LONG RUN MARGINAL COST (LRMC) PARAMETERS FOR 1 JANUARY 2005 TO 31 DECEMBER 2006

SEPTEMBER 2004

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Preface

The Energy Market Authority (EMA) implemented vesting contracts on 1 Jan 2004. The objective of the vesting regime is to control the market power of generation companies ("gencos").

2 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 price). Such contracts control market power by removing the incentives for the gencos to exercise their market power to withhold their generating capacity to push up spot prices in the wholesale market.

3 The specified price under the vesting contract, i.e. the vesting price, is set at the long run marginal cost (LRMC) of the most efficient electricity generation technology serving at least 25% of our total electricity demand. Presently, the most efficient generation technology is the combined cycle gas turbine (CCGT).

4 The existing LRMC parameters were determined in Jan 2002 and EMA will review the LRMC parameters every 24 months. In accordance with the established procedures for determining the LRMC parameters, the existing parameters will apply until 31 Dec 2004 and the next review of the LRMC is due on 1 Jan 2005.

Principles Underlying the LRMC

5 In its determination of the LRMC, EMA is guided by the principle of benchmarking the LRMC against the most efficient new entrant plant using the most cost efficient generation technology that has secured at least 25% share of the generation market. Currently, the most cost efficient generation technology in the market is the CCGT with a plant configuration comprising of a gas turbine of the 260MW class combined with a waste heat recovery boiler and steam turbine in a single-shaft arrangement.

EMA's Determination

6 EMA has completed the review of the LRMC parameters. The revised LRMC parameters, as set out in the Appendix 1, will be used to set the vesting price for 1 Jan 2005 to 31 Dec 2006. In its determination of the LRMC parameters, EMA has taken into consideration the comments and feedback it received from the industry and electricity consumers. A summary of EMA's response to feedback from gencos and consumers is given in Appendices 2 and 3 respectively.

7 The revised LRMC parameters yield a weighted average cost of capital (WACC) of 8.42%, and LRMC of $90.65/MWh based on a fuel oil price of US$26.60/bbl. The revised LRMC is lower than the existing one. For the same fuel oil price, the LRMC based on the existing parameters would be $95.73/MWh.

Lower LRMC

8 The revised LRMC is lower mainly due to the lower WACC (reduced from 9.52% to 8.42%) and the higher CCGT plant factor (increased from 70% to 76%). The reduction in WACC reflects the current lower interest rate and market risk premium (i.e. the premium or additional return required by equity investors) environment as compared to 2002. The increase in the CCGT plant factor reflects the actual performance achieved by the most efficient CCGTs currently in the market. EMA's detailed assessment of the key LRMC parameters for Jan 2005 to Dec 2006 is outlined below.

Key LRMC Parameters

Plant Factor

9 The plant factor is the expected annual proportion of total plant capacity that will be used for supplying energy for sale, assuming that the plant is efficiently base-loaded. EMA has determined the plant factor of the new entrant genco to be 76%. In its determination, EMA benchmarked against the actual performance of the most efficient CCGTs currently in the market. The most efficient new CCGTs have achieved 76% plant factor over the last financial year (Apr 03 to Mar 04). This forms the benchmark. The plant factor was therefore set at 76% to compute the LRMC.

Capital Cost

10 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 capital cost excludes the costs of installation, switchgears, fuel tanks, transmission and fuel connections, land, buildings and site development. These costs are included as part of the "land, infrastructure and development costs" (see paragraph 12).

11 EMA has determined the capital cost to be US$380/kW by benchmarking against the costs of comparable CCGTs. Specifically, EMA has used the average of the prices as published in the industry handbook (Gas Turbine World Handbook 2003) for comparable CCGTs from the major gas turbine manufacturers. The average price was adjusted by about 2% and 5% respectively to account for the cost of delivery to Singapore and the more difficult ambient operating conditions in Singapore. The ambient conditions in Singapore would cause a reduction of the output of the gas turbine component in a CCGT. However, the resulting higher exhaust energy from the gas turbine for use in the steam turbine process of the CCGT would increase the steam turbine output. The net reduction of the CCGT output is about 5%.

Land, Infrastructure & Development Cost

12 In its assessment of this cost, EMA has assumed that the new genco will develop 2 units of 370MW CCGT so as to achieve economies of scale through

sharing the costs of common items such as land, site development and basic infrastructure to support operation of the CCGT. These shared costs are allocated evenly to each of the 2 units.

