National Electricity Market of Singapore

MARKET SURVEILLANCE & COMPLIANCE PANEL

ANNUAL REPORT 2015

CONTENTS

EXECUTIVE SUMMARY

This annual report by the Market Surveillance and Compliance Panel (MSCP) covers the period 1 January to 31 December 2015. 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 2015 relative to 2014:

Supply Indices

- The average supply cushion declined 0.7 percentage point from 30.0 percent in 2014 to 29.3 percent in 2015, showing a tightening of supply conditions relative to that of demand.
- Reflecting the tightening supply, the average capacity ratio of Combined Cycle Gas Turbine (CCGT) units increased 0.4 percentage point to 62.3 percent. The capacity ratio for Steam Turbine (ST) units gained 0.02 percentage point to 0.21 percent.
- The generation market share of CCGT units inched up slightly by 0.1 percentage point to 98.0 percent.
- The concentration level in the generation sector diluted further with the combined market share of the three largest generation companies going below 60.0 percent. This figure had declined by a further 2.6 percentage points from 2014, to 59.2 percent.
- The average total generation outage per period in 2015 edged up 6.1 percent to 944MW. The average forced outage level per period rose from 17.8MW in 2014 to 24.4MW.

Demand Indices

- The average demand growth in 2015 slowed significantly to 1.5 percent, down from 3.2 percent in 2014.
- The average monthly electricity demand in 2015 was about 5,424MW, compared to 5,346MW in 2014. The average monthly electricity demand peaked in July at 5,626MW.
- The accuracy of real-time load forecast in 2015 improved with an average forecast error of 2.74 percent, the best result in the history of the National Electricity Market of Singapore.

Market Prices

- The average Wholesale Electricity Price (WEP) fell 30.0 percent to $95.85/MWh as fuel prices plunged.
- The average price of the benchmark 180-centistoke high sulphur fuel oil (180-CST HSFO) fell 47.2 percent to US$47.63/bbl in 2015.
- The total reserve cost in 2015 rose 10.2 percent from $47.9 million to $52.8 million.

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 fourteenth 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 2015. This review provides the MSCP with the opportunity to highlight significant observations.

The MSCP members (as of 31 December 2015) are:

- Thean Lip Ping, Chair;
- Lee Keh Sai;
- TPB Menon;
- Philip Chua; and
- Professor Euston Quah

Supported by the Market Assessment Unit (MAU) 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 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

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[1] it acquires and a catalogue of the monitoring indices[2] 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.

[1] 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.

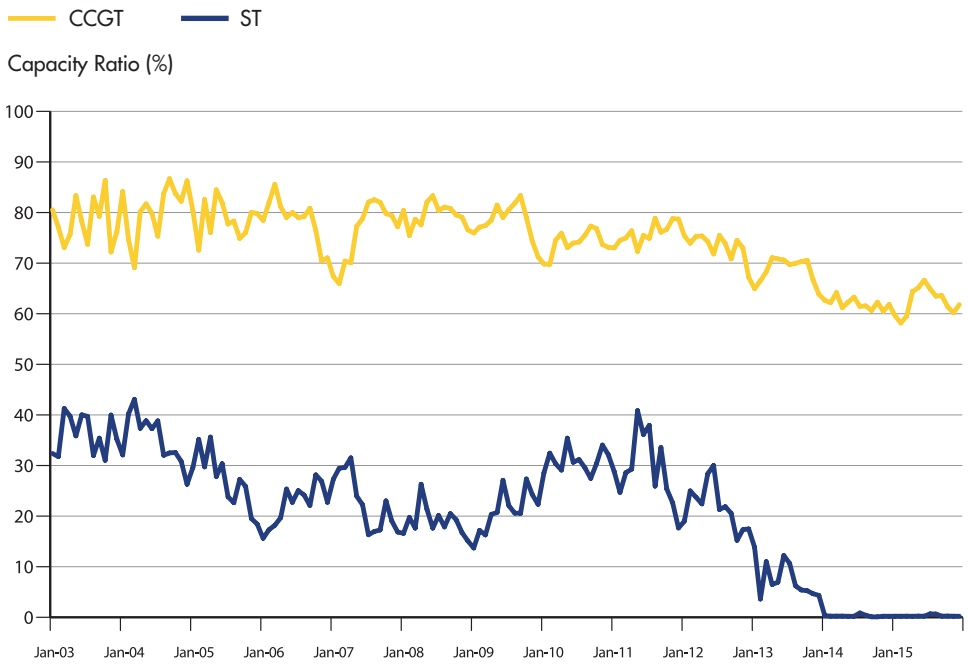
[2] On 29 July 2004, a catalogue of monitoring indices was adopted by the MSCP after public consultation. It took effect from 1 August 2004. The catalogue of monitoring indices is used to evaluate the market data collected.

Table 1: Capacity Ratio (in %) 2015

Month	CCGT	ST	OT	OCGT
Jan 15	59.55	0.13	44.84	0.07
Feb 15	58.08	0.13	52.86	0.42
Mar 15	59.44	0.14	53.79	0.00
Apr 15	64.28	0.12	50.46	0.46
May 15	65.07	0.15	52.20	0.22
Jun 15	66.54	0.13	55.62	0.91
Jul 15	64.85	0.59	54.85	0.98
Aug 15	63.38	0.56	54.38	0.19
Sep 15	63.52	0.14	47.95	0.17
Oct 15	61.28	0.16	52.45	0.00
Nov 15	60.10	0.13	51.63	0.00
Dec 15	61.72	0.12	52.94	0.00
Average	62.32	0.21	52.00	0.29

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

Chart 1: Comparison of Capacity Ratio for ST and CCGT



The capacity ratio of generation registered facilities, i.e., the ratio of scheduled generation output to maximum generation capacity of generation registered facilities

As seen from Table 1, the average capacity ratio for Combined Cycle Gas Turbine (CCGT) units was 62.3 percent in 2015, a 0.4 percentage point increase over 2014. This increase was due to a rise in scheduled output from CCGT units.

The average capacity ratio for Steam Turbine (ST) units rose 0.02 percentage point to 0.21 percent and the average capacity ratio for other facilities (OT) rose 0.7 percentage point to 52.0 percent. Similarly, the higher capacity ratios were brought about by higher levels of scheduled output from ST and OT units in 2015.

Meanwhile, the average capacity ratio for Open Cycle Gas Turbine (OCGT) units decreased 0.04 percentage point to 0.3 percent in 2015.

Chart 1 shows the capacity ratios for CCGT and ST units. Both indices have been declining since 2011; this downward trend was largely due to greater maximum generation capacity of CCGT units and lower scheduled output from ST units. The maximum generation capacity of CCGT units grew 34.0 percent from 2011 to 2015, while the scheduled output from ST units shrank 99.5 percent within the same time frame. The monthly capacity ratios for ST units in 2015 remained below 1.0 percent throughout the year.

Chart 2: Relationship between USEP and Supply Cushion

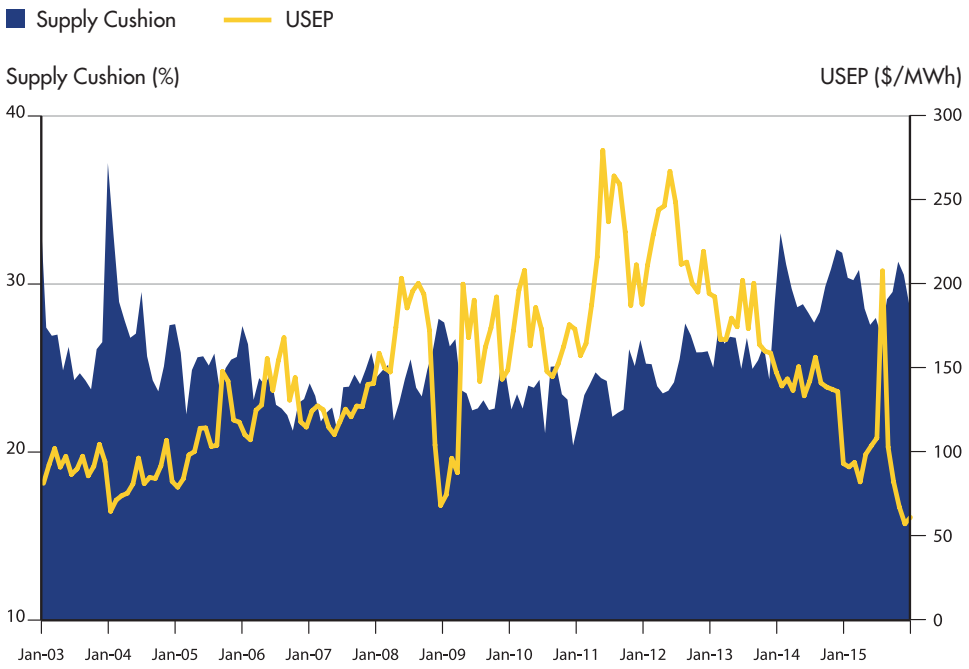


Chart 2 illustrates the relationship between the Uniform Singapore Energy Price (USEP) and the supply cushion, which measures the level of spare capacity available after dispatch.

The supply cushion weakened 0.7 percentage point from 30.0 percent in 2014 to 29.3 percent in 2015. Although demand grew 1.0 percent and supply declined 0.01 percent, the USEP decreased 29.8 percent from $136.67/MWh in 2014 to $95.97/MWh in 2015. This drop in the USEP was primarily attributed to falling fuel prices throughout the year.

Chart 3: Relationship between USEP and Supply Cushion in 2015

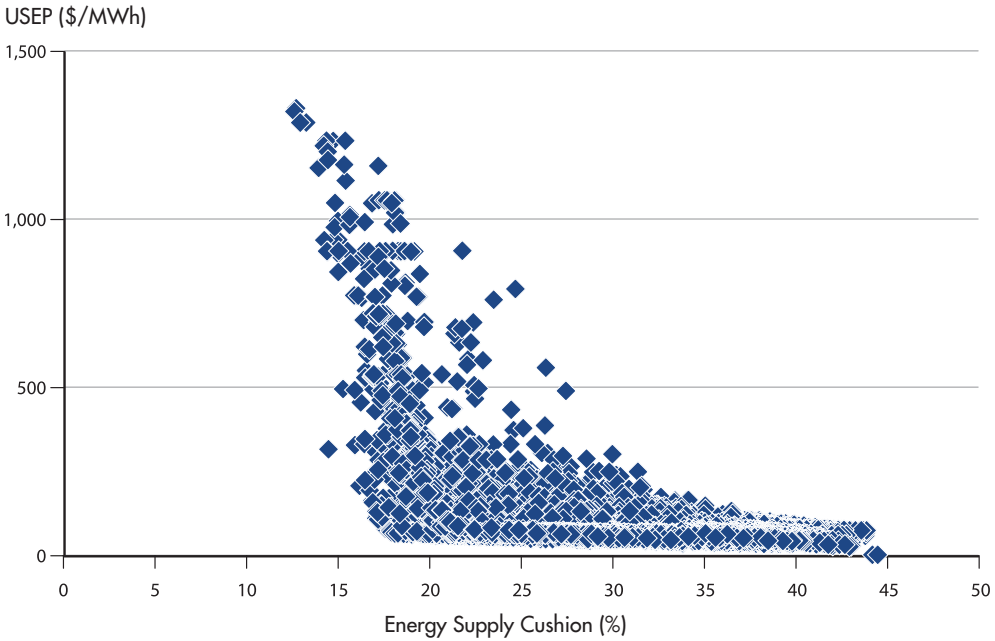


Chart 3 displays the relationship between the USEP and supply cushion in 2015. The total number of instances of the USEP being above $500/MWh increased from 52 in 2014 to 180 in 2015.

Historically, more occurrences of high prices were observed when the supply cushion slipped below 15.0 percent. In 2015, however, 160 of the 180 occurrences of the USEP being above $500/MWh happened when the supply cushion was 15.0 percent or above. Supply cushion was less than 25.0 percent in all but one occurrence.

Table 2: Relationship Between Supply Cushion and the 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)
2003	319	272.91	4,500.00	17,201	89.00	1,904.56
2004	74	339.50	4,500.00	17,494	81.26	1,624.68
2005	109	607.48	4,430.65	17,411	106.79	2,229.61
2006	191	477.21	4,500.00	17,329	128.62	930.77
2007	278	332.54	4,500.00	17,242	121.22	988.06
2008	127	391.43	1,126.03	17,441	160.59	955.52
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	1052.29	1328.06	17,499	94.82	1231.40

Table 2 shows the USEP movements since the start of the market under two supply cushion scenarios. When the supply cushion was below 15.0 percent, the average USEP in 2015 was $1,052.29/MWh, an increase of 78.5 percent from $589.54/MWh in 2014. When the supply cushion was 15.0 percent or above, the average USEP in 2015 fell 30.5 percent to $94.82/MWh from $136.36/MWh in 2014.

