Smart Energy, Sustainable Future

REVIEW OF THE LONG RUN MARGINAL COST PARAMETERS FOR SETTING THE VESTING CONTRACT PRICE FOR 2021 AND 2022

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 has appointed WSP Consultancy Pte Ltd ("WSP") and KPMG Singapore ("KPMG") ("Consultants") to review the LRMC parameters for setting the vesting contract price for 2021 and 2022. The review also covers the escalation factors to be used to update in 2021 and 2022 the capital cost and/or overhead cost parameters for setting the vesting contract price for 2022 and 2023 respectively.

1.4 EMA conducted two rounds of consultation with the industry. On 30 September 2020, 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 of consultation issued on 30 Jul 2020.

1.5 EMA has taken into account the comments received from the second round of consultation and makes the Final Determination as set out below. The Consultant's final reports are attached at ***Annex 1*** and ***Annex 2***, and the Consultant's/EMA's responses to the comments are set out in ***Annex 3***.

2. EMA'S FINAL DETERMINATION ON THE FINANCIAL PARAMETERS FOR SETTING VESTING PRICE FOR 2021 – 2022

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

2.1.1. 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:

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

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.

2.2. Base Month

2.2.1. The Base Month is **May 2020**.

2.3. Comparator Companies

2.3.1. 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, restructuring, 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. ***Geographical location of revenues***. Comparator companies should source at least 50% of its total revenue from countries with similar sovereign credit ratings as Singapore[1].

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.

2.3.2. Based on the above criteria, the following four comparator companies are selected: (i) AGL Energy Limited; (ii) Genesis Energy Limited; (iii) Origin Energy Limited; and (iv) SSE plc.

2.4. Risk Free Rate, r_f

2.4.1. 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.

2.4.2. Accordingly, the risk free rate is **1.46%** based on the average daily closing yields for the three-month period from March 2020 to May 2020 in respect of the 30-year SGS (Issue code: NA16100H) issued on 1 March 2016 and maturing on 1 March 2046 (remaining maturity of 26 years).

[1] Singapore's sovereign credit rating is Aaa by rating agency Moody's. Companies that are listed in countries with a similar credit rating between Aaa – Aa2 by Moody's were considered.

2.5. Debt Premium, *DP*

2.5.1. The debt premium is **2.44%** 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 2020 to May 2020.

2.5.2. The pre-tax cost of debt based on the above benchmarking approach is accordingly 3.90%. This is corroborated with a survey of several banks active in Singapore's power market which indicated an all-in pre-tax cost of debt of 3.89%. EMA will accordingly adopt the pre-tax cost of debt of **3.90%**.

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

2.6.1. The MRP is **6.84%** based on the mean of forward-looking MRPs and comparable overseas jurisdictions.

2.7. Gearing, *g*

2.7.1. The gearing is **0.32** based on the mean of the five-year average gearing of the comparator companies.

2.8. Tax Rate, *t*

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

2.9. Equity Beta, β_{equity}

2.9.1. The derived equity beta is **1.18** based on the comparator companies' R-squared weighted average unlevered beta of 0.84, the gearing of 0.32 and the tax rate of 17%.

3. EMA'S FINAL DETERMINATION ON THE TECHNICAL PARAMETERS FOR SETTING VESTING PRICE FOR 2021 – 2022

3.1. Base Month

3.1.1. The Base Month is **May 2020**.

3.2. Generating Technology

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

3.3. Capacity per generating unit

3.3.1. A new entrant is assumed to install two units of CCGTs. Taking into account the effects of degradation (due to fouling, erosion, roughening of gas turbine compressor blades 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 **419.9 MW**.

3.4. Heat Rate

3.4.1. The CCGT higher heating value ("HHV") heat rate is **6,999.7 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.

3.5. Exchange Rate

3.5.1. The USD/SGD and EUR/SGD exchange rates are **1.42** and **1.55** respectively, averaged over the 3-month period from March 2020 to May 2020.

3.6. Build Duration

3.6.1. The build duration is **31.5 months** after factoring in the additional time needed due to COVID-19.

3.7. Economic Lifetime

3.7.1. The economic life is **25 years**. This is the typical technical life of CCGT power plants in Singapore and the region.

