Smart Energy, Sustainable Future

REVIEW OF THE LONG RUN MARGINAL COST PARAMETERS FOR SETTING THE VESTING CONTRACT PRICE FOR 2019 AND 2020

FINAL DETERMINATION PAPER

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1. INTRODUCTION

1.1. The Energy Market Authority ("EMA") implemented vesting contracts on 1 Jan 2004. The objective of the vesting regime is to enhance economic efficiency in the electricity market by mitigating the exercise of market power by the generation companies ("gencos"). The vesting contracts mandate a specified amount of electricity (viz. the vesting contract level) to be hedged at a specified price (viz. the vesting contract price). This removes the incentives for gencos to withhold their generation capacity to sustain inefficient spot prices in the wholesale electricity market.

1.2. The vesting contract price is set based on the long run marginal cost ("LRMC") of the most efficient generation technology that accounts for at least 25% of the system demand in Singapore. The most efficient technology at present is the F-class combined cycle gas turbine ("CCGT"). EMA reviews and determines the vesting contract price parameters biennially or when necessary in accordance with the published *EMA's Procedures for Calculating the Components of the Vesting Contracts* ("Procedures").

1.3. EMA appointed PA Consulting Group ("PA") and Jacobs Group (Australia) Pty Ltd ("Jacobs") (collectively the "Consultants") to review the LRMC parameters for setting the vesting contract price for 2019 and 2020. The review also covers the escalation factors to be used to update in 2019 the capital cost parameters for setting the vesting contract price for 2020.

1.4. EMA conducted two rounds of consultation with the industry. In the second round launched on 18 September 2018, EMA issued a Draft Determination Paper to seek comments on the Consultants' draft final reports taking into account the industry comments received from the first round consultation. The Consultants' final reports after taking into account the comments received are attached at ***Annex 1*** and ***Annex 2***. The responses of the Consultant and EMA are provided in ***Annex 3***.

2. EMA'S FINAL DETERMINATION

2.1. Having considered the comments received, the Consultants' responses thereto and their final reports, EMA makes the Final Determination on the LRMC parameters for setting the 2019 and 2020 vesting contract price as set out below.

Financial and Technical Parameter Values

2.2. The LRMC parameters for setting the 2019 and 2020 vesting contract price are detailed in ***Appendix 1*** (for the financial parameters) and ***Appendix 2*** (for the technical parameters). ***Table 1*** and ***Table 2*** respectively summarises the financial parameters and technical parameters for setting the vesting price for 2019 and 2020. Overall, the indicative vesting contract price based on the finalised parameter values is **$159.22/MWh** for 2019 and 2020, compared to the current level of $159.86/MWh (refer to ***Table 3***).

Table 1: Financial Parameters

Financial Parameters	**Current (2017-2018)**	**Final Determination (2019-2020)**
Risk-free rate, r_f	2.54%	2.86%
Debt Premium, *DP*	2.61%	2.64%
Gearing, *g*	0.46	0.47
Equity Beta, β_{equity}	1.00	1.00
Market Risk Premium, *MRP*	6.12%	6.53%
Corporate Tax Rate, *t*	17%	17%
Return on Equity	8.66%	9.39%
Cost of Debt	5.15%	5.50%
Post-Tax Nominal WACC (%)	**6.65%**	**7.13%**

Table 2: Technical Parameters

Technical Parameters	**Current (2017-2018)**	**Final Determination (2019-2020)**
Capacity per Generating Unit (MW)	407.9	432.2
HHV Heat Rate (Btu/kWh)	7,108.7	7,006.1
Build Duration (months)	30	30
Economic Lifetime (years)	25	25
Plant load factor (%)	58.5	61.9
Capital Cost (S$ million) • Turnkey EPC cost • Discounted through-life capital cost	510.0[1]	528.0
Land, infrastructure and development Cost (S$ million) • Land and site preparation cost • Connection cost • Miscellaneous cost	155.6[2]	159.0
Fixed Annual Running Cost (S$ million/year)	20.3	23.6
Variable Non-fuel Cost (S$/MWh)	7.46	7.04
Carbon Price (S$/MWh)	N.A.	1.85