13 The total land, infrastructure and development costs amounts to $208.94 million for 2 units of 370MW CCGT, equivalent to $104.47 million for each 370MW unit. The detailed cost breakdown is given below:

a. Land Cost: $11.38 million

The land cost comprises land lease cost, based on the current JTC posted land lease rate of $164 per m^2 for a 30-year leasehold and a required land area of 12.5 hectares ($10.25 million), plus waterfront fees of $450 per meter per year for a 200m waterfront to cater for cooling water intake/outfall structures and a jetty for unloading of emergency fuel ($1.13 million).

b. Facilities cost: $18.75 million

This includes the cost of ancillary buildings, switch-house, seawater intake/outfall structures, jetty for emergency fuel unloading facility, and gas receiving facilities.

c. Emergency fuel tankage: $15.30 million

This is estimated based on fuel storage required to store backup fuel for the CCGT.

d. Connection charge: $27.50 million

This includes the standard connection charge of $50,000 per MW and the cost of 230kV switchgear.

e. Installation cost: $26.04 million

This includes the cost of installation, and testing and commissioning of the complete mechanical and electrical equipment up to commercial operation of the CCGT.

f. Consultancy cost: $5.50 million

This includes consultant's fees for engineering studies, legal and financial advisors.

Fixed Annual Running Cost & Variable Non-Fuel Cost

14 The fixed annual running cost includes the maintenance, operating and overhead costs that are incurred annually to keep the plant in a ready state for supplying energy and reserves. The variable non-fuel cost includes the costs, other than fuel costs, that vary with the level of energy output.

15 The fixed annual running cost of $25.67 million comprises $11.70 million for plant and other maintenance cost, $5.97 million for the carrying cost for backup fuel,

$3.11 million for manpower, corporate overheads and working capital, and $4.89 million for other expenses (insurance, property tax, etc).

16 The variable non-fuel cost was estimated at $0.91/MWh. This comprises $0.71/MWh for administrative charges by the market and system operators (i.e. EMC and PSO charges), and the remaining $0.20/MWh for consumables (specifically water and chemicals).

Weighted Average Cost of Capital (WACC)

17 The Capital Asset Pricing Model (CAPM) is adopted to estimate the WACC. The formula is given by:

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

Where:

r_f	is the risk-free rate of return;
DP	is the debt premium;
r_m	is the market rate of return;
$(r_m - r_f)$	is often referred to as the market risk premium (MRP);
β	is the measure of the expected volatility of a company's returns relative to the market;
g	is the level of gearing, i.e. debt as a proportion of debt and equity; and
t	is the marginal corporate tax rate.

18 The revised WACC of 8.42% is lower than the current WACC of 9.52% used in the existing LRMC. When the current WACC was set in 2002, the market risk premium was about 8% and the risk free rate was 4.24%. In the current market environment, the risk free rate is about 3.71% and the MRP about 6%. The details of the WACC assessment are given below.

Risk Free Rate

19 EMA benchmarked the risk free rate against the 15-year Singapore Government Bond (SGB). For transparency and certainty, EMA adopted the approach of setting the risk free rate at the average of the daily closing yields of the most recent 15-year SGB in April 04, the calendar month immediately preceding May 04 (which is the Base Date for the review). The average is 3.71% and EMA has set this as the risk free rate.

Market Risk Premium

20 The market risk premium (MRP) represents the additional return over investing in risk free securities that an investor in Singapore will demand for his equity investment. EMA has assessed the MRP for Singapore to be 6%. In this assessment EMA has taken into consideration the advice of bankers, its consultant and the published reports of local companies, some of whom have reported their revised estimate of MRP to be down from between 7-8% in previous years to 6% in

2003. As a cross check, EMA has also noted that regulators in the United States and Australia which have similar country-risk profile as Singapore, have also adopted MRP of 6%.

Beta

21 Beta is a measure of the expected volatility of a company's returns relative to the market. To determine the appropriate beta for the new entrant genco, EMA has benchmarked against a group of comparable generation companies selected based on the following criteria:

a. Does the company do business in competitive markets?
b. Is power generation its main business activity?
c. Is the company publicly listed and are beta values available?

22 After a careful search for comparable companies, EMA has used the following peer group of companies:

The AES Corp

The AES Corporation, through its subsidiaries and affiliates, is a global power company primarily engaged in owning and operating electric power generation and distribution businesses in many countries around the world. It operates in four segments: contract generation, competitive supply, large utilities and growth distribution. Its generating assets include interests in 114 facilities in 24 countries totaling over 38 GW of generating capacity.