3.8. Plant Load Factor ("PLF")

3.8.1. The PLF is set at **61.8%** based on the actual performance of existing F-class CCGTs in operation (viz. Keppel's CCP 3 and 4, PacificLight Power's CCP 1 and 2, Sembcorp's CCP 3, Senoko Energy's CCP 3 to 7, Tuas Power Generation's CCP 1 to 5, Tuaspring BLK1 and YTL PowerSeraya's CCP 1 to 4) over the period June 2019 to May 2020. This has been checked to be achievable for 2021 and 2022. Generation output for meeting internal station load is excluded when determining the PLF.

3.9. Investment Cost

3.9.1. ***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 **$541.3m**, comprising:

a. Initial Plant Capital Cost (excluding external connection cost) — *$535.7m (about US$377.3m)*

b. Discounted through-life capital cost: — *$5.6m*

3.9.2. ***Land and site preparation cost***. The total land and site preparation cost for one CCGT unit is **$15.2m**, comprising:

a. Land lease cost and water-front fees: — *$14.2m*

b. Land preparation cost: — *$1.0m*

3.9.3. ***Connection cost***. The total connection cost for one CCGT unit is **$45.9m**[2], comprising:

a.	Electrical connection cost including standard connection charge payable, gas insulated switchgear and underground cable:	*$38.5m*
b.	Gas connection cost:	*$7.3m*

3.9.4. ***Miscellaneous costs***. The total miscellaneous cost for one CCGT unit is **$98.9m**, comprising:

a.	Owner's costs after financial close including engineering, initial spares, start-up costs and construction related insurance:	*$64.0m*
b.	Owner's costs prior to financial closure including permits, licences, fees, legal and financial services, engineering and in-house costs:	*$34.9m*

3.10. Non-Fuel Operating Costs

3.10.1. ***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 **$22.2m per annum**, comprising:

a.	Manpower and allowance for head office services:	*$5.1m*
b.	Emergency fuel usage:	*$0.4m*
c.	Fixed maintenance and other fixed operations including additional cyber security maintenance, start-up impact on turbine maintenance, and distillate usage on turbine maintenance:	*$10.4m*

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

d. Working Capital[3]: *$2.2m*

e. Insurance, property tax and EMA licence fee (fixed component): *$4.1m*

3.10.2. ***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 **$7.34/MWh**, comprising:

a. Long Term Service Agreement ("LTSA") for maintenance of gas and steam turbines: *$5.77/MWh*

b. EMC, PSO and EMA licence fees (variable component): *$0.79/MWh*

c. Consumables (chemicals and town water): *$0.78/MWh*

3.11. ***Fuel Cost***. Assuming the weighted average gas price of $7.87/GJ for March 2020 to May 2020, the fuel cost component is **$58.11/MWh**.

3.12. ***Carbon Price***. With the introduction of the carbon tax in Singapore, the Procedures have taken into consideration the two parameters as shown in **Table 1**. Based on the carbon price of **$5/tonne CO_{2-e}** effective from 1 January 2019 and emission factor of **50.03 kg CO_{2-e}/GJ**, the carbon price per MWh of generation output is **$1.85/MWh**.

Table 1: Parameters to reflect carbon pricing

Item No.	Parameter	Description	Method of Determination
24a	Carbon price (SGD/tonne CO_{2-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-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

[3] 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.

4. SUMMARY OF EMA'S FINAL DETERMINATION

4.1. **Table 2** summarises the financial parameters for setting the vesting price for 2021 and 2022.

Table 2: Financial Parameters

Weighted Average Cost of Capital Parameters	Current (2019-2020)	Final Determination (2021-2022)
Risk-free rate, r_f	2.86%	1.46%
Debt Premium, *DP*	2.64%	2.44%
Gearing, *g*	0.47	0.32
Equity Beta, β_{equity}	1.00	1.18
Market Risk Premium, *MRP*	6.53%	6.84%
Corporate Tax Rate, *t*	17%	17%
Return on Equity	9.39%	9.56%
Cost of Debt	5.50%	3.90%
Post-Tax Nominal WACC (%)	**7.13%**	**7.53%**

4.2. **Table 3** summarises the technical parameters for setting the vesting price for 2021 and 2022.

