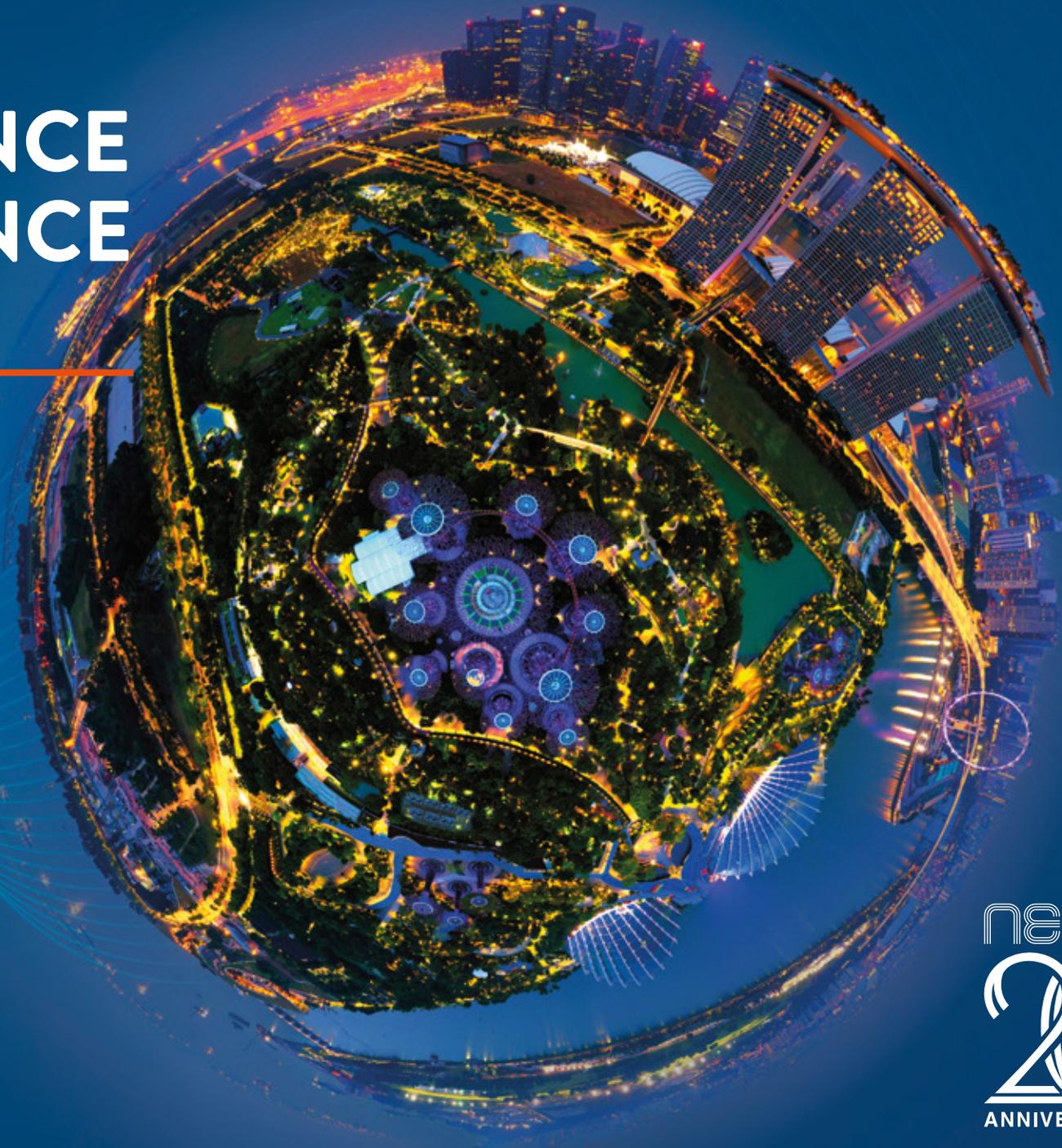


MARKET SURVEILLANCE & COMPLIANCE PANEL

ANNUAL REPORT

2023



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ANNIVERSARY

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The Market Surveillance and Compliance Panel (MSCP) Annual Report presents analysis of annual data and information about Singapore's wholesale electricity market. This edition of the report is based on market data and monitoring indices for the period 1 January to 31 December 2023, which were compiled and analysed by the Market Assessment Unit of Energy Market Company as part of its market monitoring and compliance functions.

This report has been reviewed and approved by the MSCP and provides an assessment of the wholesale electricity market's performance, highlighting key observations on a range of supply, demand, and price indices for 2023, and how they compare to 2022.

Supply Indices

Over the past year, the electricity supply in the National Electricity Market of Singapore (NEMS) continued to decrease, following 2022's decline, which had been the largest observed since the market started in 2003.

The reduced electricity supply, coupled with higher demand, resulted in lower supply cushion levels in 2023 compared to 2022. Nonetheless, wholesale electricity prices in Singapore fell in 2023, indicating that factors other than the demand and supply conditions were affecting prices.

- The average supply decreased 3.42% to 7,122 megawatts (MW) in 2023 from 7,374MW in 2022, in line with a 3.11% increase in the average outage level to 2,352MW per period in 2023 from 2,281MW per period in 2022.
- The resultant average supply cushion¹ weakened to 11.51% in 2023 from 14.44% in 2022. This was the second year the supply cushion thinned to less than 20% and also marks the lowest supply cushion recorded since the market began in 2003.

- The capacity ratio² of Energy Storage Systems (ESS) rose 6.43 percentage points from 3.65% to 10.08% in 2023. ESS was the only generation type to see an increase in capacity ratio. The capacity ratio of all other generation types, namely Combined Cycle Gas Turbine (CCGT), Steam Turbine (ST), Open Cycle Gas Turbine (OCGT), Other Facilities Turbine (OT) units and Electricity Imports (Import) decreased 0.52, 1.81, 1.89, 9.78 and 28.15 percentage points to annual averages of 63.79%, 8.05%, 0.21%, 21.62% and 9.68% respectively.
- Based on metered energy quantity, the generation sector of the NEMS became less concentrated as the combined market share of the three largest generation companies fell to 51.34% in 2023 from 52.84% in 2022.
- CCGT continued to be the predominant generation type in the NEMS, holding a market share in terms of metered energy quantity of 98.09% in 2023, up from 97.16% in 2022. Apart from CCGT, ST units' market share also grew 0.94 percentage point in 2023. On the other hand, the market share of OT units, Import and OCGT units shrank by 1.64, 0.18 and 0.06 percentage points respectively.

