



*Smart Energy, Sustainable Future*

**REVIEW OF THE LONG RUN MARGINAL COST PARAMETERS FOR  
SETTING THE VESTING CONTRACT PRICE FOR 2017 AND 2018**

**FINAL DETERMINATION PAPER**

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# REVIEW OF THE LONG RUN MARGINAL COST PARAMETERS FOR SETTING THE VESTING CONTRACT PRICE FOR 2017 AND 2018

## FINAL DETERMINATION PAPER

### 1. INTRODUCTION

1.1. The Energy Market Authority (“EMA”) implemented vesting contracts on 1 Jan 2004. The objective of the vesting regime is to mitigate the exercise of market power by the generation companies (“gencos”) to enhance economic efficiency in the electricity market. 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”). EMA also conducts a mid-term review of the capital cost parameters.<sup>1</sup>

1.3. EMA has appointed Parson Brinckerhoff Pte Ltd (“PB”) and KPMG Services Pte Ltd (“KPMG”) (“Consultants”) to conduct a review of the LRMC parameters for setting the vesting contract price for 2017 and 2018. On 3 Aug 2016, EMA issued a draft determination paper to seek comments on the Consultants’ Revised Reports setting out their assessment of the financial and technical parameters. The Consultants’ responses to the comments received are set out in **Annex 1**. Their Final Reports after taking into account the comments received are attached at **Annex 2** and **Annex 3**.

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<sup>1</sup> 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.

## 2. EMA'S FINAL DETERMINATION

2.1 Having considered the comments received, the Consultants' responses thereto and their final report, EMA makes the Final Determination on the LRMC parameters for setting the 2017 and 2018 vesting contract price as set out in **Appendix 1** (for the financial parameters) and **Appendix 2** (for the technical parameters).

2.2 **Table 1** summarises the financial parameters for setting the vesting price for 2017-2018. The financial parameters for 2017-2018 result in a slightly lower post-tax nominal weighted cost of capital ("WACC") of 6.65%, compared to the WACC of 6.82% for 2015-2016. The reduction is mainly due to the risk-free interest rate which has fallen to 2.54%, from the risk-free interest rate of 3.08% determined in 2014 for 2015-2016.

**Table 1: Financial Parameters**

<b>Weighted Average Cost of Capital ("WACC") Parameters</b>	<b>Current (2015-2016)</b>	<b>Final Determination (2017-2018)</b>
Risk-free rate, $r_f$	3.08%	2.54%
Debt Premium, DP	2.42%	2.61%
Gearing, g	0.50	0.46
Equity Beta, $\beta_{equity}$	1.00	1.00
Market Risk Premium, MRP	6.00	6.12%
Corporate Tax Rate, $t$	17%	17%
Return on Equity	9.08%	8.66%
Cost of Debt	5.50%	5.15%
<b>Post-Tax Nominal WACC (%)</b>	<b>6.82%</b>	<b>6.65%</b>

2.3 **Table 2** summarises the technical parameters for setting the vesting price for 2017-2018. Compared to the previous review:

- a. The *per MW* capital cost has decreased by 4.2%, from \$1.268m to \$1.215m due to an improvement in generation output capacity of available F-class CCGT machines which offset the increase in engineering, procurement and construction ("EPC") cost of CCGT plants in the region.
- b. A lower plant load factor ("PLF") of 58.5% is set for the current review (versus 64.4% for the previous review) taking into account the actual PLF of existing F-class CCGT operating in the Singapore market and the additional embedded generation coming into operation within the review period.

- c. The economic life of the new entrant CCGT is set at 25 years (versus 24 years in the previous review). 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.
- d. There is an improvement in fuel efficiency performance across all the available new F-class CCGTs. After adjusting for the PLF, the revised higher heating value (“HHV”) heat rate is 7,108.7 Btu/kWh, marginally higher than the HHV heat rate of 7,103.8 Btu/kWh from the previous review.
- e. The fixed annual operating cost per CCGT unit has decreased by 14.7% to \$20.3m, mainly due to the reduction in emergency fuel reserves required by EMA (from 90 days to 60 days) coupled with the significant decrease in gasoil/diesel prices.
- f. There is a 13.7% increase in the variable non-fuel cost mainly due to higher cost of the Long Term Service Agreement (“LTSA”) for CCGT (gas and steam turbine) maintenance.

