
National Electricity
Market of Singapore
MARKET SURVEILLANCE &
COMPLIANCE PANEL
ANNUAL REPORT
2018

CONTENTS

EXECUTIVE SUMMARY

This annual report by the Market Surveillance and Compliance Panel (MSCP) covers the period 1 January to 31 December 2018. It is based on analyses of data and monitoring indices compiled by the MSCP to assess the performance of the wholesale electricity markets. The MSCP highlights the following observations for 2018 relative to 2017:

Supply Indices

- The average supply cushion[1] decreased 3.5 percentage points from 28.9 percent in 2017 to 25.4 percent in 2018, showing a tightening of supply conditions relative to that of demand.

- The average capacity ratio[2] of Combined Cycle Gas Turbine (CCGT) units was 0.87 percentage point higher in 2018 at 61.92 percent. The capacity ratio for Steam Turbine (ST) units remained at the same level as 2017 at 0.1 percent.

- The generation market share of CCGT units increased 0.1 percentage point to 98.2 percent.

- The concentration level in the generation sector continued to fall, with the combined market share of the three largest generation companies declining 2.4 percentage points from 2017 to 53.1 percent.

- The average total generation outage per period in 2018 increased for the fifth consecutive year by 3.8 percent to 1,177MW. The average forced outage level per period remained at 14MW in 2018.

Demand Indices

- The average demand growth in 2018 decreased to 1.5 percent, down from 1.9 percent in 2017.

- The average demand in 2018 was about 5,750MW, compared to 5,668MW in 2017. The average monthly electricity demand peaked in May at 5,928MW.

- The accuracy of real-time load forecast in 2018 declined slightly. The average forecast error increased by 0.32 percentage point to 2.58 percent. This is still the second lowest forecast error level in the history of the National Electricity Market of Singapore.

Market Prices

- The average Wholesale Electricity Price climbed 36.1 percent to $110.50/MWh for the second consecutive year in tandem with the rebound in fuel prices.

- The average price of fuel oil increased 31.4 percent to US$73.09/bbl in 2018.

- The total reserve payment in 2018 more than doubled, rising 107.6 percent from $37.2 million to $77.3 million.

[1] Supply cushion measures the percentage of total supply available after matching off demand. Details can be found in the USER GUIDE of this report.

[2] Capacity ratio measures the ratio of scheduled output to a generation registered facility's maximum generation capacity. Details can be found in the USER GUIDE of this report.

INTRODUCTION

The Market Rules provide for the Market Surveillance and Compliance Panel (MSCP) to prepare and submit to Energy Market Company Pte Ltd (EMC) an annual report on the conduct of its monitoring and investigation activities. The report is submitted to the Energy Market Authority by EMC. This is the 17th report by the MSCP since 2003 on the wholesale electricity markets of the National Electricity Market of Singapore.

The current report covers the period 1 January to 31 December 2018. This review provides the MSCP with the opportunity to highlight significant observations.

The current MSCP members are:

- T P B Menon, Chair;
- Lee Keh Sai;
- Philip Chua;
- Professor Euston Quah; and
- Professor Walter Woon.

Supported by the Market Assessment Unit of EMC, the role of the MSCP is to monitor and investigate activities in the wholesale electricity markets and the conduct of market participants, the Market Support Services Licensee, the Power System Operator and EMC to:

- identify breaches of the Market Rules, market manual or system operation manual;

- assess whether the underlying structure of the wholesale electricity markets is consistent with the efficient and fair operation of a competitive market; and

- recommend remedial actions to mitigate the conduct and inefficiencies referred to above.

The Market Rules require this annual report to include a summary of routine reports on the MSCP's monitoring and investigation activities, and a summary of any reports regarding the possibility of anti-competitive agreements or the abuse of a dominant position contrary to sections 50 or 51 of the Electricity Act. The report also includes a summary of all complaints or referrals filed and investigations commenced and concluded, and a summary of all investigations conducted by the MSCP concerning offer variations after gate closure reported by EMC. The Market Rules require the report to contain the general assessment by the MSCP of the state of competition and compliance within, and the efficiency of, the wholesale electricity markets.

MARKET MONITORING

MARKET MONITORING: Catalogue of Data and Catalogue of Monitoring Indices/Indicators of Market Performance

Catalogue of Data and Catalogue of Monitoring Indices

To carry out monitoring effectively, the Market Rules provide for the Market Assessment Unit (MAU), under the supervision and direction of the Market Surveillance and Compliance Panel (MSCP), to develop a catalogue of the data[3] it acquires and a catalogue of the monitoring indices[4] that it uses to evaluate the acquired data.

Indicators of Market Performance

The MAU submits regular monitoring updates to the MSCP. These updates include observations of several indicators of market performance which can be broadly classified into supply, demand and price indices. In the following sections, the MSCP reports its observations from these indices for the year under review.

[3] On 29 August 2003, a catalogue of data was adopted by the MSCP after public consultation. It took effect from 1 October 2003. Data is collected according to this catalogue, with the assistance of market entities.

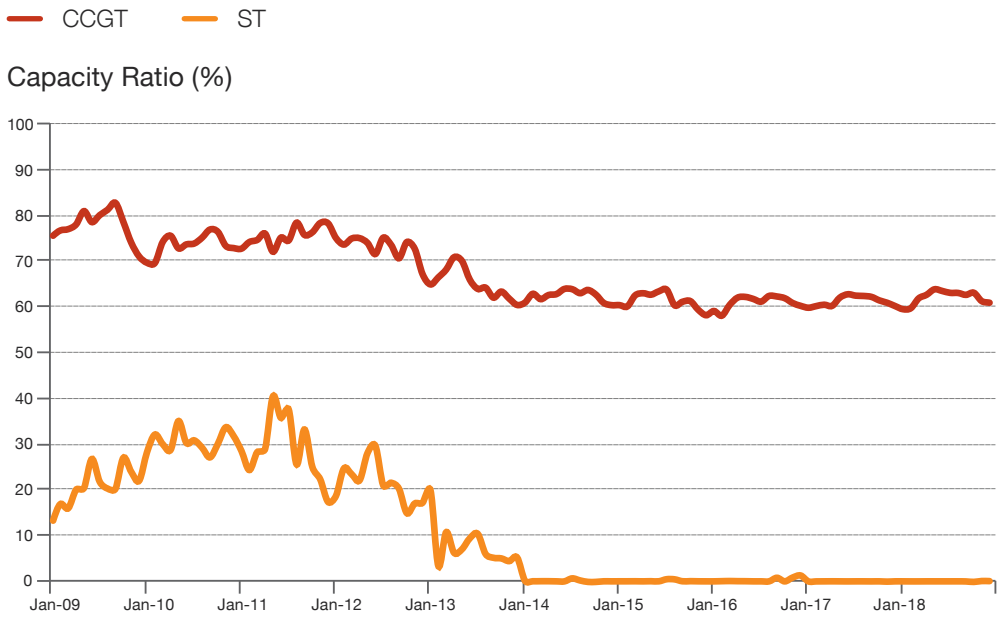
[4] On 29 July 2004, a catalogue of monitoring indices was adopted by the MSCP after public consultation. It took effect from 1 August 2004. The catalogue of monitoring indices is used to evaluate the market data collected.

Table 1: Capacity Ratio (in %) 2018

Month	CCGT	ST	OT	OCGT
Jan 18	59.24	0.12	53.25	0.00
Feb 18	59.46	0.11	51.97	0.00
Mar 18	61.68	0.11	44.47	0.19
Apr 18	62.49	0.12	45.87	0.00
May 18	63.73	0.12	43.52	0.06
Jun 18	63.35	0.12	47.62	0.00
Jul 18	62.93	0.12	50.45	0.00
Aug 18	62.91	0.12	47.78	0.00
Sep 18	62.48	0.10	45.94	0.11
Oct 18	62.95	0.00	46.09	0.31
Nov 18	61.07	0.19	48.26	0.00
Dec 18	60.70	0.17	45.94	0.00
Average	61.92	0.12	47.60	0.06

OT = other facilities, i.e., incineration plants that convert energy from incinerated refuse

Chart 1: Comparison of Capacity Ratio for CCGT and ST



The capacity ratio of generation registered facilities refers to the ratio of scheduled generation output to maximum generation capacity of generation registered facilities

Capacity ratio represents the utilisation level of a generation type. Table 1 shows the monthly capacity ratio of the four generation types for 2018.

In 2018, the average capacity ratio for Combined Cycle Gas Turbine (CCGT) units rose 0.87 percentage point to 61.92 percent, and that for other facilities (OT) fell 1.13 percentage points to 47.6 percent. There was no noticeable change in the average capacity ratio for the other generation types – the average capacity ratio for Open Cycle Gas Turbine (OCGT) units increased 0.05 percentage point to 0.06 percent, while the average capacity ratio for Steam Turbine (ST) units remained at 0.1 percent.

Chart 1 shows the capacity ratio for CCGT and ST units for the past ten years.

From 2009 to 2010, the capacity ratio for CCGT units fell because of an increase in generation capacity of CCGT units, whereas the capacity ratio for ST units rose due to lower generation capacity and higher scheduled output of ST units.

In 2011, the capacity ratios for the two generation types continued to move in opposite directions. The capacity ratio for CCGT units climbed 1.9 percentage points due to lower generation capacity and higher scheduled output of CCGT units; the capacity ratio for ST units slipped 1.7 percentage points as the decrease in scheduled output of ST units outpaced the decrease in generation capacity.

Both indices fell from 2012 to 2014. This was largely brought about by the growing generation capacity of CCGT units and declining scheduled output of ST units. The generation capacity of CCGT units increased 47.2 percent from 2012 to 2014, while the scheduled output of ST units decreased 99.4 percent in the same period. The significant drop in the scheduled output of ST units caused the capacity ratio for ST units to fall from 21.8 percent in 2012 to below 1.0 percent in 2014.

From 2015 to 2018, the capacity ratio of CCGT units hovered around 60 percent as the increase in generation capacity was matched by the increase in scheduled output of CCGT units. The low scheduled output of ST units kept the capacity ratio for ST units below 1.0 percent throughout those four years.

Chart 2: Relationship between Supply Cushion and USEP

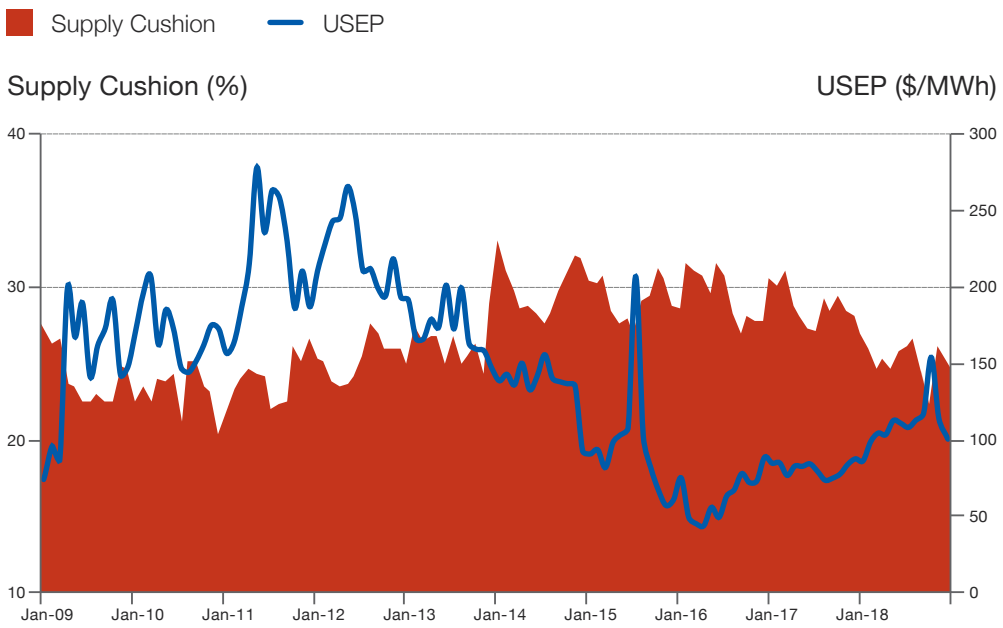


Chart 2 illustrates the relationship between the Uniform Singapore Energy Price (USEP) and the supply cushion from 2009 to 2018. The supply cushion measures the level of spare capacity available after dispatch.

The average forecasted demand went up 2.2 percent in 2018. Coupled with a 2.5 percent decrease in average supply, the supply cushion shrank 3.5 percentage points from 28.9 percent in 2017 to 25.4 percent in 2018. The USEP increased 36.3 percent from $80.91/MWh in 2017 to $110.29/MWh in 2018. The change in the USEP corresponded with the rise in the fuel oil price, which increased 31.4 percent from 2017.

Chart 3: Relationship between Supply Cushion and USEP in 2018

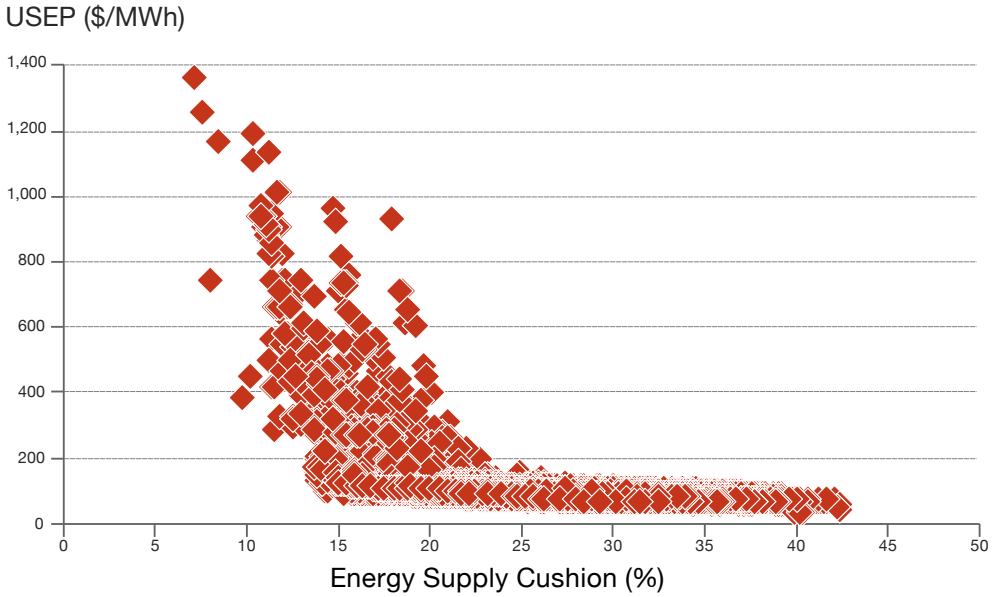


Chart 3 shows the relationship between the USEP and the supply cushion in 2018. The total number of instances of the USEP being above $400/MWh increased from ten in 2017 to 150 in 2018.