Demand Indices

Continuing 2022's trend, electricity demand grew 0.05% in 2023. This meant that demand in 2023 outstripped 2022's record to mark the highest demand observed since the start of the NEMS in 2003.

- The average demand rose 0.03% to 6,302MW in 2023 from 6,300MW in 2022. The peak monthly average electricity demand also increased to 6,574MW, as observed in May 2023, compared to the previous year's peak of 6,430MW recorded in May 2022.
- The accuracy of real-time load forecast in 2023 improved by a lesser extent than in 2022. The average forecast error shrank a further 0.54 percentage point to 0.94%, the smallest forecast error recorded since the market started.

Price Indices

Notwithstanding higher demand and lower supply, which led to a contracted supply cushion, the annual average Wholesale Electricity Price (WEP) dropped to \$246.72 per megawatt hour (MWh), which was still the second highest annual average since the NEMS started in 2003. This was observed in a context of regulatory changes in the NEMS, namely the introduction of the Temporary Price Cap (TPC) mechanism and the new vesting contract regime in 2023.

In the first five months of 2023, we saw a continuation of higher electricity prices, extending 2022's trend amid market volatility. WEP eventually hit a monthly average high at \$488.71/MWh in May 2023, when forecasted demand reached a historical high of 6,574MW. Subsequently, the WEP stabilised for the rest of the year, coinciding with the application of the TPC and the new vesting contract regime introduced in July 2023. The Uniform Singapore Energy Price (USEP) followed a similar trend to the WEP, registering a monthly high for 2023 at \$492.09/MWh in May. This was the fourth time monthly USEP has surpassed \$400/MWh since the market started.

- The WEP continued to stay above the \$200/MWh level and averaged \$246.72/MWh in 2023, 15.77% below 2022's average of \$292.91/MWh. This was the second highest WEP observed since the NEMS started.
- The decrease in WEP in 2023 could be attributed to an overall 13.19% drop in the fuel oil price to US\$453.77 per metric tonne (MT) in 2023 from US\$522.73/MT in 2022 and a stabilisation of prices in the context of the TPC and new vesting contract regime.
- The total reserve payment decreased 63.84% to \$61.13 million in 2023 from \$169.06 million in 2022, reflecting a 54.28% decrease in the contingency reserve price to \$16.51/MWh in 2023 from \$36.11/MWh in 2022.

¹ Supply cushion measures supply adequacy, the level of capacity which was offered but not scheduled and could be called up if necessary. 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.

The Market Surveillance and Compliance Panel (MSCP) is an independent body established under the Singapore Electricity Market Rules (Market Rules). The work of the MSCP is guided by the functions and duties assigned to it under the Market Rules, namely monitoring, surveillance, and investigation responsibilities over the National Electricity Market of Singapore (NEMS).

The Market Rules establish that the MSCP monitors and investigates the conduct of market participants, the Market Support Services Licensee, the Power System Operator (PSO) and Energy Market Company (EMC), as well as the structure and performance of, and activities in, the wholesale electricity market that provide indications of the following phenomena:

- potential breaches of the [Market Rules](#), the [market manuals](#), or the System Operation Manual;
- actual or potential design or other flaws and inefficiencies in the Market Rules, market manuals, System Operation Manual, and other rules and procedures of EMC or the PSO. This includes an assessment of whether the underlying structure of the wholesale electricity market is consistent with the efficient and fair operation of a competitive market; and
- actual or potential design or other flaws in the overall structure of the wholesale electricity market.

When appropriate, the MSCP may exercise the enforcement powers conferred on it under the Market Rules and recommend remedial actions to mitigate the conduct and inefficiencies referred to above. This includes, but is not limited to, the imposition of financial penalties and the issuance of non-compliance letters, suspension orders, termination orders, and revocation orders. All enforcement actions are administered by EMC at the direction of the MSCP.

Additionally, the MSCP assists the Energy Market Authority (EMA) with fulfilling its obligations regarding competition and abuse of a dominant position under sections 50 and 51 of the Electricity Act, Chapter 89A.

Structure and Composition of the MSCP

In accordance with the Market Rules, the Chair and members of the MSCP are appointed by the EMC Board for a three-year term of office and are subject to reappointment. The appointed panel members are specially selected to ensure that the MSCP as a whole has extensive and relevant experience covering the areas of competitive wholesale electricity market or financial or commodity markets, Singapore laws and/or electricity regulations, competition laws and policies, power system operation, and/or economics.

Since the constitution of the MSCP, the EMC Board has endeavoured to appoint professionals with a range of expertise, such that the combined expertise of MSCP members covers the areas specified and ensures that the MSCP can perform the functions and duties assigned under the authority of the Market Rules, any applicable market manual, constituent documents and any resolution of the EMC Board.

The current composition of the MSCP reflects an appropriate mix of skill sets, experience, and qualifications that are relevant to assess and safeguard the governance of the market. In exercising its duties, the MSCP is supported by the Market Assessment Unit (MAU).

Professor Walter Woon, Chairman, MSCP



Professor Woon, Senior Counsel, is the chairman of RHTLaw Asia. He is also currently Lee Kong Chian Visiting Professor at the Yong Pung How School of Law, Singapore Management University, an Honorary Fellow of St John's College Cambridge, and an Emeritus Professor at the National

University of Singapore, having held the post of David Marshall Professor at the Law Faculty of the National University of Singapore for 12 years until his retirement in 2022.

In addition, Professor Woon has held many prominent appointments in the past, including Attorney-General (2008 to 2010), Solicitor-General (2006 to 2008), Ambassador (1997 to 2006), legal adviser to the President and Council of Presidential Advisers (1995 to 1997) and Nominated Member of Parliament (1992 to 1996).

Professor Woon's main areas of interest are company law, criminal law, and international law. He has published many articles, and written law books and novels.

Professor Woon was appointed a member of the MSCP in 2016 and became the Chairman of the Panel in 2022. During his years as a member of the MSCP, Professor Woon has contributed significantly to the Panel by supporting and clarifying several legal matters related to the application of the Market Rules and the provisions established in the Singapore law.

Mr T P B Menon



Mr Menon is currently a consultant with Wee Swee Teow LLP. Mr Menon was admitted to the Bar on 26 January 1962. He practised with Oehlers & Choa from 1962 to 1988, becoming a senior partner in 1980. Following the merger of Wee Swee Teow & Co with Oehlers & Choa in 1989, Mr Menon took on the role of

senior partner at Wee Swee Teow & Co., retiring in 2002 and then acting as a consultant to the firm.

