

Market Surveillance & Compliance Panel Market Watch

Issue 67

First Quarter (January to March 2023)

Executive Summary

The energy prices in the National Electricity Market of Singapore (“NEMS”) rose for the first time after four quarters of consecutive fall since Q1 2022. The growth was primarily attributed to higher fuel oil price levels that had been declining for the past two quarters. Despite the upswing in energy prices, this quarter observed a higher supply cushion, reduced demand, and an increase in the planned and forced outage volumes.

Notably, this quarter marks the official opening of Sembcorp Energy Storage System (ESS). The new ESS has a maximum storage capacity of 285 megawatt-hours (MWh) with a quick response time to store and supply power¹. This could help to maintain the stability of our power system, as more solar power is integrated into the NEMS’ energy mix.

Chart 1. USEP and WEP by Quarter

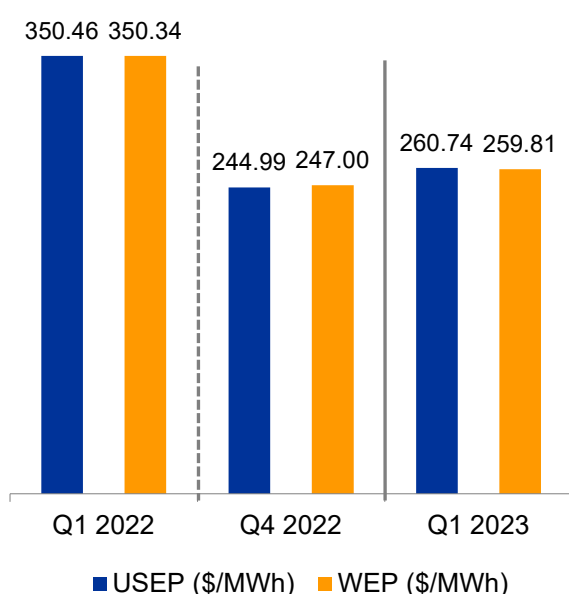


Table 1. Quarterly Outage Volume and Ancillary Service Prices

Quarter	Q1 2022	Q4 2022	Q1 2023
Total Outage Volume (MWh Cumulative)			
Planned Outage	4,743,129	9,898,996	10,627,157
Forced Outage	77,742	60,716	65,151
Ancillary Services (\$/MWh)			
Primary Reserve	0.45	3.79	0.19
Contingency Reserve	42.85	19.19	8.82
Regulation	56.33	34.00	45.23

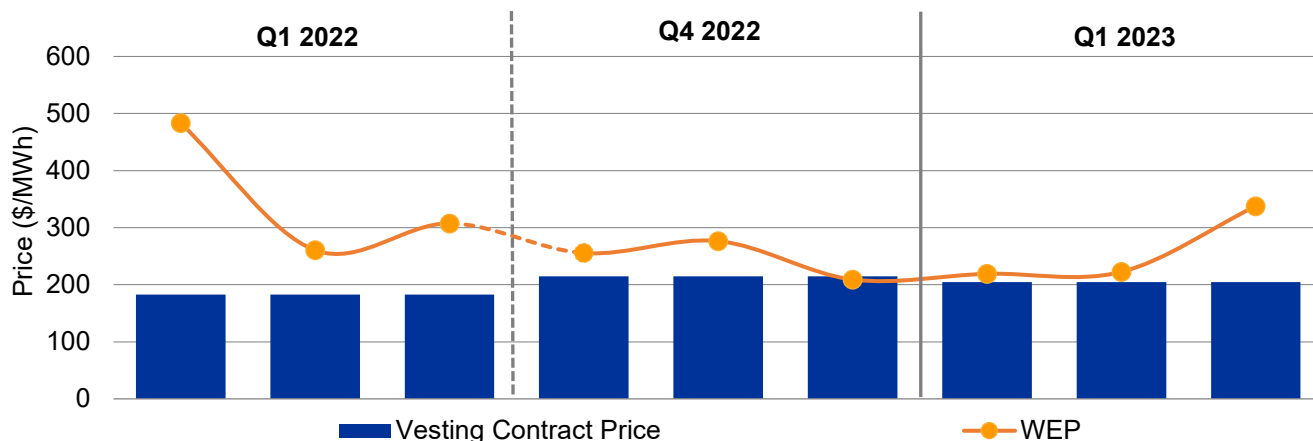
The Uniform Singapore Energy Price (“USEP”) and the Wholesale Electricity Price (“WEP”) increased by 6.43% to \$260.74/MWh and 5.19% to \$259.81/MWh respectively on a quarter-to-quarter comparison. This rise is largely attributed to an increase in the fuel cost that went up by 1.72% to US\$404/4/MT, and an increase in the percentage of energy offers made at or above \$400/MWh by 1.87 percentage points, from 5.13% in Q4 2022 to 7.00% in Q1 2023. In addition, the planned outage volume surged 7.36% to a record high of 10,627,157 MWh, and an increase in forced outage volume by 7.30% to 65,151 MWh, in line with the contraction in supply.

The prices of ancillary services were mixed across the board. The price of the contingency reserve decreased by 54.05% to \$8.82/MWh and the primary reserve price decreased by 94.89% to \$0.19/MWh. Conversely, the price of regulation increased 33.01% to \$45.23/MWh this quarter, which is consistent with higher regulation shortfalls. This quarter recorded 29 periods compared to 17 periods of regulation shortfalls observed in the previous quarter.

¹ https://www.ema.gov.sg/media_release.aspx?news_sid=20230202XPxwAa8H2L7v

Prices in Q1 2023

Chart 2. Vesting Contract Price Versus WEP by Quarter



In Q1 2023, the WEP increased by 5.19% from \$247.00/MWh in Q4 2022 to \$259.81/MWh. The difference between the vesting contract price and the WEP continued to narrow this quarter and marks the sixth consecutive quarter with average WEP levels above the vesting contract price. The WEP cleared 27.09% higher than the Q1 2023 vesting contract price as compared to a 15.00% increase recorded in Q4 2022.

In contrast, the vesting contract price decreased by 4.81% from \$214.78/MWh in Q4 2022 to \$204.44/MWh in Q1 2023, displaying a downward trend since the previous quarter. Nonetheless, the vesting contract price remained 11.81% higher than in Q1 2022 due to the prolonged geopolitical tensions between Russia and Ukraine.