Based on historical data, high prices usually occur when the supply cushion falls below 15 percent. In 2018, 102 occurrences of high prices were observed when the supply cushion was below 15 percent. The supply cushion ranged from 15 percent to 20 percent during the remaining 48 occurrences of high prices.

Table 2: Relationship between Supply Cushion and USEP

	Supply Cushion < 15%			Supply Cushion ≥ 15%		
Year	No. of periods	Average USEP ($/MWh)	Max USEP ($/MWh)	No. of periods	Average USEP ($/MWh)	Max USEP ($/MWh)
2009	268	599.42	4,499.41	17,252	140.73	1,572.58
2010	498	310.67	3,234.93	17,022	166.41	910.94
2011	289	505.36	4,500.00	17,231	209.96	693.45
2012	82	925.72	4,500.00	17,486	219.19	805.13
2013	128	525.74	2,787.87	17,392	170.64	785.50
2014	12	589.54	936.81	17,508	136.36	857.78
2015	21	1,052.29	1,328.06	17,499	94.82	1,231.40
2016	13	329.55	1,252.59	17,555	63.08	1,053.62
2017	1	902.94	902.94	17,519	80.87	732.52
2018	216	453.73	1,354.60	17,304	106.01	924.33

Table 2 summarises the yearly USEP movements under two supply cushion scenarios.

The number of periods with the supply cushion below 15 percent rose from one in 2017 to 216 in 2018. The average USEP during such periods was $453.73/MWh in 2018.

For the periods when the supply cushion was at least 15 percent, the average USEP increased 31.1 percent from $80.87/MWh in 2017 to $106.01/MWh in 2018.

The highest USEP recorded under both supply cushion scenarios were higher in 2018 compared to 2017. When the supply cushion was below 15 percent, the highest USEP recorded in 2018 was $1,354.60/MWh, compared to $902.94/MWh in 2017. When the supply cushion was at least 15 percent, the highest USEP recorded in 2018 was $924.33/MWh, compared to $732.52/MWh in 2017.

Chart 4: Market Share Based on Metered Energy Quantity by Generation Type

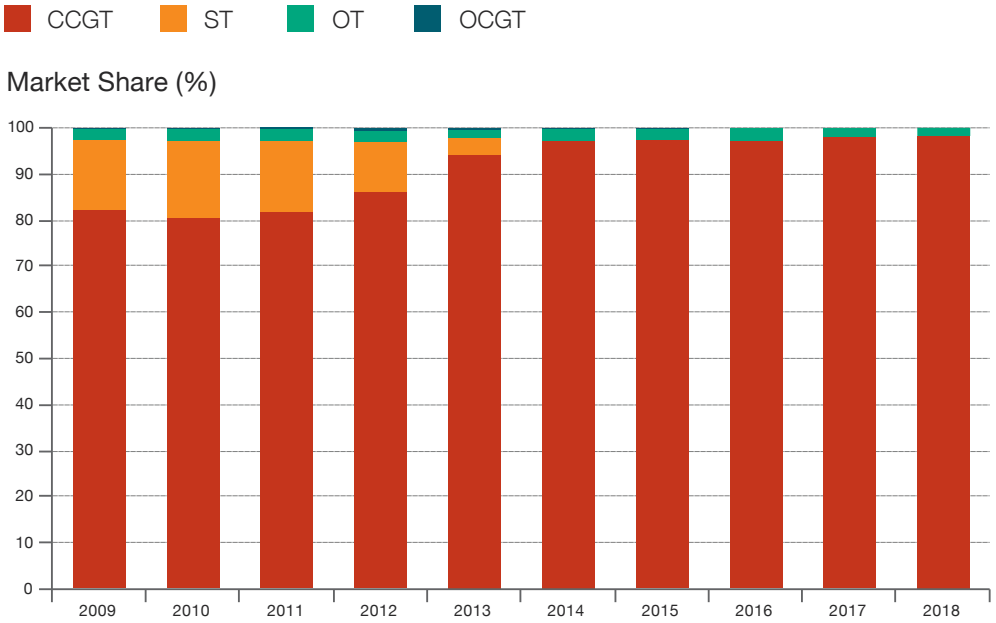
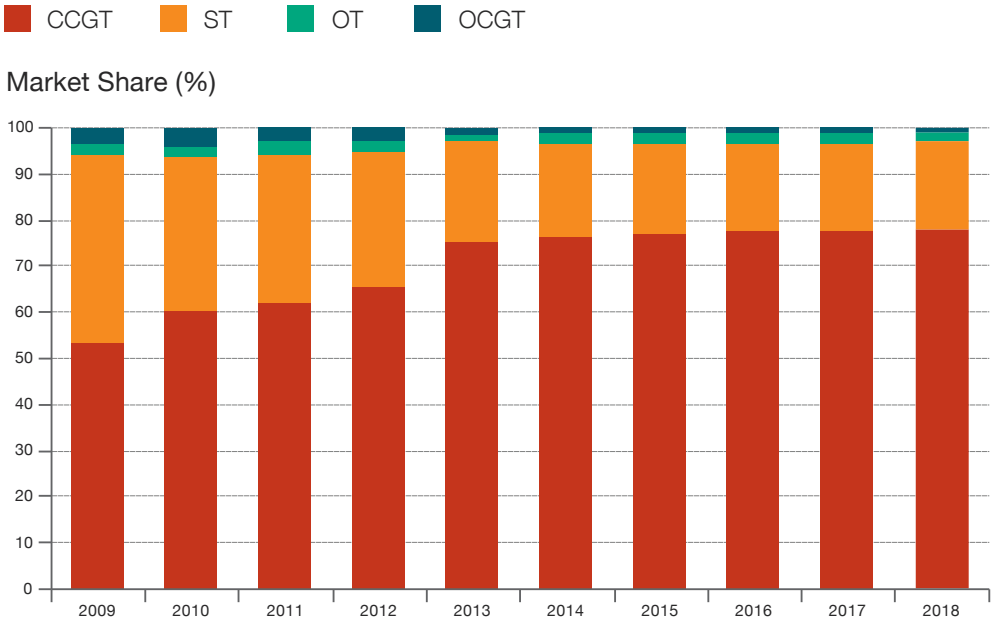


Chart 5: Market Share Based on Maximum Capacity by Generation Type



Charts 4 and 5 present the yearly market shares by generation types based on metered energy quantity and maximum capacity respectively.

Based on metered energy quantity, the market share of CCGT units increased 0.1 percentage point to 98.2 percent, and that of OT decreased 0.1 percentage point to 1.8 percent in 2018. The market share of ST units and OCGT units remained at close to 0 percent in 2018.

Based on maximum capacity, the market share of CCGT units grew 0.2 percentage point to 77.8 percent, and that of ST units fell 0.1 percentage point to 19.0 percent in 2018.

Chart 6: Market Share Based on Metered Energy Quantity by Generation Company

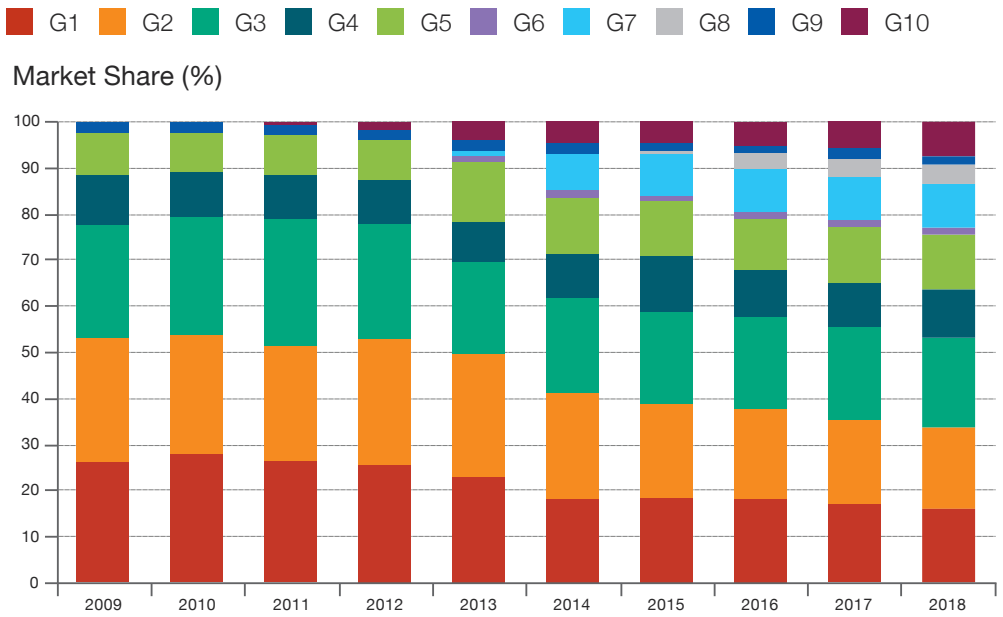
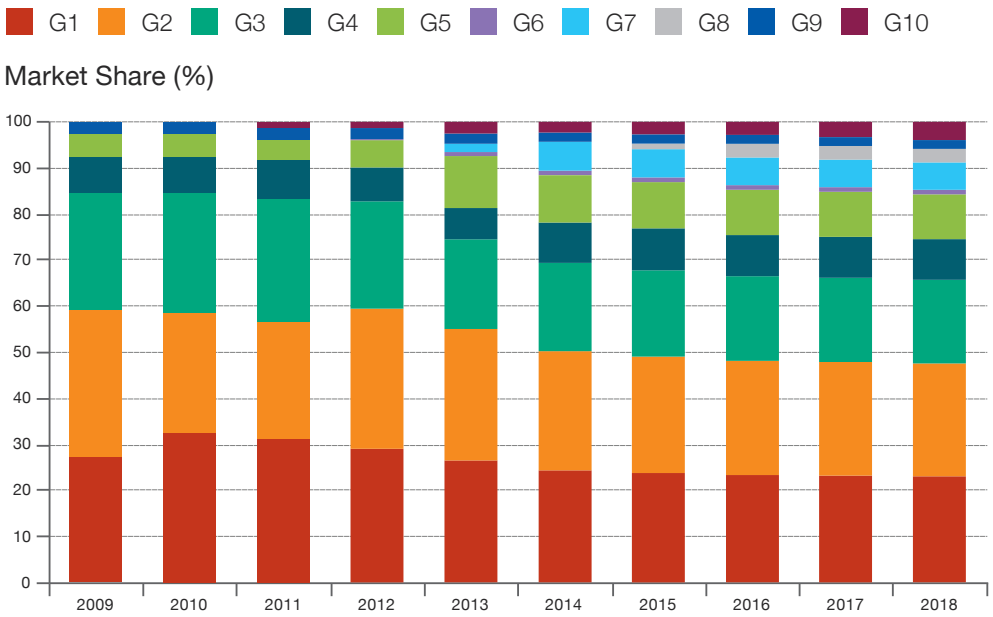


Chart 7: Market Share Based on Maximum Capacity by Generation Company



Charts 6 and 7 show the yearly market shares[5] of all generation companies based on metered energy quantity and maximum capacity respectively.

The market share of embedded generators based on metered energy quantity grew 1.7 percentage points to 7.5 percent, and that based on maximum capacity grew 0.7 percentage point to 4.0 percent.

The combined market share of the three largest generation companies based on metered energy quantity has been on a downward trend after 2010. It declined a further 2.4 percentage points from 55.5 percent in 2017 to 53.1 percent in 2018. The combined market share of the three largest generation companies in terms of maximum capacity has been shrinking as well. The three largest generation companies held 66.1 percent of market share in 2017 and 65.7 percent in 2018.

[5] The yearly market shares exclude generation registered facilities operating below 10MW.

Table 3 provides an overview of the outage levels by generation type and year. Total outages per period increased 3.8 percent to 1,177MW in 2018, the second highest level recorded in the past ten years. This outage level translated to 8.7 percent of the total installed capacity. The rise in total outages was mainly led by a higher level of anticipated outages[6] from CCGT units.

Average forced outages remained at 14MW per period in 2018. This was amongst the lowest levels of average forced outages observed in the market in the past decade.

Chart 8 shows the yearly percentage breakdown of the three types of plant outages. The distribution of total outages between planned and forced outages remained the same as 2017, at 98.8 percent and 1.2 percent respectively.

[6] Anticipated outages refer to the sum of planned and unplanned outages. From 1 June 2012, the category of "unplanned outages" was removed. Outages previously classified under unplanned were subsumed under planned or forced outages, depending on the time and duration of occurrence.