Mr Menon was president of the Law Society from 1980 to 1983 and president of the ASEAN Law Association from 1984 to 1986. He was a member of the Military Court of Appeal from 1980 to 1990 and president of the Strata Titles Boards from 1990 to 1993. He also served as deputy chairman of the Board of Legal Education from 1978 to 2001.

Mr Menon was chairman of the Disciplinary Committee of the Law Society appointed by the Chief Justice from 1991 to 2004 and a member of the Advisory Editorial Board of Halsbury's Laws of Singapore. He has published several articles and delivered papers at international conferences. Mr Menon was awarded a PBM (Pingat Bakti Masyarakat – Public Service Medal) in 1993.

Mr Menon has been a member of the MSCP since 2003, from the commencement of the NEMS, and was the Chairman of the Panel between 2016 and 2021. Mr Menon's extensive legal knowledge and vast experience have enriched and nurtured the decision-making process of the MSCP, making sure that all determinations are fair, efficient, and aligned with the competitive operation of the NEMS, as well as safeguarding the financial integrity of the market.

Mr Yeo Yek Seng



Mr Yeo Yek Seng is the former deputy chief executive of the Energy Market Authority of Singapore (EMA). Before his retirement, he oversaw the regulation of the electricity and gas industries in Singapore, planning of the electricity and gas transmission infrastructure and development of the electricity market.

Prior to his appointment in EMA, Mr Yeo was with the Public Utilities Board, holding various engineering and managerial positions in its Electricity Department before rising to the position of Director, Regulation Department.

Mr Yeo holds a Bachelor of Engineering (Electrical Engineering), 1st Class Honours (1973) and a Master of Science (Industrial Engineering) (1980), both degrees from the University of Singapore. He is also a Fellow of the Institution of Engineers, Singapore. In 2012, Mr Yeo received the Public Administration Medal (Gold) at the National Day Awards.

Mr Yeo was appointed a member of the MSCP in 2023. Mr Yeo's noteworthy expertise has added great value to the Panel by bringing a technical expert angle from his deep knowledge of the electricity and gas industries.

Mr Philip Chua



Mr Philip Chua is a consultant in the financial industry. Prior to this, he was the senior country executive of American Express Bank Singapore. As the bank's chief executive, he drove local integration of global strategic directions and was also responsible for the bank's governance.

Concurrently, Mr Chua was the head of Global Financial Markets South East Asia, global product head of the Collateralized Trading Program, and regional treasurer for Asia, positions which he assumed progressively after joining the bank. He also served as a council member of the Association of Banks in Singapore and was a lecturer with the Institute of Banking & Finance.

Mr Chua's vast experience in financial markets began with his banking career at Chase Manhattan Bank, where he was Second Vice President and Senior Dealer, Money Market, before joining American Express Bank.

Mr Chua holds a Master of Business Administration from the Kelley School of Business at Indiana University, Bloomington, Indiana, US, and a Bachelor of Science in Business Administration, summa cum laude, from the University of Oregon, Eugene, Oregon, US.

Mr Chua has been a member of the MSCP since 2008. Mr Chua's financial trading and management experience across different instruments and markets have provided the MSCP with a broader perspective of the market dynamics, and market participants' behaviour in response to market conditions, price movements, and market liquidity, ensuring that the MSCP's determinations are consistent with the financial stability of the market.

Professor Euston Quah



Professor Euston Quah is Albert Winsemius Chair Professor of Economics, Professor of Cost-Benefit Analysis and Environment, and Director, Economic Growth Centre at the Nanyang Technological University, Singapore. He is also president of the Economic Society of Singapore, and editor of the Singapore Economic Review.

Professor Quah's extensive research, papers, and articles have been selected for inclusion by the International Library of Critical Writings in Economics in the UK. His textbooks, "Cost-Benefit Analysis", with E.J. Mishan, (6th edition, Routledge UK 2021), and "Principles of Economics", with Gregory Mankiw and Peter Wilson (3rd edition, Cengage Singapore 2021) are used by many universities and governments.

Professor Quah is listed in Google Scholar Profiler since 2020 among the top ten most highly cited university economists in Cost-Benefit Analysis in the world. He has consulted for Genting International, Price Waterhouse, Canadian International Development Agency, Asian Development Bank, and World Bank, among others. He was formerly vice dean of the Faculty of Arts and Social Sciences at the National University of Singapore and headed the economics departments at both Nanyang Technological University and the National University of Singapore. Professor Quah has been, and continues to be, advisor to many government ministries in Singapore. He also serves on the Boards of Competition and Consumer Commission of Singapore, Energy Market Authority, Energy Studies Institute (NUS), Institute of Southeast Asian Studies, among others. He was a recipient of the Public Administration Medal (Silver) in 2020.

Professor Quah has been a member of the MSCP since 2015. His experience undertaking cost-benefit analysis, evaluating government policies, and his extensive knowledge of environmental economics, provide a framework based on economic principles for the analysis of electricity market drivers, market trends, and market player incentives and behaviour.

Professor Quah has also been a solid contributor and supporter of the improvements applied to the econometric model for the Uniform Singapore Energy Price outliers.

Dr Stanley Lai



Dr Stanley Lai, Senior Counsel, is the head of Allen & Gledhill's Intellectual Property (IP) Practice and co-head of its Cybersecurity & Data Protection Practice.

Dr Lai specialises in IP litigation and information technology disputes and is also a commercial/chancery litigator. He maintains a strong advisory practice for IP/data management and cybersecurity, and represents clients in investigations that are undertaken by the Personal Data Protection Commission.

Dr Lai is currently the chairman of the Intellectual Property Office of Singapore, the commissioner of the Government Procurement Adjudication Tribunal and a member of the Singapore International Arbitration Centre IP Panel.

Dr Lai serves as a senior mediator in the Singapore Mediation Centre and as a specialist mediator in the Singapore International Mediation Centre. He is also an administrative panellist at the Asian Domain Name Dispute Resolution Centre.

Dr Lai is the first Singapore-born lawyer to be conferred a Ph.D. in Law from the University of Cambridge. He was awarded the Public Service Medal (Pingat Bakti Masyarakat) at the Singapore National Day Awards 2020 and the Singapore Academy of Law Merit Award in 2022. Dr Lai has published extensively on IP and information technology law, including his book "The Copyright Protection of Computer Software in the United Kingdom".

Dr Lai was appointed a member of the MSCP in 2022. His broad business experience and expertise in Competition Laws provide a further dimension of knowledge to the MSCP, involving the dynamics of different models of market structure, as well as the behaviour and interaction between market players applied to various markets in Singapore.

