



**REVIEW OF THE LONG RUN MARGINAL COST (LRMC) PARAMETERS FOR SETTING THE  
VESTING CONTRACT PRICE FOR THE PERIOD 1 JANUARY 2011 TO 31 DECEMBER 2012**

**FINAL DETERMINATION PAPER**

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ENERGY MARKET AUTHORITY  
991G Alexandra Road  
#01-29 Singapore 238164  
[www.ema.gov.sg](http://www.ema.gov.sg)

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# REVIEW OF THE LONG RUN MARGINAL COST (LRMC) PARAMETERS FOR SETTING THE VESTING CONTRACT PRICE FOR THE PERIOD 1 JANUARY 2011 TO 31 DECEMBER 2012

## FINAL DETERMINATION PAPER

### 1. INTRODUCTION

1.1. The Energy Market Authority (“EMA”) implemented Vesting Contracts on 1 January 2004. The objective of the Vesting Contract regime is to control the exercise of market power by the generation companies (“Gencos”) and promote efficiency and competition in the electricity market. The Vesting Contracts commit the Gencos to sell a specified amount of electricity (viz, the Vesting Contract level) at a specified price (viz. the Vesting Contract price).

1.2. The Vesting Contract price is set taking into account both the long run marginal cost (“LRMC”) of the most efficient technology that accounts for at least 25% of our system demand and the policy objective to promote efficiency and competition in the electricity market for the benefit of consumers. The most efficient generation technology at present is the “F” Class combined cycle gas turbine or CCGT.

1.3. EMA conducts a review of the LRMC parameters used to set the Vesting Contract price biennially or at other times where it considers necessary. The existing procedures for determining the Vesting Contract price can be found in the document “EMA’s Procedures for Calculating the Components of the Vesting Contracts (Version 1.6)” (“Vesting Contract Procedures”). EMA has appointed PA Consulting Group Pte Ltd (“PA Consulting”) to assist in the review of the LRMC parameters for setting the Vesting Contract price for the period 1 January 2011 to 31 December 2012.

1.4. This report summarises EMA’s final determination of the LRMC parameters to be used to set the Vesting Contract price for the period **1 January 2011 to 31 December 2012**.

## **2. BASE MONTH**

2.1 EMA has adopted May 2010 as the “Base Month” for the determination of the LRMC parameters for setting the Vesting Contract price for the period 1 January 2011 to 31 December 2012.

2.2 EMA has identified that the following base parameters can be volatile.

- a. Exchange rate to convert the costs denominated in foreign currencies into Singapore Dollars;
- b. Diesel price to calculate cost of carrying back up fuel;
- c. Risk-free rate;
- d. Debt premium used to calculate cost of debt;
- e. Consumer Price Index;
- f. Domestic Supply Price Index; and
- g. Imported Iron & Steel Index.

2.3 For the purpose of reducing volatility of results, the data used in the estimation of the parameters listed in paragraph 2.2 above have been averaged over a three month period leading up to and including the "base month" for this review.

### **3. REVIEW OF TECHNICAL PARAMETERS**

#### ***Generating Technology***

3.1 Currently, the most efficient technology that accounts for at least 25% of the system demand in Singapore is the 'F' class combined cycle gas turbine ("CCGT"). The costs of common items such as land, site development and basic infrastructure to support the operation of the CCGTs would be shared between two units.

#### ***Capacity per generating unit***

3.2 Taking into account of degradation due to fouling, erosion and material losses in the turbine section; local air temperature; local cooling water temperature and allowance for gas compression, the achievable effective plant capacity in Singapore for an 'F' class CCGT would be **381 MW**.

#### ***HHV Heat Rate***

3.3 The HHV heat rate for the proxy plant is **7,010** Btu/kWh. This takes into account the effects of degradation, local air temperature, local cooling water temperature, part load factor, start-up gas usage and adjustments for gas compressor.

#### ***Build Duration***

3.4 The build duration of the proxy plant is taken to be **30 months**.

#### ***Economic Lifetime***

3.5 The economic lifetime of the proxy plant based on PA's modelling is **24 years**.

#### ***Plant Load Factor***

3.6 The plant load factor is set at **74.9%**, based on the actual performance of the existing 'F' class CCGTs in operation in the system for the 12 months June 2009 to May 2010 i.e. Senoko Energy's CCGT units 3 to 5, PowerSeraya's CCGT units 1 and 2, Tuas Power Generation's CCGT units 1 to 4 and checked to be achievable for 2011 and 2012. Station load has been subtracted when determining the plant load factor.