Chart 3. Distribution of WEP Over Time

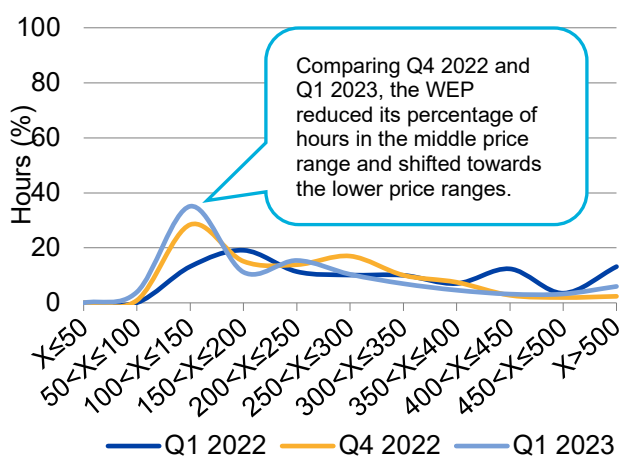
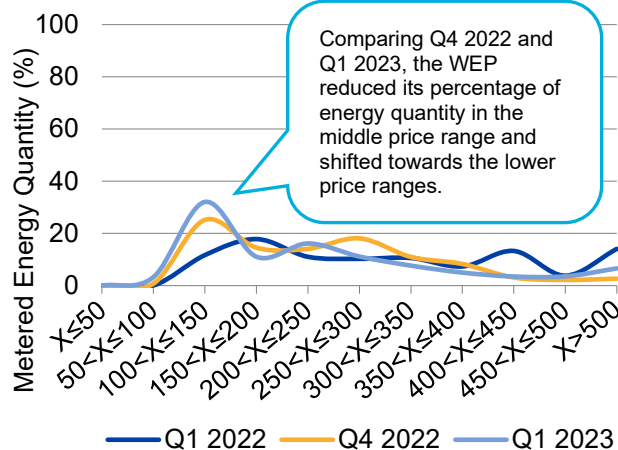


Chart 4. Distribution of WEP Over Total Metered Energy Quantity



Charts 3 and 4 illustrate the frequency of the WEP across different price ranges, measured as a percentage of the total number of hours and a percentage of the total metered energy quantity for Q1 2023, compared to the previous quarter and the same quarter for the previous year.

Similar to the previous quarter (Q4 2022), a higher proportion of the distribution of the WEP in Q1 2023 was concentrated at a price range of \$100/MWh to \$150/MWh. The frequencies of WEP in the price range of \$100/MWh to \$150/MWh increased to 35.12 percentage points as compared to 28.44 percentage points in Q4 2022.

In the current quarter, it was observed that some energy offers moved to higher price tranches as compared to Q4 2022, but not as high as recorded in Q1 2022. As a result, the WEP exceeded \$500/MWh for 5.97 % of the time in Q1 2023, which is an increase from 2.38% in Q4 2022, but a reduction from 13.17% in Q1 2022.

The distribution of the WEP in terms of percentage metered energy quantity in the market also showed a similar change to its distribution based on the percentage number of hours. This suggests that the demand may have maintained a consistent profile throughout the quarter with minor fluctuations on exceptional days. The WEP was concentrated in the lower price range for most of the metered energy quantity in Q4 2022 and Q1 2023 (Chart 4).

Chart 5. Correlation Between WEP and Metered Energy Quantity **Chart 6. WEP Versus Fuel Oil Price**

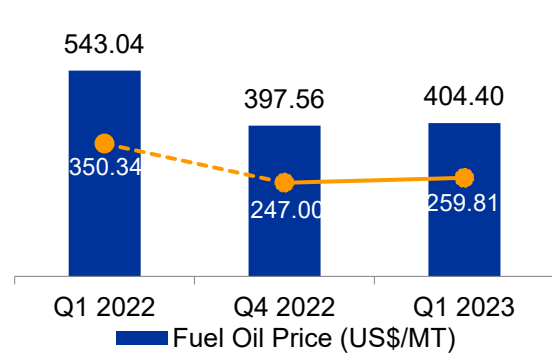
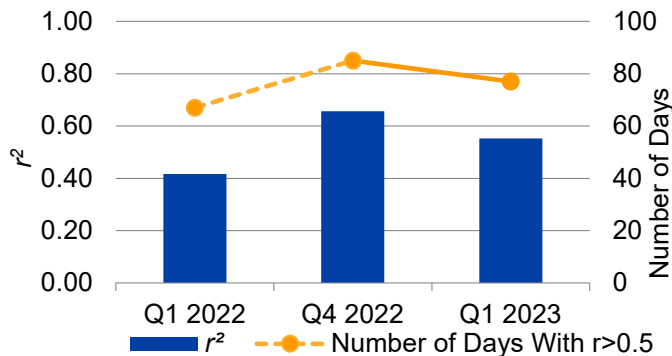


Chart 5 shows the proportion of variance in the WEP which could be explained by changes in the metered energy quantity measured by r^2 . It was observed that changes in the metered energy quantity for Q1 2023 had a lesser impact on the WEP movements as the correlation between the two variables slightly weakened. The r^2 value decreased to 0.55 in Q1 2023 compared to 0.66 in Q4 2022, implying that the changes in the metered energy quantity could account for 55% of the changes in the WEP during the quarter.

Correspondingly, there were 8 fewer days in Q1 2023 where r was greater than 0.5 compared to Q4 2022. This indicated that the metered energy quantity and the WEP had a strong positive correlation over a limited time in Q1 2023 (77 out of 92 days) than in Q3 2022 (85 out of 92 days). As observed in Chart 5, the metered energy quantity remained the main contributing factor to the movements in the WEP attributed to the stronger correlation results in Q1 2023.

As shown in Chart 6, the fuel oil price rose by 1.72% from US\$397.56/MT in Q4 2022 to US\$404.40/MT in Q1 2023, while a decrease of 25.53% from US\$543.04/MT was observed from Q1 2022. The geopolitical tension between Russia and Ukraine led to a reduction in the production of fuel oil by Russia despite the growth in demand, causing an increase in fuel cost.² As fuel cost is one of the key cost components of electricity generation, the WEP moved in tandem with the increase in the fuel oil price.

² <https://www.reuters.com/business/energy/oil-steadies-after-fall-fear-rate-hikes-rising-inventories-2023-02-28/>

Table 2. Variation Between Real-Time Dispatch Price and Forecast Price³

Month/Quarter	Variation Between RTS and STS (\$/MWh)	Maximum Periodic Variation (\$/MWh)
Jan-22	5.30	1,852.80
Feb-22	-2.21	2,128.83
Mar-22	3.48	2,544.09
Oct-22	1.08	2,437.96
Nov-22	11.20	3,346.45
Dec-22	-2.55	2,624.05
Jan-23	8.34	3,732.04
Feb-23	-16.95	3,980.44
Mar-23	-3.07	2,336.81
Q1 2022	3.66	2,544.09
Q4 2022	4.94	3,346.45
Q1 2023	9.45	3,980.44

Table 2 shows the monthly and quarterly average variation in the USEP produced in the real-time dispatch schedule (“RTS”) and the short-term schedule (“STS”), along with the largest variation observed in a single dispatch period during each month and quarter. A positive variation means the RTS produced a higher USEP than the STS, while a negative variation means the RTS produced a lower USEP than the STS.