Decisions of the MSCP

The decisions made by the MSCP lie fundamentally upon the monitoring, evaluations and analyses undertaken by the MAU, which are regularly reported to the MSCP. Under the Market Rules, the quorum for the transaction of any business at a meeting of the MSCP is a simple majority of the appointed members, and all decisions of the MSCP are made by a majority of the votes cast, with each MSCP member eligible to cast one vote unless there exists a conflict of interest that requires the member(s) to abstain from voting on the given matter.

Where the MSCP concludes that a breach has occurred, a determination recording the facts and circumstances of the breach and details of any sanctions imposed will be published on the [Panel Determinations section of the EMC website](#).

Market Assessment Unit

The MAU manages the market surveillance, compliance, and dispute resolution processes. It advises and supports three external and independent governance bodies: namely the MSCP, the Dispute Resolution Counsellor (DRC), and the Dispute Resolution and Compensation Panel (DRCP).

The MAU enforces compliance with the Market Rules through its surveillance activities, investigations of alleged rule breaches, as well as supporting and advising the independent MSCP on enforcement actions. It monitors the outcomes of the wholesale electricity market and the behaviour of market participants to ensure that the market is functioning efficiently and identifies areas of inefficiency. It provides market training to and advises the MSCP on the state of competition and efficiency of the wholesale market, for the MSCP to recommend changes or remedial actions to the EMA to address areas of inefficiency. The MAU also acts as the key point of communication between market players and the MSCP.

The MAU assists the DRC with setting up and maintaining dispute management systems among market participants. It provides market training and operational support to the DRC and the DRCP members on all dispute-related matters.

While the Market Rules provide for employees of the MAU to report to and be administratively managed by EMC, the MAU also reports to and takes direction from the Chair of the MSCP on all matters related to the market monitoring and investigation duties contained in the Market Rules.

MSCP Annual Reporting

The MSCP Annual Report is developed in accordance with section 4.4.6 of Chapter 3 of the Market Rules. Pursuant to these provisions, the MSCP is required to prepare an annual report on the conduct of its monitoring activities and investigations for submission to EMC and its subsequent provision to the EMA.

The annual report includes a summary of routine reports on the MSCP's monitoring and investigation activities, and a summary of any report 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 contains a summary of all complaints or referrals filed and investigations commenced and concluded, a summary of all investigations conducted by the MSCP concerning offer variations after gate closure reported by EMC, and a general assessment by the MSCP of the state of competition and compliance within, and the efficiency of, the wholesale electricity market.

The MSCP Annual Report 2023 covers the period 1 January to 31 December 2023 and provides the MSCP with the opportunity to highlight significant outcomes relating to supply, demand, and electricity prices in the NEMS to inform market participants, potential entrants to the market, the regulatory body, and the industry as a whole about the market conditions observed throughout the year. The MSCP Annual Report also includes a section on the MSCP's market compliance decisions and enforcement actions taken by the MSCP based on the investigation of alleged breaches as part of its monitoring and compliance functions.

This is the 22nd report issued and published by the MSCP since 2003 on the wholesale electricity market of the NEMS. All annual reports by the MSCP are publicly available under the [Publications section of the EMC website](#).

MARKET MONITORING



CATALOGUE OF DATA AND CATALOGUE OF MONITORING INDICES/INDICATORS OF MARKET PERFORMANCE

Catalogues of Data and Monitoring Indices

The Singapore Electricity Market Rules (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 it acquires and a catalogue of the monitoring indices to evaluate market performance.

The [Catalogue of Data](#) and [Catalogue of Monitoring Indices](#) are publicly available on the Energy Market Company (EMC) website. The [Catalogue of Data](#) was last reviewed by the MSCP in consultation with the industry and the regulator in 2023 to incorporate new data, including data related to Electricity Imports (Import) and the Power System Operator's (PSO) Directed Supply Scheme (DSS) and Standby Capacity Scheme (SCS). The monitoring drivers in the [Catalogue of Monitoring Indices](#) were adopted following its update in July 2020 and incorporated since the MSCP Annual Report 2020.

Catalogue of Data

The information contained under the Catalogue of Data is collected by the MAU on a pre-determined frequency from different sources (including EMC, the PSO, and market participants) and is broadly categorised as generation registered facility characteristics data, transmission system data, supply data, demand data, pricing data and other data.

The latest catalogue of data was published and made effective on 1 February 2023.

Catalogue of Monitoring Indices

The catalogue of monitoring indices adopted by the MSCP include supply indices, demand indices and price indices, as listed below.

The latest catalogue of monitoring indices was made effective on 1 July 2020.

TABLE 1: CATALOGUE OF MONITORING INDICES

Type of Indices	Description of Indices
Supply Indices	Capacity ratio of a generation registered facility – Ratio of a generation registered facility's (a) scheduled generation output to (b) maximum generation capacity
	Supply cushion – Ratio of (a) the difference between total offered volume and system demand to (b) total offered volume
	Outage frequency
	Market share by: (a) generation type; (b) generation licensee; (c) generation registered facility and corresponding Herfindahl-Hirschman Index (HHI)
	Percentage of time output when there was one pivotal supplier
	Trend of price setting generating units
	Comparison of metered generation quantity with scheduled dispatch quantity by generation registered facility/generation licensee
	Frequency of issuance by the PSO of dispatch instructions deviating from real-time dispatch schedule
	Frequency of offer/bid variations or revisions to standing offers/bids exceeding offer/bid change limits
	Reasons and timings for the change in offer/bid variations exceeding offer/bid change limits
Frequency of demand response activation and analysis of energy bids	
Demand Indices	Comparison of latest available very short-term load forecast with real-time load forecast
	Comparison of real-time load forecast with metered generation quantity
Price Indices	Trend of Uniform Singapore Energy Price (USEP), reserve prices, regulation price and comparison of trends
	Percentage of hours and quantity of load when Wholesale Electricity Price (WEP) falls into a particular price range
	Correlation between WEP and system demand
	Correlation between WEP and fuel price
	Comparison of latest available short-term schedule projected prices with real-time prices

CATALOGUE OF DATA AND CATALOGUE OF MONITORING INDICES/INDICATORS OF MARKET PERFORMANCE

The temporary price cap (TPC) mechanism was introduced by the Energy Market Authority (EMA) on 1 July 2023 as part of a suite of initiatives to strengthen Singapore's energy market. The mechanism aims to mitigate extreme price volatility in the Singapore Wholesale Electricity Market. On a bi-weekly frequency, the EMA calculates the Moving Average Price Threshold (MAPT). When the average Uniform Singapore Energy Price (USEP) over a specified number of consecutive half-hour periods (currently at 48 periods) crosses the MAPT, this will trigger the activation of the TPC for the next 48 periods such that the USEP is capped at the TPC if the marginal energy offer price is at, or above, the TPC. The TPC will be automatically lifted once the average USEP over 48 consecutive half-hourly trading periods falls below the MAPT.