Table 3: Indicative Vesting Contract Price

	Current (2017-2018)	**Indicative (2019-2020)**
Vesting Contract Price ($/MWh)	**159.86**	**159.22[3]**
Capital Cost Component ($/MWh)	31.80	30.94
Non-fuel Operating Cost Component ($/MWh)	17.14	17.12
Carbon Price ($/MWh)	-	1.85
Fuel Component ($/MWh)*	110.92	109.32

** Based on the weighted average gas price of S$14.79/GJ from March 2018 to May 2018.*

[1] Updated (from S$495.7million for 2017) following mid-term review conducted in 2017 for 2018.

[2] Updated (from S$155.7million for 2017) following mid-term review conducted in 2017 for 2018.

[3] Number does not add up due to rounding.

Escalation Factors for Updating Capital Cost Parameters in 2019 to Set Vesting Contract Price for 2020

2.3. EMA presently conducts a mid-term review of the capital cost parameters[4] using the same methodology used for the biennial review. To streamline and remove the need for conducting a mid-term review in 2019 to update the capital cost parameters for 2020, EMA will apply the following escalation factors to update the capital cost parameters for 2020:

a. <u>Item 7 – Capital cost of the plant</u>

The breakdown of Item 7 is shown in ***Table 4***.

Taking into account the Consultants' assessment that there is oversupply of capacity for manufacturing CCGT plants, and that there is no indication that the demand for large CCGT plants would increase over the next few years, EMA will maintain the same cost for 2019 and 2020 in respect of Specialised Equipment and Other Equipment within the EPC cost under Item 7.

The remaining items within the EPC cost under Item 7 as well as the discounted through-life capital cost are largely construction-related costs. These will be adjusted based on the **Tender Price Index** published by the Building and Construction Authority ("**BCA**").

Table 4: Breakdown of Item 7 – Capital Cost

Item	Cost (S$ million)	% of Total Cost	Escalation Factor
EPC (Specialised Equipment and Other Equipment)	250.4	47%	Nil
EPC (Others)	270.3	53%	BCA Tender Price Index
Discounted Through-life Capital Cost	7.3		

[4] The capital cost parameters refer to item 7 (Capital cost of the plant) and item 8 (Land, infrastructure and development cost of the plant) under Section 2.3 of the Procedures.

b. <u>Item 8 – Land, infrastructure and development cost of the plant</u>

The breakdown of Item 8 is shown in ***Table 5***.

As land and site preparation costs are largely property-related items, such costs will be adjusted based on the **Industrial Property Price Index** published by the Jurong Town Corporation ("**JTC**").

As owner's costs typically follow the general inflation of the economy, such cost will be adjusted based on the **Core Inflation** published by the Monetary Authority of Singapore ("**MAS**").

The generation connection charge will be adjusted in accordance with the prevailing **Transmission Service Rate Schedule** ("**TSRS**") published by SP PowerAssets Limited ("**SPPA**").

The remaining items within the connection cost under Item 8 (consisting of gas insulated switchgear and gas connection costs) are assessed to follow the trend of construction-related costs, and will be accordingly adjusted based on the **Tender Price Index** published by **BCA**.

Table 5: Breakdown of Item 8 – Land, Infrastructure and Development Cost

Item	**Cost (S$ million)**	**% of Total Cost**	**Escalation Factor**
Land and Site Preparation Cost	15.4	10%	JTC Industrial Property Price Index
Owner's Costs	96.5	61%	MAS Core Inflation
Connection Cost (SPPA's Generation Connection Charge)	24.4	15%	In accordance with the TSRS published by SPPA
Connection Cost (Gas Insulated Switchgear and Gas Connection Costs)	22.7	14%	BCA Tender Price Index

2.4. Given the above escalation factors, EMA will accordingly update Items 7 and 8 in 2019 for 2020 in accordance with the following formula:

Cost of Item 7 for 2020 = Cost of Item 7 determined by EMA in 2018 for 2019 x (47% x 1 + 53% x TPI)

Cost of Item 8 for 2020 = Cost of Item 8 determined by EMA in 2018 for 2019 x (15% x SP + 10% x PPI + 14% x TPI + 61% x OCI)

where:

PPI	is equal to PPI_{2019} / PPI_{2018};
PPI_{2019}	is the "All Industrial" Property Price Index for *2019 (up to the latest month available)* published by JTC in year *2019*;
PPI_{2018}	is the "All Industrial" Property Price Index for year *2018* published by JTC in year *2019*;
TPI	is equal to TPI_{2019} / TPI_{2018};
TPI_{2019}	is the Tender Price Index for *2019 (up to the latest month available)* published by BCA in year *2019*;
TPI_{2018}	is the Tender Price Index for year *2018* published by BCA in year *2019*;
OCI	is the Overhead Cost Index for *2020* and is equal to $(1 + MASCIR_{2020})$;
$MASCIR_{2020}$	is the mid-point of the latest available range of projected MAS Core Inflation for 2020 published by MAS in year *2019*; and
SP	is the percentage change (if any) in generation connection cost determined in accordance with the prevailing TSRS published by SPPA, relative to such cost determined by EMA in 2018 for 2019.

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Appendix 1

EMA'S FINAL DETERMINATION ON THE FINANCIAL PARAMETERS FOR SETTING VESTING PRICE FOR 2019-2020

1. Weighted Average Cost of Capital ("WACC")

1.1. The following formula based on the Capital Asset Pricing Model ("CAPM") is used to determine the post-tax nominal WACC for a new generation entrant in Singapore:

$$WACC = [\, g \times (r_f + DP) \times (1 - t) \,] + \{\, (1 - g) \times [\, r_f + \beta_{equity} * (r_m - r_f) \,] \,\}$$

where:

r_f	is the risk-free rate;
DP	is the debt premium;
r_m	is the market rate of return;
$(r_m - r_f)$	is the market risk premium ("MRP");
β_{equity}	is the measure of the sensitivity of the company's returns to market returns;
g	is the level of gearing, i.e. total debt as a proportion of total debt and equity; and
t	is the corporate tax rate.

2. Base Month

2.1. The Base Month is **May 2018**.

3. Comparator Companies

3.1. The **gearing** and **equity beta** are determined using publicly available information in respect of comparator companies. In selecting the comparator companies, the following screening criteria are applied to proxy a new generation entrant in the Singapore market with merchant power market structure and thermal power generation sources:

a. ***Availability of information***. Only companies which are publicly listed are selected so that financial information is transparent and adheres to international financial reporting standards. Selected companies are also required to have at least 5 years of historical information.

b. ***Financial health***. Comparator companies should not have adverse financial health in the past 5 years, such as bankruptcy, insolvency, significant losses, or problems covering interest payments on debt. Companies with a 5-year probability of default based on Bloomberg's Default Risk Model of greater than 10% are excluded.

c. ***Business location***. Comparator companies should operate mainly in countries with similar credit ratings as Singapore[5].

d. ***Revenue source***. Comparator companies should derive at least 50% of their respective total revenue from electricity generation and sales in merchant markets.

e. ***Generation portfolio***. Thermal generation plants are exposed to different commodity and operational risks as compared to other types of power plants. As the majority of Singapore's power generation is generated from natural gas, at least 50% of each comparator company's generation portfolio should be from thermal generation.

3.2. Based on the above criteria, the following three comparator companies are selected: (i) Capital Power Corporation; (ii) SSE plc; and (iii) TransAlta Corp.

4. Risk Free Rate, r_f

4.1. The risk free rate is calculated based on the yield of the Singapore Government Security ("SGS") with a remaining maturity period that most closely matches the economic life of the relevant asset.