Energy Development Limited

The principal activities of the company are in the development and operation of power generation and waste-to-energy conversion projects. It exploits opportunities in the Australian electricity sector, and has a portfolio of electricity assets. It is an integrated energy company that develops, owns and operates power generation and transmission projects.

International Power

International Power is an international wholesale power generator and developer with interests in 13 countries. Its operating power plants have capacity totaling 16 GW. The company's diverse portfolio includes plants that are fuelled by natural gas, coal and oil.

23 The average equity beta for AES Corp, Energy Development and International Power is 1.75 and EMA has used this as the beta of the new entrant genco in Singapore.

Gearing (Proportion of Debt to Total Assets)

24 EMA has benchmarked the gearing against the expected gearing of a new entrant genco that has a minimum credit rating of BB+. For such a genco, a gearing

ratio of 0.6 is a reasonable reflection of an efficient capital structure. The gearing of 0.6 is also comparable to the average gearing ratio of the 3 companies referenced for the calculation of beta (viz. AES Corp, International Power and Energy Development).

Cost of Debt

25 The cost of debt is given by the risk free rate plus a debt premium. A debt premium of 2% is reasonable for a new entrant genco that has a minimum credit rating of BB+. Taken together with the risk free rate at 3.71% (see paragraph 19), the cost of debt is 5.71%.

~ End ~

Appendix 1

REVISED LRMC PARAMETER VALUES TO SET VESTING PRICE FOR 1 JAN 2005 TO 31 DEC 2006

S/No.	Parameter	Revised Value
1	Base Year	2004
2	Capacity per generating unit (MW)	370
3	HHV Heat Rate (Btu/kWh)	7,492
4	Build Duration (months)	27
5	Plant Factor	76%
6	Capital Cost:	
	per kW (US$)	380
	per 370 MW unit (US$ million)	140.60
	per 370 MW unit (S$ million)[1]	236.77
7	Land, Infrastructure & Development Cost (S$million)	104.47
8	Total Capital and Land, Infrastructure & Development Cost (S$million)	341.24
9	Variable Non-Fuel Cost (S$/MWh)	0.91
10	Fixed Annual Running Cost (S$million /year)	25.67
11	Proportion of Debt to Assets (gearing)	0.60
12	Risk-Free Rate	3.71%
13	Debt Premium	2%
14	Cost of Debt	5.71%
15	Tax Rate	20%
16	Beta	1.75
17	Market Risk Premium	6%
18	Cost of Equity	14.21%
20	Weighted Average Cost of Capital (WACC)	8.42%

[1] Exchange rate: US$1 = S$1.684

Appendix 2

FEEDBACK FROM GENCOS

Capital Cost

(1) *The gencos have proposed that the CCGT capital cost should range from US$387/kW to US$500/kW based on recent overseas transactions by OEMs or work-in-progress CCGTs in Singapore*.

EMA's response:

- In the LRMC determination, 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 capital cost excludes the costs of installation, switch-gears, fuel tanks, transmission and fuel connections, land, buildings and site development. These latter costs are included as part of the "land, infrastructure and development costs".

- EMA has determined the capital cost to be US$380/kW. EMA has benchmarked this cost against the current costs of the most cost efficient generation technology in the Singapore market, viz the CCGT with a plant configuration comprising of a gas turbine of the 260 MW class combined with a waste heat recovery boiler and steam turbine in a single-shaft arrangement. Specifically, EMA has used the average of the published prices in the industry handbook (Gas Turbine World Handbook 2003) for comparable CCGTs from the major gas turbine manufacturers (namely Siemens, GE, Mitsubishi and Alstom). The average price is adjusted by about 2% and 5% respectively to account for the cost of delivery to Singapore and the more difficult ambient operating conditions in Singapore. The ambient conditions in Singapore would cause a reduction of the output of the gas turbine component in a CCGT. However, the resulting higher exhaust energy from the gas turbine for use in the steam turbine process of the CCGT would increase the steam turbine output. The net reduction of the CCGT output is about 5%.

- The project cost figures cited by the gencos include cost components that are classified as "Land, Infrastructure & Development" in the LRMC computation. If those project cost figures were adopted as the capital cost of the CCGT in the LRMC setting, there will be "double counting" of cost components.