Chart 8: Composition of Total Plant Outages

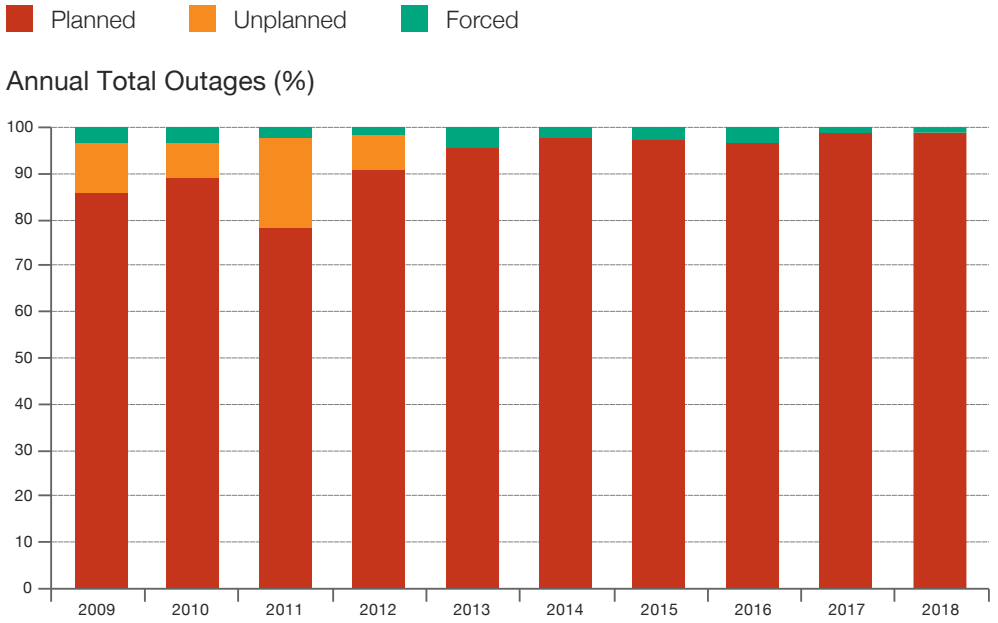


Table 3: Average Outages by Generation Type and Technology in MW (per period)

	Anticipated Outages (MW)								Forced Outages (MW)				Total Outages (MW)
	Planned Outages				Unplanned Outages								
Year	ST	CCGT	OCGT	OT	ST	CCGT	OCGT	OT	ST	CCGT	OCGT	OT	
2009	826	250	2	13	108	29	0	2	20	7	10	1	1,266
2010	312	391	38	45	22	40	2	1	5	24	0	0	880
2011	387	281	7	10	85	87	1	0	7	11	1	0	878
2012	392	436	5	36	21	51	0	0	2	12	1	0	956
2013	335	483	3	4	0	0	0	0	3	35	0	0	863
2014	316	536	3	17	0	0	0	0	0	18	0	0	890
2015	206	701	1	11	0	0	0	0	0	24	0	0	944
2016	169	864	3	38	0	0	0	0	0	35	0	0	1,109
2017	322	744	33	22	0	0	0	0	0	14	0	0	1,134
2018	242	875	32	14	0	0	0	0	0	14	0	0	1,177

Chart 9: Average Quarterly Anticipated Outages vs Average USEP

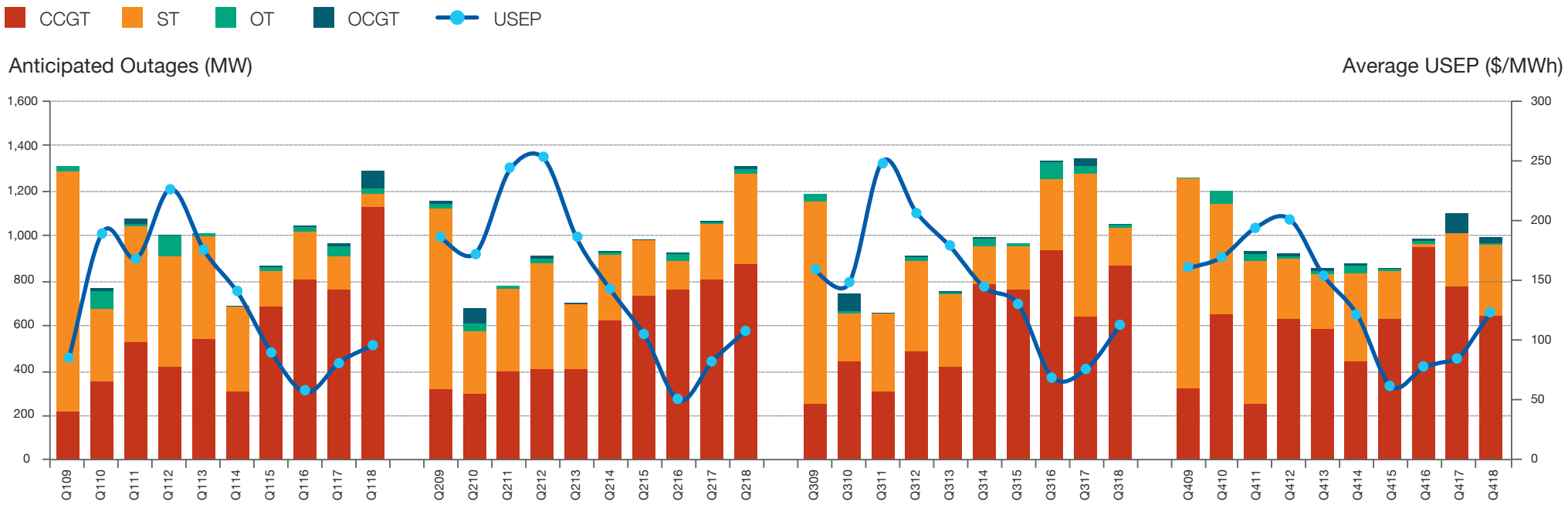


Chart 9 compares the average anticipated outages with the average USEP on a quarterly basis from 2009 to 2018.

Intuitively, a higher level of anticipated outages coincides with a higher USEP because of a contraction in supply. The average level of anticipated outages in Q1 2018 was 33.1 percent higher than that in Q1 2017. Correspondingly, the average USEP in Q1 2018 was 17.5 percent higher than that in Q1 2017.

This relationship was also noted in the second quarter of 2018. The average level of anticipated outages in Q2 2018 was 23.8 percent higher than that in Q2 2017, and the average USEP in Q2 2018 was 31.0 percent higher than that in Q2 2017.

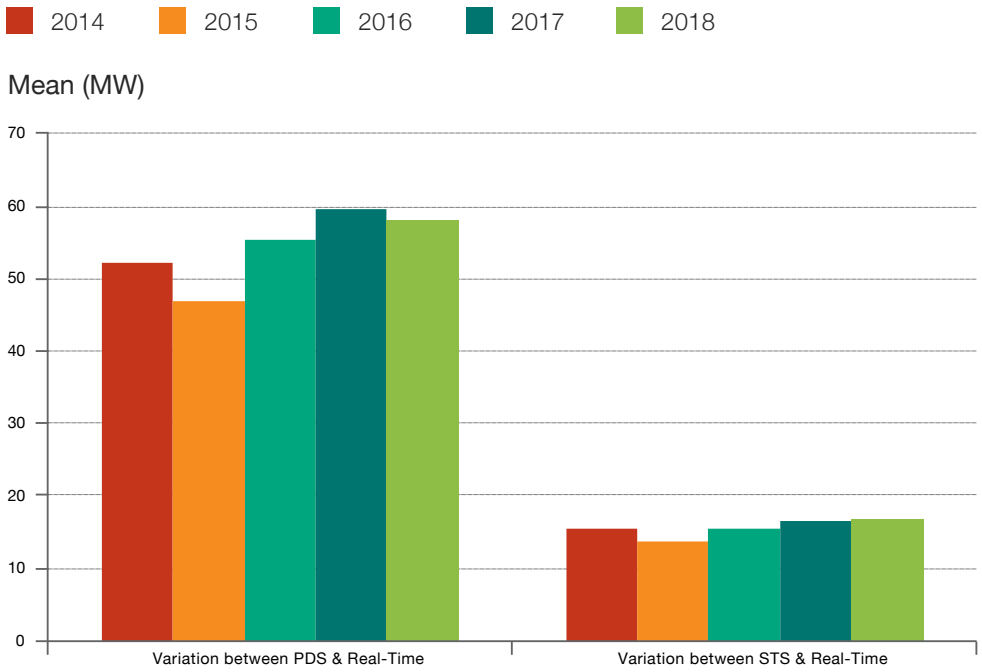
Even though the average level of anticipated outages in Q3 2018 was 21.7 percent lower than that in Q3 2017, the average USEP in Q3 2018 was 48.8 percent higher than that in Q3 2017. The higher average USEP was partly due to higher fuel oil prices, which rose 45.4 percent from US$54.05/bbl in Q3 2017 to US$78.61/bbl in Q3 2018. Apart from an increase in fuel oil prices, there were more periods of high USEP at or above $400/MWh observed in Q3 2018 compared to Q3 2017. The high USEP recorded in Q3 2018 ranged from $415.56/MWh to $1,354.60/MWh. In comparison, the highest USEP recorded in Q3 2017 was $187.57/MWh.

Similarly, while the average level of anticipated outages in Q4 2018 was 10.3 percent lower than that in Q4 2017, the average USEP in Q4 2018 was 48.2 percent higher than that in Q4 2017. The fuel oil price rose 23.7 percent from US$61.73/bbl in Q4 2017 to US$76.36/bbl in Q4 2018, contributing to the higher average USEP in Q4 2018. There were 81 periods of high USEP at or above $400/MWh observed in Q4 2018, compared to one period observed in Q4 2017.

Table 4: Variation in Load Forecasts

Year 2018				
	Variation between PDS & Real-time		Variation between STS & Real-time	
Month	Mean (in MW)	Standard Deviation (in MW)	Mean (in MW)	Standard Deviation (in MW)
Jan	87.87	54.77	24.52	15.41
Feb	46.52	31.07	20.77	43.74
Mar	51.73	45.04	14.39	12.89
Apr	40.95	21.51	11.41	5.95
May	58.56	47.22	16.22	13.08
Jun	92.32	60.27	25.80	16.76
Jul	46.85	42.60	13.22	12.07
Aug	66.89	39.60	18.50	11.19
Sep	72.46	50.44	20.43	14.08
Oct	65.73	50.36	18.35	14.13
Nov	31.13	21.40	8.78	6.26
Dec	34.59	23.71	9.42	6.16
Average	57.97	40.67	16.82	14.31

Chart 10: Average Mean Load Forecast Variations between Forecast and Real-Time Schedules



In the NEMS, three forecast schedules with different time horizons are made available to market participants. The accuracy of forecast schedules is important for the efficient operation of the market, as it determines the responsiveness of generation facilities to real-time demand conditions.

Table 4 shows the accuracy of the load forecast as measured by the mean and standard deviation of the variations between forecast schedules with different time horizons and real-time schedules. The variation between the Pre-dispatch Schedule (PDS) forecast and real-time load forecast was 3.4 times as large as the variation between the Short-term Schedule (STS) forecast and real-time load forecast. PDS forecasts tend to be less accurate than STS forecasts – PDS forecasts are updated every two hours, with a forecast horizon of between 12 and 36 hours, compared to STS forecasts which are updated every half hour, with a forecast horizon of up to six hours.

Chart 10 compares the PDS and STS forecasts to the real-time load forecast, based on the mean of the variation for the past five years. The average difference between PDS forecast and real-time load forecast in 2018 was 3.2 percent lower than that in 2017. The average difference between STS forecast and real-time load forecast increased 0.7 percent to 16.8MW in 2018, the largest difference recorded in the past five years.

Table 5: Percentage of Variation in Real-Time Load Forecast

Month	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Jan	3.46	3.18	3.24	2.73	3.00	3.46	3.23	2.57	2.53	2.70
Feb	3.48	3.74	2.93	2.82	2.83	3.28	3.19	3.05	2.58	2.49
Mar	3.40	3.64	2.95	2.93	2.75	3.00	2.97	2.65	2.20	2.44
Apr	3.50	3.74	3.13	3.01	2.34	3.20	2.67	2.52	2.43	2.58
May	3.41	3.83	1.96	2.76	2.77	3.27	2.76	2.64	2.06	2.41
Jun	3.93	3.15	2.65	2.61	3.00	3.10	2.67	2.92	2.31	2.64
Jul	3.45	3.17	3.36	2.75	3.04	3.30	2.40	2.71	2.09	2.68
Aug	3.54	3.54	3.14	2.86	2.90	3.70	2.63	2.31	2.18	2.63
Sep	3.34	3.42	3.20	2.93	3.24	3.29	2.58	2.89	2.09	2.73
Oct	3.54	3.56	3.01	2.81	3.28	3.26	2.60	2.88	1.85	2.60
Nov	3.28	3.62	2.94	3.05	3.23	3.82	2.57	2.71	2.12	2.58
Dec	3.24	3.64	2.88	3.17	3.46	3.35	2.62	2.49	2.68	2.49
Average	3.46	3.52	2.95	2.87	2.99	3.34	2.74	2.70	2.26	2.58

The accuracy of the load forecast used in generating real-time dispatch and pricing schedules is important for efficient pricing outcomes and system stability.

A small variation between real-time load forecast and actual demand (metered energy quantity) is expected. There are a few factors contributing to this variation. For example, the real-time load forecast contains the station load and auxiliary load consumption, while the metered energy quantity which is based on settlement data furnished by the Market Support Services Licensee (MSSL) omits these components. Other factors include loss factors and metering errors.

As seen in Table 5, the average load forecast error remained relatively low – it increased 0.32 percentage point to 2.58 percent in 2018.

Chart 11: Monthly Volume-Weighted Average VCHP vs WEP

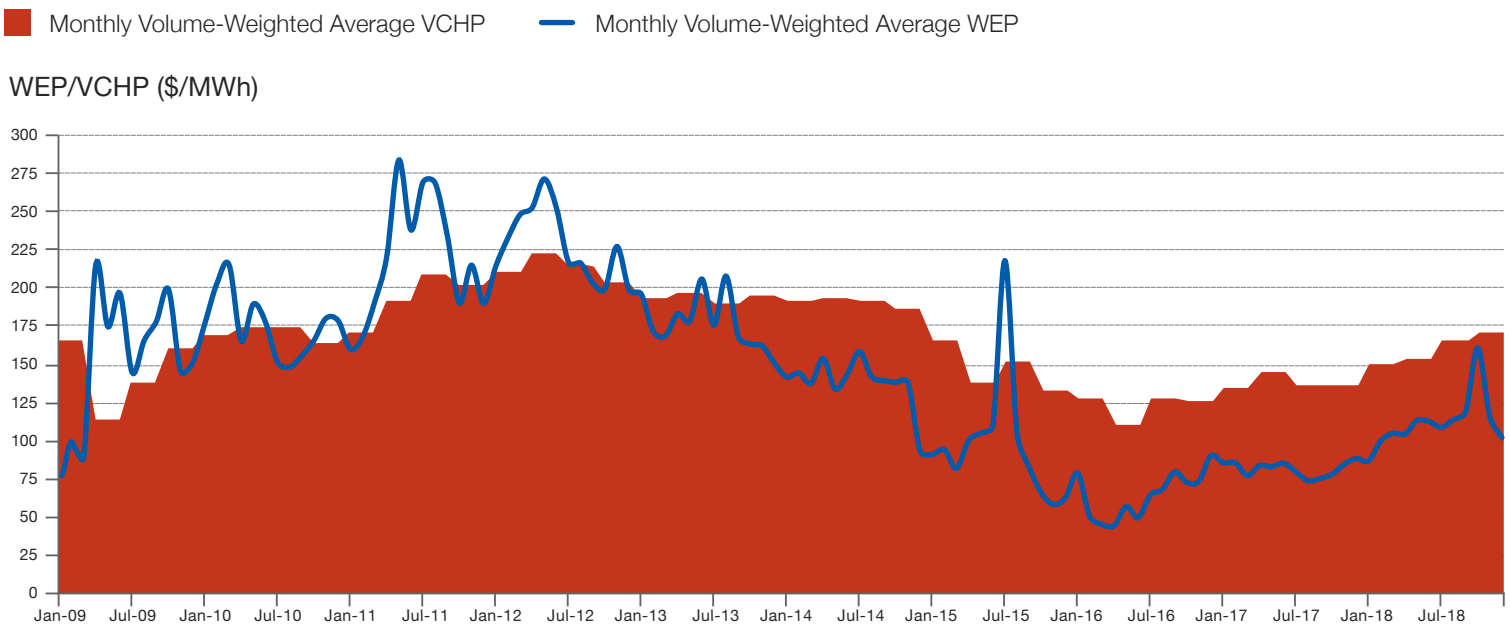


Chart 11 tracks the movements of the volume-weighted averages of the Wholesale Electricity Price (WEP) and Vesting Contract Hedge Price[7] (VCHP).