The price index on the "Trend of USEP, reserve prices, regulation price and comparison of trends" contains information and analysis on the application of the TPC mechanism.

Indicators of Market Performance

The MAU submits regular market performance monitoring updates to the MSCP. These updates include observations of several market performance indicators which are broadly classified into supply, demand, price, as well as energy and ancillary services indices.

MARKET CONCENTRATION: MARKET SHARE

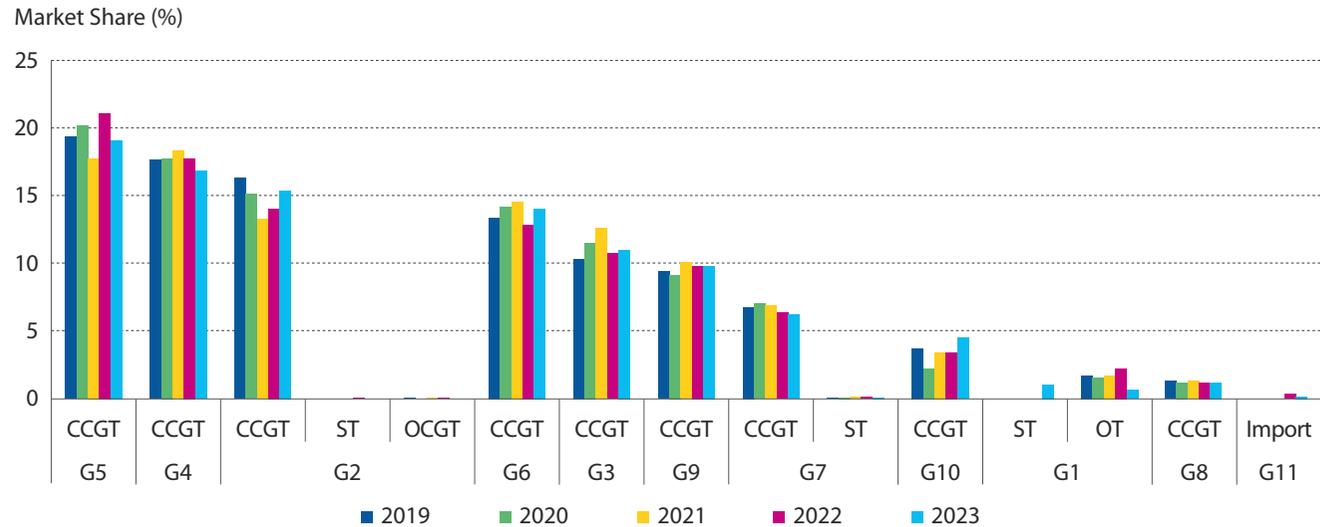
Chart 1 shows the market share by generation type of each generation company in the National Electricity Market of Singapore (NEMS) measured by the metered energy quantity, for the last five years. The generation companies are arranged in descending order according to their market share in 2023.

The market is largely dominated by the Combined Cycle Gas Turbine (CCGT) units, which recorded a market share of 98.09% in 2023. This was followed by Steam Turbine (ST) units under G1 and G7, Other Facilities (OT) units under G1, and Electricity Imports (Import) under G11, which accounted for 1.13%, 0.61% and 0.16% of the market respectively. Open Cycle Gas Turbine (OCGT) units did not record any generation in 2023. The market shares across the generation mix remained largely similar over the last five years, with strong dependency on the more efficient CCGT units, which have accounted for more than 97% of the market since 2019. The CCGT and ST market shares saw the largest gains of the past five years in 2023. In contrast, the OT market share dipped to its lowest level since 2019.

The Import under G11 commenced providing supply into the system in 2022 and constituted 0.16% of total metered energy quantity in 2023. The OCGT and ST units under G2 and G7 ran intermittently over the last five years and therefore are not significantly reflected in Chart 1.

Table 2 shows the yearly average market share of all generation companies in terms of metered energy quantity. The three generation companies with the largest market share by metered energy quantity in 2023 are G5, G4, and G2. Their combined market share was 51.34%, a slight reduction from 52.84% in the previous year. This was consistent with the trend of the past five years, where the top three generation companies accounted for 50% to 54% of the total market share. The ranking of all 11 generation companies remained unchanged from 2022.

CHART 1: MARKET SHARE BASED ON METERED ENERGY QUANTITY BY GENERATION COMPANY AND GENERATION TYPE



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

TABLE 2: MARKET SHARE BASED ON METERED ENERGY QUANTITY BY GENERATION COMPANY (%)

Year	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11
2019	1.74	16.36	10.35	17.66	19.29	13.36	6.81	1.38	9.41	3.64	-
2020	1.57	15.04	11.54	17.81	20.18	14.12	7.17	1.20	9.13	2.23	-
2021	1.71	13.36	12.54	18.24	17.75	14.55	7.02	1.37	10.03	3.41	-
2022	2.25	14.10	10.77	17.68	21.06	12.91	6.42	1.20	9.86	3.42	0.34
2023	1.67	15.34	11.02	16.88	19.13	13.99	6.35	1.15	9.81	4.51	0.16

Note: The percentages in this table may not add up to 100% due to rounding.