4.2. Accordingly, the risk free rate is **2.86%** based on the average daily closing yields for the three-month period from March 2018 to May 2018 in respect of the 30-year SGS (Issue code: NA121000N) issued on 2 April 2012 and maturing on 1 April 2042 (remaining maturity of 24 years).

[5] Singapore's sovereign credit rating is AAA by the three rating agencies viz. Standard and Poor's ("S&P"), Fitch and Moody's. A similar credit rating has been taken as AAA – AA for S&P, AAA – AA for Fitch, and Aaa – Aa2 for Moody's.

5. Debt Premium, *DP*

5.1. The debt premium is 1.51% based on the average yield to maturity of investment-grade rated "Baa" bonds in Moody's Bond Indices for the utility sector less the average yield of US government 30-year bond for the three-month period from March 2018 to May 2018.

5.2. Taking into account market information, including bank quotes from several local and foreign financial institutions active in the Singapore power market for project financing of new generation planting in Singapore, the pre-tax cost of debt will be set at **5.50%** (i.e. debt premium of **2.64%**).

6. Market Risk Premium ("MRP"), $(r_m - r_f)$

6.1. The MRP is **6.53%** based on the mean of forward-looking MRPs and comparable overseas jurisdictions.

7. Gearing, *g*

7.1. The gearing is **0.47** based on the mean of the average five-year gearing of the comparator companies.

8. Tax Rate, *t*

8.1. The tax rate is **17%** which is the corporate tax rate in Singapore.

9. Equity Beta, β_{equity}

9.1. The derived equity beta is 0.95 based on the comparator companies' R-squared weighted unlevered beta of 0.55, the gearing of 0.47 and the tax rate of 17%. On the consideration that the returns for commercial generation companies in Singapore would over time correlate closely with the overall Singapore market returns, the equity beta will be set at **1.00**.

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Appendix 2

EMA'S FINAL DETERMINATION ON THE TECHNICAL PARAMETERS FOR SETTING VESTING PRICE FOR 2019-2020

1. Base Month

1.1. The Base Month is **May 2018**.

2. Generating Technology

2.1. Currently, the most efficient technology that accounts for at least 25% of the system demand in Singapore is the **F-class CCGT**.

3. Capacity per generating unit

3.1. A new entrant is assumed to install two units of CCGTs. Taking into account the effects of degradation (due to fouling, erosion and material losses in the turbine section), local air temperature and conditions, and allowance for gas compression, the achievable effective plant capacity in Singapore for an F-class CCGT is **432.2 MW**.

4. Heat Rate

4.1. The CCGT higher heating value ("HHV") heat rate is **7,006.1 Btu/kWh**, after taking into account the effects of degradation, local air temperature and conditions, part load factor, start-up gas usage, and adjustments for gas compression.

5. Exchange Rate

5.1. The USD/SGD and EUR/SGD exchange rates are **1.32** and **1.61** respectively, averaged over the 3-month period from March 2018 to May 2018.

6. Build Duration

6.1. The build duration is **30 months**.

7. Economic Lifetime

7.1. The economic life is **25 years**. This is the typical technical life of CCGT power plants in Singapore and the region, which is expected to be achievable taking into account the historical trend in the improvement in the net heat rate and capital cost of CCGTs.

8. Plant Load Factor ("PLF")

8.1. The PLF is set at **61.9%** based on the actual performance of existing F-class CCGTs in operation (viz. Senoko Energy's CCP 3 to 7, YTL PowerSeraya's CCP 1 to 4, Tuas Power Generation's CCP 1 to 5, Keppel's CCP 3 and 4, Sembcorp's CCP 3, PacificLight Power's CCP 1 and 2 and Tuaspring BLK1) over the period June 2017 to May 2018. This has been checked to be achievable for 2019 and 2020. Generation output for meeting internal station load is excluded when determining the PLF.