Continuing the upward trend observed in 2017, both prices increased in 2018. The volume-weighted average WEP rose 37.3 percent from $81.82/MWh in 2017 to $112.35/MWh in 2018, while the volume-weighted average VCHP increased 15.9 percent from $138.97/MWh in 2017 to $161.00/MWh in 2018.

In 2018, the volume-weighted average WEP was 30.2 percent lower than the volume-weighted average VCHP.

[7] The volume-weighted VCHP considers the LNG, balance and tendered vesting prices after volume adjustment.

Chart 12: Comparisons of Actual Demand

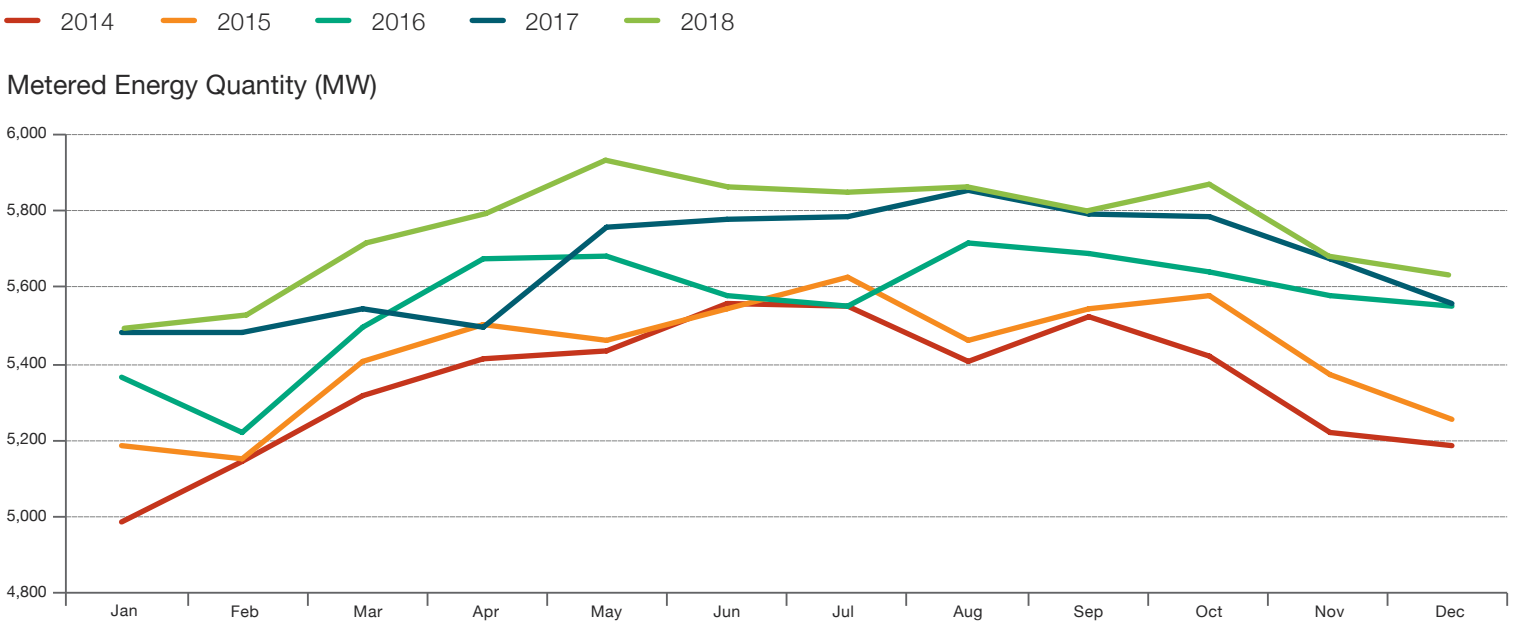


Chart 12 compares the actual demand (computed from metered energy quantity) from 2014 to 2018. Average demand has been on the rise since the market started. Overall, demand grew 1.4 percent from 5,668MW in 2017 to 5,750MW in 2018.

The average demand of 5,750MW and the peak average monthly demand of 5,928MW were higher than the previous record levels registered in 2017. The average monthly demand was the highest in May 2018.

Table 6: Monthly Average Correlation Coefficient of WEP and Metered Energy Quantity

	2017			2018		
Month	**Correlation Coefficient, *r***	**r^2**	**Number of days with *r* > 0.5**	**Correlation Coefficient, *r***	**r^2**	**Number of days with *r* > 0.5**
Jan	0.79	0.62	28	0.79	0.62	27
Feb	0.66	0.43	21	0.58	0.34	21
Mar	0.78	0.61	29	0.41	0.17	17
Apr	0.74	0.55	29	0.55	0.30	18
May	0.63	0.40	21	0.51	0.26	19
Jun	0.52	0.27	16	0.72	0.52	28
Jul	0.55	0.30	20	0.71	0.50	27
Aug	0.67	0.45	26	0.68	0.46	25
Sep	0.62	0.38	21	0.71	0.50	25
Oct	0.78	0.61	30	0.67	0.45	25
Nov	0.80	0.63	28	0.78	0.61	27
Dec	0.75	0.56	28	0.80	0.65	28
Average / Sum	0.69	0.48	297	0.66	0.45	287

Due to a technical error, some data of 2017 have been revised which are slightly different from the data published in the 2017 report.

The correlation coefficient *r* in Table 6 measures the strength of the relationship between the WEP and metered energy quantity. A positive correlation indicates that as demand increases, energy price follows and vice versa. The square of the correlation coefficient r^2 can be interpreted as the proportion of variance in prices which can be explained by variations in demand.

In 2018, the highest *r* value of 0.80 was observed in December and there were 287 days when *r* was greater than 0.5. These statistics imply a similar connection between demand and prices in 2017 and 2018. In 2017, the highest *r* value was also 0.80 and there were 297 days when *r* was greater than 0.5.

Chart 13: Correlation between WEP and Metered Energy Quantity in 2018

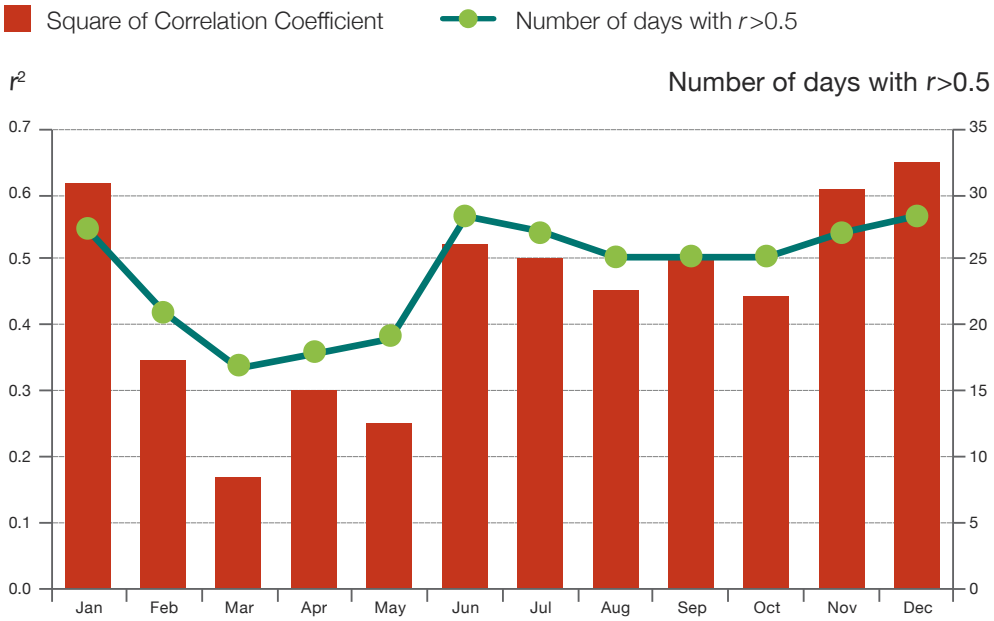


Chart 13 illustrates the correlation between the WEP and metered energy quantity in 2018. The highest r^2 value recorded during the year was 0.65 in December, when there were 28 days when r was greater than 0.5. The lowest r^2 value of 0.17 occurred in March, when there were 17 days with r greater than 0.5.

Chart 14: Correlation between WEP and Metered Energy Quantity

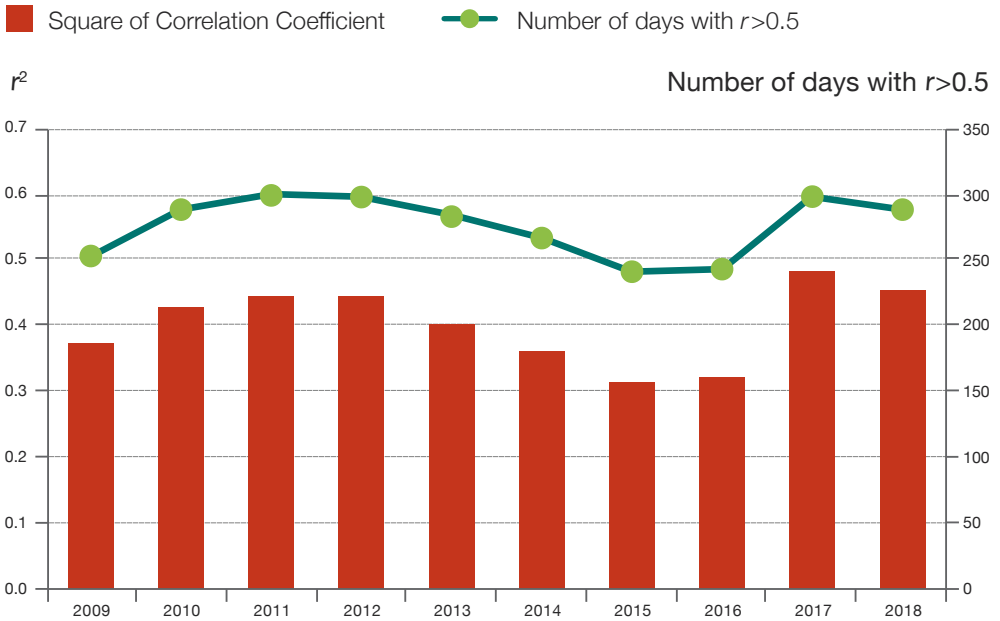


Chart 14 shows the correlation between the WEP and metered energy quantity from 2009 to 2018.

From 2009 to 2016, the r^2 value and the number of days with r greater than 0.5 moved in tandem without major fluctuation in either indicator. Significant changes were seen in 2017, when the r^2 value rose to 0.48 and the number of days with r greater than 0.5 increased to 297. In 2018, the r^2 value fell to 0.45 and the number of days with r greater than 0.5 decreased to 287. The figures in 2017 and 2018 were amongst the highest recorded in the past ten years, suggesting the growing influence of demand on energy prices.

Chart 15: Percentage of Hours when WEP Falls into a Particular Price Range

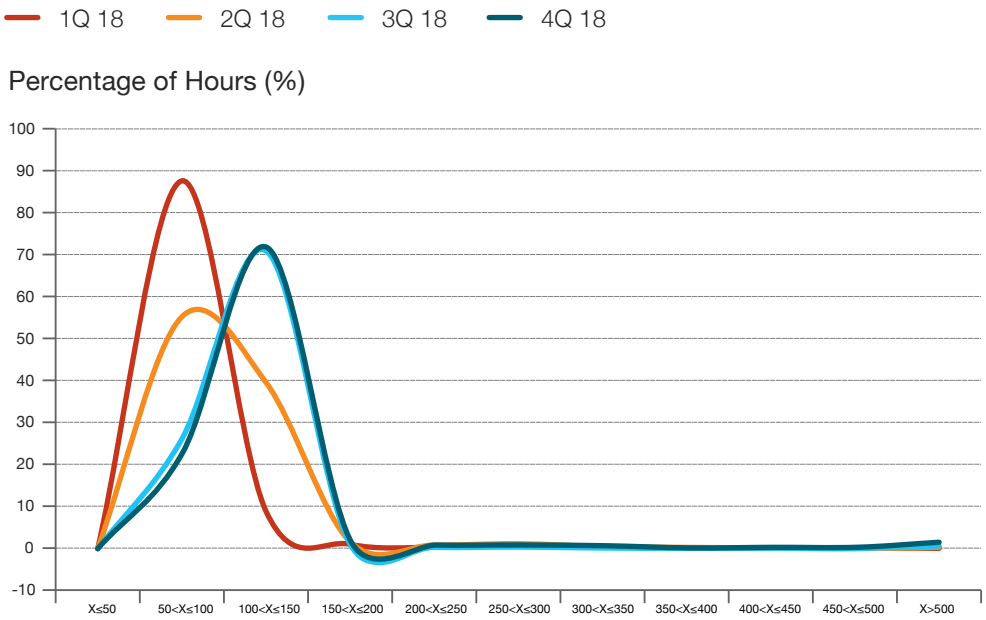


Chart 15 illustrates the distribution of the WEP based on percentage of hours of occurrence in 2018. Prices for the first quarter continued the trend of 2017 and mostly settled in the $50/MWh to $100/MWh tranche. In the second quarter, the WEP started to shift rightward due to more prices falling into the $100/MWh to $150/MWh tranche. Prices for the third and fourth quarters continued moving rightward and mostly settled in the $100/MWh to $150/MWh tranche.