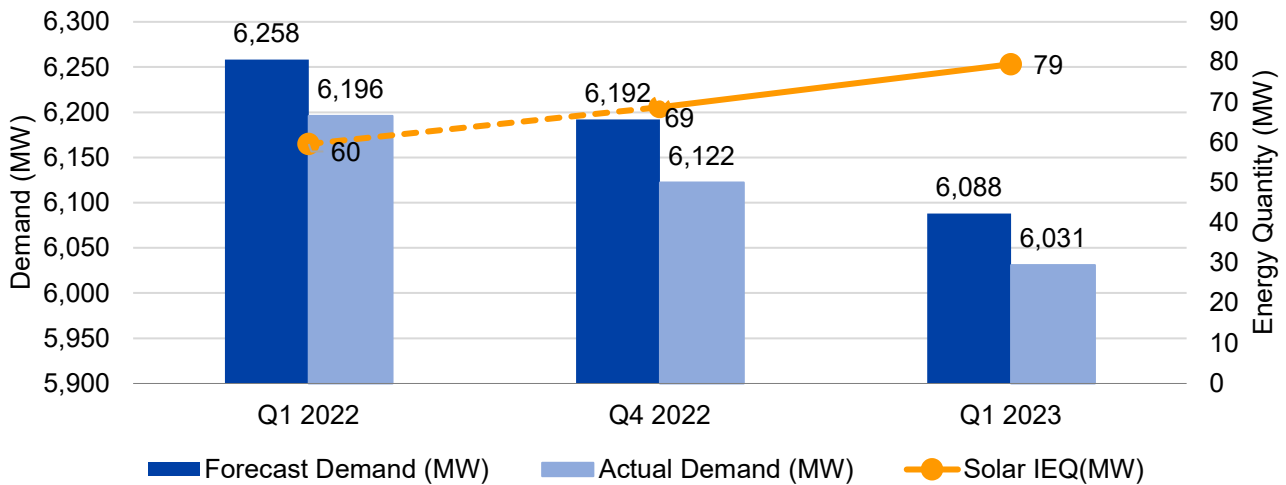
The average variation between the forecast USEP in the STS and the RTS increased to \$9.45/MWh in Q1 2023, \$4.51/MWh higher than the price variation observed in Q4 2022 at \$4.94/MWh and \$5.79/MWh higher than that in Q1 2022. It is noteworthy to mention that the largest price variation was as high as \$3,980.44/MWh in Q1 2023, versus \$3,346.45/MWh in Q4 2022. The higher average price variation this quarter could also be attributed to the increased forced outage volume and the higher temperature and rainfall⁴ experienced in February 2023, when compared to January and March 2023.

³ Revision to the figures for Variation Between RTS and STS in December 2022.

⁴ https://data.gov.sg/dataset/rainfall-monthly-total?view_id=be92ce92-d02e-4920-9479-ff6da87b45e8&resource_id=778814b8-1b96-404b-9ac9-68d6c00e637b

Demand and Supply in Q1 2023

Chart 7. Average Forecast and Actual Demand Versus Average Solar Energy Quantity⁵



According to Chart 7, there is a notable relationship between the average actual and forecast demand against the average solar energy quantity. Due to the intermittent nature of solar power, the energy quantity per period is dependent on weather conditions (energy quantity increases with a larger amount of sunlight, and vice versa), therefore, the energy quantity contribution from solar generation will not be consistent throughout the day.

In Q1 2023, the average solar energy quantity increased by 15.55% to 79 MW from 69 MW in Q4 2022 and a 33.32% increase from 60 MW in Q1 2022 as we see an upward trend in the installed capacity of Grid-Connected Solar Photovoltaic⁶. In contrast, the average forecast demand decreased by 1.68% from 6,192 MW in Q4 2022 to 6,088 MW in Q1 2023 while the average actual demand decreased by 1.49%, from 6,031 MW in Q4 2022 to 6,122 MW in Q1 2023. This decrease may be attributed to the higher solar energy quantity and cooler average temperature as Q1 2023 recorded an average monthly temperature of 27.46 °C, while Q4 2022 and Q1 2022 recorded an average temperature of 27.74 °C and 28.33 °C respectively.

Chart 8. Peak Forecast and Actual Demand

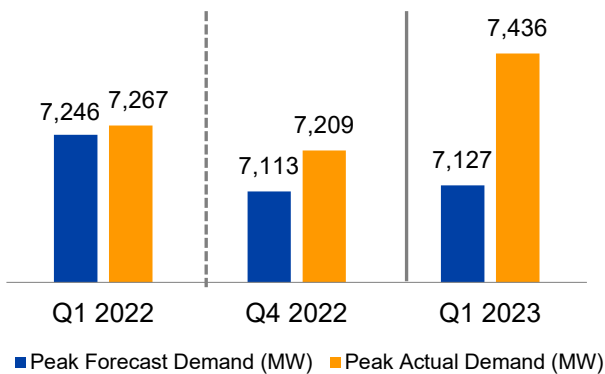
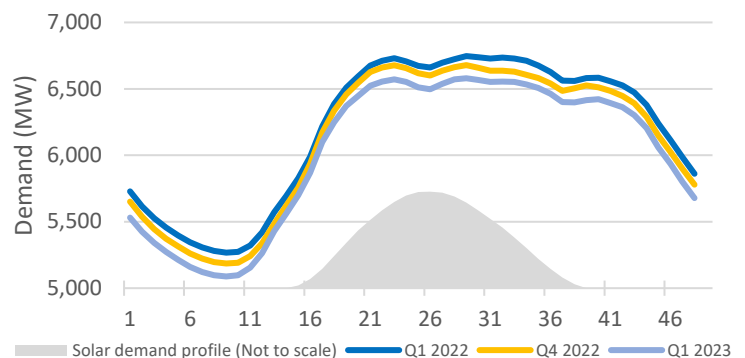


Chart 9. Actual Demand Profile⁷



As shown in Chart 8, the peak forecast and peak actual demand increased 0.20% and 3.15% respectively in Q1 2023 when compared to Q4 2022. The peak demand was recorded between periods 29 to 33 coinciding with the reduction in solar energy production. Chart 9 shows the daily average demand profile on a quarterly basis after offsetting the solar energy quantity for Q1 2022, Q4 2022, and Q1 2023. With an increase in the contribution of solar energy production in the Singapore energy market, the curve could potentially form a distinctly duck-like shape which is referred to as a duck

⁵ Due to an increase in the installed capacity of Grid-Connected Solar Photovoltaic, the Average Forecast and Actual Demand (Chart 7) will include Solar Energy Quantity.

⁶ https://www.ema.gov.sg/statistic.aspx?sta_sid=20170711hc85chOLVvWp (please refer to the Excel version)

⁷ The solar generation profile source: https://www.ema.gov.sg/Solar_Generation_Profile.aspx

curve⁸. The duck curve represents a visual representation of the variation in power generation, highlighting the impact of solar energy production on the energy demand throughout the day.