**Table 2: Technical Parameters\***

Technical Parameters	Current (2015-2016)	Final Determination (2017-2018)
Capacity per Generating Unit (MW)	386.7	407.9
HHV Heat Rate (Btu/kWh)	7,103.8	7,108.7
Build Duration (months)	30	30
Economic Lifetime (years)	24	25
Plant load factor (%)	64.4	58.5
Capital Cost (S\$ million/unit) <ul style="list-style-type: none"> <li>• Turnkey EPC cost</li> <li>• Discounted through-life capital cost</li> </ul>	490.4 <sup>^</sup>	495.7
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>	155.4 <sup>^</sup>	155.7
Fixed Annual Running Cost (S\$ million/year/unit)	23.8	20.3
Variable Non-fuel Cost (S\$/MWh)	6.56	7.46

\* Numbers may not add up due to rounding.

<sup>^</sup> Updated parameter following mid-term review for 2016. The other parameters are as determined in the biennial review for 2015-2016.

2.4 Overall, the indicative vesting price for 2017-2018 (assuming the weighted average gas price of S\$9.87/GJ for Mar to May 2016) is \$122.31/MWh, marginally lower than the current vesting price of \$122.33/MWh (refer to **Table 3**).

**Table 3: Indicative Vesting Contract Price for 2017-2018**

	<b>Current (2015-2016)</b>	<b>Final Determination (2017-2018)</b>
<b>Vesting Contract Price (S\$/MWh)</b>	<b>122.33</b>	<b>122.31</b>
Capital Cost Component (S\$/MWh)	30.60	31.14
Non-fuel Operating Cost Component (S\$/MWh)	17.75	17.14
Fuel Component (S\$/MWh)*	73.98	74.03

\*Based on the weighted average gas price of S\$9.87/GJ for Mar-May 2016.

\* \* \*

## EMA's Final Determination on the Financial Parameters for Setting the Vesting Price for 2017-2018

### 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:

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

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");
	$\beta_{equity}$	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. Averaging of historical data for parameters such as risk-free rates, exchange rates and diesel prices will be over a three-month period leading up to and including the Base Month of **May 2016**.

### 3. Comparator Companies

3.1. The **gearing** and **equity beta** are determined by referencing publicly available information in respect of comparator companies. In selecting the comparator companies, the following screening criteria are applied to ensure that the comparator companies are as relevant as possible for a theoretical 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 standard reporting requirements. 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 acquisitions and/or restructuring.
- c. **Business location.** Comparator companies should operate mainly in countries with similar credit ratings as Singapore<sup>2</sup>.
- d. **Revenue source.** Comparator companies should derive more than or equal to 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, more than or equal to 50% of each comparator company's generation portfolio should be from thermal generation.

3.2. Based on the above criteria, the following five comparator companies are selected: (i) Calpine Corporation; (ii) Capital Power Corporation; (iii) NRG Energy; (iv) SSE plc; and (v) Drax Group plc. Refer to **Appendix 3** for the profile of each comparator company selected.

### 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.

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<sup>2</sup> Singapore's sovereign credit rating is AAA by the three rating agencies of S&P, Fitch and Moody's.



4.2 Based on the average daily closing yields for the three-month period Mar 2016 to May 2016 in respect of the 30-year SGS (Issue code: NA12100N) issued on 2 Apr 2012 and maturing on 1 Apr 2042 (remaining maturity of 26 years), the risk free rate is 2.54% (refer to **Appendix 4** for detailed computation).

## 5. Debt Premium (*DP*) and Cost of Debt

5.1 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 period Mar 2016 to May 2016, the debt premium is 2.18% (refer to **Appendix 5** for detailed computation). The corresponding pre-tax cost of debt is 4.72% (i.e. debt premium of 2.18% plus risk-free rate of 2.54%).

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 5.15% (i.e. debt premium of 2.61%).

## 6. Gearing, *g*

6.1 The gearing is 0.46 based on the median of the average gearing of the comparator companies.

## 7. Tax Rate, *t*

7.1 The tax rate is 17%, which is the corporate tax rate in Singapore.

## 8. Equity Beta, $\beta_{equity}$

8.1 Based on the comparator companies’ R-squared weighted unlevered beta of 0.52, the derived equity beta is 0.89 (refer to **Appendix 6** for the detailed computation). On the consideration that the returns for commercial generation companies in Singapore would over time correlate closely with the overall Singapore market returns, EMA will adjust the equity beta to 1.00.

## 9. Market Risk Premium (“MRP”), ( $r_m - r_f$ )

9.1 There are various empirical approaches for estimating MRP. Both historical and forward-looking MRPs for Singapore and comparable overseas jurisdictions are used to estimate MRP. The median of the estimated MRPs is 6.12% (refer to **Appendix 7** for details).