Chart 16: Percentage of Energy Quantity when WEP Falls into a Particular Price Range

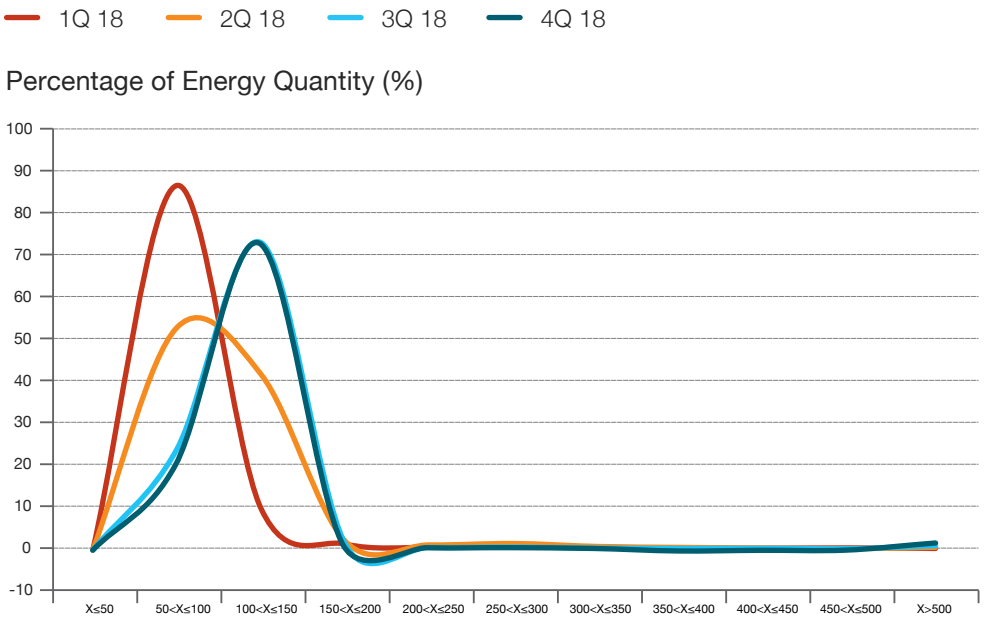


Chart 16 illustrates the distribution of the WEP based on percentage of energy quantity. The distribution is similar to that of the WEP by percentage of hours of occurrence (Chart 15).

MARKET MONITORING: Energy Indices: Frequency Distribution of WEP by (a) Percentage of Hours of Occurrence and (b) Percentage of Energy Quantity Affected

Chart 17: Percentage of Hours when WEP Falls into a Particular Price Range

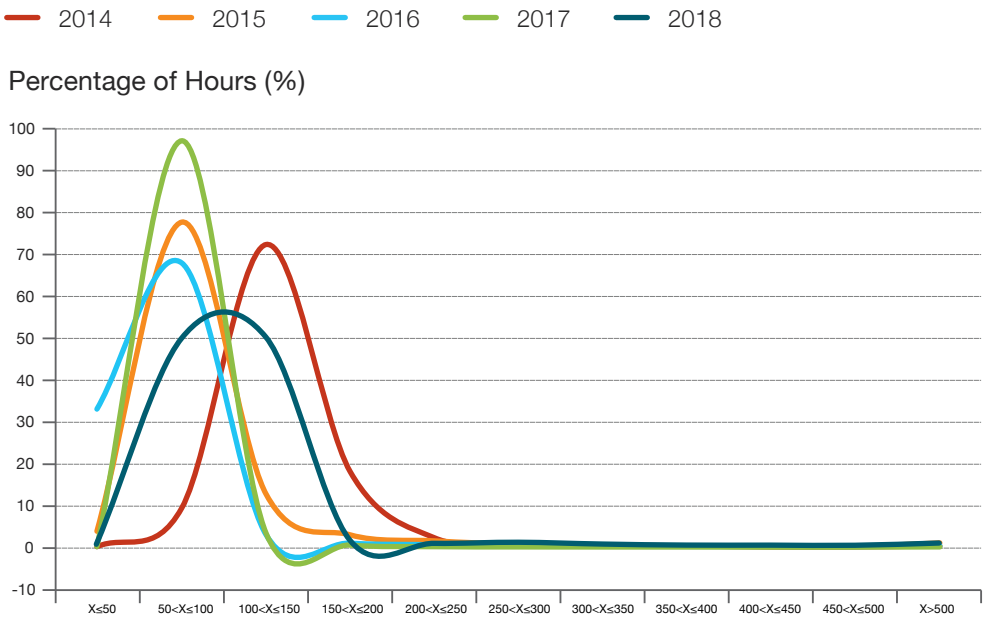


Chart 17 juxtaposes the historical price distribution curves with the price distribution curve of 2018, allowing us to examine longer-term trends. The percentage of hours of WEP distribution gradually shifted to a lower price range from 2014 to 2016, reaching the lowest level in 2016. From 2017 to 2018, the trend reversed. In 2018, the percentage of hours when the WEP fell within the price tranche of between $100/MWh and $150/MWh increased by 44.8 percent from 2017. The yearly average WEP settled at $110.50/MWh in 2018.

Chart 18: Percentage of Energy Quantity when WEP Falls into a Particular Price Range

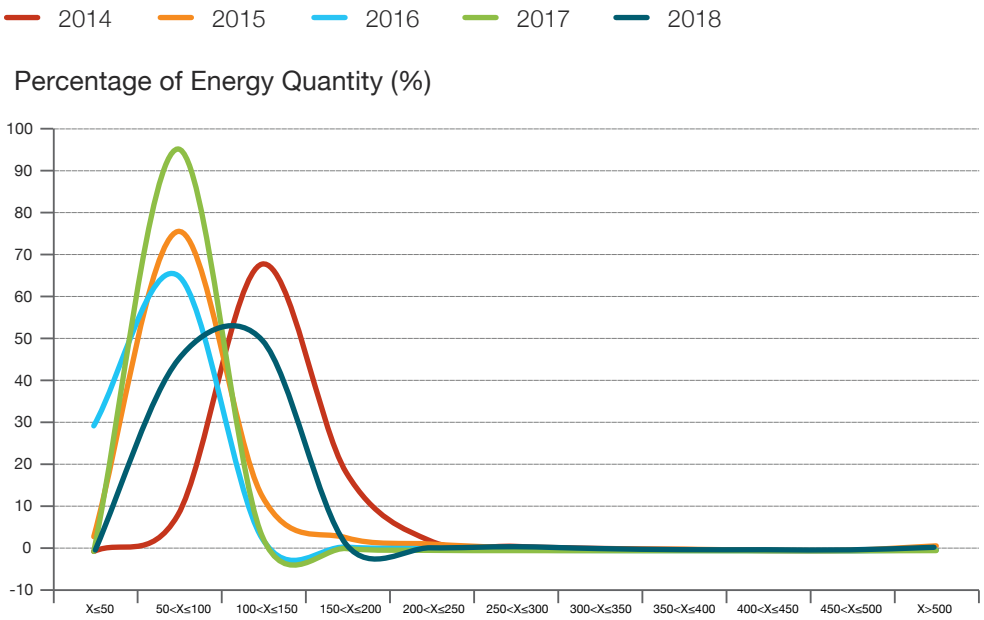


Chart 18 shows the long-term trend in the distribution of the WEP from 2014 to 2018 based on percentage of energy quantity, permitting the same observations as Chart 17.

MARKET MONITORING: Energy Indices: Correlation between VCHP, WEP, Fuel Oil Prices and Electricity Tariff

Chart 19: Index of VCHP, WEP, Fuel Oil Price, Electricity Tariff

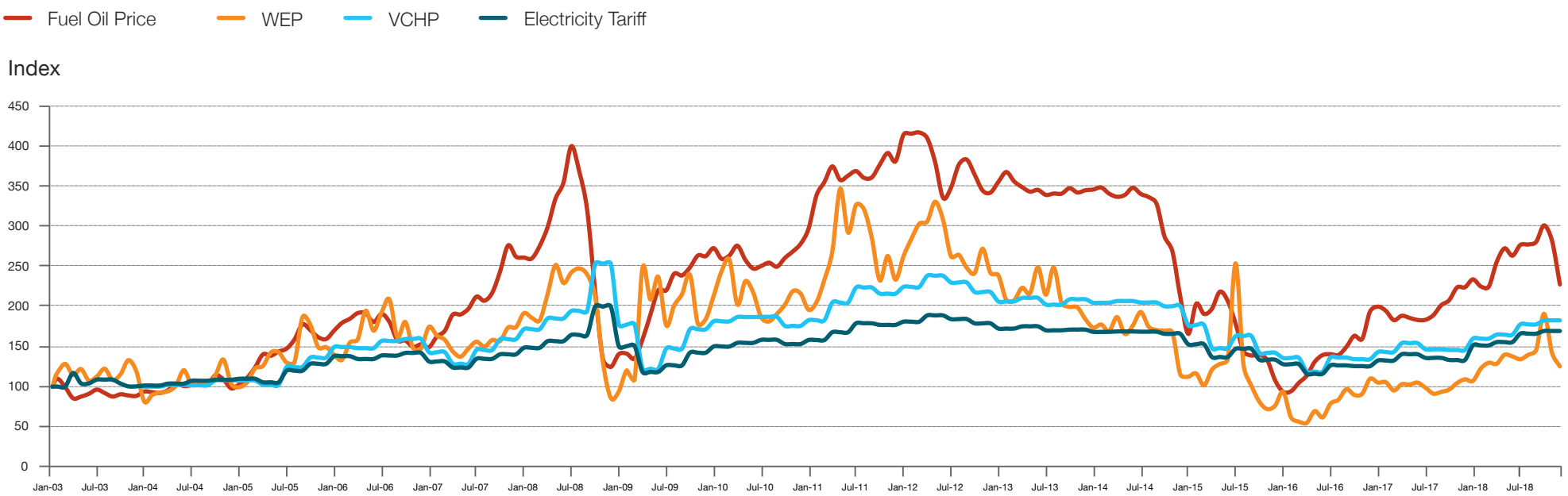


Chart 19 shows the correlation between the fuel oil price, the VCHP, the WEP and electricity tariff. In 2018, fuel oil prices continued to increase and traded at an average of US$73.09/bbl, an increase of 31.4 percent from 2017. The WEP rose 36.1 percent to reach $110.50/MWh in 2018. The monthly average WEP ranged from $86.31/MWh to $153.90/MWh. The peak monthly average WEP of $153.90/MWh was recorded in October 2018.

Chart 20: Average Reserve Prices

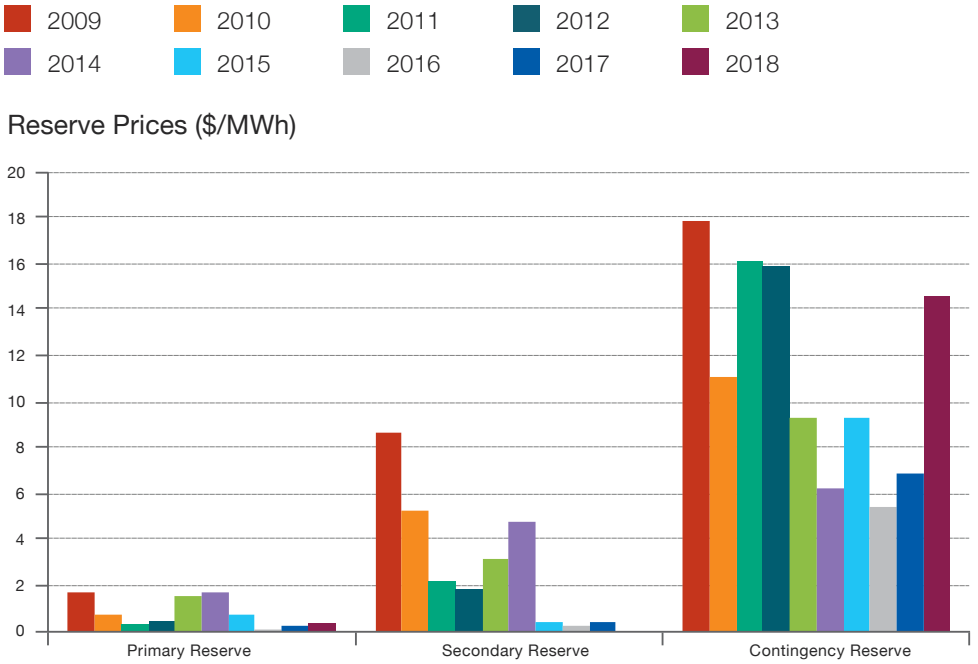
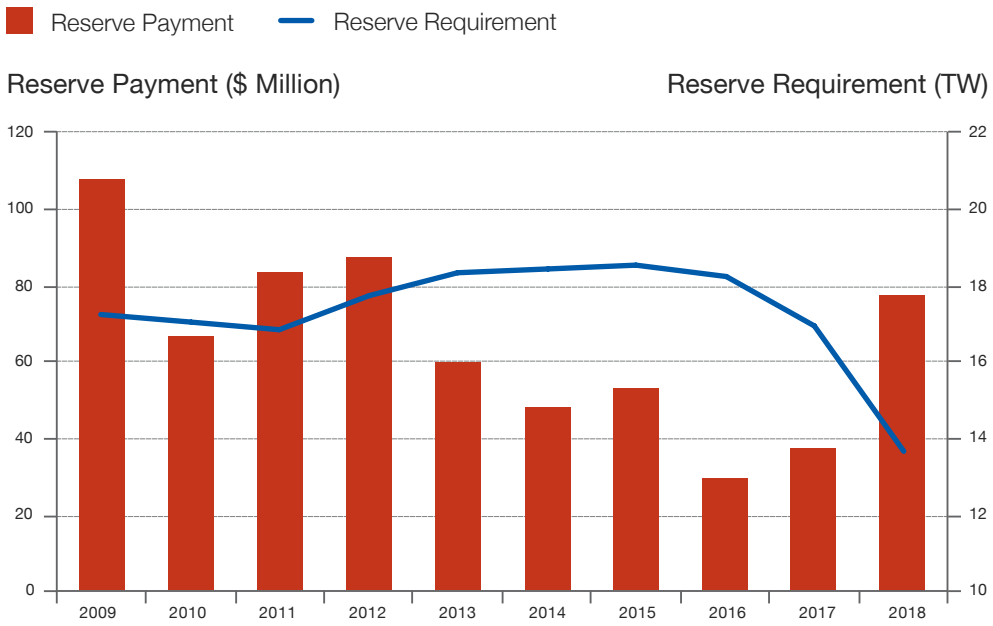


Chart 21: Annual Reserve Payment and Requirement



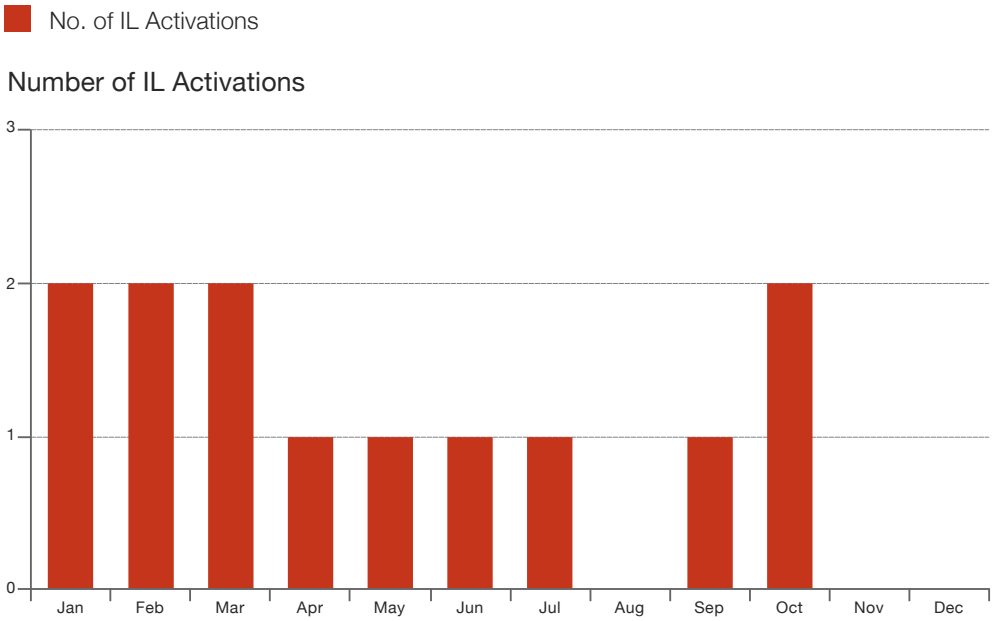
With effect from 1 October 2017, the primary and secondary reserve classes were combined into a single primary reserve class. Hence, there was no secondary reserve price in 2018.