From the chart, it shows a downward shift in the quarterly demand profile, similar to the trend observed in Chart 7 where the quarterly average demand is decreasing. The highest average demand was recorded between periods 29 to 33 which is consistent with the declining solar generation profile. This was a rightward shift from periods 21 to 25, the highest average demand recorded before the introduction of solar energy. Notably, a reduction in the demand profile is observed from quarter to quarter and is more pronounced between periods 21 to 38 from Q4 2022 to Q1 2023 with the increase in the contribution of solar energy quantity. Looking ahead, we anticipate a continuous reduction in the demand profile as solar generation increases in the system, in particular for periods with higher solar energy production.

Table 3. Quarterly Average Supply and Supply Cushion

Quarter	Q1 2022	Q4 2022	Q1 2023
Average Supply (MW)	7,666	6,936	6,921
Supply Cushion (%)	18.38	10.85	12.15

Table 3 shows a decrease in the quarterly average supply in Q1 2023 by 0.23% to 6,921 MW from 6,936 MW in Q4 2022. The shrinkage in supply availability could be attributed to the higher outage and forced outage volume. As observed in Table 1, the planned outage and forced outage volume rose by 7.36% and 7.30% respectively in Q1 2023 compared to the previous quarter.

Despite the slight reduction in supply, the reduction in demand was of greater magnitude, causing the corresponding supply cushion to rise by 1.30 percentage points from 10.85% in Q4 2022 to 12.15% in Q1 2023. The supply cushion had been in decline since Q4 2021, and this quarter marked the first increase after five consecutive quarters of decline.

Chart 10. Trend Of Energy Offer Price Proportion

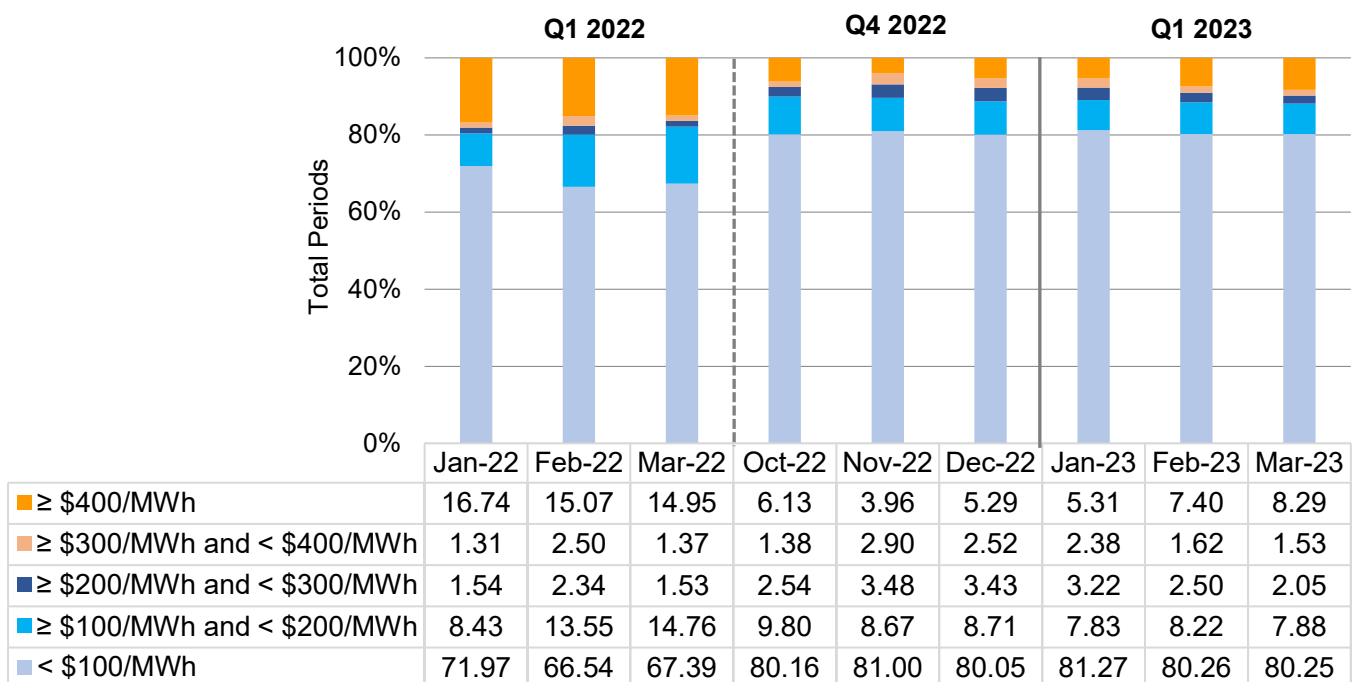


Chart 10 shows an increase in the proportion of energy offers below \$100/MWh and above \$400/MWh from Q4 2022 to Q1 2023, with a greater proportion of energy offers priced between \$100/MWh to \$400/MWh and shifting to the price tranche below \$100/MWh and above \$400/MWh. The shift in energy offers to higher price ranges likely outweighed the

⁸ https://en.wikipedia.org/wiki/Duck_curve

impact of the higher supply cushion as the resultant WEP was higher this quarter with the average quarterly WEP increased from \$247.00/MWh in Q4 2022 to \$259.81/MWh in Q1 2023.

Chart 11. Monthly Average Variation Between Real-Time Dispatch Schedule and Forecast Load

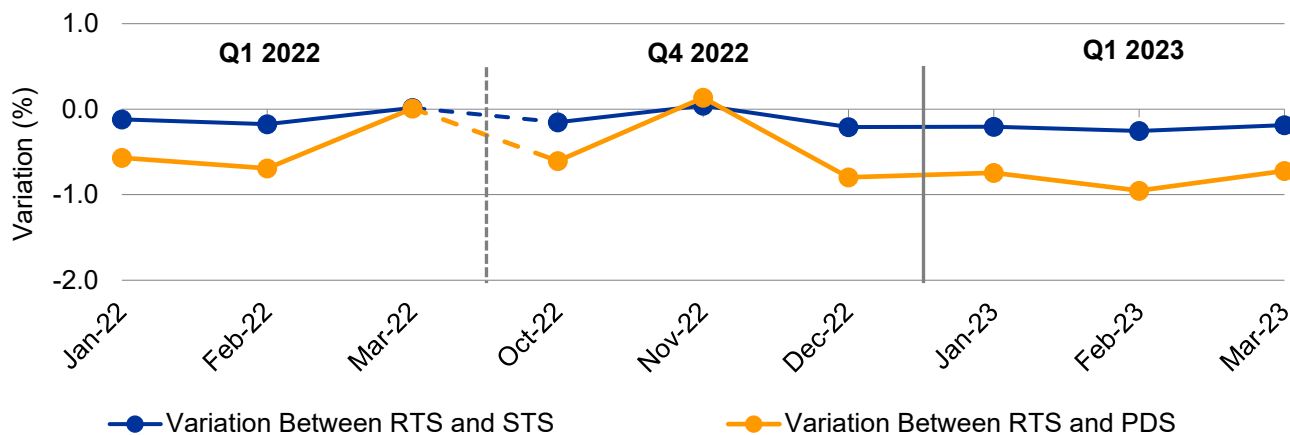


Chart 11 displays the variations in the pre-dispatch schedule (“PDS”) and short-term schedule (“STS”) against the real-time schedule (“RTS”). The average monthly variations remained relatively small in Q1 2023 (0.22 for variation between RTS and STS and 0.81 for variation between RTS and PDS, in percentage points) despite an increased from Q4 2022 (0.13 for variation between RTS and STS and 0.51 for variation between RTS and PDS, in percentage points).