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## EMA's Final Determination on the Technical Parameters for Setting the Vesting Price for 2017-2018

### 1. Base Month

1.1 Averaging of historical data for parameters such as risk-free rates, exchange rates and diesel prices will be over a three-month period leading up to and including the Base month of **May 2016**.

### 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 **407.9 MW**.

### 4. Heat Rate

4.1 The CCGT higher heating value ("HHV") heat rate is **7,108.7 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.

### 5. Exchange Rate

5.1 The SGD/USD and SGD/EUR exchange rates, averaged over the three-month period from Mar 2016 to May 2016, are **1.3643** and **1.5357** respectively.

### 6. Build Duration

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

## 7. Economic Lifetime

7.1 The economic life is set at 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 **58.5%** 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<sup>3</sup>) over the period Jun 2015 to May 2016 and checked to be achievable<sup>4</sup> for 2017 and 2018. 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 **\$495.7m**, comprising:

- |   |  |
|---|--|
| a. Turnkey Engineering, Procurement and Construction (“EPC”) cost: <sup>5</sup> | <b>\$488.4m</b><br><i>(about US\$357.9m)</i> |
| b. Discounted through-life capital cost:  | <b>\$7.3m</b>                                |

9.2 **Land and site preparation cost.** The total land and site preparation cost for one CCGT unit is **\$18.8m**, comprising:

- |  |                |
|--|----------------|
| a. Land lease cost and water front fees: | <b>\$17.7m</b> |
| b. Land preparation cost:                | <b>\$1.1m</b>  |

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<sup>3</sup> Tuaspring BLK1 is included in the computation of the plant load factor for the period 1 Mar 16 to 31 May 16.

<sup>4</sup> Embedded generation that are expected to come into operation in 2017 and 2018 have been taken into consideration when checking for achievability.

<sup>5</sup> 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 **\$46.1m**, comprising:

- |   |         |
|---|---------|
| a. Electrical connection cost including standard connection charge payable, switchgear GIS and underground cable: | \$39.0m |
| b. Gas connection cost:   | \$7.1m  |

9.4 **Miscellaneous costs.** The total miscellaneous cost for one CCGT unit is **\$90.9m**, comprising:

- |  |          |
|--|----------|
| a. Owner's costs after financial close including engineering, initial spares, start-up costs and construction related insurance:             | \$58.8 m |
| b. Owner's costs prior to financial closure including permits, licences, fees, legal and financial services, engineering and in-house costs: | \$32.1m  |

## 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 **\$20.3m per annum**, comprising:

- |  |        |
|--|--------|
| a. Manpower and allowance for head office services:  | \$4.3m |
| b. Emergency fuel usage:   | \$0.5m |
| c. Fixed maintenance and other fixed operations including start-up impact on turbine maintenance, and distillate usage on turbine maintenance: | \$9.6m |
| d. Working Capital: <sup>6</sup>   | \$2.2m |

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<sup>6</sup> The working capital costs include the costs of holding emergency fuel inventories, which is based on EMA's requirement on commercial generation companies to maintain a 30-day backup fuel reserves onsite for their exclusive right of use, and an additional 30-day backup fuel reserves offsite for their first right of use.

- e. Insurance, property tax and EMA licence fee (fixed component): \$3.7m

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 \$7.46/MWh<sup>7</sup>, comprising:

- a. Long Term Service Agreement (“LTSA”) for maintenance of gas and steam turbines: \$6.02/MWh
- b. EMC, PSO and EMA licence fees (variable component): \$0.71/MWh
- c. Consumables (chemicals and town water): \$0.74/MWh

10.3 **Fuel Cost.** Assuming the weighted average gas price of \$9.87/GJ for Mar to May 2016, the fuel cost component is \$74.03/MWh.

\* \* \*

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<sup>7</sup> Numbers may not add up due to rounding.

## **Profile of Comparator Companies Selected**

*(Source: Capital IQ, Company Websites, Company Annual Reports)*

### **Calpine Corp (NYSE:CPN)**

Calpine Corporation, a wholesale power generation company, owns and operates natural gas-fired and geothermal power plants in North America. It operates natural gas-fired combustion turbines and renewable geothermal conventional steam turbines.

The company sells power, steam, capacity, renewable energy credits, and ancillary services to utilities, independent electric system operators, industrial and agricultural companies, retail power providers, municipalities and other governmental entities, and power marketers, as well as retail commercial, industrial, and residential customers.