In 2018, the average prices for both primary and contingency reserves more than doubled, rising 103.4 percent and 116.6 percent to reach $0.38/MWh and $14.60/MWh respectively. The average price for contingency reserve recorded was the highest in six years.

The total reserve payment rose 107.6 percent from $37.2 million in 2017 to $77.3 million in 2018, as seen in Chart 21. This was the highest level in the past six years, after reaching the lowest level in 2016.

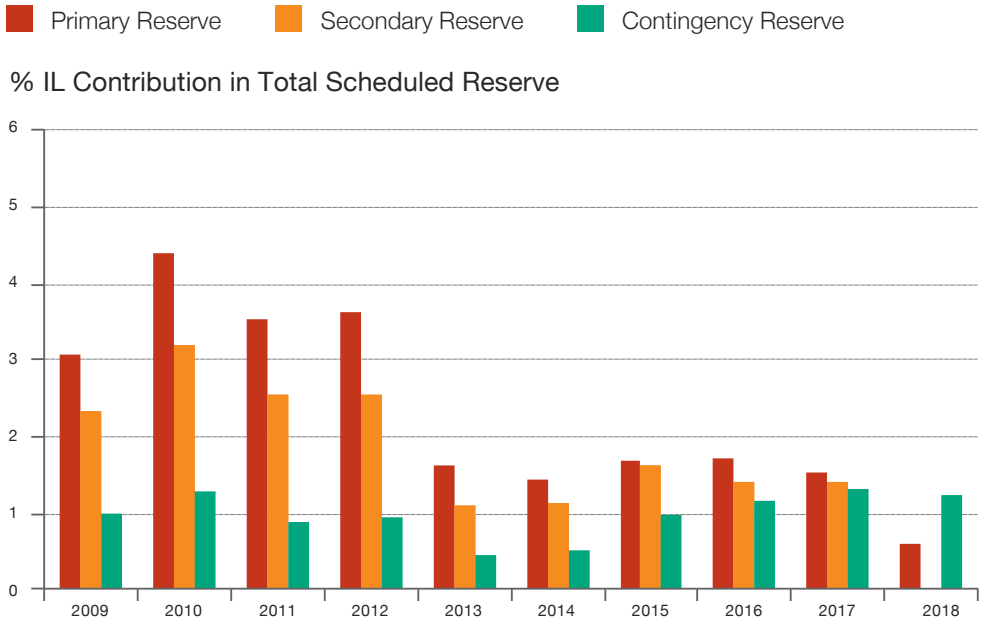
The reserve requirement declined 19.2 percent in 2018 following the removal of the secondary reserve class.

Chart 22: Number of IL Activations in 2018



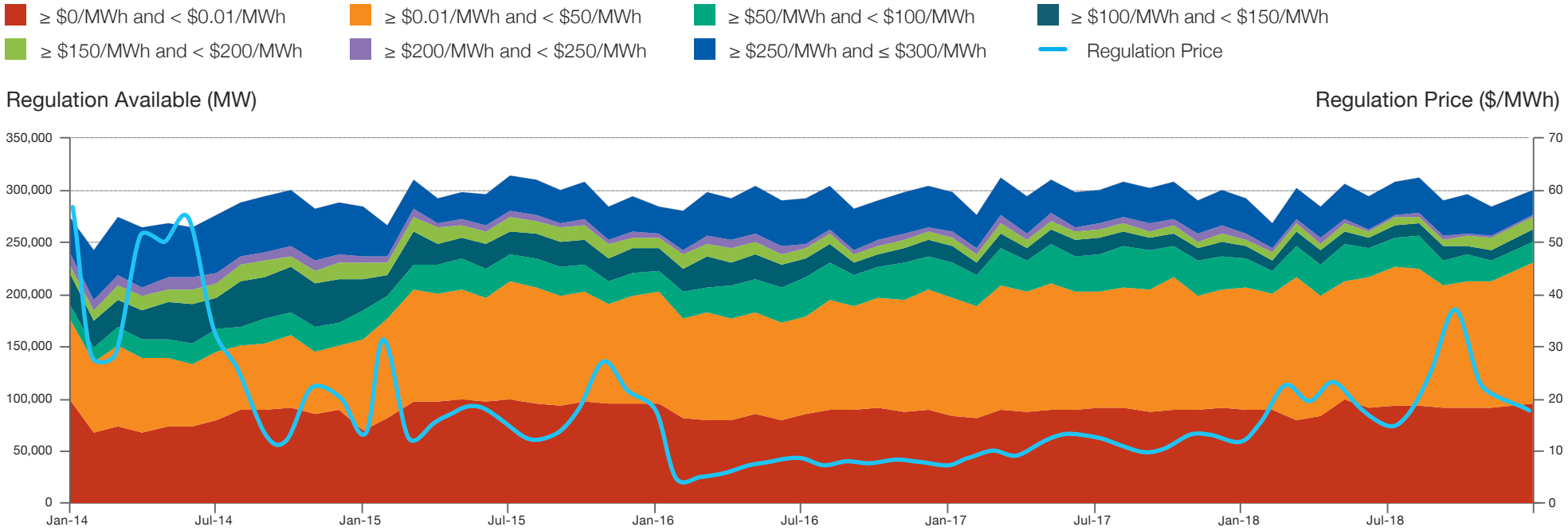
From Chart 22, it can be seen that in 2018, Interruptible Load (IL) was activated on 13 occasions to provide reserve, compared to 12 occasions in 2017. IL was activated twice each in January, February, March and October, and once each in April, May, June, July and September.

Chart 23: Total Percentage Contribution from IL in Three Classes of Scheduled Reserve



In 2018, the percentage contributions from IL in both primary and contingency reserve classes were lower than those in 2017, as seen in Chart 23. The total scheduled quantity for primary reserve from IL declined 58.6 percent in 2018 compared with 2017, while the total scheduled quantity for primary reserve increased slightly by 2.3 percent. This resulted in the primary reserve contribution from IL falling by 59.5 percent in 2018.

Chart 24: Regulation Availability vs Regulation Price



The average regulation price rose by 80.9 percent from $11.48/MWh in 2017 to $20.76/MWh in 2018. This was the second consecutive year that regulation price had increased after bottoming in 2016. Despite the increase, this was still the fourth lowest yearly regulation price since the market started. The 2018 peak monthly regulation price of $37.20/MWh was observed in October.

Chart 24 shows the regulation offer patterns in various offer tranches. The biggest increase was observed in the "≥$0.01/MWh and <$50/MWh" offer tranche, where the proportion of offers expanded 3.2 percentage points to reach 41.7 percent in 2018. The biggest decrease of 2.2 percentage points was observed in the "≥$50/MWh and <$100/MWh" offer tranche.

ECONOMETRIC MODEL AND OUTLIER PRICES

ECONOMETRIC MODEL AND OUTLIER PRICES

In 2007, the Market Surveillance and Compliance Panel (MSCP) started using an econometric model to identify and analyse high price incidents[8]. The model provides a means of estimating the average Uniform Singapore Energy Price (USEP) through the use of independent variables, including the Combined Cycle Gas Turbine (CCGT) supply, Steam Turbine (ST) supply, energy supply cushion, offers lower than $100/MWh, energy demand, reserve cushion and lagging fuel oil prices. The model is also adjusted to differentiate planned outages from generation companies with different portfolios, and forced outages by month, day-of-week, and year via the use of dummy variables.

As part of the effort to review and enhance the model, following the publication of the 2008 MSCP Annual Report, the issue of multicollinearity between variables within the model was tackled. While multicollinearity does not affect the predictive and detection powers of the model, it may misrepresent the explanatory power of the variables in the model. In particular, the coefficients of the independent variables may be distorted to some degree. In addition, some variables may be statistically insignificant.

To reduce multicollinearity in the model, stepwise regression was used. Stepwise regression is a statistical technique in which variables are added to a model in a forward selection or backward elimination procedure to determine their contribution to the regression model. The statistical significance of the variable is measured by its additional contribution to the residual sum of squares (RSS). If the RSS is not improved significantly by the addition of a variable, the variable is left out of the final model.

By employing stepwise regression, it was found that selecting three variables would create a model with an R-squared value of 83 percent. The three variables selected were: lagged fuel oil price, supply cushion and CCGT supply.

[8] Details of the model and its methodology can be found in the paper, "How Market Fundamental Factors Affect Energy Prices in the NEMS – An Econometric Model", available on www.emcsg.com.

Table 7: Estimation Results – January 2003 to December 2018

Variable	Coefficient	P-value
Constant	8.49	0.000
LOG (Lagged Fuel Oil Price)	0.89	0.000
LOG (Supply Cushion)	-0.72	0.000
LOG (CCGT Supply)	-0.58	0.000

Model Diagnostics	
R-squared	0.83
Adjusted R-squared	0.83
Number of observations	5,814

Table 7 provides the following observations, which are in line with expectations:

- a one unit increase in the logarithm of the lagged fuel oil price will bring about a 0.89 unit increase in the logarithm of the USEP;
- a one unit increase in the logarithm of the supply cushion will bring about a 0.72 unit decrease in the logarithm of the USEP; and
- a one unit increase in the logarithm of the CCGT supply will bring about a 0.58 unit decrease in the logarithm of the USEP.

Chart 25: Actual vs Predicted LOG USEP within Three Standard Error Bands

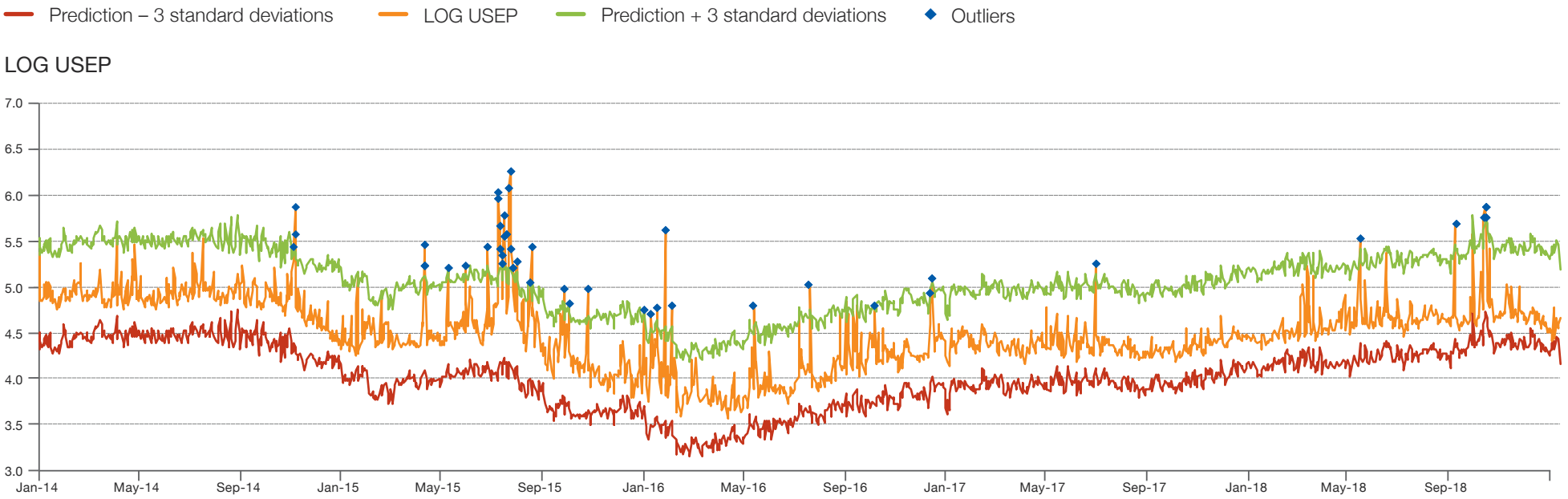
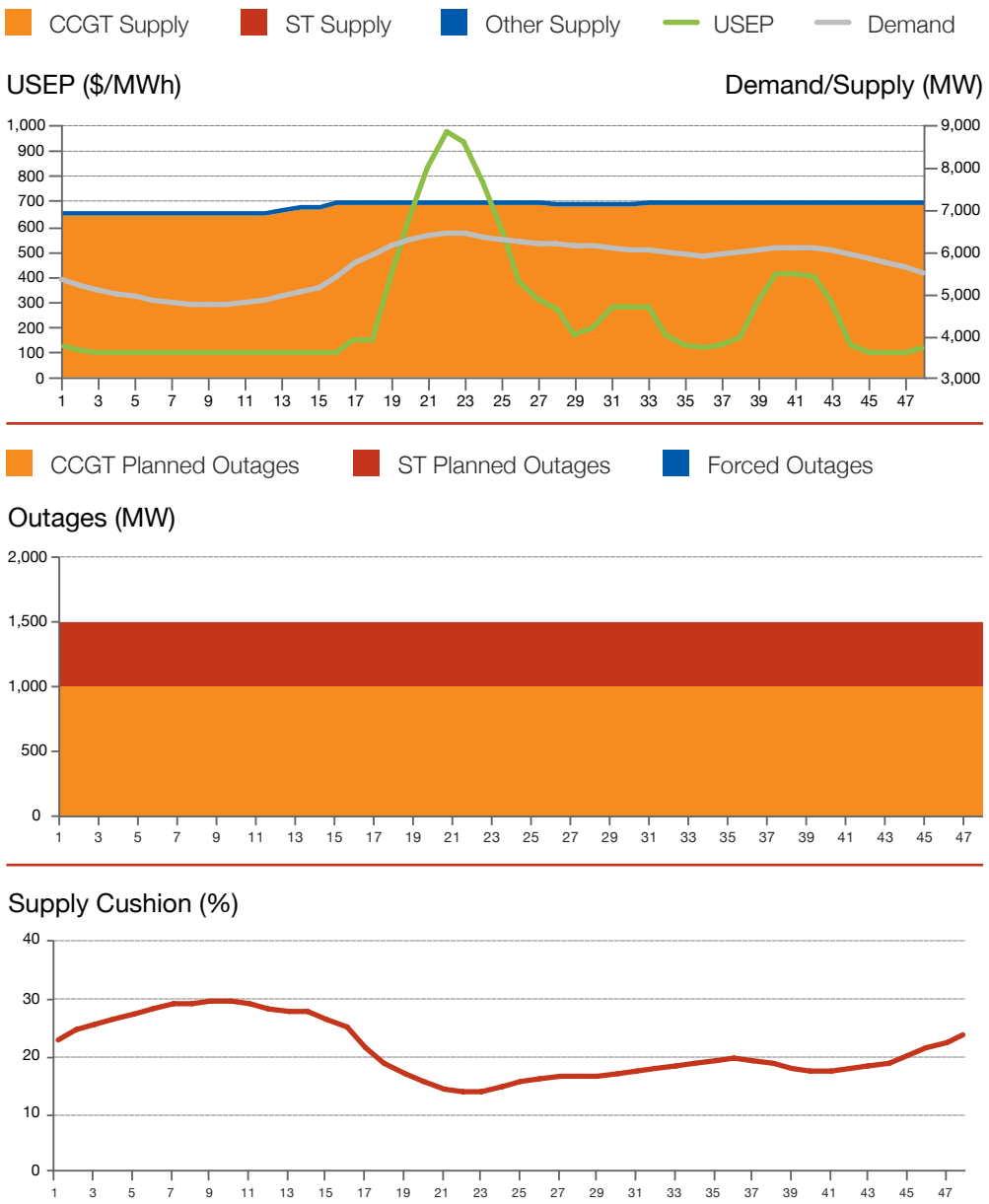