MARKET CONCENTRATION: MARKET SHARE

CHART 2: MARKET SHARE BASED ON MAXIMUM CAPACITY BY GENERATION COMPANY AND GENERATION TYPE

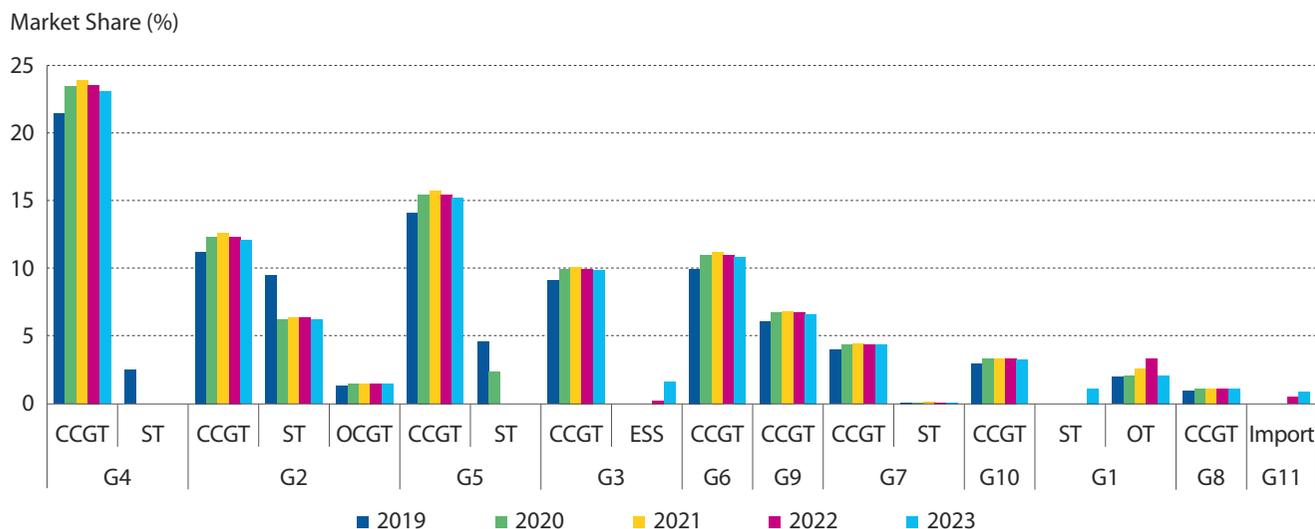


Chart 2 shows the market share based on maximum capacity by generation company. The generation companies are arranged in descending order according to their market share in 2023.

After reaching a five-year high of 89.38% in 2021, the annual average market share of the CCGT generation type based on maximum capacity dipped for a second consecutive year to 86.48% in 2023. The market shares of the OT and OCGT categories also shrank 1.19 and 0.03 percentage points respectively compared to the previous year.

With the loss of market shares for the CCGT, OT and OCGT generation types, there were gains in market shares mainly for the ST and Energy Storage System³ (ESS) generation types. ST's market share rose for the first time in five years, growing to 7.43% in 2023 from 6.42% in 2022. Of all the generation types, ESS recorded the largest annual growth in its market share, which rose 1.45 percentage points to 1.66% in 2023. Import's market share rose modestly to 0.83% in 2023 from 0.46% in 2022.

TABLE 3: MARKET SHARE BASED ON MAXIMUM CAPACITY BY GENERATION COMPANY (%)

Year	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11
2019	1.96	22.08	9.08	23.94	18.69	10.01	4.08	1.02	6.11	3.02	-
2020	2.15	20.10	9.95	23.49	17.75	10.96	4.47	1.12	6.69	3.31	-
2021	2.57	20.50	10.14	23.95	15.75	11.18	4.56	1.14	6.83	3.38	-
2022	3.31	20.20	10.20	23.61	15.52	11.02	4.50	1.12	6.73	3.33	0.46
2023	3.24	19.82	11.47	23.17	15.23	10.84	4.41	1.10	6.62	3.27	0.83

Note: The percentages in this table may not add up to 100% due to rounding.

Table 3 consolidates the yearly average market share of all generation companies in terms of maximum capacity. When ranked by maximum capacity, the top three generation companies of 2023 kept their positions from 2022. However, their combined market share continued to shrink, falling 1.11 percentage points to 58.22% in 2023 from the year before.

Of the generation companies, only G3 and G11 recorded growth in market share. The highest growth was seen in G3, whose market share rose to 11.47% in 2023 due to the addition of a new facility, up from 10.20% in 2022. On the other hand, the three leading generation companies saw the most significant year-on-year declines in market share. G4's market share shrank most – slipping 0.44 percentage point compared to 2022.

³ Actual capacities of the ESS facilities are used.

MARKET CONCENTRATION: HERFINDAHL-HIRSCHMAN INDEX

TABLE 4: HERFINDAHL-HIRSCHMAN INDEX

Year	Minimum	Maximum	Average	Maximum Share (%)
2019	1,349	1,467	1,400	19.29
2020	1,350	1,534	1,441	20.18
2021	1,322	1,433	1,366	18.24
2022	1,326	1,512	1,407	21.06
2023	1,322	1,455	1,371	19.13

The Herfindahl-Hirschman Index (HHI) is a globally-used measurement of market concentration in electricity markets. A higher HHI indicates a decrease in the number of generation companies in the market and/or a larger difference in proportion of market share among the generation companies.

The HHI is the sum of squares of the market share of each firm in a market – based on the generation companies’ metered energy quantity and expressed as decimals – multiplied by 10,000.

In Table 4, the HHI calculates the market share of generation companies measured by the metered energy quantity of their annual electricity generation.

The HHI classifies the electricity market into three categories: in “unconcentrated markets” where the index is below 1,000, in “moderately concentrated markets” where the index is between 1,000 and 1,800, and in “highly concentrated markets” where the index is above 1,800. The classification is adopted from the United States Department of Justice and the Federal Trade Commission under the [Horizontal Merger Guidelines in 1992](#).

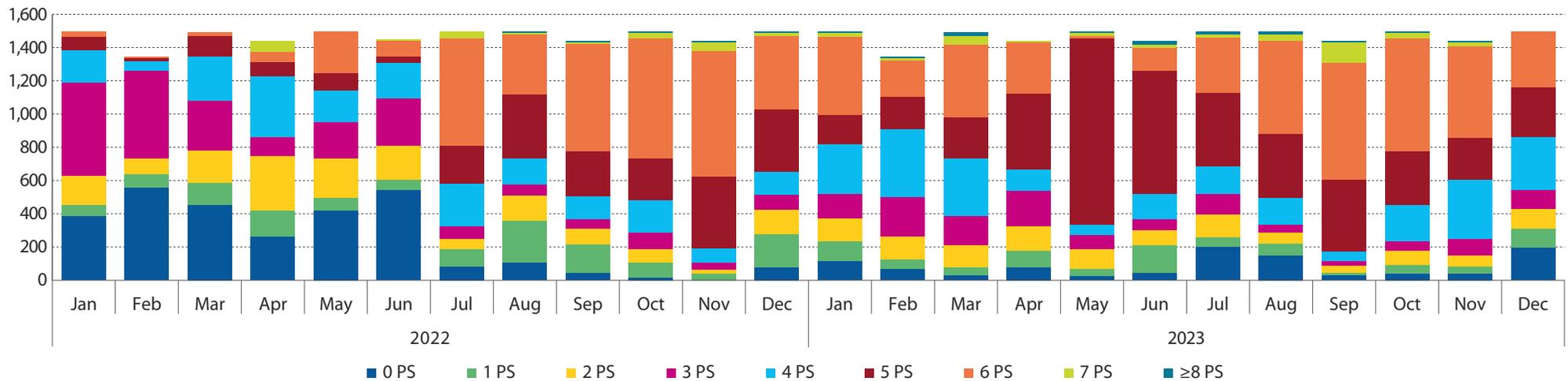
The monthly average HHI for the NEMS decreased to 1,371 in 2023 from 1,407 in 2022. This was in line with a dip in the maximum market share held by the generation company with the highest percentage of metered energy quantity to 19.13% in 2023 from 21.06% in 2022, as observed in Table 2. Moreover, the range between the minimum and maximum HHI of 2023 narrowed to 134 from the five-year high of 186 seen in 2022.