### **Capital Power Corporation (TSX:CPX)**

Capital Power Corporation acquires, develops, operates, and optimizes power generation facilities in Canada and the United States. The company generates electricity from various energy sources, such as natural gas, landfill gas, coal, wind, solid fuels, and solar.

As of February 18, 2016, it owned approximately 3,200 megawatts of power generation capacity at 18 facilities; 371 megawatts of capacity through a power purchase agreement; and 530 megawatts of owned generation capacity under the advanced stages of development. Capital Power Corporation was founded in 1891 and is headquartered in Edmonton, Canada.

### **NRG Energy, Inc (NYSE:NRG)**

NRG Energy, Inc., or NRG, is an integrated competitive power company, which produces, sells and delivers energy and energy products and services in major competitive power markets in the U.S. while positioning itself as a leader in the way residential, industrial and commercial consumers think about and use energy products and services.

NRG has one of the nation's largest and most diverse competitive generation portfolios balanced with the nation's largest competitive retail energy business.

NRG owns and operates approximately 50,000 MW of generation; engages in the trading of wholesale energy, capacity and related products; transacts in and trades fuel and transportation services; and directly sells energy, services, and innovative, sustainable products and services to retail customers under the names "NRG", "Reliant" and other retail brand names owned by NRG. NRG was incorporated as a Delaware corporation on May 29, 1992.

## **SSE plc (LSE:SSE)**

SSE plc generates, transmits, distributes, and supplies electricity in the United Kingdom and Ireland. The company also produces, stores, distributes, and supplies natural gas, as well as is involved in energy portfolio management activities. It generates electricity from gas, oil, coal, water, and wind.

The company operates in three segments: Networks, Retail, and Wholesale. Its electricity networks transmit and distribute electricity to approximately 3.7 million businesses, offices, and homes through approximately 130,000 kilometres of overhead lines and underground cables; and gas networks distribute gas to approximately 5.7 million homes, offices, and businesses through 75,000 kilometres of gas mains. The company also supplies electricity and gas to approximately 9 million households and businesses under the SSE, Scottish Hydro, Southern Electric, SWALEC, Atlantic, and SSE Airtricity brands.

It owns or has an ownership interest in approximately 11,733 megawatts of generation capacity.

## **Drax Group plc (LSE:DRX)**

Drax Group plc, together with its subsidiaries, engages in the generation and supply of electricity in the United Kingdom. It operates through three segments: Generation, Biomass Supply, and Retail.

The company owns and operates Drax Power Station that produces electricity from biomass located in Selby, North Yorkshire. It sells its electricity to the wholesale market and business customers. In addition, the company manufactures and supplies compressed wood pellets for commercial and domestic customers for heating. Drax Group plc was incorporated in 2005 and is based in Selby, the United Kingdom.

**Average Yield on Singapore Government Securities: 30-Year Bond***(Source: <https://secure.sgs.gov.sg/fdanet/BenchmarkPricesAndYields.aspx>)*

Yield on Singapore Government 30-Year Security "NA12100N" Issued in 2012 and Maturing 2042			
01-Mar-16	2.78	15-Apr-16	2.52
02-Mar-16	2.81	18-Apr-16	2.46
03-Mar-16	2.79	19-Apr-16	2.47
04-Mar-16	2.75	20-Apr-16	2.47
07-Mar-16	2.73	21-Apr-16	2.55
08-Mar-16	2.68	22-Apr-16	2.54
09-Mar-16	2.63	25-Apr-16	2.55
10-Mar-16	2.65	26-Apr-16	2.60
11-Mar-16	2.68	27-Apr-16	2.56
14-Mar-16	2.75	28-Apr-16	2.50
15-Mar-16	2.78	29-Apr-16	2.51
16-Mar-16	2.74	03-May-16	2.51
17-Mar-16	2.61	04-May-16	2.50
18-Mar-16	2.59	05-May-16	2.50
21-Mar-16	2.61	06-May-16	2.49
22-Mar-16	2.60	09-May-16	2.50
23-Mar-16	2.61	10-May-16	2.49
24-Mar-16	2.55	11-May-16	2.45
28-Mar-16	2.55	12-May-16	2.42
29-Mar-16	2.51	13-May-16	2.41
30-Mar-16	2.42	16-May-16	2.39
31-Mar-16	2.42	17-May-16	2.43
01-Apr-16	2.43	18-May-16	2.48
04-Apr-16	2.42	19-May-16	2.53
05-Apr-16	2.43	20-May-16	2.52
06-Apr-16	2.45	23-May-16	2.51
07-Apr-16	2.45	24-May-16	2.53
08-Apr-16	2.45	25-May-16	2.55
11-Apr-16	2.44	26-May-16	2.47
12-Apr-16	2.45	27-May-16	2.50
13-Apr-16	2.48	30-May-16	2.57
14-Apr-16	2.55	31-May-16	2.57