Chart 25 illustrates the actual daily average USEP, the upper and lower bands of the estimated USEP, and the outliers identified by the econometric model, from January 2014 to December 2018. In 2018, there were six days during which outlier prices were detected by the model. Three of these days will be discussed in this report because the remaining cases were lesser recurrences of similar phenomena.

Chart 26: Demand and Supply Conditions — 5 May 2018



Date	Saturday 5 May 2018	All Saturdays in May 2018
Daily USEP ($/MWh)	253.21	166.40
Max USEP ($/MWh)	963.02	963.02
No. of USEP ≥ $1,000/MWh	0	0
Demand (MW)	5,777	5,823
Supply Cushion (in %)	21.3	22.1
Offers ≤ $100/MWh (in %)	78.1	77.9

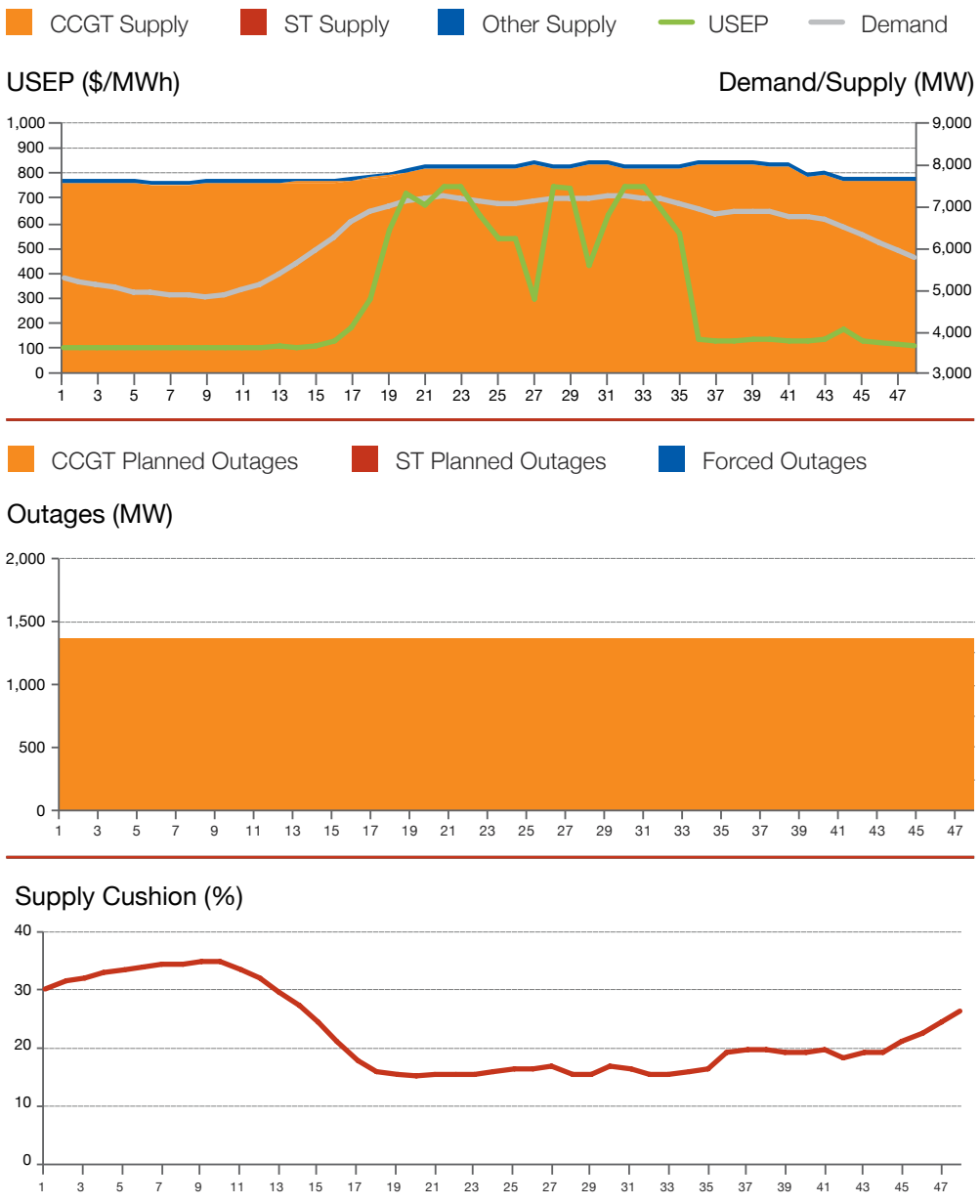
Summary

On Saturday, 5 May 2018, the USEP rose above $400/MWh for nine periods, reaching as high as $963.02/MWh.

The high prices were largely due to a lower supply cushion caused by a high level of planned outage (1,551MW). Four CCGT units (including two embedded generators) and two ST units were taken out of the grid for maintenance. The supply cushion averaged 16.2 percent during the periods of high USEP, sinking to a low of 14.5 percent in the period when the USEP was at its peak.

Contingency reserve shortfalls were reported for 16 periods including the nine periods with high prices.

Chart 27: Demand and Supply Conditions — 27 August 2018



Date	Monday 27 Aug 2018	All Mondays in Aug 2018
Daily USEP ($/MWh)	297.06	154.17
Max USEP ($/MWh)	732.97	732.97
No. of USEP ≥ $1,000/MWh	0	0
Demand (MW)	6,220	6,169
Supply Cushion (in %)	22.3	25.4
Offers ≤ $100/MWh (in %)	74.5	72.7

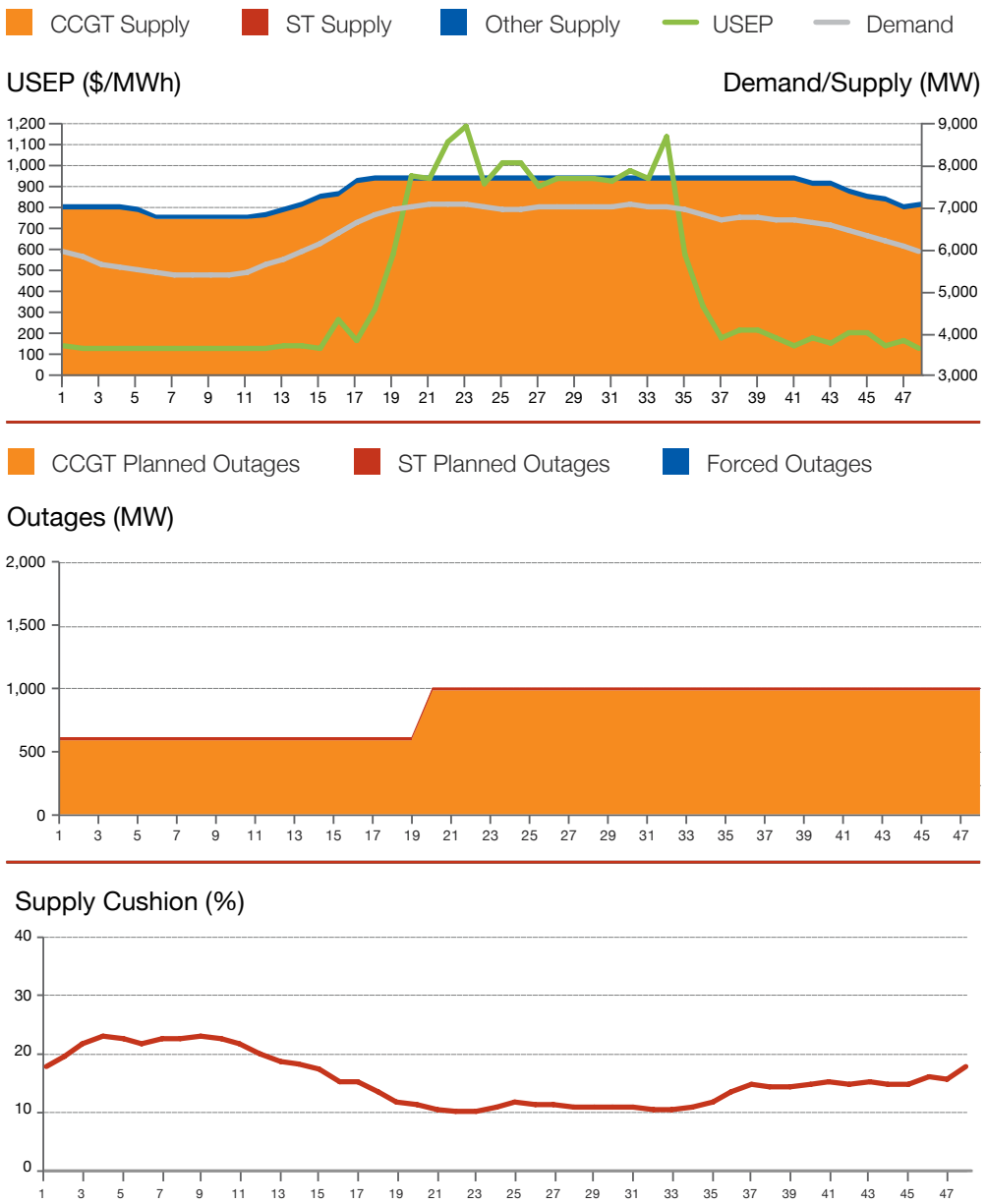
Summary

On Monday, 27 August 2018, the USEP cleared above $400/MWh for 16 periods, ranging from $422.53/MWh to $732.97/MWh.

The high prices were mainly due to a lower supply cushion caused by high demand and a high level of planned outage (1,376MW). Four major CCGT units were taken out of the grid for maintenance.

Contingency reserve shortfalls were reported for 16 periods, which coincided with the 16 periods of high prices. The average supply cushion during the affected periods was as low as 15.5 percent, pushing prices up as more expensive offers were scheduled to meet the demand during these periods.

Chart 28: Demand and Supply Conditions — 4 October 2018



Date	Thursday 4 Oct 2018	All Thursdays in Oct 2018
Daily USEP ($/MWh)	435.02	197.41
Max USEP ($/MWh)	1,181.65	1,181.65
No. of USEP ≥ $1,000/MWh	5	5
Demand (MW)	6,391	6,115
Supply Cushion (in %)	15.4	21.1
Offers ≤ $100/MWh (in %)	75.8	73.7

Summary

On Thursday, 4 October 2018, the USEP spiked above $400/MWh for 17 periods when demand was at its peak. The highest USEP of $1,181.65/MWh was registered in Period 23.

The high prices were largely due to a low supply cushion caused by high demand and a high level of planned outage (1,096MW). Three major CCGT units were taken out of the grid for maintenance. The daily average demand of 6,391MW was the highest level since the market started. Consequently, the daily average supply cushion fell to 15.4 percent, which was also the lowest level since the market started.

During these periods of high USEP, the supply cushion averaged 11.0 percent, putting upward price pressure on the affected periods and pushing up the daily average USEP.

Contingency reserve shortfalls were reported for 19 periods on that day, including the 17 periods with high prices.

INVESTIGATIONS

Under the Market Rules, the Market Surveillance and Compliance Panel (MSCP) may initiate an investigation into any activity in the wholesale electricity markets or into the conduct of a market participant, the Market Support Services Licensee, Energy Market Company or the Power System Operator that is brought to its attention by way of a referral or complaint from any source, or that the MSCP of its own volition determines as warranting an investigation.

The MSCP may refuse to commence or may terminate an investigation when it is of the view that a complaint, referral or investigation is frivolous, vexatious, immaterial or unjustifiable, not directly related to the operation of the wholesale electricity markets, or within the jurisdiction of another party.