The highest USEP observed when the supply cushion was below 15.0 percent was $1,328.06/MWh in 2015, compared to $936.81/MWh in 2014. The highest USEP observed when the supply cushion was 15.0 percent or above rose from $857.78/MWh in 2014 to $1,231.40/MWh in 2015.

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

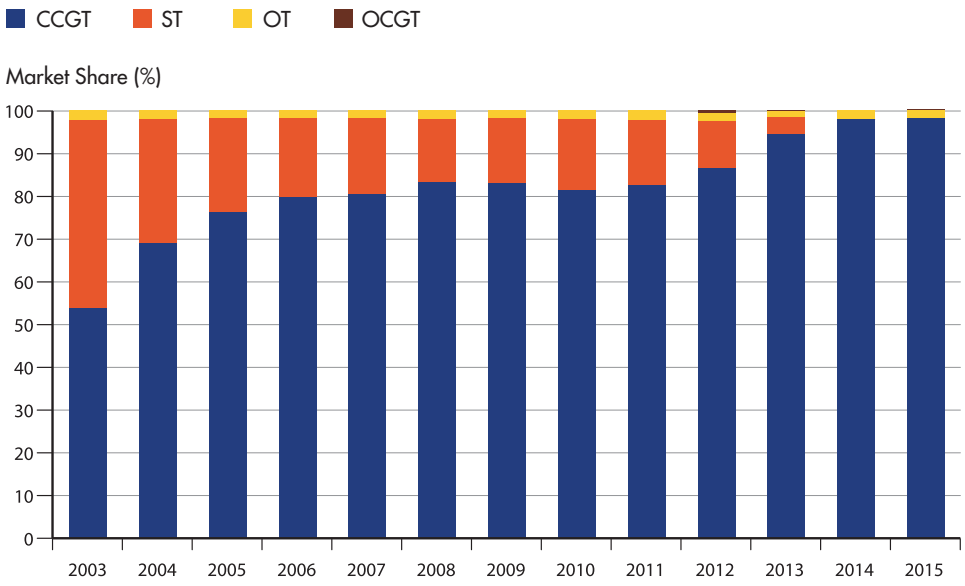
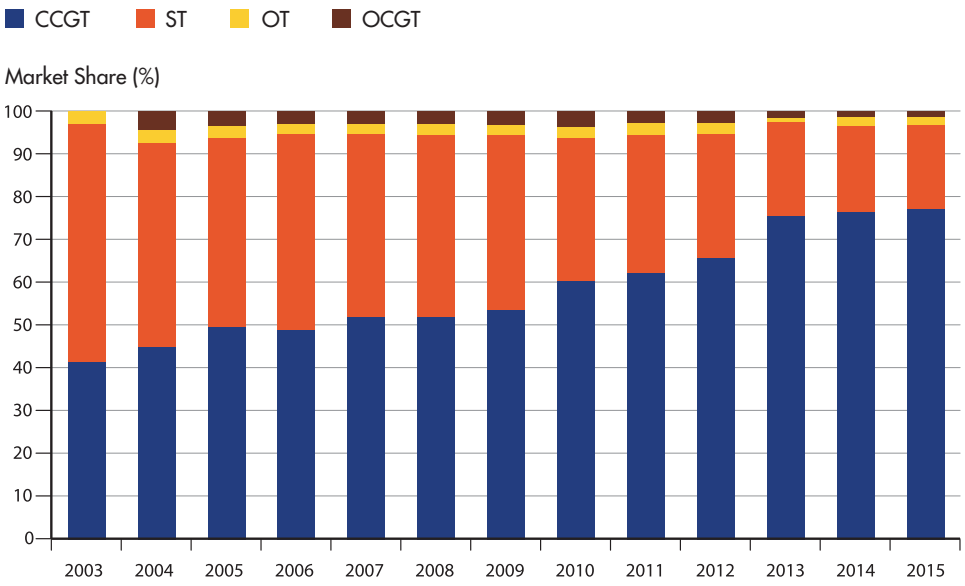


Chart 5: Market Share Based on Maximum Capacity by Generation Type



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 98.0 percent.

Based on maximum capacity, the market share of CCGT units expanded 0.5 percentage point to 77.1 percent. Conversely, the market share of ST units fell 0.5 percentage point to 19.6 percent.

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

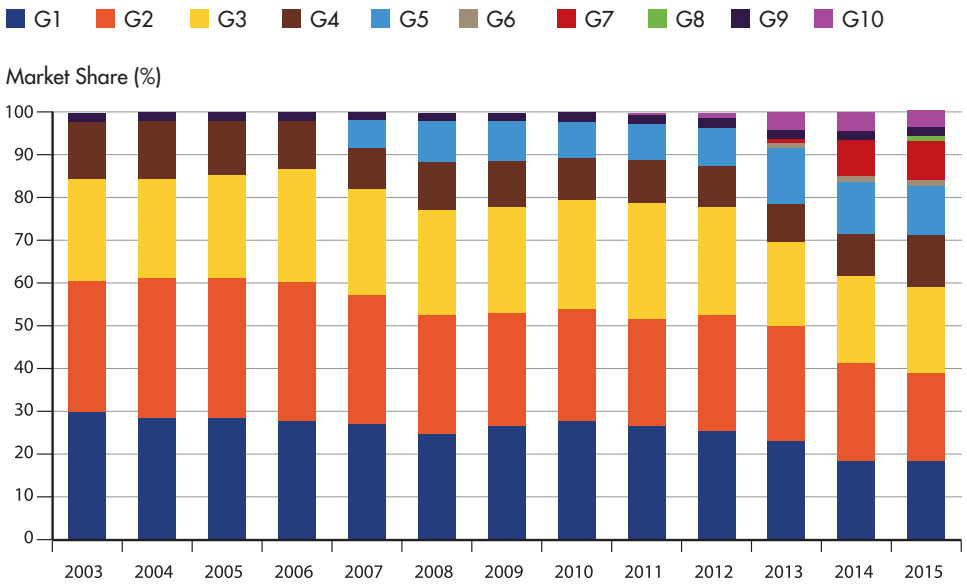
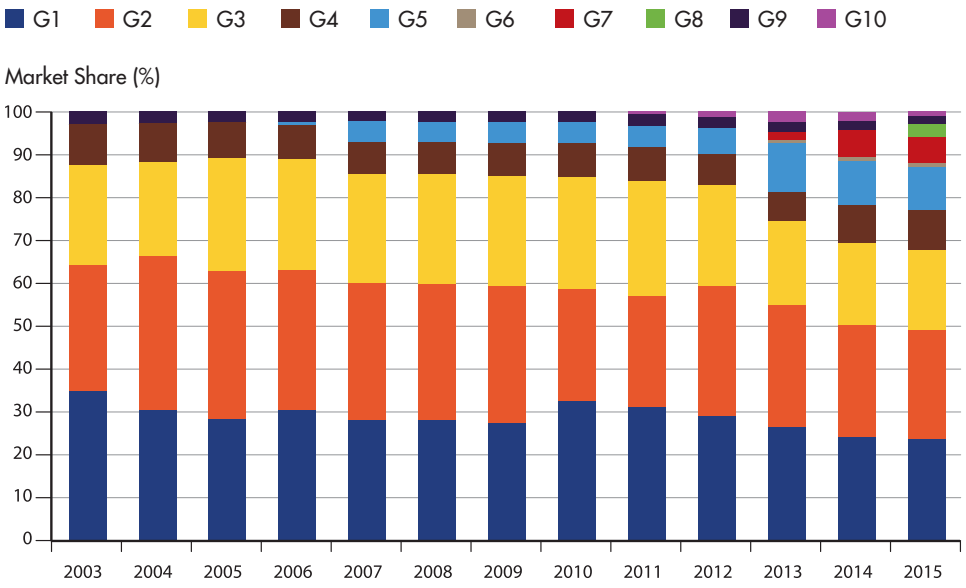


Chart 7: Market Share Based on Maximum Capacity by Generation Company



Charts 6 and 7 show the yearly market shares[3] of all generation companies based on metered energy quantity and maximum capacity respectively.

Embedded generators held 4.2 percent of the market share based on metered energy quantity and 2.8 percent of the market share based on maximum capacity.

The combined market share of the three largest generation companies based on metered energy quantity declined 2.6 percentage points, from 61.8 percent in 2014 to 59.2 percent in 2015. This was due to the installation of new generation facilities from other companies.

[3] The yearly market shares exclude generators operating below 10MW.

Total outages per period increased 6.1 percent from 890MW in 2014 to 944MW in 2015. This quantity of outages represented 6.6 percent of the total installed capacity. The increase in total outages was led by higher levels of anticipated and forced outages of CCGT units.

As a result of a higher level of forced outages of CCGT units, average forced outages rose from 17.8MW per period in 2014 to 24.4MW per period in 2015.

Chart 8 provides the percentage breakdown of the three types of plant outages. Planned outages contributed 97.4 percent of total outages in 2015, while forced outages formed 2.6 percent. This was in contrast to 2014, when planned and forced outages made up 98.0 percent and 2.0 percent respectively.

Chart 8: Composition of Total Plant Outages

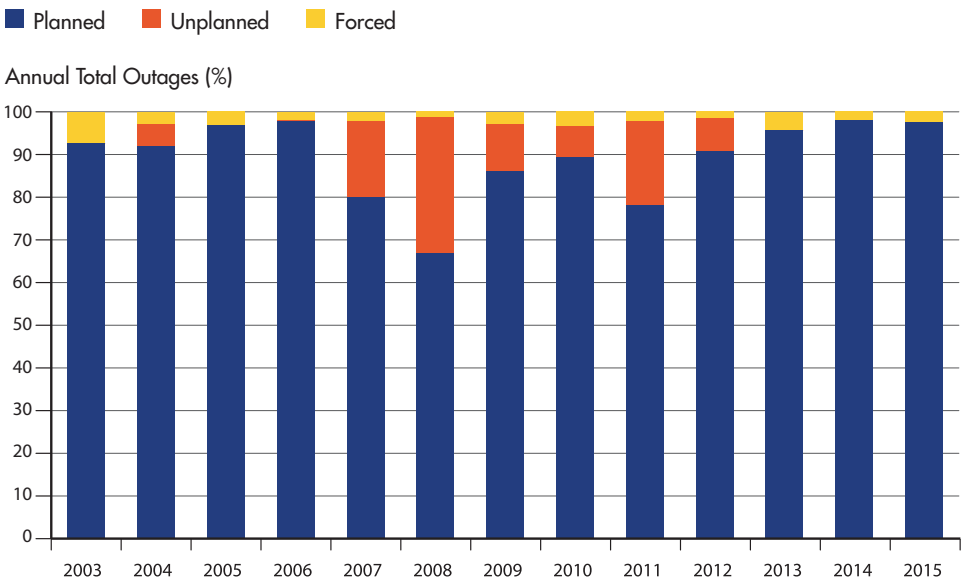


Table 3: Average Outages by Generation Type and Technology in MW (per period)

	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	
2003	425	167	5	30	0	0	0	0	4	45	0	1	677
2004	982	204	14	3	64	2	2	0	2	37	0	0	1,309
2005	915	363	22	26	0	1	1	0	7	35	0	0	1,370
2006	854	283	51	17	0	2	1	0	4	21	1	0	1,234
2007	761	348	28	32	159	94	1	7	6	27	0	0	1,464
2008	439	236	1	6	298	26	0	2	2	10	0	0	1,020
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	1	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