Average

2.54



**Average Yield on US Gov't 30-Year Bond & Moody's Bond Indices for Utilities**  
 (Source: U.S. Department of the Treasury and Bloomberg)

Date	30 year T-Bill	Baa	Date	30 year T-Bill	Baa
01-Mar-16	2.70	5.32	15-Apr-16	2.56	4.70
02-Mar-16	2.69	5.30	18-Apr-16	2.58	4.73
03-Mar-16	2.65	5.26	19-Apr-16	2.60	4.71
04-Mar-16	2.70	5.28	20-Apr-16	2.66	4.74
07-Mar-16	2.71	5.26	21-Apr-16	2.69	4.75
08-Mar-16	2.63	5.18	22-Apr-16	2.70	4.74
09-Mar-16	2.68	5.24	25-Apr-16	2.72	4.75
10-Mar-16	2.70	5.20	26-Apr-16	2.76	4.76
11-Mar-16	2.75	5.22	27-Apr-16	2.71	4.70
14-Mar-16	2.74	5.19	28-Apr-16	2.68	4.70
15-Mar-16	2.73	5.17	29-Apr-16	2.66	4.66
16-Mar-16	2.73	5.17	02-May-16	2.71	4.71
17-Mar-16	2.69	5.12	03-May-16	2.66	4.60
18-Mar-16	2.68	5.05	04-May-16	2.64	4.57
21-Mar-16	2.72	5.07	05-May-16	2.60	4.55
22-Mar-16	2.72	5.05	06-May-16	2.62	4.58
23-Mar-16	2.65	4.96	09-May-16	2.61	4.57
24-Mar-16	2.67	4.98	10-May-16	2.61	4.58
28-Mar-16	2.66	4.95	11-May-16	2.58	4.55
29-Mar-16	2.60	4.91	12-May-16	2.60	4.57
30-Mar-16	2.65	4.94	13-May-16	2.55	4.51
31-Mar-16	2.61	4.89	16-May-16	2.59	4.56
01-Apr-16	2.62	4.87	17-May-16	2.59	4.55
04-Apr-16	2.60	4.86	18-May-16	2.67	4.65
05-Apr-16	2.54	4.79	19-May-16	2.64	4.60
06-Apr-16	2.58	4.80	20-May-16	2.63	4.61
07-Apr-16	2.52	4.71	23-May-16	2.63	4.61
08-Apr-16	2.55	4.74	24-May-16	2.65	4.63
11-Apr-16	2.56	4.72	25-May-16	2.67	4.66
12-Apr-16	2.61	4.76	26-May-16	2.64	4.62
13-Apr-16	2.58	4.72	27-May-16	2.65	4.63
14-Apr-16	2.61	4.74	31-May-16	2.64	4.62

	30 year T Bill	Baa
<b>Average</b>	2.65	4.83

Debt Premium = 4.83 - 2.65 = 2.18%

## Beta

Comparator company	5-year average D/E	5-year levered beta	Tax rate	Unlevered beta	R <sup>2</sup>
Calpine Corporation (NYSE:CPN)	1.49	0.96	40.0%	0.51	0.24
Capital Power Corporation (TSX:CPX)	0.85	0.75	26.5%	0.46	0.17
NRG Energy, Inc. (NYSE:NRG)	2.50	1.03	40.0%	0.41	0.19
SSE plc (LSE:SSE)	0.45	0.69	20.0%	0.51	0.24
Drax Group plc. (LSE:DRX)	0.14	0.91	20.0%	0.82	0.13

<b>R<sup>2</sup> weighted average un-levered beta:</b>	0.52
<b>Singapore corporate tax rate:</b>	17%
<b>D/E ratio:</b>	0.85
<b>Re-levered beta:</b>	<b>0.89</b>