The forecasted schedule was over-forecasted as both the variations in PDS and STS were largely negatively correlated to RTS. This could be attributed to the changes in the temperature from January to March 2023 – with the average temperature in January at 27.16°C, rising to 27.64°C in February before declining to 27.58°C in March.

Chart 12. Quarterly Average Variation Between Real-Time Dispatch Schedule and Metered Energy Quantity

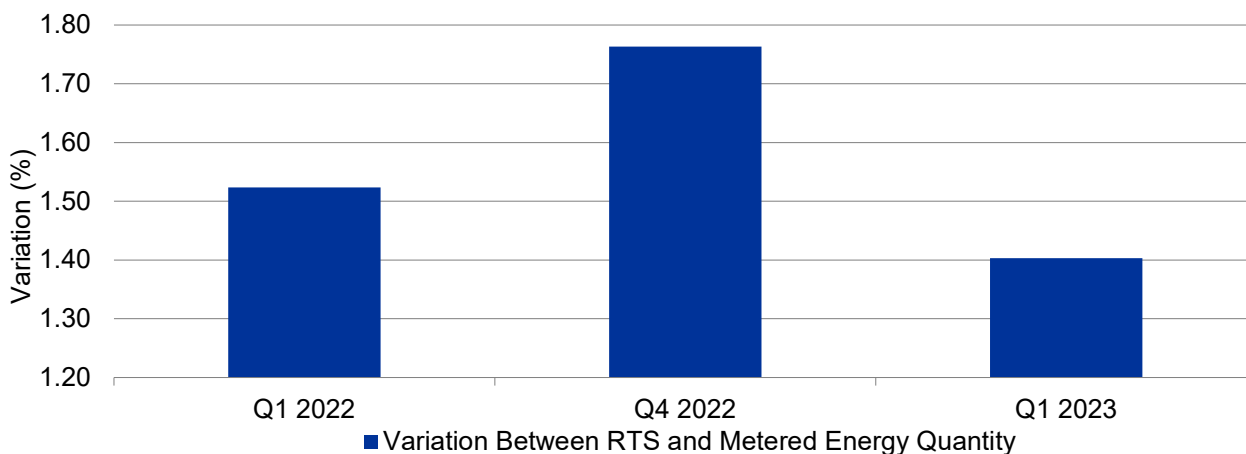
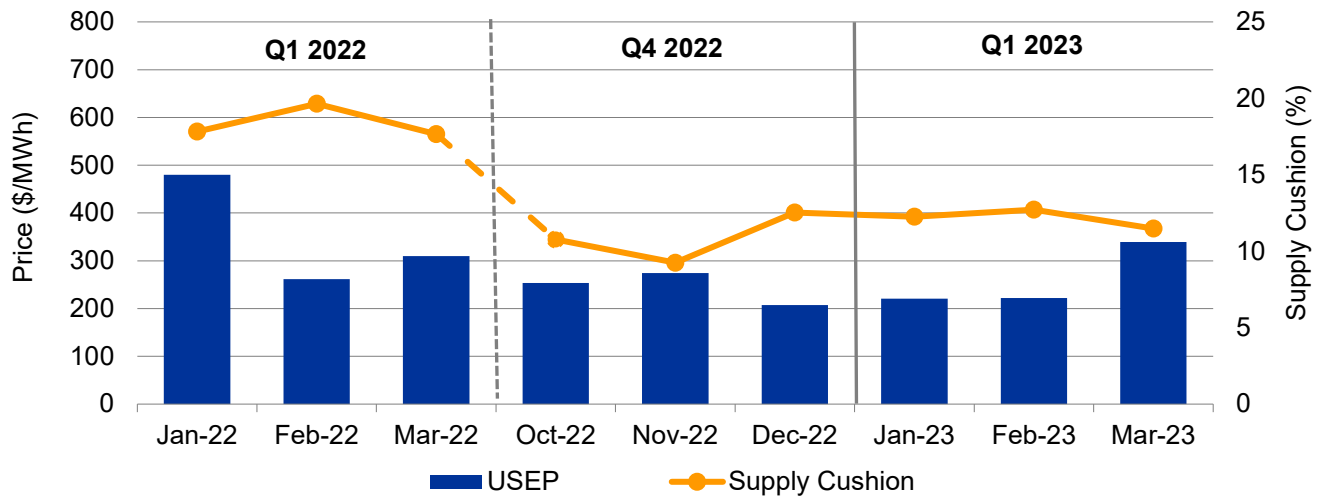


Chart 12 shows that Q1 2023 outperformed Q4 2022 and recorded a smaller variation in the quarterly average load variation between the RTS and the metered energy quantity. The average monthly load variation between the RTS and the metered energy quantity reduced from 1.76% in Q4 2022 to 1.40% in Q1 2023. The reduction implied a continual improvement of load forecast accuracy in comparison to Q1 2022 and Q4 2022.

Chart 13. USEP and Supply Cushion



In Q1 2023, the supply cushion averaged 12.15%, compared to 10.85% in Q4 2022. It was observed that the higher USEP was inversely correlated with the lower supply cushion.

On the monthly level, a similar inverse correlation was observed for January, February, and March 2023, where the higher supply cushion correlates with a lower USEP and vice versa. The highest monthly average USEP for the quarter was recorded in March 2023 at \$339.26/MWh, with a monthly average supply cushion level of 11.49%. This could be attributed to a conflation of factors, including a higher volume of forced outages from generation companies and an increase in demand observed in March 2023. In addition, the fuel oil price rose from US\$396.07/MT in February to US\$433.83/MT in March, which may have further strengthened the USEP.