Table 3: Technical Parameters

Technical Parameters	Current (2019-2020)	Final Determination
Capacity per Generating Unit (MW)	432.2	419.9
HHV Heat Rate (Btu/kWh)	7,006.1	6,999.7
Build Duration (months)	30	31.5
Economic Lifetime (years)	25	25
Plant load factor (%)	61.9	61.8
Capital Cost (S$ million) • Turnkey EPC cost • Discounted through-life capital cost	531.2[4]	541.3
Land, infrastructure and development Cost (S$ million) • Land and site preparation cost • Connection cost • Miscellaneous cost	160.2[5]	159.9
Fixed Annual Running Cost (S$ million/year)	23.6	22.2
Variable Non-fuel Cost (S$/MWh)	7.04	7.34

4.3. The indicative LNG vesting contract price based on the finalised parameter values is **$111.23/MWh** for 2021 and 2022, compared to the current level of $108.27/MWh (refer to **Table 4)**.

Table 4: Indicative LNG Vesting Contract Price

	Current (2019-2020)	Indicative (2021-2022)
Vesting Contract Price (S$/MWh)	**108.27**	**111.23**
Capital Cost Component (S$/MWh)	31.14	34.15
Non-fuel Operating Cost Component (S$/MWh)	17.12	17.12
Carbon Price (S$/MWh)	1.85	1.85
Fuel Component (S$/MWh)*	58.16	58.11

** Based on the weighted average gas price of S$7.87/GJ from March to May 2020.*

[4] Updated from $528.0m following application of escalation factors in 2019 for 2020.
[5] Updated from $159.0m following application of escalation factors in 2019 for 2020.

5. ESCALATION FACTORS TO UPDATE CAPITAL AND OVERHEAD COST PARAMETERS FOR 2022 AND 2023

5.1. Use of Escalation Factors

5.1.1. EMA presently uses escalation factors to update certain cost parameters[6] annually:

a. In accordance with the Final Determination Paper on the "*Review of the Long Run Marginal Cost Parameters for Setting the Vesting Contract Price for 2019 and 2020*", the capital cost parameters were escalated in 2019 for 2020 using various publicly available indices.

b. Since the Final Determination Paper on the "*Review of the Long Run Marginal Cost (LRMC) Parameters for Setting the Vesting Contract Price for the Period 1 January 2013 to 31 December 2014*", the overhead cost parameters have been escalated annually based on the Core Inflation published by the Monetary Authority of Singapore ("MAS").

5.1.2. To streamline the review process, EMA will apply the same approach as described in para 5.1.1.a to update the capital cost parameters in 2021 for 2022.

5.1.3. Further, as the Vesting Contracts will be phased out from 1 Jul 2023, EMA will apply the same approach as described in para 5.1.1 to update the capital and overhead cost parameters in 2022 for the period 1 Jan 2023 to 30 Jun 2023. For avoidance of doubt, EMA will hold all other parameters in **Table 2** and **Table 3** that are not covered below constant till the expiry of the Vesting Contracts on 30 Jun 2023.

5.2. Capital Cost Parameters

a. Item 7 – Capital cost of the plant

The breakdown of Item 7 is shown in **Table 5**.

In view 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 retain the same cost for 2021, 2022 and 2023 in respect of Specialised Equipment and Other Equipment within the EPC cost under Item 7.

[6] The cost parameters refer to: (i) capital cost parameters viz. item 7 (Capital cost of the plant) and item 8 (Land, infrastructure and development cost of the plant); and (ii) overhead cost parameters viz. item 15 (Fixed annual running cost of the plant) and item 16 (Variable non-fuel cost of the plant) under Section 2.3 of the Procedures.

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 can be adjusted based on the Tender Price Index published by the Building and Construction Authority ("BCA").

Table 5: Breakdown of Item 7 – Capital Cost

Item	Cost (S$ million)	% of Total Cost	Escalation Factor
EPC (Specialised Equipment and Other Equipment)	248.8	46%	Nil
EPC (Others)	286.9	54%	BCA Tender Price Index
Discounted Through-life Capital Cost	5.6		

b. Item 8 – Land, infrastructure and development cost of the plant.

The breakdown of Item 8 is shown in **Table 6**.