Chart 9: Average Quarterly Anticipated Outages vs Average USEP

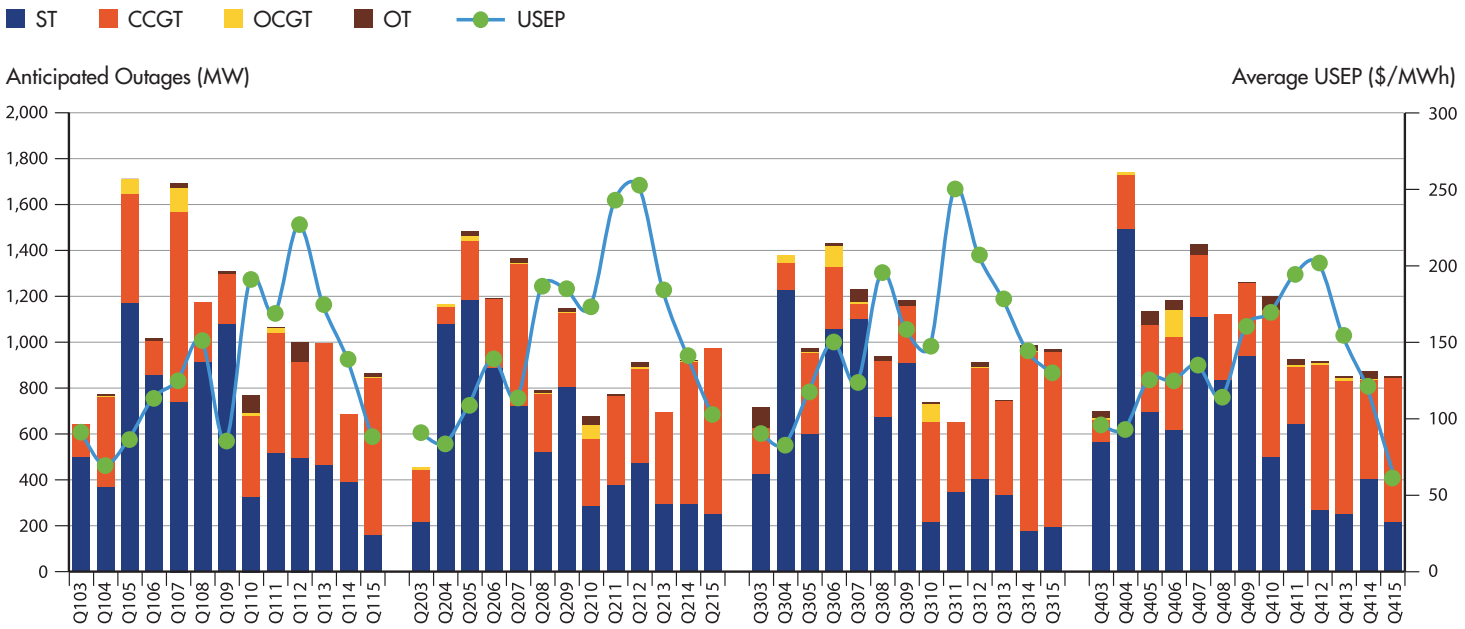


Chart 9 compares the average anticipated outages[4] with the average USEP on a quarterly basis.

Intuitively, a higher level of anticipated outages coincides with a higher USEP because the former leads to a contraction in supply. The average level of anticipated outages for Q3 2015 was 2.1 percent lower than that for Q3 2014; the average USEP for Q3 2015 was 10.0 percent lower than that for Q3 2014.

Such a relationship was seen in Q4 2015 as well. The average level of anticipated outages for Q4 2015 was 2.7 percent lower than that for Q4 2014; the average USEP for Q4 2015 was 49.4 percent lower than that for Q4 2014. In this case, the decrease in average USEP was more pronounced as there were several instances of price spikes in July 2015, which increased the average USEP for Q3 2015.

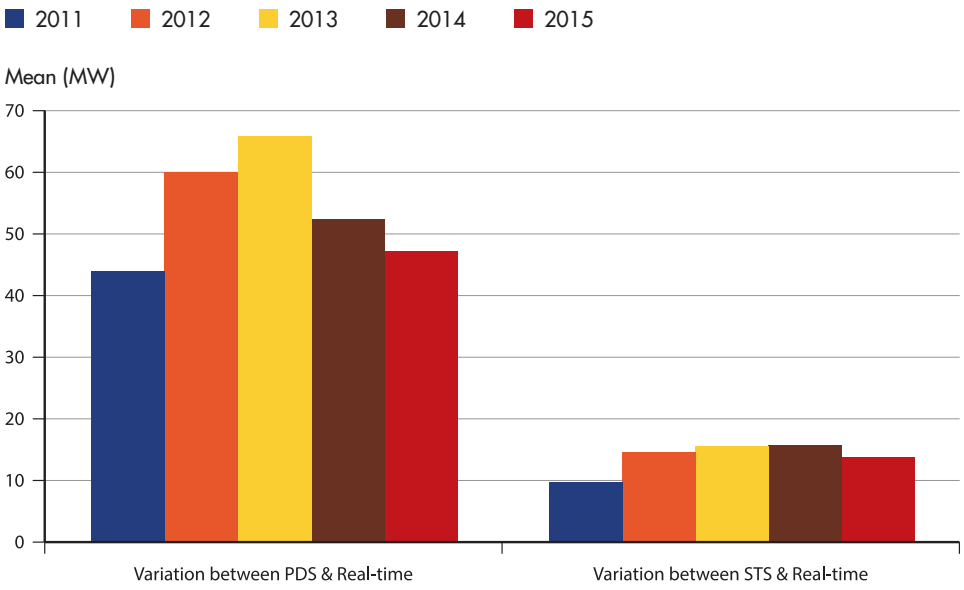
Even though the average level of anticipated outages for Q1 2015 was 26.5 percent higher than that for Q1 2014, the average USEP for Q1 2015 was 36.4 percent lower than that for Q1 2014. The lower average USEP was an effect of lower fuel oil prices in Q1 2015. This was also observed in parallel comparisons between Q2 2015 and Q2 2014.

[4] 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.

Table 4: Variation in Load Forecasts

Year 2015				
	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	34.12	31.61	11.02	9.43
Feb	37.55	22.26	12.25	7.26
Mar	41.81	27.06	13.45	8.92
Apr	56.39	31.46	15.97	8.83
May	52.27	38.47	14.40	10.96
Jun	73.77	45.61	20.79	12.66
Jul	48.10	29.30	13.27	8.14
Aug	48.43	45.98	13.85	12.73
Sep	45.12	25.35	12.79	7.08
Oct	44.16	30.16	12.41	8.52
Nov	35.81	25.23	10.02	7.15
Dec	47.81	38.66	13.50	10.71
Average	47.11	32.60	13.64	9.36

Chart 10: Average Mean Variation between Load Forecast & Real-time



In the National Electricity Market of Singapore (NEMS), three forecast schedules with different time horizons are made available to market participants (MPs). The accuracy of forecast schedules is important for the efficient operation of the market, as it determines how well generation plants can respond 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 and real-time load. The variation between the Pre-Dispatch Schedule (PDS) forecast and real-time load was 3.5 times as large as the variation between the Short Term Schedule (STS) forecast and real-time load. PDS forecasts are likely to be less accurate than STS forecasts – PDS forecasts are updated every two hours, with a forecast horizon of between 12 to 36 hours, compared to STS forecasts which are updated every half-hour, with a forecast horizon of up to six hours.

In Chart 10, the average difference between PDS forecast and real-time load in 2015 was 9.9 percent lower than that in 2014. The average difference between STS forecast and real-time load reduced by 12.8 percent in 2015.

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

The accuracy of the real-time load forecast improved in 2015. As seen in Table 5, the average load forecast error dropped 0.6 percentage point from 3.3 percent in 2014 to 2.7 percent in 2015.

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

Month	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	4.29	3.93	3.46	3.18	3.24	2.73	3.00	3.46	3.23
Feb	4.52	4.01	3.48	3.74	2.93	2.82	2.83	3.28	3.19
Mar	4.25	3.77	3.40	3.64	2.95	2.93	2.75	3.00	2.97
Apr	4.40	3.97	3.50	3.74	3.13	3.01	2.34	3.20	2.67
May	4.20	3.89	3.41	3.83	1.96	2.76	2.77	3.27	2.76
Jun	4.11	3.76	3.93	3.15	2.65	2.61	3.00	3.10	2.67
Jul	4.05	3.96	3.45	3.17	3.36	2.75	3.04	3.30	2.40
Aug	3.94	3.68	3.54	3.54	3.14	2.86	2.90	3.70	2.63
Sep	3.94	3.70	3.34	3.42	3.20	2.93	3.24	3.29	2.58
Oct	4.21	3.74	3.54	3.56	3.01	2.81	3.28	3.26	2.60
Nov	3.88	3.40	3.28	3.62	2.94	3.05	3.23	3.82	2.57
Dec	3.74	3.60	3.24	3.64	2.88	3.17	3.46	3.35	2.62
Average	4.13	3.78	3.46	3.52	2.95	2.87	2.99	3.34	2.74

Chart 11: Monthly Volume-weighted Average VCHP vs WEP

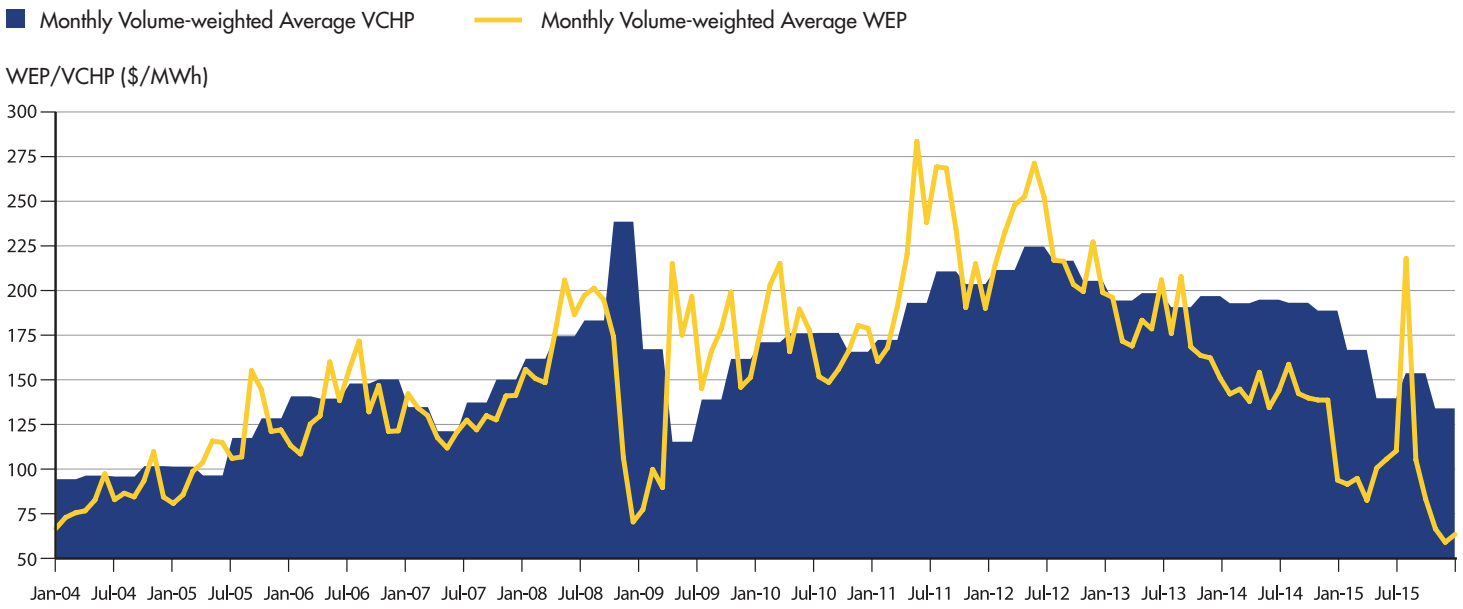


Chart 11 tracks the movements of the volume-weighted averages of the Wholesale Electricity Price (WEP) and Vesting Contract Hedge Price[5] (VCHP). The average VCHP fell 22.6 percent from $192.45/MWh in 2014 to $149.04/MWh in 2015.

In 2015, the volume-weighted average WEP was 33.8 percent lower than the volume-weighted average VCHP. The volume-weighted average WEP decreased 29.0 percent from $138.95/MWh in 2014 to $98.67/MWh in 2015.

[5] The volume-weighted VCHP takes into account the LNG, balance and tendered vesting prices after considering volume adjustment.

