting & Approvals Cost	267,000	278,240	11,240
Design & Project Management	6,120,000	6,242,400	122,400
Other Costs			
Initial Spares	500,000	511,250	11,250
Site services	150,000	152,250	2,250
Start-up cost	1,766,000	1,797,080	31,080
Contingency	5,842,000	5,990,260	148,260
Total	**20,083,280**	**20,505,237**	**421,957**

Following our assessment of the 2017 cost the overall M factor has increased slightly by approximately $421,957 mainly due to a change in increased hourly rates and higher capital cost for this year's 160 MW OCGT:

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 $20,505,237 is considered to be within the range expected for this factor.

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	Nello Nigro	Osama Al Dali		Kieran Jacka		25.10.17
1	Nello Nigro	Osama Al Dali		Kieran Jacka		27.10.17
2	Nello Nigro	Osama Al Dali		Kieran Jacka		09.11.17

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