Plant Factor

(2) *The gencos have proposed a plant factor ranging from 55% to 65% based on the average plant factors of all existing CCGTs in the power system.*

EMA's response:

- In its determination, EMA benchmarked against the actual performance of the most efficient CCGTs currently in the market. Presently, the most efficient CCGT technology is one with a plant configuration comprising of a gas turbine of the 260MW class combined with a waste heat recovery boiler and steam turbine in a single-shaft arrangement.

- The most efficient CCGTs in the Singapore power system have actually achieved 76% plant factor over the last financial year (Apr 03 to Mar 04) and EMA therefore set the plant factor at this level to compute the LRMC.

Land, Infrastructure & Development

(3) *The gencos have proposed that land, infrastructure & development cost should range from $120m to $140m. They gave the feedback that the consultant's initial proposed value of $3.25m for consultancy fees was on the low side and that the generation connection cost should be included. Some gencos also commented that their land lease costs are paid to JTC annually and hence land lease costs should be included as part of the fixed annual running cost.*

EMA's response:

- The land, infrastructure & development cost includes besides land cost, the costs of installation, site development and basic infrastructure to support operation of the CCGT (e.g. the seawater intake/outfall facilities, tanks for backup fuel, switchgear and generation connection).

- EMA has assessed the cost details and determined that the cost should be $104.47m. EMA has included consultant's fees for engineering studies, legal and financial advisors of $5.5m and generation connection cost at $18.5m. As for the cost of the land lease, JTC posts 2 prices for its land lease: one is an annual rental and the other is an "upfront premium" for the long term (30 years) land lease. It is more cost efficient to make the upfront payment. EMA has accordingly adopted the substantially lower land cost at $10.25m based on current JTC land lease rate of S$164 per m^2 for a 30-year leasehold.

Gearing (Proportion of Debt to Total Assets)

(4) *The gencos have proposed a range of values from 50% to 55% for the gearing, which they think would be more appropriate for potential new entrant gencos in the Singapore market.*

EMA's response:

- EMA has benchmarked the gearing against the expected gearing of a new entrant genco that has a minimum credit rating of BB+. For such a genco, a gearing ratio of 0.6 is reasonable reflection of an efficient capital structure.

- EMA has further cross checked its assessment with the gearing of power companies overseas where figures are available. The gearing of 0.6 is comparable to the average gearing ratio of AES Corp, International Power and Energy Development.

Risk Free Rate

(5) *The gencos commented that a more forward-looking approach that takes into account the impending rise in interest rates should be adopted to determine the risk free rate. Some also suggested that the risk free rate should be derived closer to the date of determination for WACC.*

EMA's response:

- EMA benchmarks the risk free rate against the yield of the 15-year Singapore Government Bond (SGB).

- The bond market is generally considered efficient and market expectations of the trend in interest rates would have been incorporated in current rates.

- In this review, the Base Date is May 04. In accordance with the established procedure, the risk free rate is taken as the average of the daily closing yields of the most recent 15-year SGB for the calendar month immediately preceding the Base Date, i.e. Apr 04.

Cost of Debt

(6) *The gencos have commented that in the Singapore market with high price uncertainty and volatility, the debt premium would be in the range of 2% to 2.5%.*

EMA's response:

- The cost of debt is given by the risk free rate plus a debt premium. A debt premium of 2% is reasonable for a new entrant genco that has a minimum credit rating of BB+. Taken together with the risk free rate at 3.71%, the cost of debt will therefore be 5.71%.

Market Risk Premium

(7) *The gencos have commented that a decline in the market risk premium from the existing 7.84% to 6% is too low and fast, and have suggested that the market risk premium would be in the range of 7% to 7.84%.*

EMA's response:

- The market risk premium (MRP) represents the additional return over investing in risk free securities that an investor in Singapore will demand for his equity investment. EMA has assessed the MRP for Singapore to be 6%. In the assessment EMA has taken into consideration the advice of

bankers, the consultant and the published reports of local companies, some of whom have reported their revised estimate of MRP to be down from 7-8% in previous years to 6% in 2003. As a cross check, EMA has also noted that regulators in the United States and Australia which have similar country-risk profile as Singapore, have also adopted MRP of 6%.

Appendix 3

FEEDBACK FROM CONSUMERS

Land, Infrastructure & Development

(1) *As shown in the consultant's draft report, there is an increase in land, infrastructure cost but generally land rental rates have reduced in the past two years.*

EMA's response:

- The land, infrastructure & development cost includes besides land cost, the costs of installation, site development and basic infrastructure to support operation of the CCGT (e.g. the seawater intake/outfall facilities, tanks for backup fuel, switchgear and generation connection). In its determination, EMA has benchmarked the costs against local benchmarks and similar power projects overseas.