Chart 12: Comparisons of Actual Demand

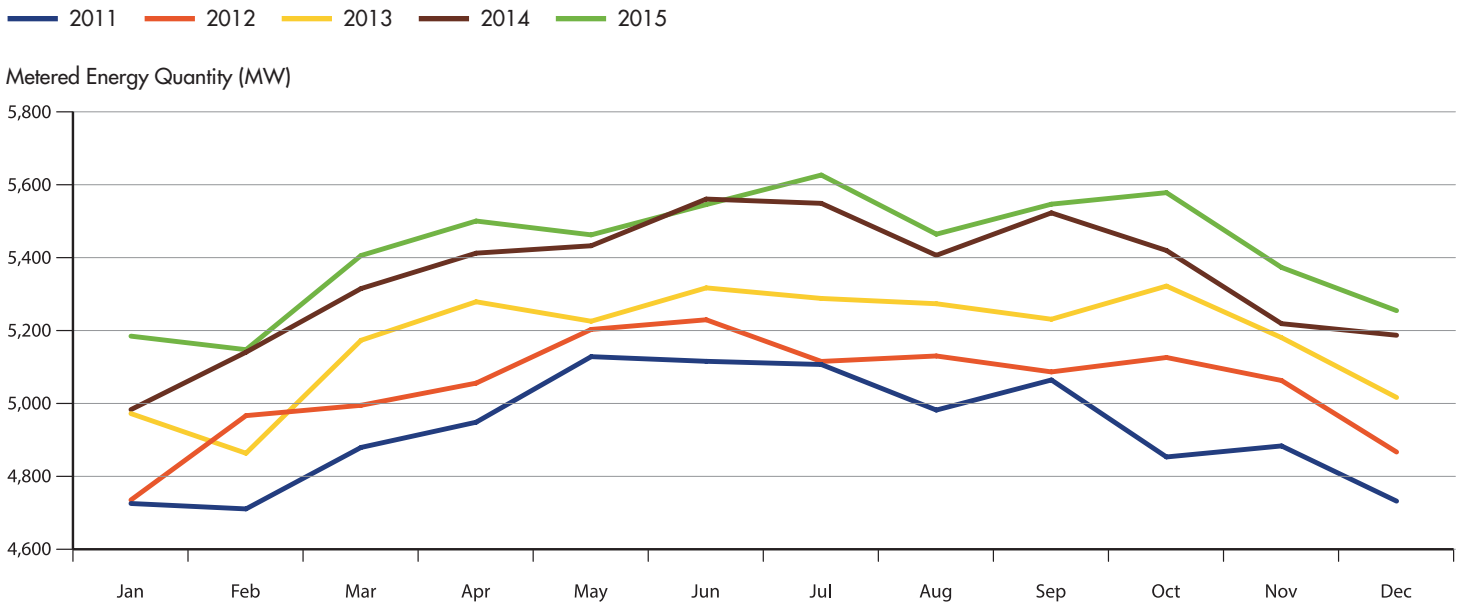


Chart 12 compares the actual demand (computed from the metered energy quantity) from 2011 to 2015. With the exception of June, all other months in 2015 displayed a higher demand than in 2014. In 2015, the average demand grew 1.5 percent from the year before.

The average system demand for the year was 5,424MW. The peak average monthly system demand was 5,626MW in July 2015. Both figures are the highest since the market was established in 2003.

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

	2014			2015		
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	0.66	0.44	28	0.46	0.21	16
Feb	0.62	0.38	20	0.31	0.10	9
Mar	0.62	0.39	23	0.46	0.21	16
Apr	0.63	0.40	25	0.54	0.29	23
May	0.35	0.12	11	0.45	0.20	16
Jun	0.54	0.29	20	0.34	0.11	10
Jul	0.68	0.46	25	0.72	0.52	30
Aug	0.60	0.36	21	0.54	0.29	22
Sep	0.66	0.43	24	0.67	0.45	26
Oct	0.64	0.41	25	0.62	0.38	21
Nov	0.63	0.40	24	0.73	0.53	26
Dec	0.41	0.17	18	0.65	0.42	24
Average	0.59	0.35	264	0.54	0.31	239

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 2015, the highest r value of 0.73 was observed in November. This was higher than that observed in 2014. However, there were 239 days when r was greater than 0.5 in 2015, which was lesser than the 264 days in 2014. Hence, the average r value in 2015 was 0.05 lower than that in 2014.

Chart 13: Correlation between WEP & Metered Energy Quantity in 2015

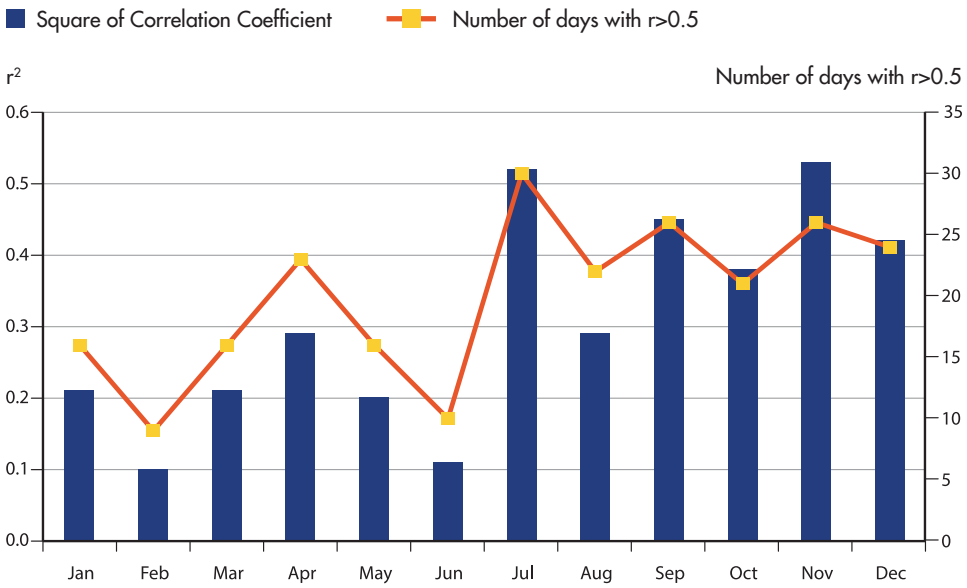


Chart 13 illustrates the correlation between the WEP and metered energy quantity in 2015. The highest r^2 value during the year was recorded at 0.53 in November. During that month, there were 26 days when r was greater than 0.5. The lowest r^2 value of 0.10 occurred in February, when there were only nine days with r greater than 0.5.

Chart 14: Correlation between WEP & Metered Energy Quantity

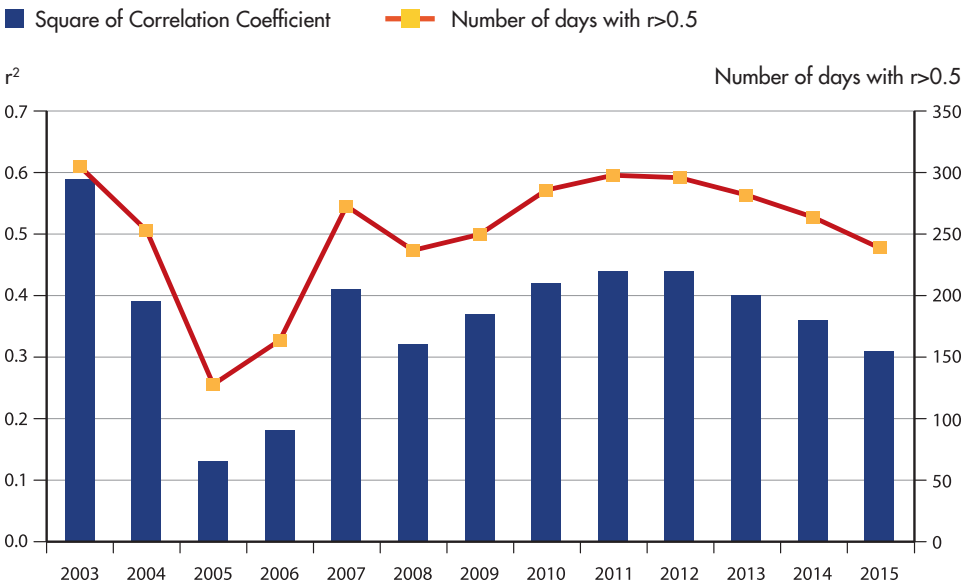


Chart 14 shows the correlation between the WEP and metered energy quantity between 2003 and 2015. Except for the sharp dip and subsequent increase between 2004 and 2007, there was no major fluctuation in the square of the correlation coefficient and the number of days with r greater than 0.5.

Since 2011, the square of the correlation coefficient and the number of days with r greater than 0.5 have been gradually decreasing. This indicates that non-demand factors have a growing impact on energy prices.

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

Chart 15: Percentage of Hours When WEP Falls Into a Particular Price Range

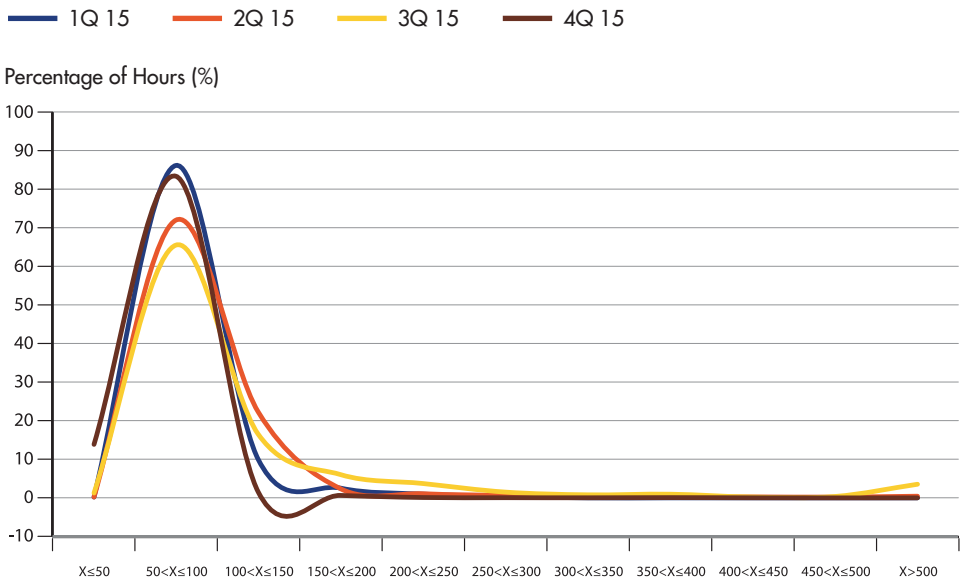


Chart 15 illustrates the distribution of the WEP based on percentage of hours of occurrence in 2015. Prices for all four quarters mostly settled in the $50/MWh to $100/MWh tranche.

Chart 16: Percentage of Energy Quantity When WEP Falls Into a Particular Price Range

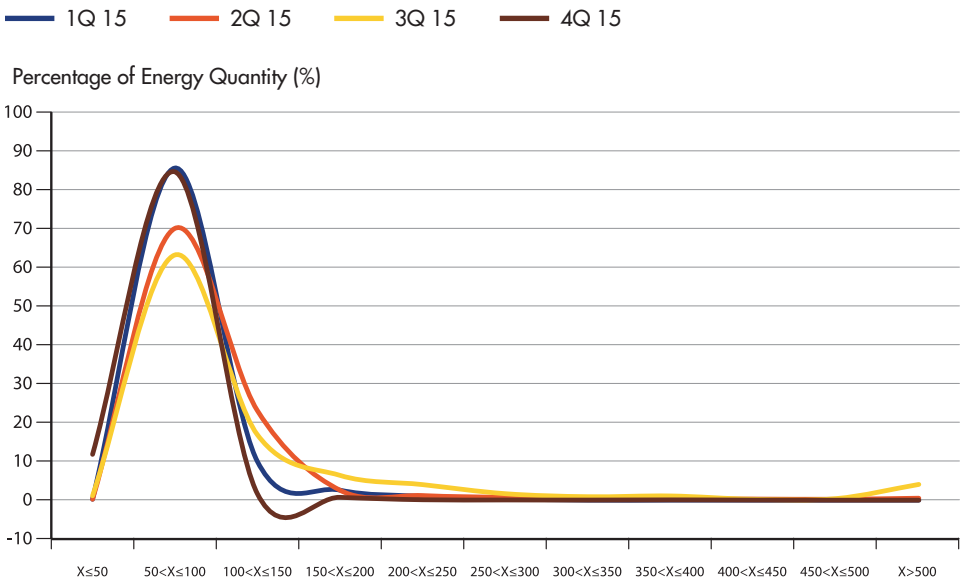


Chart 16 illustrates the distribution of the WEP based on percentage of energy quantity. The distribution is similar to that of the WEP by percentage of hours of occurrence (Chart 15).