## **Investment Cost**

### Capital Cost

3.7 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.

3.8 The total capital cost is **\$559.2 million** for one unit of 'F' class CCGT, comprising of:

- |   |                 |
|---|-----------------|
| a. Turnkey EPC cost                     | \$550.9 million |
| b. Discounted through-life capital cost | \$8.3 million   |

3.9 Capital cost includes (i) facility costs, comprising ancillary buildings, demineralisation plant, sea water intake/outfall structures, constructing the jetty for emergency fuel unloading facility and gas receiving facilities (these costs were classified under land and site preparation cost in previous reviews), (ii) emergency fuel facilities (classified under land and site preparation cost in previous reviews), (iii) civil works for the plants, erection and assembly, detailed engineering and start-up costs, and contractor soft costs (classified under connection cost in previous reviews) and (iv) discounted through life capital cost (classified under miscellaneous cost in previous reviews).

### Land and Site Preparation Cost

3.10 The total land and site preparation cost for one unit of 'F' class CCGT is **\$13.65 million**, comprising of:

- |   |                |
|---|----------------|
| a. Land lease cost and water front fees | \$12.9 million |
| b. Land preparation cost                | \$0.75 million |

3.11 The land and site preparation cost excludes (i) facility costs (ancillary buildings, demineralisation plant, sea water intake/outfall structures, constructing the jetty for emergency fuel unloading facility and gas receiving facilities) and (ii) emergency fuel facilities. These costs have been included under capital cost for the current review.

### Connection Cost

3.12 The total connection cost for one unit of 'F' class CCGT is **\$38.25 million**, comprising of:

- a. Electrical connection cost \$31.6 million  
*Standard connection charge (\$50,000 per MW payable to SPPG), switchgear GIS and underground cable*
- b. Gas connection costs \$6.65 million

3.13 Connection cost excludes civil works for the plants, erection and assembly, detailed engineering and start-up costs. These costs have been included under capital cost for the current review.

### Miscellaneous costs

3.14 The total miscellaneous cost for one unit of 'F' class CCGT is **\$100.1 million**. This cost consists of:

- a. Owner's costs after financial closure \$64.8 million  
*owner's engineering; owner's "minor items"; initial spares; start-up costs and construction related insurance*
- b. Owner's costs prior to financial closure \$35.3 million  
*Permits, licenses, fees; legal and financial advice and costs; and owner's engineering and in-house costs*

3.15 Miscellaneous cost excludes discounted through life capital cost. These costs have been included under capital cost for the current review.

### ***Non-fuel Operation Costs***

#### Fixed Annual Running Cost

3.16 The fixed annual running cost includes the fixed operating and overhead costs that are incurred in having the plant available for supplying energy and reserves but are not dependent on the quantity of energy supplied.

3.17 The fixed annual running cost for one unit of 'F' class CCGT is **\$22.49 million** per annum, comprising :

- a. Manpower and allowance for head office services \$3.36 million

b. Emergency fuel usage	\$0.75 million
c. Fixed maintenance and other fixed operations <i>Fixed maintenance and other fixed operations; start-up impact on turbine maintenance; and distillate usage on turbine maintenance.</i>	\$8.32 million
d. Working Capital	\$6.76 million
e. Insurance, property tax and fixed EMA licence fee of \$50,000	\$3.3 million

### Variable Non-Fuel Cost

3.18 The variable non-fuel cost includes any costs, other than fuel costs, that vary with the level of energy output. The variable non-fuel cost is estimated at **\$6.55/MWh** for one unit of 'F' class CCGT, comprising of:

a. LTSA for maintenance of Gas Turbine and Steam Turbine	\$5.14/MWh
b. EMC, PSO and EMA licence (variable at \$0.155/MWh) fees	\$0.71/MWh
c. Consumables (chemicals and town water)	\$0.70/MWh

### **Fuel Cost**

3.19 The fuel cost included in the Vesting Contract price is determined quarterly based on the procedures set out in the Vesting Contract Procedures paper.