Overall, the NEMS remained moderately concentrated as there was no significant change in the proportion of metered generation quantity in the market in 2023. Over the last five years, the monthly HHI of the NEMS hovered between 1,300 and 1,600, which lies in the “moderately concentrated markets” range of 1,000 to 1,800.

MARKET CONCENTRATION: PIVOTAL SUPPLIER TEST

CHART 3: FREQUENCY OF GENERATION COMPANIES AS PIVOTAL SUPPLIERS (PS) PER PERIOD

Number of Periods



The pivotal supplier test is an indicator of structural market power in the NEMS. A pivotal supplier is present when the total system demand for a particular period cannot be met without including the supply capacity of any one market participant.

Chart 3 above displays the frequency of pivotal suppliers for each month in 2022 and 2023.

The number of periods with zero to three pivotal suppliers decreased from the previous year, dropping a combined 46.63% between 2022 and 2023. In contrast, the number of trading periods with five pivotal suppliers rose by the greatest magnitude to a total of 5,036 periods in 2023, more than double what it was in 2022.

Notably, the maximum number of pivotal suppliers recorded per period reached a new high in 2023. In 2022, the peak number of pivotal suppliers per period was eight, for a total of 37 periods in the year. This soared to 20 pivotal suppliers in 2023, and this maximum number surfaced in five periods. This was consistent with the record low supply cushion in 2023, which saw numerous periods of energy, regulation and reserve shortfall throughout the year. Of the 24 periods with ten or more pivotal suppliers in 2023, 18 of those periods experienced energy shortfalls, and five periods had ancillary product shortfalls.

Given the record low supply cushion in 2023, it is reasonable that generation companies, even those with relatively smaller capacities, became pivotal suppliers. As a record number of generation companies were identified as pivotal suppliers, these market participants may have gained unilateral market power in 2023.

SUPPLY INDICES: CAPACITY RATIO

TABLE 5: CAPACITY RATIO BY GENERATION TYPE (%)

Year	CCGT	ST	OT	OCGT	Import	ESS
2022	64.31	9.86	31.40	2.09	37.82	3.65
2023	63.79	8.05	21.62	0.21	9.68	10.08
YOY Change	-0.52	-1.81	-9.78	-1.89	-28.15	6.43

The capacity ratio represents the utilisation level of each generation type – its scheduled output to its maximum generation capacity. Table 5 compares the yearly average capacity ratio of the six generation types in 2022 and 2023.

In 2023, the capacity ratios by generation type shrunk across the board, with the exception of ESS. For the ST, OT, and OCGT generation types, the declines were consistent with higher outage levels in 2023. The capacity ratio for CCGT was relatively unchanged from the previous year, dipping 0.52 percentage point in 2023 to a yearly average of 63.79%.

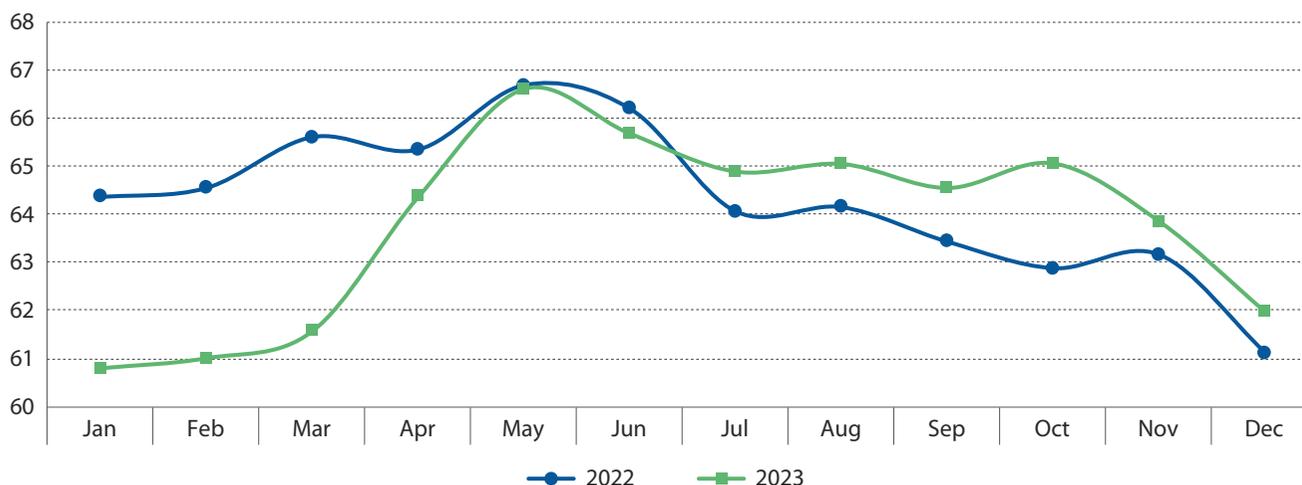
The lower capacity ratios were also in line with the lower frequency and magnitude of dispatch directions issued by the PSO in 2023, compared to 2022. The capacity ratio for Imports fell 28.15 percentage points to 9.68% in 2023 from 37.82% in 2022. The Lao People's Democratic Republic-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP), which commenced in June 2022, was the first electricity import trial. More feasibility testing is expected in the initial years of the trial, which may account for the variability in the capacity ratio across 2022 and 2023.

The primary gainer in terms of capacity ratio in 2023 was the ESS generation type. This was in line with the addition of a new facility and the role ESS may have played in supplementing supply to meet peak demand during the year. This resulted in a 6.43 percentage point gain in the ESS capacity ratio to a yearly average of 10.08% in 2023.

Overall, the NEMS continued to rely on the CCGT units to meet system demand. The CCGT units continued to hold the largest capacity ratio by generation type, as the most efficient generation type in the NEMS.