MARKET MONITORING: Energy Indices: Frequency Distribution of the 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

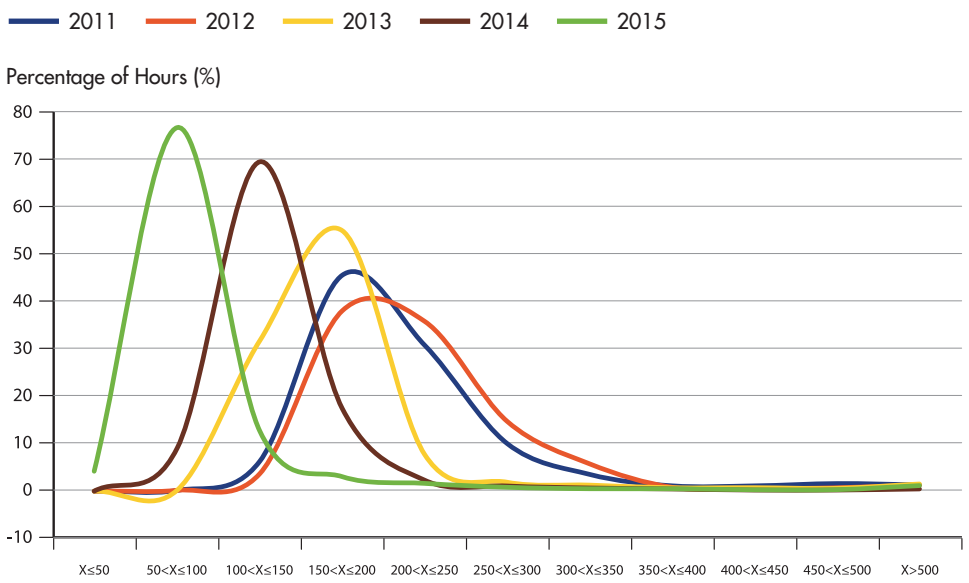


Chart 17 juxtaposes the historical price distribution curves with the price distribution curve of 2015, allowing us to examine longer-term trends. Between 2011 and 2012, the percentage of hours of WEP distribution gradually shifted to a higher price range. 2013 and 2014 saw the trend reversing. In 2015, WEP reached the lowest level of the past five years, settling in the $50/MWh to $100/MWh tranche.

Chart 18: Percentage of Energy Quantity When WEP Falls Into a Particular Price Range

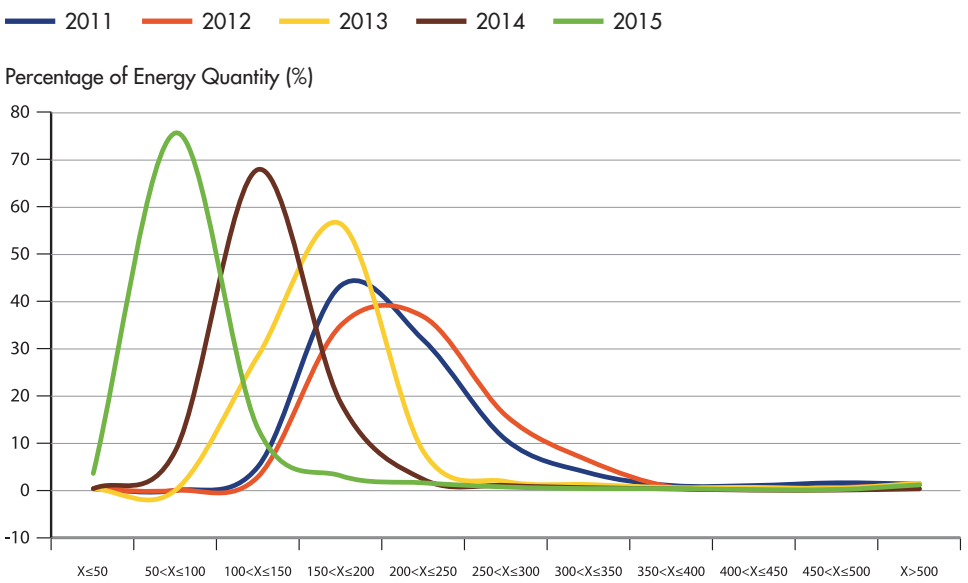


Chart 18 shows the long-term trend in the distribution of the WEP from 2011 to 2015 based on percentage of energy quantity, permitting the same observations as Chart 17.

Chart 19: Index of VCHP, WEP, Fuel Oil (180-CST HSFO), Electricity Tariff

Chart 19 shows the correlation between the high sulphur fuel oil (180-CST HSFO) price, the VCHP, the WEP and electricity tariff. In 2015, the fuel oil price traded at an average of US$47.63/bbl, a drop of 47.2 percent from 2014. The WEP declined by 30.0 percent to reach $95.85/MWh in 2015. The peak monthly average WEP of $204.58/MWh was recorded in July 2015.

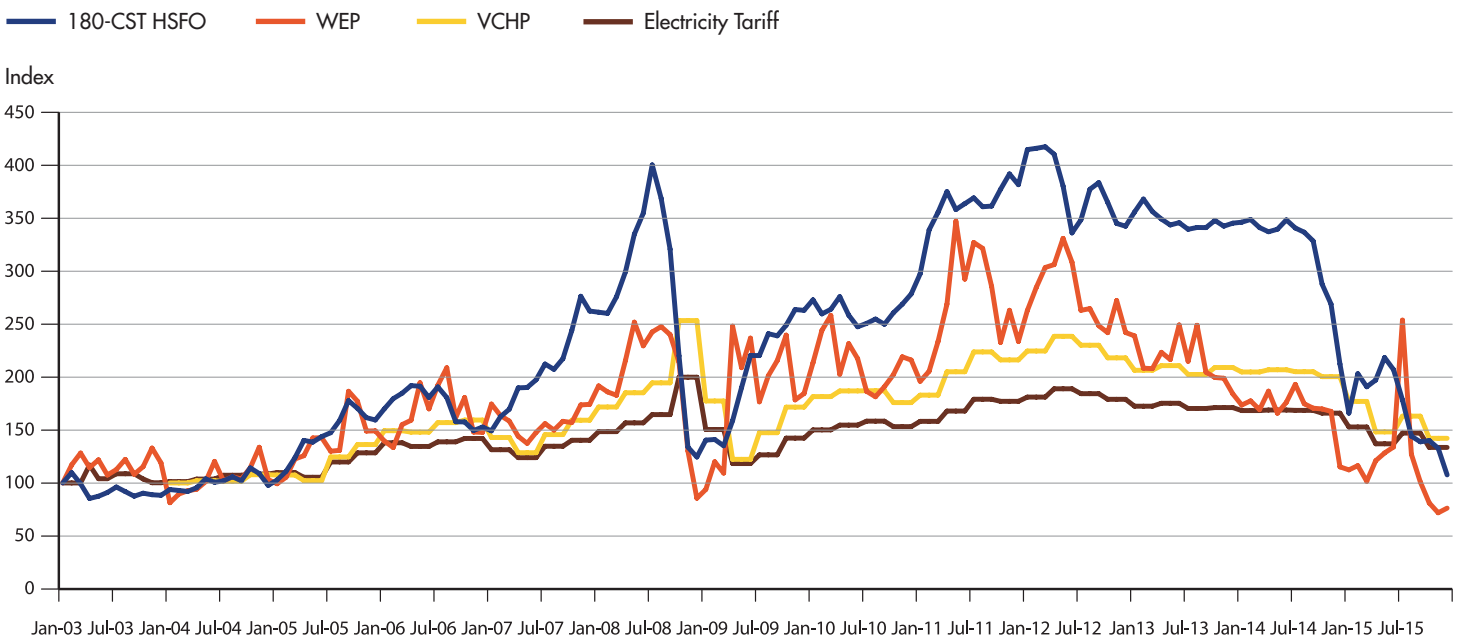
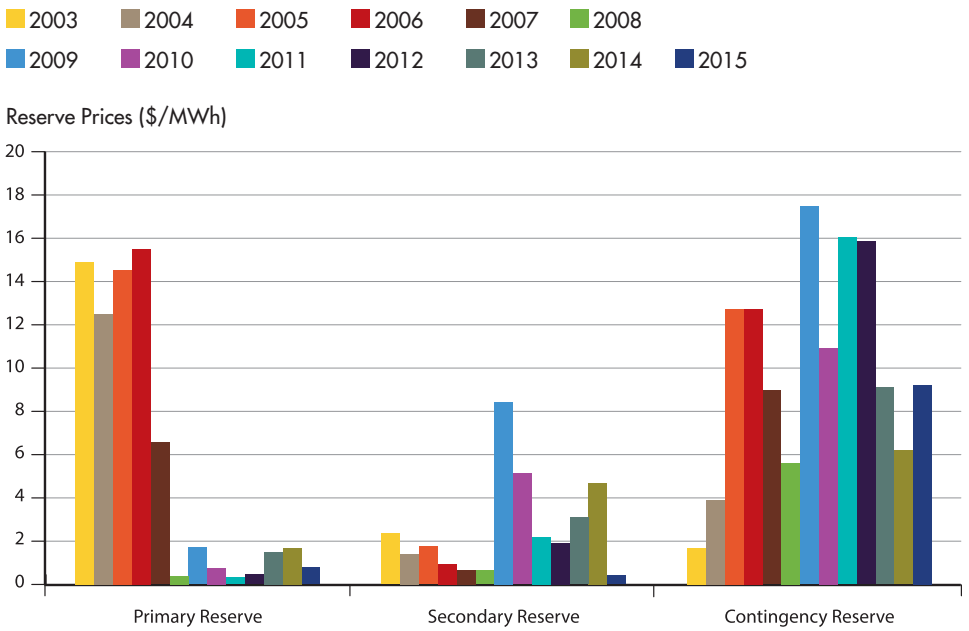
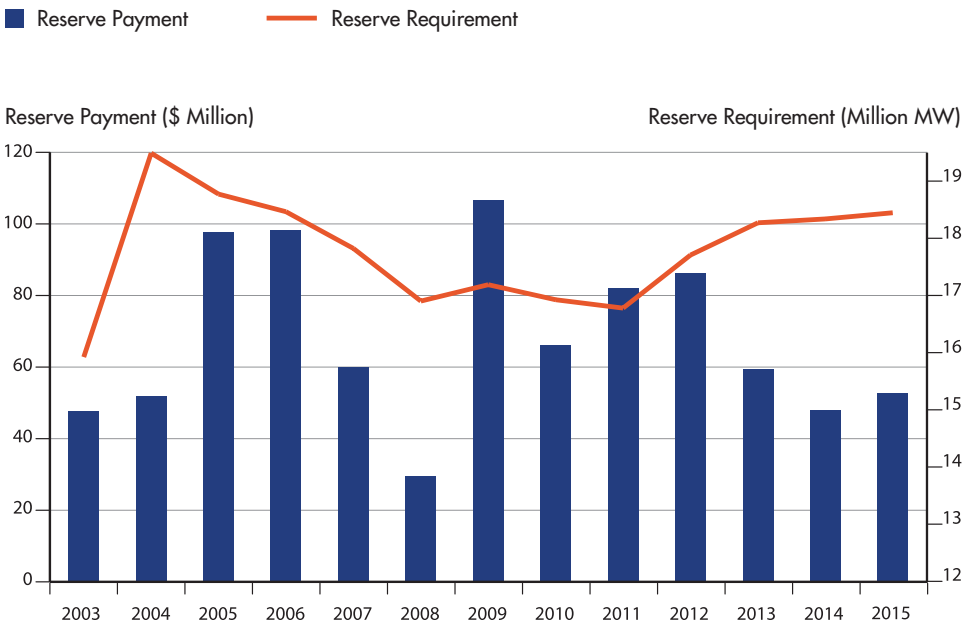


Chart 20: Average Reserve Prices



From Chart 20, it can be seen that the average primary reserve price and average secondary reserve price decreased by 53.3 percent and 91.5 percent in 2015 to reach $0.78/MWh and $0.40/MWh respectively. On the other hand, average contingency reserve price increased by 49.0 percent in 2015 to reach $9.23/MWh.

Chart 21: Annual Reserve Cost and Requirement



The total reserve cost increased 10.2 percent from $47.9 million in 2014 to $52.8 million in 2015, as seen in Chart 21.