Chart 14. Capacity Ratio by Generation Type

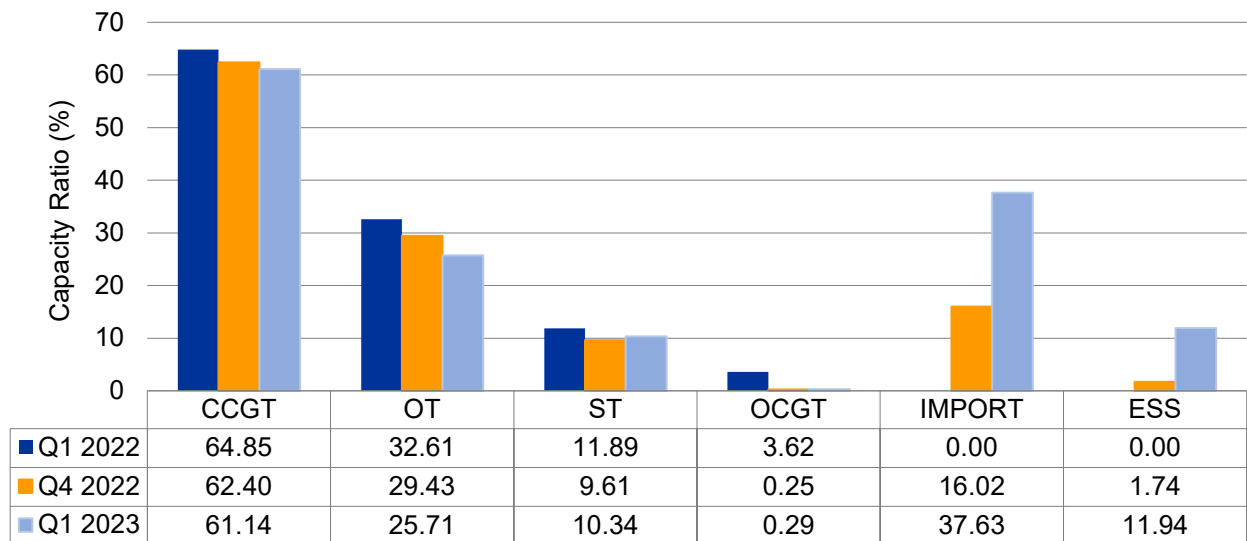


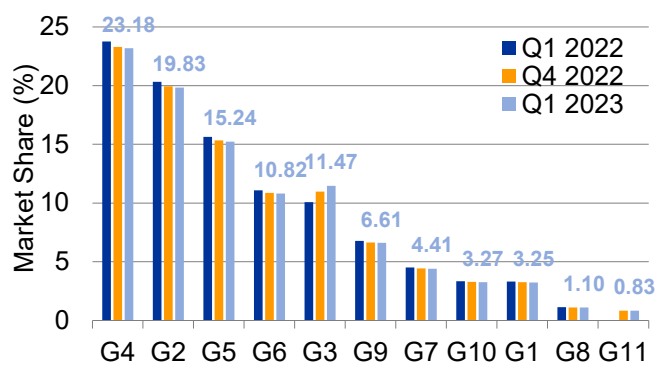
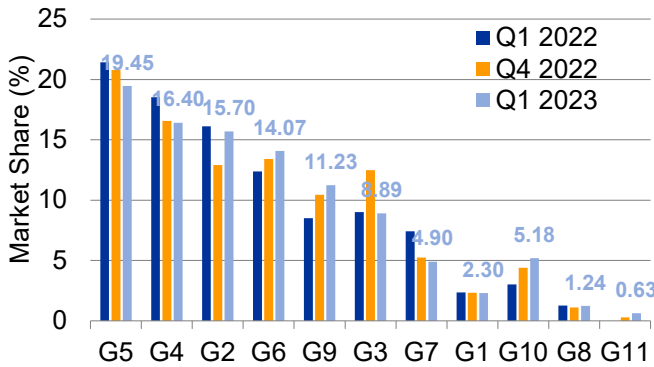
Chart 14 depicts the quarterly average capacity ratios of the six generation types in the NEMS which comprise Combined-Cycle Gas Turbine (“CCGT”), Others (“OT”), Steam Turbine (“ST”), Open-Cycle Gas Turbine (“OCGT”), imports (“IMPORT”), and Energy Storage System (“ESS”). IMPORT and ESS were newly introduced to the system in Q3 2022 and Q4 2022 respectively.

Compared to Q4 2022, the capacity ratios of CCGT and OT reduced by 1.26 and 3.72 percentage points respectively. This is consistent with the lower supply due to higher outages and forced outage volume as indicated in Table 1. In contrast, the capacity ratios of ST and IMPORT rose by 0.73 percentage points, 0.04 percentage points, and 21.61 percentage points respectively. This is to compensate for the reduction in the volume by CCGT and OT.

The capacity ratio of OCGT increased by 0.04 percentage points, likely due to OCGT's energy offers being at the higher price tranches and the strengthening in the USEP, which could have potentially caused an increase in OCGT utilisation. Similarly, ESS recorded an increase of 10.20 percentage points as compared to Q4 2022 with the registration of two new ESS facilities, which contributed to the growth in ESS capacity.

Chart 15. Market Share in Percentage of Generation Companies Based on Metered Energy Quantity⁹

Chart 16. Market Share in Percentage of Generation Companies Based on Maximum Generation Capacity¹⁰



Charts 15 and 16 provide a comparison of the market share comparison in the NEMS based on metered energy quantity and maximum generation capacity by generation companies.

As shown in Chart 15, G5, G4, and G2 are the top three largest generation companies based on the metered energy quantity with G2 surpassing G6 this quarter. The generation companies that are in the top three positions held 51.55% of the total market share in Q1 2023, an increase from 50.26% in Q4 2022. In comparison to the previous year, there was a reduction of 4.51 percentage points from 56.05% in Q1 2022, mainly due to the introduction of new facilities in the system. Despite G6 ranking in the fourth position this quarter, its market share rose 0.65% to 14.05% in the total market share as compared to 13.42% in Q4 2022.

The distribution of market share for the big three generation companies based on generation capacity remained above 50% despite the entry of new generation registered facilities into the Singapore Wholesale Electricity Market. As shown in Chart 16, the big three generation companies held 58.25% of the total market share in Q1 2023, a slight reduction from 58.58% in Q4 2022. The market share of G3 had the greatest increase of 0.50 percentage points from 10.97% in Q4 2022 to 11.47% in Q1 2023.

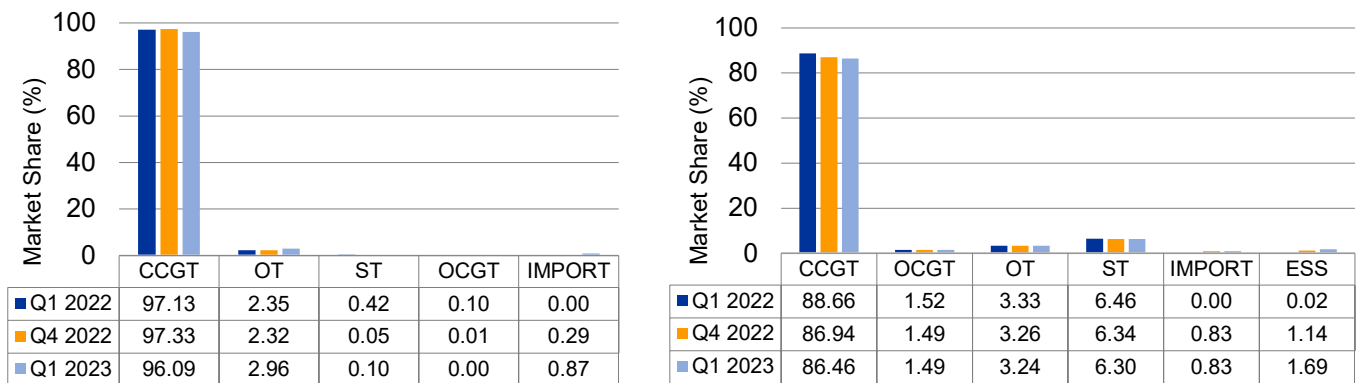
Chart 17. Market Share in Percentage of Generation Types Based on Metered Energy Quantity¹¹

Chart 18. Market Share in Percentage of Generation Types Based on Maximum Generation Capacity

⁹ Exclude intermittent generation facilities and Market Participants with net negative quarterly metered energy quantity.