#### 4. REVIEW OF WACC PARAMETERS

4.1 The following formula based on the Capital Asset Pricing Model (“CAPM”) is used to determine the post-tax nominal weighted average cost of capital (“WACC”) for determining the opportunity cost of investment for a new entrant:

$$WACC = [g \times (r_f + DP)(1 - t)] + \{(1 - g)[r_f + \beta(r_m - r_f)]\}$$

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)
	$\beta$ (equity)	is the measure of the sensitivity of the company’s returns to market returns
	$g$	is the level of gearing, i.e. debt as a proportion of total assets
	$t$	is the corporate tax rate

##### **Risk Free Rate, $r_f$**

4.2 The risk free rate is **3.31%**, based on the average daily closing yields of an “AAA” rated 20-year Singapore Government Bond (CTSGD20Y) for March, April and May 2010.

##### **Debt Premium, $DP$**

4.3 The debt premium is **250 basis points** (“bps”). Island Power Company, a new entrant with an investment-grade parent company GMR has indicated its financing spread is 250 basis points. Based on this evidence, the debt premium is set at 250 basis points, which is higher than the other empirical data of 197 basis points determined by PA Consulting.

##### **Gearing, $g$**

4.4 The gearing of **0.342** is derived from the average debt-to-equity ratio of the panel of comparator companies.

### ***Equity Beta, $\beta$ (equity)***

4.5 The equity beta based on the comparator companies is 0.778, which is unexpectedly low relative to the equity beta used in previous previews. Given the current lack of long-term contracting in the Singapore power market, one would expect electricity returns to be more closely correlated with general economic returns than they might be in other markets. To account for the higher expected degree of correlation in Singapore, the equity beta has been adjusted to be **1.00** for the purposes of this review.

### ***Market Risk Premium, $(r_m-r_f)$***

4.6 The market risk premium (“MRP”) is set at **7%** based on a balanced consideration of several approaches, viz. the forward-looking Dividend Discount Model approach and the Historical Premium approach, Volatility Adjusted approach as well as local and overseas benchmarks (viz. MRPs used by Singapore listed companies and regulators in Australia and UK).

### ***Tax Rate, $t$***

4.7 The tax rate is **17%**, being Singapore’s corporate tax rate.

**5. SUMMARY OF THE LONG RUN MARGINAL COST (LRMC) PARAMETERS FOR SETTING THE VESTING CONTRACT PRICE FOR THE PERIOD 1 JANUARY 2011 TO 31 DECEMBER 2012**

<b>Technical Parameters</b>	<b>Current Review (2011 - 2012)</b>
Base Month	May 2010
Capacity per Generating Unit (MW)	381
HHV Heat Rate (Btu/kWh)	7,010
Build Duration (months)	30
Economic Lifetime (years)	24
Plant factor (%)	74.9
Capital Cost (S\$ million) <ul style="list-style-type: none"> <li>• Turnkey Engineering, Procurement and Construction (EPC) cost</li> <li>• Discounted through-life capital cost</li> </ul>	559.2
Land, infrastructure and Development Cost (S\$ million) <ul style="list-style-type: none"> <li>• Land and site preparation cost</li> <li>• Connection cost</li> <li>• Miscellaneous cost</li> </ul>	152.0
Fixed Annual Running Cost (S\$ million/year)	22.49
Variable Non-fuel Cost (S\$/MWh)	6.55

<b>WACC Parameters</b>	<b>Current Review (2011 - 2012)</b>
Risk-free rate, $r_f$ (%)	3.31
Debt Premium, DP (bps)	250
Gearing, g	0.342
Equity Beta, $\beta_{equity}$	1.00
Market Risk Premium, $r_m - r_f$ (%)	7.0
Corporate Tax Rate, t (%)	17.0
<b>Post-Tax Nominal WACC (%)</b>	<b>8.43</b>

<b>Vesting Contract Price</b>	<b>Current Review (2011 - 2012)</b>
<b>Vesting Contract Price (S\$/MWh)</b>	<b>177.8</b>
Vesting Contract Price (S\$/MWh) – Non-Fuel Component*	50.4
Vesting Contract Price (S\$/MWh) – Fuel Component	127.4

\*Based on gas price of S\$17.219/GJ used for setting of Q2 2010 Vesting Contract price.