Chart 22: Number of IL Activations in 2015

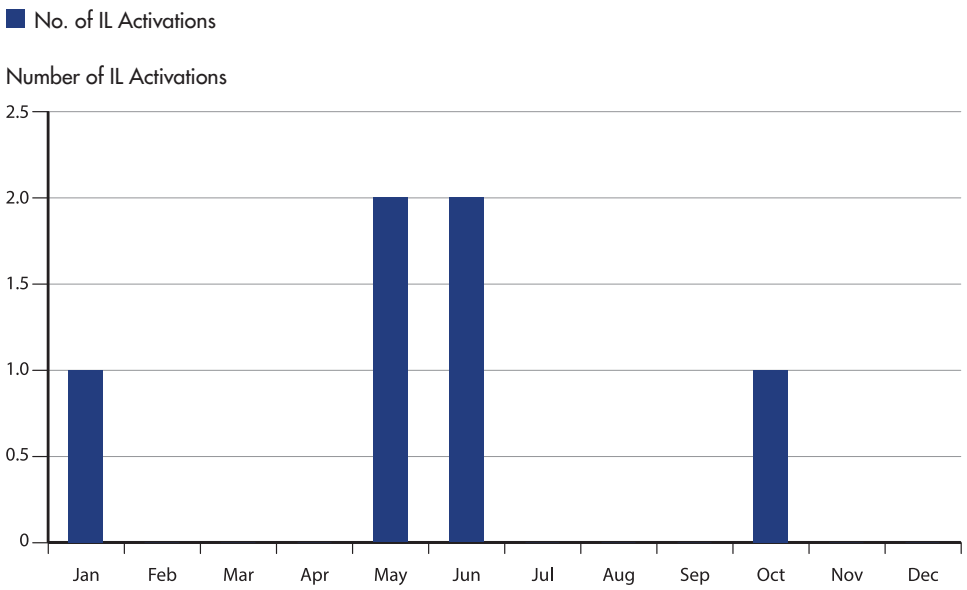
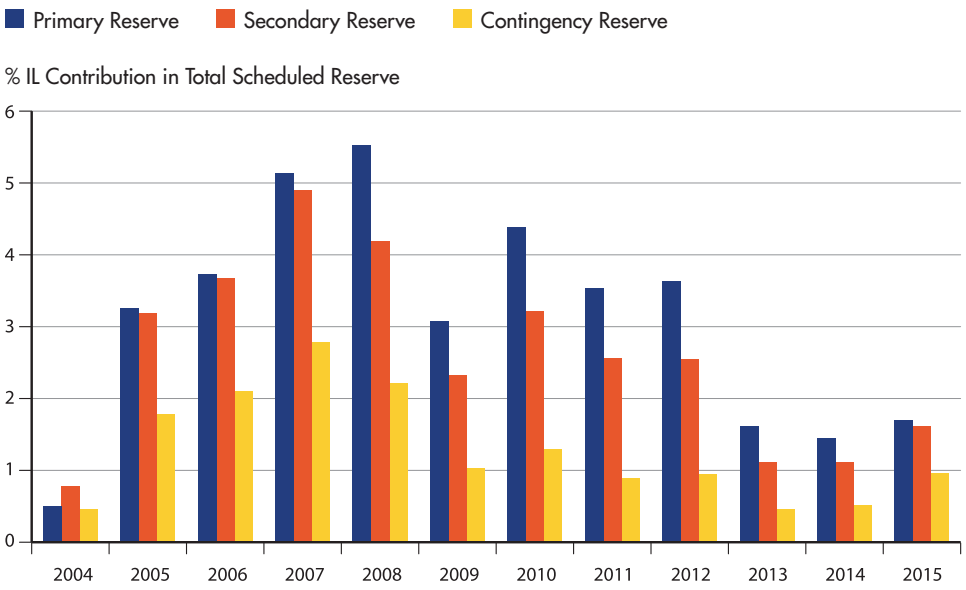
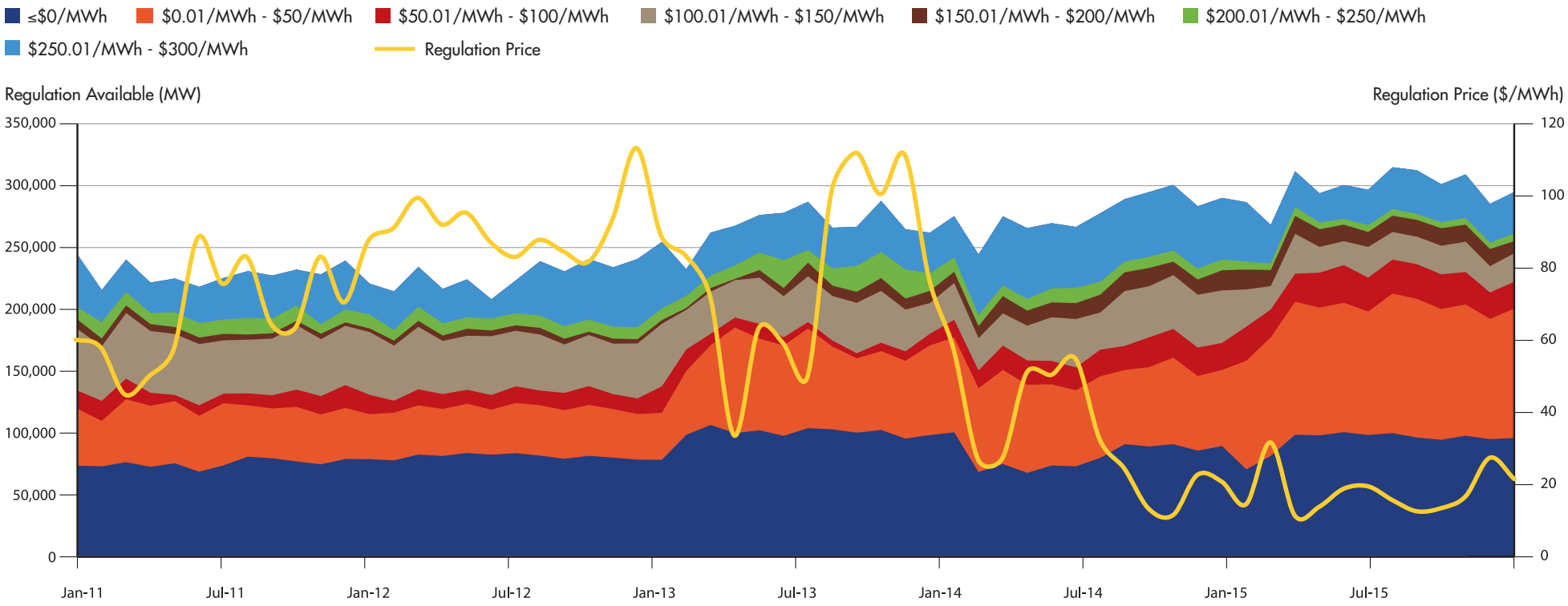


Chart 23: Total Percentage Contribution from IL in Three Classes of Scheduled Reserve



From Chart 22, it can be observed that in 2015, Interruptible Load (IL) was activated on six occasions to provide reserve, compared to 15 occasions in 2014. IL was activated on two occasions each for the months of May and June, and one occasion each in January and October. Despite the drop in IL activations, the percentage contributions from IL in primary, secondary and contingency reserve classes in 2015 were higher than that in 2014, as seen in Chart 23.

Chart 24: Regulation Availability vs Regulation Price



The average regulation price decreased 44.8 percent from $33.00/MWh in 2014 to $18.23/MWh in 2015. The 2015 peak monthly regulation price of $31.89/MWh was observed in February.

Chart 24 shows the regulation offer patterns in various offer tranches. The biggest change can be observed in the "$0.01/MWh - $50/MWh" offer tranche, where the proportion of offers increased by 10.6 percentage points to reach 34.6 percent in 2015. The biggest decrease of 7.5 percentage points can be observed in the "$250.01/MWh - $300/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[6]. 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 80.6 percent. The three variables selected were: lagged fuel oil price, supply cushion and CCGT supply.

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 0.87 unit increase in the logarithm of the USEP;
- a one unit increase in the logarithm of the supply cushion will bring about a 0.74 unit decrease in the logarithm of the USEP; and
- a one unit increase in the logarithm of the CCGT supply will bring about a 0.48 unit decrease in the logarithm of the USEP.

[6] 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 2015

Variable	Coefficient	P-value
Constant	7.84	0.09
LOG (Lagged Fuel Oil Price)	0.87	0.01
LOG (Supply Cushion)	-0.74	0.01
LOG (CCGT Supply)	-0.48	0.02
Model Diagnostics		
R-squared	0.80	
Adjusted R-squared	0.80	
Number of observations	4,718	

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

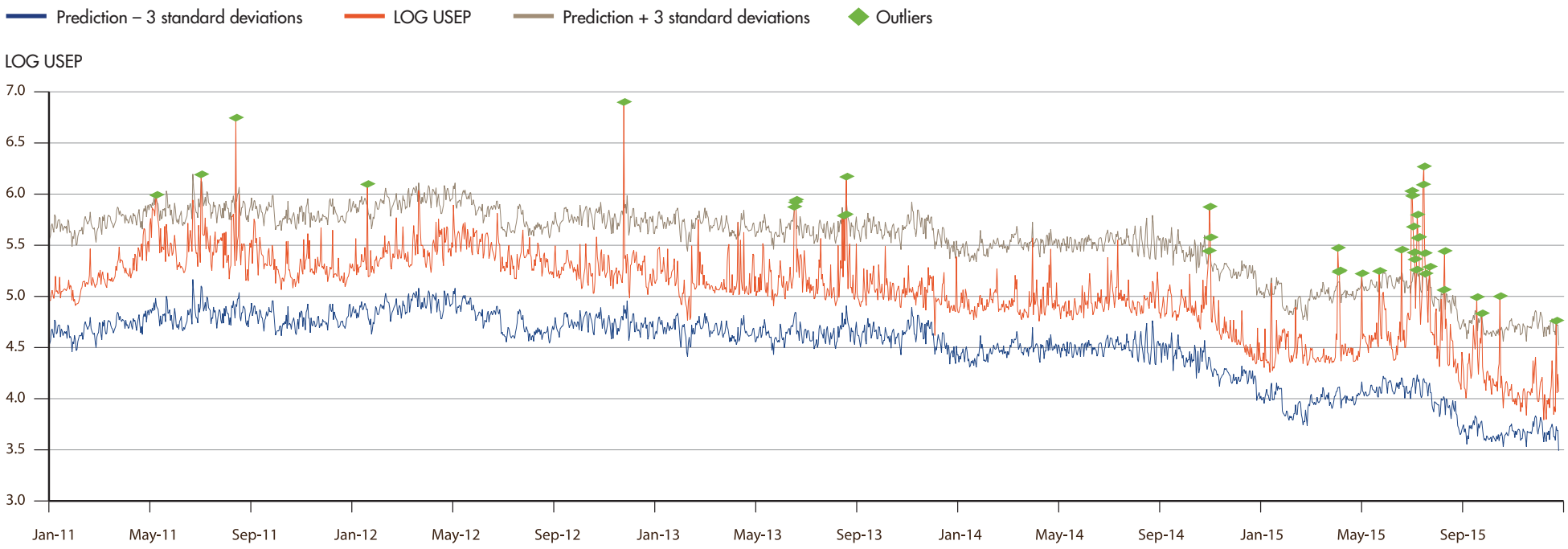
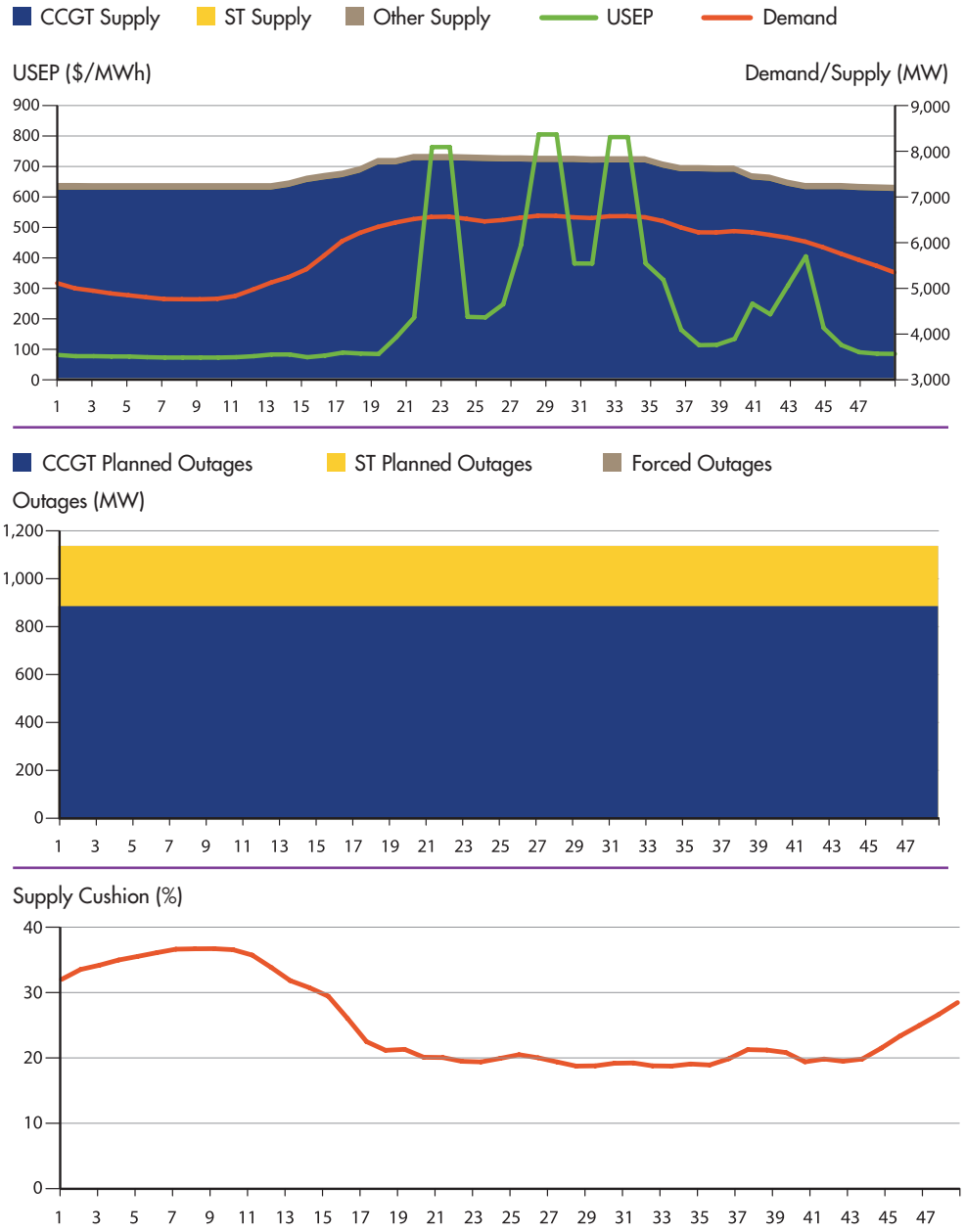


Chart 25 illustrates the actual daily average USEP, the upper and lower bands of the estimated USEP, and the outliers identified by the econometric model, from January 2011 to December 2015. For 2015, there were 26 days in which outlier prices were detected by the model. Four of these days will be discussed in this report as the rest of the cases were small-scale recurrences of similar phenomena.