¹⁰ Exclude intermittent generation facilities and Market Participants with lesser than 5 MW maximum generation capacity. The actual capacities of the ESS facilities were used for the computation.

¹¹ Exclude intermittent generation facilities and technology type with net negative quarterly metered energy quantity.



Most of the generation in the NEMS is produced by the most efficient generation technology, this is evidenced by the majority of the generation in the NEMS being produced by CCGT facilities. Charts 17 and 18 show that the CCGTs accounted for 96.09% of the metered energy quantity and 86.46% of the total maximum generation capacity in Q1 2023.

However, with the introduction of more renewable energy to the Singapore Wholesale Electricity Market, we observed a downward trend in the market share of CCGT facilities. In Chart 17, the market share of CCGT for metered energy quantity reduced by 1.24 percentage points from 97.33% in Q4 2022 to 96.09% in Q1 2023, corresponding to Chart 16, the market share of CCGT for total maximum generation capacity declined by 0.48 percentage points from 86.94% in Q4 2022 to 86.46% in Q1 2023. On the other hand, the market share of IMPORT for metered energy quantity rose by 0.58 percentage points from 0.29% in Q4 2022 to 0.87% in Q1 2023 (Chart 17) and the market share of ESS for total maximum generation capacity increased by 0.55 percentage points from 1.14% in Q4 2022 to 1.69% in Q1 2023 (Chart 18).

Chart 19. Frequency of the Number of Generation Companies as Pivotal Supplier (PS) Per Period

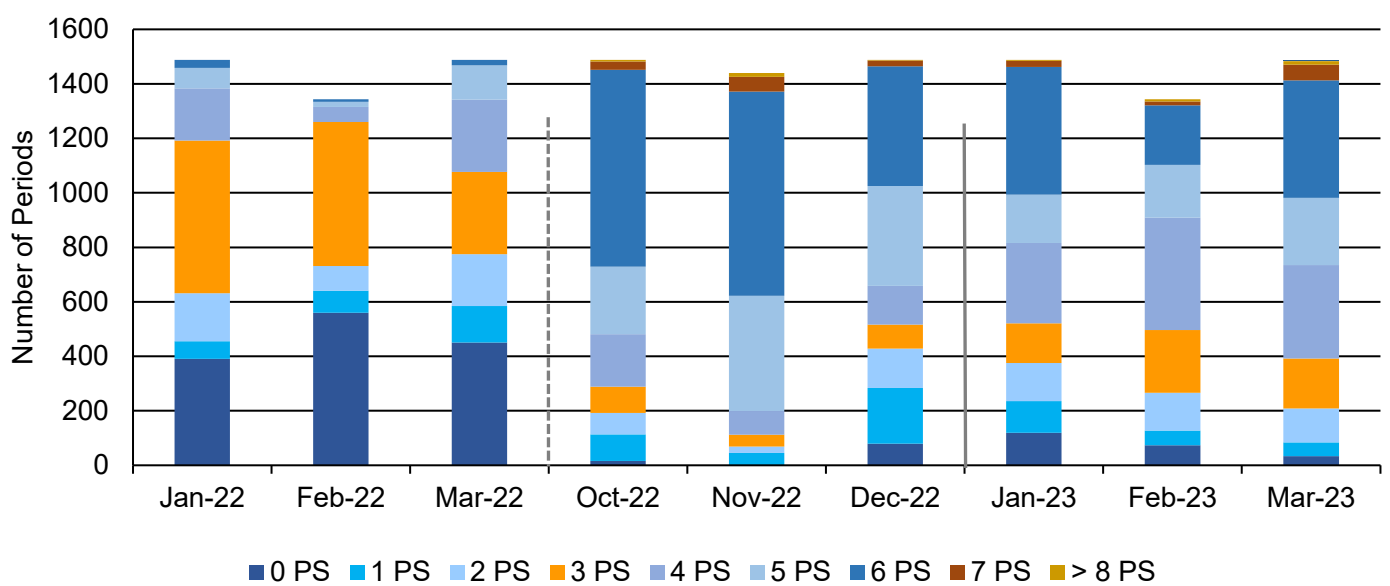


Chart 19 shows the number of trading periods with the number of pivotal suppliers per period for each month in Q1 2022, Q4 2022, and Q1 2023.

Q1 2023 recorded 2,460 periods with less than 4 pivotal suppliers per period, higher than what was observed in Q4 2022 with 1,338 periods while lesser than Q1 2022 which recorded 4,040 periods. The reason for the reduction in the frequency of less than 4 pivotal suppliers in Q1 2023 as compared to Q4 2022 was due to the higher supply cushion observed this quarter (Chart 13) and this represents that the generation companies that were identified as pivotal suppliers with the potential ability to exercise unilateral market power were reduced.

Chart 20. Trend of Price Setting Generation Companies

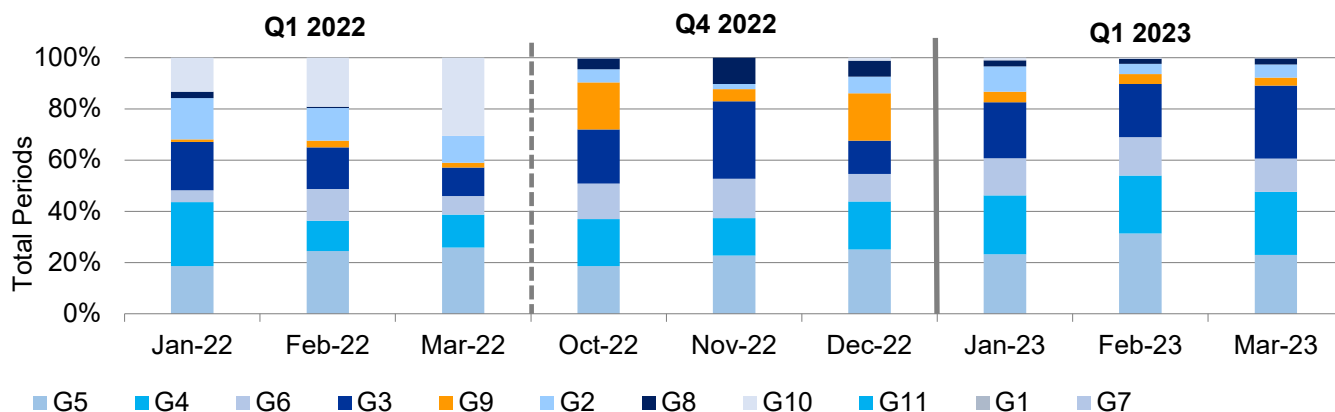


Chart 20 shows the monthly breakdown of price-setting generation companies in Q1 2023, Q4 2022, and Q1 2022. G3, G5, and G4 remained the top three highest frequency price-setting generation companies in the market in Q1 2023, which were the same top three positions in Q4 2022. The price setting frequency for G3, G5, and G4 grew 1.95, 3.86, and 6.02 percentage points respectively in Q1 2023 compared to Q4 2022.