## Gearing

Comparator company	Average total debt (SGD millions)					
	Filing currency	2012	2013	2014	2015	2016
Calpine Corporation (NYSE:CPN)	USD	13,405	13,606	14,598	16,240	16,108
Capital Power Corporation (TSX:CPX)	CAD	1,957	1,995	1,788	1,726	1,612
NRG Energy, Inc. (NYSE:NRG)	USD	12,968	20,595	22,094	28,423	25,997
SSE plc (LSE:SSE)	GBP	12,991	11,962	13,804	13,402	14,694
Drax Group plc. (LSE:DRX)	GBP	16	405	665	657	670

Comparator company	Average market value of equity (SGD millions)					
	Filing currency	2012	2013	2014	2015	2016
Calpine Corporation (NYSE:CPN)	USD	10,452	11,704	12,381	10,093	7,322
Capital Power Corporation (TSX:CPX)	CAD	2,004	1,857	2,453	2,678	1,951
NRG Energy, Inc. (NYSE:NRG)	USD	4,495	10,418	15,073	11,333	7,108
SSE plc (LSE:SSE)	GBP	24,673	28,655	31,736	33,849	30,742
Drax Group plc. (LSE:DRX)	GBP	3,958	4,414	5,348	3,303	2,520

Comparator company	Gearing ratios					5-year average gearing ratio
	2012	2013	2014	2015	2016	
Calpine Corporation (NYSE:CPN)	0.562	0.538	0.541	0.617	0.687	0.598
Capital Power Corporation (TSX:CPX)	0.494	0.518	0.422	0.392	0.452	0.459
NRG Energy, Inc. (NYSE:NRG)	0.743	0.664	0.594	0.715	0.785	0.714
SSE plc (LSE:SSE)	0.345	0.295	0.303	0.284	0.323	0.311
Drax Group plc. (LSE:DRX)	0.004	0.084	0.111	0.166	0.210	0.120

<b>Median gearing ratio:</b>	<b>0.459</b>
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**Market Risk Premium (MRP)**

**Summary of Approaches**

MRP Approach	MRP Estimate
Historical market risk premium <sup>8</sup>	5.57%
Implied market risk premium <sup>9</sup>	6.12%
Local benchmark <sup>10</sup>	5.00%
Overseas benchmarks	6.32%
Dividend Growth Model <sup>11</sup>	6.22%
<b>Median:</b>	<b>6.12%</b>

Historical Market Risk Premium

Country	Arithmetic Mean	Geometric Mean
Australia	6.60%	5.00%
New Zealand	5.50%	4.00%
United Kingdom	5.00%	3.60%
United States	6.40%	4.30%
<b>Median:</b>	5.95%	4.15%
<b>Weighting factor:</b>	0.79	0.21
<b>Weighted average historical market risk premium<sup>12</sup>:</b>	5.57%	

<sup>8</sup> Source: Equity Risk Premiums (ERP): Determinants, Estimation and Implications – The 2016 Edition, Damodaran, 2016.

<sup>9</sup> Implied market risk premium is based on Aswath Damodaran, <http://pages.stern.nyu/~adamodar/>

<sup>10</sup> 2015 company annual reports. The estimated MRP for the Local benchmark is based on the median MRP of Keppel Corporation (5.0%), SembCorp Industries (5.0%), CapitaLand Limited (5.78%) and SMRT Corporation (5.0%) and ST Engineering (5.0%).

<sup>11</sup> Source: Bloomberg

<sup>12</sup> The Historical Premium Approach used to calculate the MRP can be based on Geometric Mean (“GM”) or Arithmetic Mean (“AM”). Both GM and AM can be weighted for a more representative market risk premium - refer to study by Daniel C. Indro and Wayne Y. Lee (Biases in Arithmetic and Geometric Averages as Estimates of Long-Run Expected Returns and Risk Premia, Financial Management 26(4) p81- 90).

**Market Risk Premium (MRP) (continued)**

Overseas Benchmarks

<b>Country</b>	<b>MRP</b>
Australia <sup>13</sup>	6.90%
New Zealand <sup>14</sup>	6.32%
United Kingdom <sup>15</sup>	5.28%
Median:	6.32%

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<sup>13</sup> Sources: Rate of Return Factsheet, October 2015, Australia Energy Regulator and Review of the method for estimating the Weighted Average Cost of Capital for the Regulated Railway Networks – Final Decision, September 2015, Economic Regulation Authority

<sup>14</sup> Source: Cost of capital determination for information disclosure year 2017 for electricity distribution services and specified airport services (March year-end), April 2016, Commerce Commission New Zealand

<sup>15</sup> Source: Cost of Capital – Annual Update Report: 2015-16, March 2016, UK Regulators Network