Chart 26: Demand and Supply Conditions - 8 April 2015



Date	Wednesday 8 Apr 2015	All Wednesdays in Apr 2015
Daily USEP ($/MWh)	239.00	113.31
Max USEP ($/MWh)	809.19	809.19
No. of USEP ≥ $1,000/MWh	0	0
Demand (MW)	5,838.79	5,786.56
Supply Cushion (in %)	24.94	28.43
Offers ≤ $100/MWh (in %)	76.55	74.69

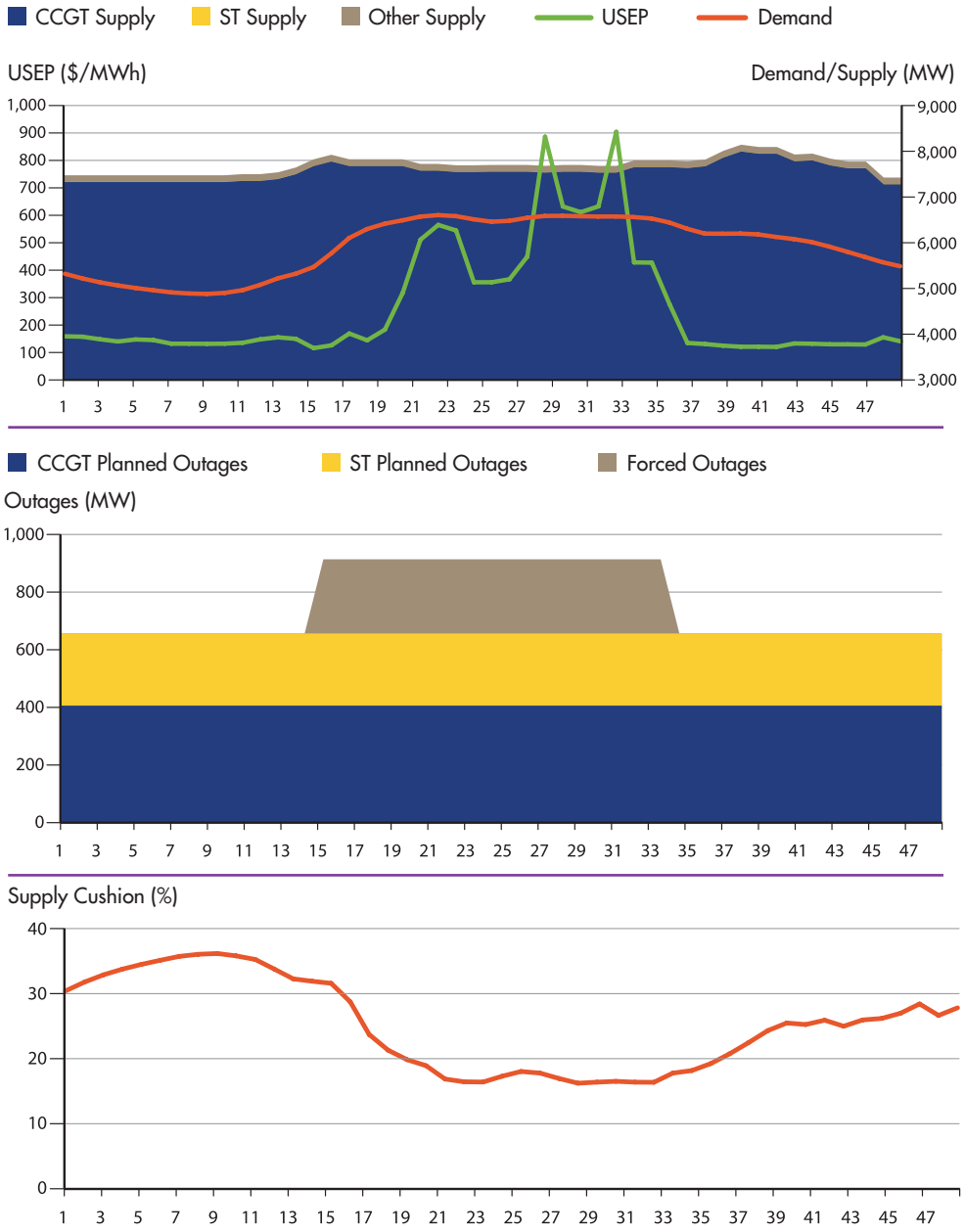
Summary

On Wednesday, 8 April 2015, there were eight periods during which the USEP rose above $400/MWh, reaching as high as $809.19/MWh.

The high prices were largely due to price separation experienced during some of the periods, which in turn was caused by security constraints being reached on some transmission lines.

In addition, there was a high level of planned maintenance (1,135.9MW) due to three CCGT/COGEN/TRIGEN units and one ST unit being taken out of the grid. Higher demand and lower supply pushed the supply cushion of the affected periods down to below 20.0 percent.

Chart 27: Demand and Supply Conditions - 24 June 2015



Date	Wednesday 24 Jun 2015	All Wednesdays in Jun 2015
Daily USEP ($/MWh)	234.93	136.49
Max USEP ($/MWh)	902.08	902.08
No. of USEP ≥ $1,000/MWh	0	0
Demand (MW)	5,907.77	5,829.59
Supply Cushion (in %)	25.24	26.52
Offers ≤ $100/MWh (in %)	74.05	75.23

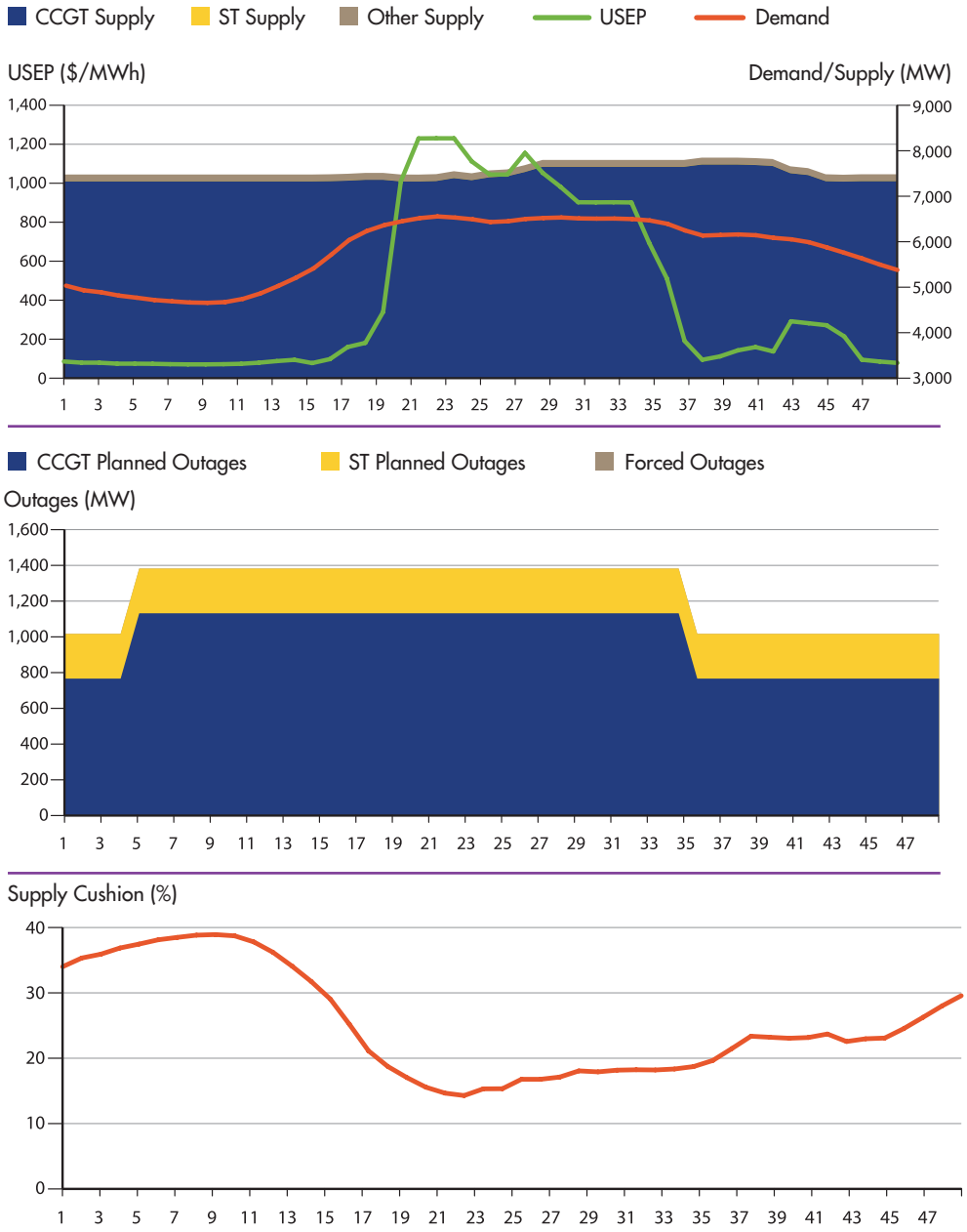
Summary

On Wednesday, 24 June 2015, the USEP went above $400/MWh for 11 periods, hitting $902.08/MWh at its peak.

The reasons for the high prices were similar to the ones on 8 April 2015, i.e., they were due to price separation experienced during some of the periods, which in turn was caused by security constraints being reached on some transmission lines.

During the periods of high USEP, planned maintenance was around 655.9MW, although an additional forced outage of 257MW of a CCGT unit exacerbated the situation, providing further upward price pressure.