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

The owner's costs are assessed to follow the general inflation of the economy, and can be adjusted based on the Core Inflation published by MAS.

The generation connection charge can 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 can be adjusted based on the Tender Price Index published by BCA.

Table 6: Breakdown of Item 8 – Land, Infrastructure and Development Cost

Item	Cost (S$ million)	% of Total Cost	Escalation Factor
Land and Site Preparation Cost	15.2	9%	JTC Industrial Property Price Index
Owner's Costs	98.9	62%	MAS Core Inflation
Connection Cost (SPPA's Generation Connection Charge)	22.6	14%	In accordance with the TSRS published by SPPA
Connection Cost (Gas Insulated Switchgear and Gas Connection Costs)	23.3	15%	BCA Tender Price Index

5.2.1. EMA will update Items 7 and 8 in: (i) 2021 for 2022; and (ii) 2022 for 2023 in accordance with the following formulae:

Cost of Item 7 for 2022/2023 = Cost of Item 7 determined by EMA in 2020 for 2021
x (46% x 1 + 54% x TPI)

Cost of Item 8 for 2022/2023 = Cost of Item 8 determined by EMA in 2020 for 2021
x (14% x SP + 9% x PPI + 15% x TPI
+ 62% x OCI)

where:

PPI set in 2021 for 2022, is equal to PPI_{2021} / PPI_{2020}, and set in 2022 for 2023, is equal to PPI_{2022} / PPI_{2020};

PPI_{2022} is the "All Industrial" Property Price Index for *2022 (up to the latest month available)* published by JTC in year *2022*;

PPI_{2021} is the "All Industrial" Property Price Index for *2021 (up to the latest month available)* published by JTC in year *2021*;

PPI_{2020} is the "All Industrial" Property Price Index for year *2020* published by JTC in year *2021*;

TPI set in 2021 for 2022, is equal to TPI_{2021} / TPI_{2020}, and set in 2022 for 2023, is equal to TPI_{2022} / TPI_{2020};

TPI_{2022} is the Tender Price Index for *2022 (up to the latest month available)* published by BCA in year *2022*;

TPI_{2021} is the Tender Price Index for *2021 (up to the latest month*

available) published by BCA in year *2021*;

TPI_{2020} is the Tender Price Index for year *2020* published by BCA in year *2021*;

OCI the Overhead Cost Index,
set in 2021 for 2022, is equal to $(1 + MASCIR_{2022})$, and
set in 2022 for 2023, is equal to $MASCI_{2022} / MASCI_{2020}$;

$MASCI_{2022}$ is equal to the Core Inflation published by MAS for the *3-month period of March, April and May 2022*, multiplied by $(1 + MASCIR_{2023})$;

$MASCI_{2020}$ is equal to the Core Inflation published by MAS for the *3-month period of March, April and May 2020*;

$MASCIR_{2022}$ is the mid-point of the latest available range of projected MAS Core Inflation for 2022 published by the Monetary Authority of Singapore ("MAS") in year *2021*;

$MASCIR_{2023}$ is the mid-point of the latest available range of projected MAS Core Inflation for 2023 published by the Monetary Authority of Singapore ("MAS") in year *2022*; 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 2020 for 2021.

5.3. Overhead Cost Parameters

5.3.1. As mentioned in para 5.1.1, EMA currently escalates the overhead cost parameters annually based on the Core Inflation published by MAS. EMA will adopt the same approach to update the overhead cost parameters in 2022 for 2023:

Cost of Items 15 and 16 for 2023 = Cost of Items 15 and 16 determined by EMA in 2020 x OCI

where: *OCI* the Overhead Cost Index,
is equal to $MASCI_{2022} / MASCI_{2020}$;

$MASCI_{2022}$ is equal to the Core Inflation published by MAS for the *3-month period of March, April and May 2022*, multiplied

by *(1 + $MASCIR_{2023}$)*;

$MASCI_{2020}$ is equal to the Core Inflation published by MAS for the *3-month period of March, April and May 2020*; and

$MASCIR_{2023}$ is the mid-point of the latest available range of projected MAS Core Inflation for 2023 published by the Monetary Authority of Singapore ("MAS") in year *2022*.