- JTC posts 2 prices for its land lease: one is an annual rental and the other is an "upfront premium" for the long term (30 years) land lease. The consultant initially estimated the land cost at $20.31m based on an annual rental rate of $13 per m^2. EMA has determined that it is cost efficient to make the upfront payment for a 30-year lease instead of annual rental payments. EMA has revised the land cost downwards to $10.25m based on the current JTC land lease rate of S$164 per m^2 for a 30-year leasehold.

Fixed Annual Running Cost & Variable Non-Fuel Cost

(2a) *Only the capital cost (WACC) is benchmarked worldwide. How about running cost?*
(2b) *Please explain the increase since in reality, we actually experienced decrease in plant maintenance cost.*

EMA's response:

- In its determination of the LRMC, EMA is guided by the principle of benchmarking against the most efficient new entrant plants using the most cost efficient generation technology that has secured at least 25% share of the generation market. EMA's detailed assessment of the key LRMC parameters for Jan 2005 to Dec 2006 is outlined in the main report above.

- As compared to the LRMC parameters values determined in 2002, EMA's assessment based on industry sources shows that there has been an increase of $0.5m for yearly power plant servicing & maintenance, from $10.0m a year to $10.5m a year.

(2c) *Substantial increase seems to be due to high fuel reserves. Suggest to review the need to keep 90 days onsite reserve.*

EMA's response:

- The fuel reserve requirement is necessary for security purpose. EMA requires gencos to have 45 days of fuel reserves on-site and the other 45 days can be "off-site" reserves.

WACC

(3a) *The additional risk factor built into the WACC as an initial measure has impacted the consumers quite significantly. We are satisfied with the adjustment of the WACC through the removal of the additional risk factor. However, we are interested to know why this change is proposed to only be implemented in 2005, when the paper suggests that including the risk factor was not necessary, independent of time factors. We suggest that this WACC change be applied retrospectively, or with immediate effect as it builds an inaccurately high vesting hedge price, thus causing an inaccurate benchmark for market prices of electricity.*

(3b) *Beta value has been drastically increased. It is very high compared to Australia and Western Europe.*

(3c) *Suggested beta of 1.75 means that power plant equity investment is significantly riskier than average of the whole equity market. This may not be the case in Singapore where, due to small market size, a large number of market players are not expected. So Singapore may continue to see a few generators holding most of market share which may not contribute to significant variability in equity return of power sector in Singapore. We believe a lower beta should be considered.*

3(d) *If we are changing the WACC, should it be implemented from year 2004 since we are changing the assumptions?*

EMA's response:

- The existing WACC of 9.52% was determined in Jan 2002. The approach adopted at that time was to use an additional risk factor so that the WACC would properly reflect the risk of the new entrant genco. In the determination of the WACC for Jan 05 to Dec 06, EMA has refined the approach to use a beta that fully reflects the equity risk of new entrant power plants in Singapore. With this approach, there is no longer the need to include the additional risk factor.

- To determine the appropriate beta for the new entrant genco, EMA has benchmarked against a group of comparable generation companies selected based on the following criteria:

    a. Does the company do business in competitive markets?
    b. Is power generation its main business activity?
    c. Is the company publicly listed and are beta values available?

- After a careful search for comparable companies, EMA has identified AES Corp, Energy Development and International Power. The average equity

beta for these companies is 1.75 and EMA has used this as the beta of the new entrant genco in Singapore.

- The revised parameters will take effect only from 1 Jan 05. In accordance with the established procedures for determining the LRMC parameters, the parameters are to be updated every 2 years to reflect prevailing environment at the time of the review for implementation over the next 2 years. The revised WACC reflects the current lower interest rate and market risk premium (i.e. the premium or additional return required by equity investors) environment as compared to 2002. It would not be correct in principle to implement the updated WACC retrospectively.

Other Costs

(4) *Other non-genco cost such as transmission cost, PSO and MSSL charges etc should be reviewed as these form a substantial portion of the total bill.*

EMA's response:

- EMA regulates the transmission (i.e. use-of-system), MSSL, EMC and PSO charges to ensure that cost of inefficiencies is not passed through to consumers. Transmission cost had been reduced by 8% on 1 April 03 and another 3% on 1 May 04. The EMC and PSO charges for FY 04/05 have also been reduced from $0.47/MWh and $0.26/MWh respectively to $0.46/MWh and $0.245/MWh respectively.