Chart 28: Demand and Supply Conditions - 6 July 2015



Date	Monday 6 Jul 2015	All Mondays in Jul 2015
Daily USEP ($/MWh)	417.90	340.52
Max USEP ($/MWh)	1,231.51	1,231.51
No. of USEP ≥ $1,000/MWh	9	9
Demand (MW)	5,805.84	5,861.22
Supply Cushion (in %)	25.34	24.89
Offers ≤ $100/MWh (in %)	73.52	74.14

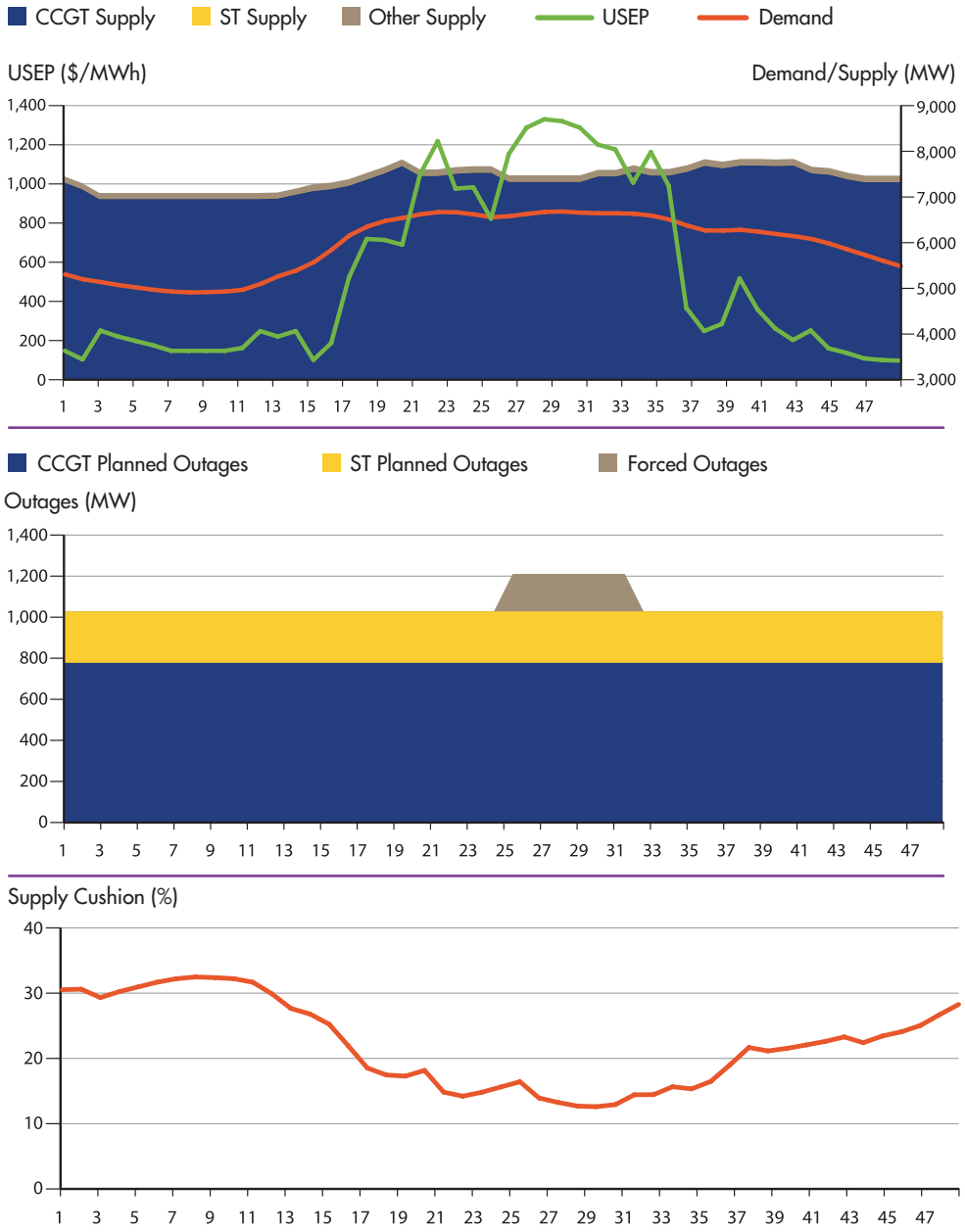
Summary

On Monday, 6 July 2015, there were 16 periods during which the USEP rose above $400/MWh, reaching as high as $1,231.51/MWh.

Again, the high prices were largely due to price separation experienced during some of the periods, which in turn was caused by security constraints being reached on some transmission lines. Generators adversely affected by the price separation, in turn, made offer variations to reduce the nodal price gaps.

In addition, there was a high level of planned maintenance (1,380.9MW) due to three CCGT/COGEN/TRIGEN units and one ST unit being taken out of the grid. The lower supply pushed the supply cushion of the affected periods down to below 20.0 percent.

Chart 29: Demand and Supply Conditions - 21 July 2015



Date	Tuesday 21 Jul 2015	All Tuesdays in Jul 2015
Daily USEP ($/MWh)	530.56	348.01
Max USEP ($/MWh)	1,328.06	1,328.06
No. of USEP ≥ $1,000/MWh	11	20
Demand (MW)	5,955.52	5,894.10
Supply Cushion (in %)	22.18	24.53
Offers ≤ $100/MWh (in %)	74.04	73.94

Summary

On Tuesday, 21 July 2015, there were 20 periods during which the USEP rose above $400/MWh, reaching as high as $1,328.06/MWh.

The high prices were largely due to price separation experienced during some of the periods, which in turn was caused by security constraints being reached on some transmission lines.

In addition, there was a high level of planned maintenance (1,025.9MW) due to two CCGT/COGEN/TRIGEN units and one ST unit being taken out of the grid. One CCGT unit also experienced forced outage, reducing supply by another 182MW during some of the affected periods. Higher demand and lower supply pushed the supply cushion of the affected periods down to around 15.0 percent.

INVESTIGATIONS

Table 8: Investigation and Enforcement Statistics

	Rule Breaches	1 Jan 2003 to 31 Dec 2015	1 Jan to 31 Dec 2015
(A)	**Total number of offer variations after gate closure received**	34,954	884
	Total number of cases closed	34,847	1,140
	- cases in which the MSCP determined a breach	128	0
	- cases in which the MSCP determined no breach	15,066	1,097
	- cases in which the MSCP took no further action	19,653	43
(B)	**Origin of cases (excluding offer variations after gate closure)**	175	3
	- self-reports	150	3
	- referrals or complaints	18	0
	- initiated by the MSCP	7	0
	Total number of cases closed	174	2
	- cases in which the MSCP determined a breach	119	1
	- cases in which the MSCP determined no breach	12	0
	- cases in which the MSCP took no further action	42	1
	- cases in which the MSCP issued suspension order	1	0
(C)	**Number of formal MSCP hearings**	5	0
(D)	**Enforcement action**		
	- highest financial penalty imposed on a party in breach	$842,861	0
	- total financial penalties imposed on parties in breach	$1,108,861	0
(E)	**Costs**		
	- highest award of costs imposed on a party in breach	$43,750	$1,500
	- total costs imposed on parties in breach	$212,075	$1,500

Market Efficiency and Fairness	1 Jan 2003 to 31 Dec 2015	1 Jan to 31 Dec 2015
Total number of cases	7	0
- referrals or complaints	2	0
- initiated by the MSCP	5	0
Total number of cases closed	7	0

Under the Market Rules, the Market Surveillance and Compliance Panel (MSCP) may initiate an investigation into any activities 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 2015, 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.

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.

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 year 2015, the MSCP and MAU submitted one report to the EMA on the USEP spikes in the month of July. That report focused on the MSCP's observations on the price spikes in the week beginning 6 July 2015. The MSCP did not determine any breach of the Market Rules leading to the price spikes.

ASSESSMENT 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 2015 is as follows:

Market Structure and Competition

Entry of new market participants and new facilities

In 2015, the following six new market participants (MPs) joined the National Electricity Market of Singapore (NEMS):

(a) Kiwi Power Singapore Pte Ltd joined as an interruptible load (IL) service provider in January 2015;
(b) Buri Energy Pte Ltd and Sun Electric Power Pte Ltd joined as retailers in June 2015;
(c) LYS Genco Beta Pte Ltd joined as a wholesaler (generation) in October 2015;
(d) Sunseap Energy Pte Ltd joined as a retailer in November 2015; and
(e) Best Electricity Supply Pte Ltd joined as a retailer in December 2015.

Three new generation facilities were introduced in the NEMS in 2015. Shell Eastern Petroleum Pte Ltd and ECO Special Waste Management Pte Ltd[7] each registered one embedded generating unit with a generation capacity of 67.8MW and 1.48MW respectively, while Tuaspring Pte Ltd registered one 395.7MW Combined Cycle Gas Turbine (CCGT) unit.

Four new IL facilities from CPvT Energy Asia Pte Ltd were also registered in the NEMS in 2015.

Transfer of registered facilities

In October 2015, Diamond Energy Pte Ltd transferred its IL facility to Diamond Energy Supply Pte Ltd.

[7] Joined the NEMS in October 2013 as a wholesale market trader.

Market Price Behaviour

Price separation incidents due to binding security constraints

There were a number of price separation incidents in 2015 that were caused by binding security constraints. In total, there were 200 periods of security constraints binding in the year. The number of periods (52) with binding security constraint was the highest in July. Price separations between Jurong Island and the rest of the grid resulted in the high wholesale electricity prices for that month.

Further energy price decrease in 2015

Energy prices have been on a downward trend since 2013. In 2015, the average Uniform Singapore Energy Price (USEP) dropped 29.8 percent from $136.67/MWh in 2014 to $95.97/MWh while the Wholesale Electricity Price (WEP) decreased 30.0 percent from $136.99/MWh to $95.85/MWh. Energy prices were below the vesting contract prices for over 93.0 percent of the time in 2015.

The decrease in energy prices in 2015 was largely due to falling fuel oil prices and cheaper offers available in the market.

Efficiency of the Electricity Markets

Productive efficiency

The market share of CCGT units continued to increase in 2015. The market share of CCGT units based on injection quantities and maximum capacity increased 0.13 percentage point and 0.54 percentage point respectively. In terms of injection quantity, the market share of other facilities (OT) decreased 0.01 percentage point while that of Gas Turbine (GT) and Steam Turbine (ST) units were unchanged. The market share of ST units dropped 0.46 percentage point based on maximum capacity, the largest decrease amongst the generation types. Overall, this represented further improvements in productive efficiency.

Pricing efficiency

Prices generally reflected relative supply and demand conditions in 2015.

Looking Ahead

Full competition in the electricity retail market

Over the last few years, the Energy Market Authority (EMA) has been progressively lowering the contestability threshold to liberalise the electricity market. Full retail contestability for consumers is expected to be achieved by the second half of 2018.

Proposed land allocation framework for new power plants

The EMA is discussing a land allocation framework for new power plants in the north-eastern part of the city state. The first site of land in the north-eastern part of Singapore is expected to provide for 800MW to 1,000MW of new generation capacity.

Secondary gas trading market

The EMA has announced its plan to establish a Secondary Gas Trading Market in Singapore which will allow gas buyers and sellers to trade gas on a short-term basis domestically. This will go towards enhancing Singapore as a liquefied natural gas hub and also pave the way for a gas futures market in the future.

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 as to 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 2015 and the previous year.

There were 884 cases of offer variations made after gate closure in 2015. This was 27.18 percent lower than in 2014. The decrease was mainly due to an interruptible load (IL) provider submitting fewer offer variations after gate closure in the last quarter of the year under review. Nevertheless, the same IL provider continues to be the main source of the offer variations made after gate closure due to frequent equipment outages.

The MSCP was also satisfied that the offer variations made after gate closure did not give rise to any significant concern.

Rule Breaches

For the period 1 January to 31 December 2015, the MSCP made one determination regarding rule breaches. This determination was made against Energy Market Company Pte Ltd for failing to release and publish real-time schedules, short-term schedules and pre-dispatch schedules on 16 January 2015.

Overall, there was no major compliance issue arising within the wholesale electricity markets in 2015.

Automatic Financial Penalty Scheme

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

From 17 November to 31 December 2015, it was observed that five generation companies were issued with automatic financial penalties for a total sum of $ 82,262.00 by the NEMS.

Table 9: Offer Variations After Gate Closure

Number of offer variations made after gate closure from 1 January 2014 to 31 December 2014	1,214
Number of offer variations made after gate closure from 1 January 2015 to 31 December 2015	884
Decrease in number of offer variations made after gate closure for year 2015 from previous year	27.18%

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 2015. Only one case of rule breach required a determination from the MSCP. The number of offer changes made after gate closure also declined significantly from 1,214 to 884. These violations were found not to have any significant market impact.

Wholesale electricity prices in 2015 fell about 30.0 percent, marking the third year in a row that prices have declined significantly. The continued slide in global fuel prices that began in late 2014 largely accounted for this. Outlier prices were observed on 26 days, significantly up from only three a year ago. Nevertheless, these have largely occurred during periods when technical constraints coincided with equipment maintenance and forced outages. Otherwise, the movements of wholesale energy prices were largely in response to changes in the underlying demand and supply drivers, and were within reasonable expectations.
The increased occurrence of price separation has raised some industry concerns. The MSCP is pleased to note that collaborative work is well underway between the industry and the Authority to address them.

On the industry front, we saw further dilution of the concentration level in the generation sector with the combined market share of the three largest generation companies falling 2.6 percentage points to 59.2 percent. The market share of the most efficient Combined Cycle Gas Turbine (CCGT) units (based on injection quantities) grew again to reach 98.0 percent in 2015. Overall, these statistics bode well for competition and efficiency in the wholesale electricity markets.

Going into 2016, the MSCP expects uncertain economic conditions to maintain pressure on both electricity generation and consumption. Nevertheless, it looks forward to the upcoming implementation of demand response mechanisms in the NEMS to further unlock economic efficiency for the economy.

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 (by the Market Clearing Engine) output of energy, 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 21-35 Periods 38-46	Periods 15-17 Periods 42-48	Periods 17-47
Off-peak	Periods 1-20 Periods 36-37 Periods 47-48	Periods 1-14	Periods 1-16 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 Combined Cycle Gas Turbine. 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 advisors before relying on this publication to make any decision.

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