9. Investment Cost

9.1. ***Capital cost***. The capital cost includes the cost of purchasing the plant and all associated equipment, including the cost of delivery of the plant in a state suitable for installation in Singapore. The total capital cost for one CCGT unit is **$528.0m**, comprising:

a. Turnkey Engineering, Procurement and Construction ("EPC") cost:[6] *$520.7m (about US$393.3m)*

b. Discounted through-life capital cost: *$7.3m*

9.2. ***Land and site preparation cost***. The total land and site preparation cost for one CCGT unit is **$15.4m**, comprising:

a. Land lease cost and water-front fees: *$14.4m*

b. Land preparation cost: *$1.0m*

[6] The EPC costs include the cost for specialised equipment, mechanical and electrical engineering, gas compressors, jetty and fuel tanks.

9.3. ***Connection cost***. The total connection cost for one CCGT unit is **$47.1m**[7], comprising:

a. Electrical connection cost including standard connection charge payable, gas insulated switchgear and underground cable: *$39.9m*

b. Gas connection cost: *$7.3m*

9.4. ***Miscellaneous costs***. The total miscellaneous cost for one CCGT unit is **$96.5m**[8], comprising:

a. Owner's costs after financial close including engineering, initial spares, start-up costs and construction related insurance: *$62.5 m*

b. Owner's costs prior to financial closure including permits, licences, fees, legal and financial services, engineering and in-house costs: *$34.1m*

10. Non-Fuel Operating Costs

10.1. ***Fixed annual running cost***. The fixed annual running cost includes the operating and overhead costs that are incurred to have the plant available for supplying energy and reserves. This cost does not vary with the level of energy output. The fixed annual running cost for one CCGT unit is **$23.6m per annum**, comprising:

a. Manpower and allowance for head office services: *$4.8m*

b. Emergency fuel usage: *$0.8m*

c. Fixed maintenance and other fixed operations including cyber security maintenance, start-up impact on turbine maintenance, and distillate usage on turbine maintenance: *$10.2m*

[7] Number does not add up due to rounding.
[8] Number does not add up due to rounding.

d. Working Capital:[9] *$3.9m*

e. Insurance, property tax and EMA licence fee (fixed component): *$3.9m*

10.2. ***Variable Non-Fuel Costs***. The variable non-fuel costs include costs, other than fuel cost, that vary with the level of energy output. The variable non-fuel cost for one unit of CCGT is **$7.04/MWh[10]**, comprising:

a. Long Term Service Agreement ("LTSA") for maintenance of gas and steam turbines: *$5.47/MWh*

b. EMC, PSO and EMA licence fees (variable component): *$0.77/MWh*

c. Consumables (chemicals and town water): *$0.81/MWh*

11. ***Fuel Cost***. Assuming the weighted average gas price of $14.79/GJ from March 2018 to May 2018, the fuel cost component is **$109.32/MWh**.

12. ***Carbon Price***. With the introduction of the carbon tax in Singapore, the Procedures will be updated to include two additional parameters in ***Table A***. Based on the carbon price of **$5/tonne $CO_{2\text{-}e}$** effective from 1 January 2019 and emission factor of **50.03 kg $CO_{2\text{-}e}$/GJ**, the carbon price per MWh of generation output is **$1.85/MWh**.

Table A: Update to Vesting Contract Procedures to reflect carbon pricing

Item No.	Parameter	Description	Method of Determination
24a	Carbon price (SGD/tonne $CO_{2\text{-}e}$)	Carbon price for the emissions of greenhouse gas	Determined by EMA in accordance with the Carbon Pricing Act
24b	Carbon emission factor (tonnes $CO_{2\text{-}e}$/GJ)	Carbon emissions factor for the fuels used by the plant	Determined by EMA in accordance with the International Panel on Climate Change ("IPCC") 2006

* * *

[9] The working capital costs include the costs of holding emergency fuel inventories, which is based on EMA's requirement on Gencos to maintain a 30-day backup fuel stockpile onsite for their exclusive right of use, and an additional 30-day backup fuel stockpile offsite for their first right of use.
[10] Number does not add up due to rounding.