Table 8 reflects the position with regard to investigation and enforcement activities from the start of the market on 1 January 2003 to 31 December 2018, with the last column focusing on the period under review.

Reports of determinations of breach made by the MSCP are published in accordance with the Market Rules.

Table 8: Investigation and Enforcement Statistics

	Rule Breaches	1 Jan 2003 to 31 Dec 2018	1 Jan to 31 Dec 2018
(A)	**Total number of offer variations after gate closure received**	36,776	497
	Total number of cases closed	36,675	475
	- cases in which the MSCP determined a breach	146	10
	- cases in which the MSCP determined no breach	16,849	462
	- cases in which the MSCP took no further action	19,680	3
(B)	**Origin of cases (excluding offer variations after gate closure)**	190	7
	- self-reports	162	4
	- referrals or complaints	21	3
	- initiated by the MSCP	7	0
	Total number of cases closed	188	5
	- cases in which the MSCP determined a breach	127	1
	- cases in which the MSCP determined no breach	13	0
	- cases in which the MSCP took no further action	44	1
	- cases in which the MSCP issued suspension order	3	2
	- cases in which the MSCP issued other order	1	1
(C)	**Number of formal MSCP hearings**	10	3
(D)	**Enforcement action**		
	- highest financial penalty imposed on a party in breach	$842,861	$7,500
	- total financial penalties imposed on parties in breach	$1,146,861	$20,000
(E)	**Costs**		
	- highest award of costs imposed on a party in breach	$43,750	$9,000
	- total costs imposed on parties in breach	$255,675	$17,000

	Market Efficiency and Fairness	1 Jan 2003 to 31 Dec 2018	1 Jan to 31 Dec 2018
	Total number of cases	7	0
	- referrals or complaints	2	0
	- initiated by MSCP	5	0
	Total number of cases closed	7	0

SECTIONS 50 AND 51 OF THE ELECTRICITY ACT

SECTIONS 50 AND 51 OF THE ELECTRICITY ACT

Information Requirements to Assist the Authority

The Market Rules provide for the Market Assessment Unit (MAU), under the supervision and direction of the Market Surveillance and Compliance Panel (MSCP), to develop a set of information requirements to assist the Energy Market Authority (EMA) to fulfil its obligations with respect to prohibiting anti-competitive agreements and abuse of a dominant position under sections 50 and 51 of the Electricity Act.

The first set of information requirements was finalised in consultation with the EMA and published on 27 March 2003. As the market evolved, modifications to the information requirements were published on 18 August 2003, 28 January 2004 and 3 April 2012, with the latest modification made and published on 22 August 2016.

The MAU regularly provides data to the EMA according to the information requirements.

Reports to the Authority

The Market Rules provide for the MSCP to include in its report a summary of reports that have been made to the EMA regarding any complaint that may have been received or any information that may have been uncovered, that may indicate the possibility of anti-competitive agreements, or the abuse of a dominant position, contrary to sections 50 or 51 of the Electricity Act.

In the course of monitoring and investigative activities carried out from January to December 2018, the MSCP and MAU submitted one report to the EMA regarding the MSCP's observations on the Uniform Singapore Energy Price (USEP) spikes from 1 October to 4 October 2018. The MSCP did not determine any breach of the Market Rules leading to the price spikes.

ASSESSMENT OF THE WHOLESALE ELECTRICITY MARKETS

ASSESSMENT OF THE WHOLESALE ELECTRICITY MARKETS:
State of Competition and Efficiency of the Wholesale Electricity Markets

Under the Market Rules, the Market Surveillance and Compliance Panel (MSCP) is required to provide a general assessment of the state of competition and compliance within, and the efficiency of, the wholesale electricity markets. The MSCP's assessment for 2018 is as follows:

Market Structure and Competition

Entry of new market participants

Six new market participants (MPs) joined the National Electricity Market of Singapore (NEMS) in 2018 as shown in the table on the right.

New facilities in the market

20 new intermittent generation sources (IGS) were introduced in the NEMS in 2018.

This brings the total registered capacity of IGS facilities in the NEMS to 50.483MW.

SP Services Limited also registered one 10.628MW CCGT unit in the market.

In addition, three non-exporting IGS facilities were registered in the NEMS in 2018 (total: 5.60MW) by Changi Mega Solar Pte Ltd, Cleantech Solar Singapore Assets Pte Ltd and Sunseap Leasing Pte Ltd.

Withdrawal of market participants

In 2018, seven MPs withdrew their participation in the NEMS.

New Market Participants

	Name of MP	Date Joined NEMS
Retailers	Peerer Energy Pte Ltd	9 February 2018
	MyElectricity Pte Ltd	27 March 2018
	UGS Energy Pte Ltd	8 June 2018
	GreenCity Energy Pte Ltd	25 July 2018
	SingNet Pte Ltd	30 October 2018
Generator	TuasOne Pte Ltd	1 June 2018

New IGS Facilities

Name of MP	Number of New IGS Facilities in 2018	Total Registered Capacity in 2018
Sembcorp Solar Singapore Pte Ltd	4	6.156MW
SP Services Limited	1	0.005MW
Sunseap Leasing Pte Ltd	3	2.451MW
Sunseap Leasing Beta Pte Ltd	3	3.564MW
Sun Electric Energy Assets Pte Ltd	9	1.759MW

Market Participant Withdrawals

	Name of MP
Wholesale Market Traders	Banyan Utilities Pte Ltd
	Glaxo Wellcome Manufacturing Pte Ltd – GlaxoSmithKline Biologicals
	GreenSync Holdings Pte Ltd
	Nanyang Technological University
	Pfizer Asia Pacific Pte Ltd
Retailers	Energy Supply Solutions Pte Ltd
	SmartCity Energy Pte Ltd

Market Price Behaviour

Continued rise in USEP in 2018

This year saw an increase of 36.3 percent in the average Uniform Singapore Energy Price (USEP) from $80.91/MWh in 2017 to $110.29/MWh. This was the USEP's second consecutive year of increase since 2016. The Wholesale Electricity Price increased 36.1 percent from $81.19/MWh to $110.50/MWh.

The higher energy prices were attributed to a higher demand and lower supply in 2018. Forecasted demand rose 2.2 percent from 5,748MW to 5,874MW, while supply dropped 2.5 percent from 8,070MW to 7,864MW this year. This lowered the supply cushion to 25.4 percent.

Efficiency of the Electricity Markets

Productive efficiency

The market share of Combined Cycle Gas Turbine (CCGT) units based on metered energy quantity increased 0.1 percent to 98.2 percent this year. The market share of other units (OT) decreased 0.1 percent to 1.8 percent.

In terms of maximum capacity, the market share of CCGT units increased 0.2 percentage point to 77.8 percent in 2018. The market share of Steam Turbine (ST) units, OT and Open Cycle Gas Turbine (OCGT) units decreased 0.1, 0.01 and 0.01 percentage point respectively.

Overall, this represented further improvements in productive efficiency.

Pricing efficiency

Prices generally reflected relative supply and demand conditions in 2018.

Looking Ahead

Full retail contestability in the electricity market

The retail electricity market has opened in progressive phases in its move towards full retail contestability. The nationwide Open Electricity Market was launched in November 2018 according to geographical zones and is expected to be fully rolled out from 1 May 2019.

Publishing additional load scenarios in the forecast schedules

Currently, EMC publishes three load scenarios in the Market Outlook Scenario (MOS) and Pre-Dispatch Schedule (PDS) based on the normal load forecast, high load forecast (+100MW) and low load forecast (-100MW). From 28 May 2019, EMC will be publishing two additional load scenarios in the Short Term Schedule (STS), and removing the high and low load scenarios published in the MOS and PDS.

Validation of load forecasts

Effective from 26 June 2019, the Power System Operator (PSO) will provide the lower and upper limits of the load forecasts for each period for EMC to conduct a validation check on load forecasts. This rule change is implemented in response to a 0MW load forecast error received by EMC's Market Clearing Engine from the PSO's energy management system on 6 January 2015 for a few consecutive periods.

Ensuring compliance with the Market Rules is important in the operation of a competitive and reliable electricity market. MPs that breach the rules may be subject to sanctions if the MSCP considers it appropriate.

The assessment of the state of compliance within the wholesale electricity markets is set out below.

Offer Variations After Gate Closure

Table 9 compares the number of offer variations after gate closure submitted by MPs in 2018 and the previous year.

There were 497 cases of offer variations made after gate closure in 2018. This was 31 percent lower than in 2017.

Table 9: Offer Variations After Gate Closure

Number of offer variations made after gate closure from 1 January 2017 to 31 December 2017	719
Number of offer variations made after gate closure from 1 January 2018 to 31 December 2018	497
Decrease in number of offer variations made after gate closure for year 2018 from previous year	- 31%

Rule Breaches

For the period 1 January to 31 December 2018, the MSCP made three determinations regarding rule breaches. The determinations were made against Shell Eastern Petroleum (Pte) Ltd, Sembcorp Cogen Pte Ltd and Energy Market Company Pte Ltd.

The rule breach determinations were as follows:

- Shell Eastern Petroleum (Pte) Ltd's failure to comply with gate closure rules from August to November 2017.
- Sembcorp Cogen Pte Ltd's failure to comply with gate closure rules on 25 January 2018.
- Energy Market Company Pte Ltd's incorrect settlement components from 31 January to 8 February 2018.

The MSCP also issued two suspension orders to Energy Supply Solutions Pte Ltd and Charis Electric Pte Ltd on 24 May 2018 and 16 October 2018 respectively.

Overall, there were no major compliance issues arising within the wholesale electricity markets in 2018.

Automatic Financial Penalty Scheme

The Automatic Financial Penalty Scheme for generation registered facilities that deviate from their dispatch schedule came into effect on 17 November 2015.

In 2018, it was observed that 11 generation companies were issued with automatic financial penalties for a total sum of $401,146.29 by the NEMS.

CONCLUSION

CONCLUSION

The Market Surveillance and Compliance Panel (MSCP) is generally satisfied with the state of compliance in the National Electricity Market of Singapore (NEMS) in 2018. The MSCP determined three cases of rule breaches over the year. The number of offer changes made after gate closure declined from 719 to 497. In all, rule breaches and gate closure violations were found not to have had any significant impact on the NEMS.

Two suspension orders were issued to two retail licensees following their respective unremedied defaults. The suspension hearing processes were applied promptly, and both exits were managed in an orderly manner, ensuring that they did not create a financial impact on other market participants. The MSCP commends the swift coordinated actions of the EMA, EMC and SP Services in making that possible.

After a relatively stable 2017, volatility in the Wholesale Electricity Price (WEP) picked up in 2018. As the average WEP rose over 36 percent on the back of a continued rebound in fuel prices, instances of outlier prices also picked up. They were observed for six days, up from only one a year ago. While these observations had been largely reflective of underlying demand and supply conditions, they inevitably contributed to the increased number of default events.

Structural improvements in the market continued in 2018, as competition intensified in both the generation and retail sectors. The combined market share of the three largest generation companies fell 2.4 percentage points to 53.1 percent. On the retail front, a total of five new participants entered the market. In total, there were six new participants across all classes of participants in the NEMS. Notably, 20 new intermittent generation facilities totalling some 14MW were added to the NEMS, contributing to diversity in the generation space. New Market Rules were also introduced to provide greater transparency over market-relevant information in the NEMS. Finally, the launch of the Open Electricity Market for household consumers in November 2018 added a new dimension to the retail electricity market.

In all, these developments together will bring about a more competitive and dynamic electricity industry for years to come. The MSCP looks forward to the industry evolving to greater heights.

USER GUIDE

Data

- All real-time and forecast prices and settlement data are provided by Energy Market Company Pte Ltd (EMC).
- Vesting Contract Hedge Prices (VCHP) are computed by SP Services Ltd (SP Services) based on a formula set by the Energy Market Authority.
- Data for forecast demand and outages is compiled from reports prepared by the Power System Operator (PSO), including advisory notices.
- Metered energy quantities are supplied by SP Services as the Market Support Services Licensee (MSSL). All metered data used in this report is final data, derived after any settlement reruns.
- Throughout this document, demand figures are based on the forecast demand supplied by the PSO, except where metered energy quantities are indicated.
- Combined Cycle Gas Turbine (CCGT) units refer to all generating units clustered under the CCGT/COGEN/TRIGEN umbrella.

Supply Indices

- Capacity ratio measures the scheduled output of energy (by the Market Clearing Engine), reserve and regulation as a ratio of a generation registered facility's maximum generation capacity at a given time.
- Supply cushion is the ratio between (a) the supply and demand gap (i.e., the difference between total offered volume and demand) and (b) supply. This index measures supply adequacy. It indicates the level of unused capacity that was offered but not scheduled, and could be called up if required. The total offered volume refers to the total amount of energy offered by all generation registered facilities. Demand refers to the demand forecast by the PSO used to determine the real-time dispatch schedule for energy.
- Market share is computed based on the generation output of each company. The maximum capacity for each generation company is the registered maximum capacity in the standing data.
- Under the Market Rules and System Operation Manual (SOM), outages of generation registered facilities are defined as follows:

Table 10: Definition of Peak, Shoulder and Off-peak Periods*

	Sunday/Public Holiday	Weekday	Saturday
Peak	-	Periods 18-41	-
Shoulder	Periods 22-46	Periods 15-17 Periods 42-48	Periods 18-47
Off-peak	Periods 1-21 Periods 47-48	Periods 1-14	Periods 1-17 Period 48

* Source: MSSL

a) planned outage is defined in the SOM to "include both the Annual Outage plan for overhaul, retrofitting or inspection and the Short-term Outage Plan for urgent repair or maintenance"; and

b) forced outage is defined in the Market Rules as "an unanticipated intentional or automatic removal from service of equipment or the temporary de-rating of, restriction of use or reduction in performance of equipment".

There may be slight differences in the calculation of outages in the Annual Report of the MSCP and the NEMS Market Report due to differing methodologies.

Vesting Contracts

The VCHP is calculated by the MSSL every three months. It is determined using the long-run marginal cost of the most efficient technology in the Singapore power system, i.e., the CCGT. EMC's settlement system uses the VCHP to settle the vesting quantity between the MSSL and the generation companies.

Periods

Each day is divided into 48 half-hour periods. Period 1 is from 0000 to 0029 and Period 48 is from 2330 to 2359.

Important Notice

This publication is meant only for general information and nothing in it may be construed as advice. Whilst the Market Surveillance and Compliance Panel (MSCP) has taken reasonable care in the preparation of this publication, the MSCP does not warrant its suitability for any purpose. You should always consult your professional advisers before making any decision.

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