Chart 21. Demand Response Activations

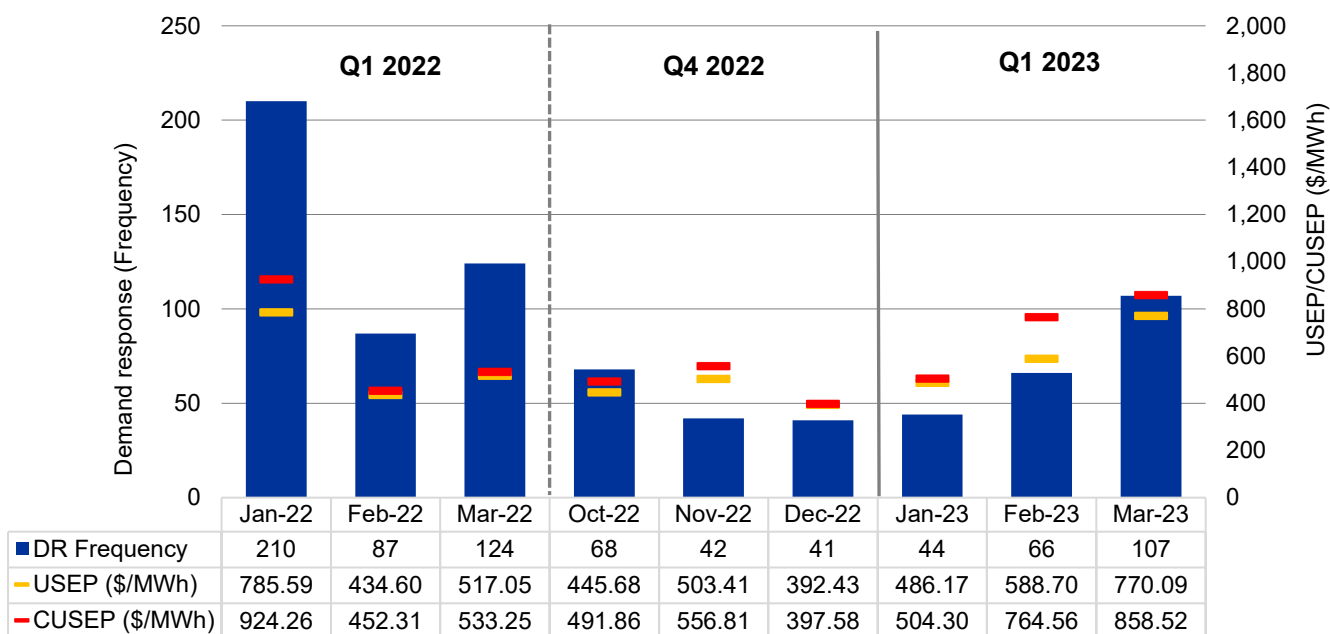


Chart 21 lists the Demand Response (“DR”) activations in Q1 2023, Q4 2022 and Q1 2022, and the associated USEP and counterfactual USEP (“CUSEP”) during those periods with DR activations.

There were 217 DR activations in Q1 2023, which was higher than the cumulative total of 151 occurrences recorded from the DR activation in Q4 2022. The daily average USEP for periods with DR activation in Q1 2023 was \$657.35/MWh, while the average CUSEP was \$758.12/MWh without DR curtailment.

The number of DR activation is usually reflective of the number of USEP spikes and there were more USEP spikes in Q1 2023 compared to Q4 2022 (553 USEP spikes in Q1 2023 and 307 USEP spikes in Q4 2022). Furthermore, the Energy Market Authority (“EMA”) launched Demand Side Management Sandbox (“DSM Sandbox”) from 1 January 2023 to 31 December 2024 to enhance the DR and Interruptible Load (“IL”) programs. The introduction of the DSM Sandbox could encourage more participation and contribute to an increase in the activation. ¹²

¹² https://www.ema.gov.sg/media_release.aspx?news_sid=20221024BUJD4YDq1igs

Compliance Statistics for Q1 2023



Potential Breaches of the Market Rules



Determinations*



Enforcement

100 cases in total

2 self-reports
98 referrals/complaints
0 MSCP initiative

153 determinations in total

6 cases determined to be in breach
8 cases determined to take no further action
139 cases determined not to be in breach
0 cases determined to be event of default

3 cases in total

1 financial penalty
2 non-compliance letters
0 suspension order
0 termination order
0 other MSCP order
\$75,000 of financial penalty imposed
\$16,000 of costs awarded

*This section includes determinations of cases referred to the MSCP in previous quarters.

The MSCP issued 3 rule breach determinations in Q1 2023 to:

- i. 1 case from YTL PowerSeraya Pte. Limited regarding failure to comply with PSO directions on 17 May 2022 (\$7,000 costs)
- ii. 1 case from YTL PowerSeraya Pte. Limited regarding failure to comply with PSO directions on 20 May 2022 (\$7,000 costs)
- iii. 1 case from YTL PowerSeraya Pte. Limited regarding failure to comply with PSO directions on 1 August 2022 (Financial penalty \$75,000, \$2,000 costs)

MSCP Market Watch

This is a quarterly report prepared by the Market Assessment Unit (“MAU”) of EMC and submitted to the MSCP. The report summarises the MAU’s day-to-day monitoring, evaluation activities and analyses, and compares the market performance for the current quarter with the quarter a year ago and the previous quarter.

All prices and percentages in this report are rounded off to two decimal places.

The [User Guide to MSCP Market Watch](#) provides a glossary of the terms used in the MSCP Market Watch among other information to facilitate readers’ understanding.

Market Surveillance and Compliance Panel

The MSCP is established by the EMC Board in accordance with section 2.6 of Chapter 3 of the Singapore Electricity Market Rules.

The MSCP, with the assistance of the MAU, monitors and investigates the conduct of market participants, the market support services licensee, EMC and the Power System Operator and the structure and performance of the wholesale electricity markets.

The MSCP comprises the following members:

- Professor Walter Woon, Chairman
- T P B Menon
- Philip Chua
- Professor Euston Quah
- Dr Stanley Lai
- Yeo Yek Seng

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