CHART 4: COMPARISON OF CAPACITY RATIOS OF CCGT UNITS

Capacity Ratio (%)



A monthly comparison of the capacity ratio of CCGT units in 2022 and 2023 is shown in Chart 4.

In 2023, the monthly average capacity ratio of CCGT units was significantly lower than 2022 in the first quarter of the year, in line with increased levels of CCGT planned and unplanned maintenance observed in 2023. Conversely, the CCGT capacity ratio was moderately higher for Q2 to Q4 2023 as compared to 2022, consistent with the 6.99% contraction in CCGT outages for those quarters.

The larger year-on-year (YOY) drop observed in the capacity ratio for Q1 was counteracted by climbs in the remaining three quarters of the year. Hence, the yearly average capacity ratio for CCGT units dipped marginally by 0.52 percentage point to 63.79% in 2023 from 64.31% in 2022, despite a decline in the overall average CCGT outage level.

SUPPLY INDICES: OUTAGES

TABLE 6: AVERAGE OUTAGES BY GENERATION TYPE (MW)

Year	Planned Outages								Forced Outages								Total Outages	YOY Change (%)
	CCGT	ST	OT	OCGT	Import	ESS	Sum	%	CCGT	ST	OT	OCGT	Import	ESS	Sum	%		
2019	961.64	299.29	5.82	14.43	-	-	1,281.18	94.57	73.51	0.02	0.06	0.00	-	-	73.59	5.43	1,354.77	15.13
2020	965.25	91.79	25.23	33.87	-	-	1,116.15	92.57	89.27	0.02	0.24	0.00	-	-	89.53	7.43	1,205.67	-11.01
2021	1,027.38	106.99	26.76	5.39	-	-	1,166.53	92.59	84.08	7.62	1.19	0.48	-	-	93.37	7.41	1,259.90	4.50
2022	1,751.34	317.90	98.03	12.79	10.57	-	2,190.63	96.04	88.85	0.32	0.89	0.01	0.16	-	90.23	3.96	2,280.86	81.04
2023	1,668.56	469.42	139.83	15.26	7.80	0.27	2,301.14	97.84	46.54	0.02	3.84	0.02	0.34	-	50.76	2.16	2,351.90	3.11

Note: The outage volume of ESS will be published from 2023 onwards.

Table 6 provides an overview of the periodic outage volume by generation type for the last five years.

As observed in 2022, CCGT planned maintenance levels climbed significantly, pushing the total outage volume to almost double that in 2021. This trend could be reflective of how several facilities are nearing the end of their economic life.

Although the CCGT planned outages eased slightly in 2023, they remained at a relatively elevated level. On the other hand, the average planned outage volume increased for ST, OT, and OCGT units from the previous year. This resulted in 2023 recording the highest average planned outage volume of the past five years, hitting just above 2,300 megawatts (MW).

In contrast, the volume of annual average forced outages per period fell to 50.76MW in 2023 from 90.23MW in 2022. This improvement was mostly attributed to the decline in CCGT forced outage levels.

Overall, this resulted in a minor 3.11% year-on-year increase in the yearly total outages to 2,351.90MW.

SUPPLY INDICES: OUTAGES

CHART 5: PLANNED OUTAGES VS USEP

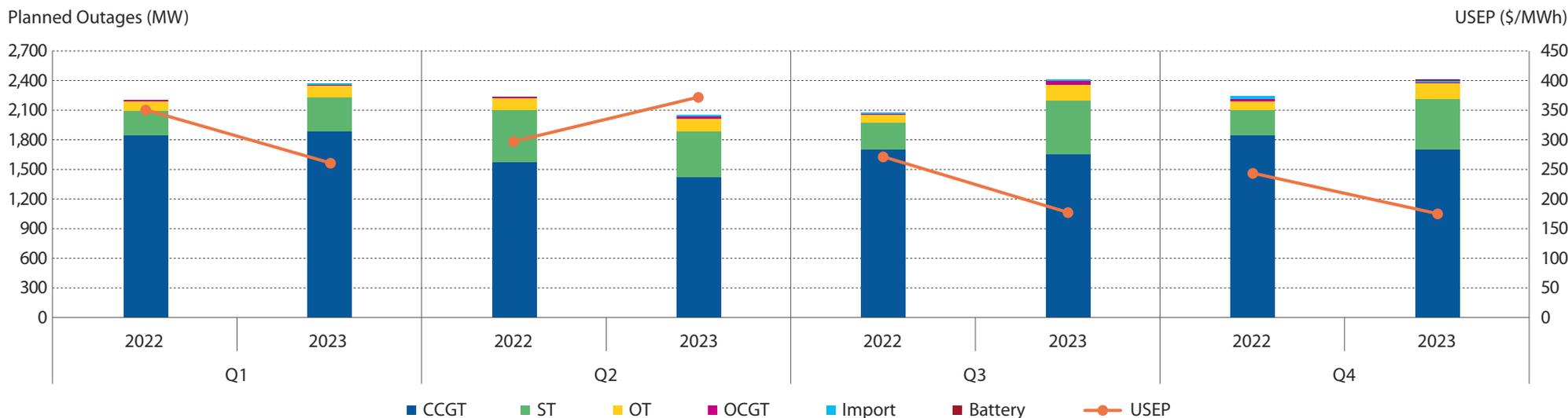


Chart 5 compares the quarterly average planned outages against the quarterly average USEP in 2022 and 2023.

The USEP is typically expected to move in tandem with planned outage volumes, as a higher level of planned outages means a contraction in supply and hence a higher USEP. However, Chart 5 shows that this was not the case in 2023, as the level of planned outages each quarter followed an inverse trend to the USEP's movement.

In Q1, Q3 and Q4, a rise in planned outages, compared to the corresponding quarter in 2022, was coupled with a decline in the USEP. This contrary behaviour might be explained by the PSO's dispatch directions under the DSS, which were higher in those quarters. Additionally, the activation of the TPC for a total of 187 periods in Q3, as well as relatively cheaper energy offers compared to 2022, might also have contributed to the lower USEP in 2023.

On the other hand, despite a lower level of planned outages, the USEP rose 25.83% to \$373.73 per megawatt hour (MWh) in Q2 2023 from \$297.01/MWh in Q2 2022. This was in line with the occurrences of energy shortfall in 2023, mostly observed in June, which was the month with the lowest periodic supply cushion levels of the year. Energy shortfalls in late June pushed the USEP to clear at the price cap of \$4,500/MWh for a total of five periods.

SUPPLY INDICES: AVAILABLE GENERATION CAPACITY

CHART 6: AVAILABLE GENERATION CAPACITY⁴

Available Capacity (MW)

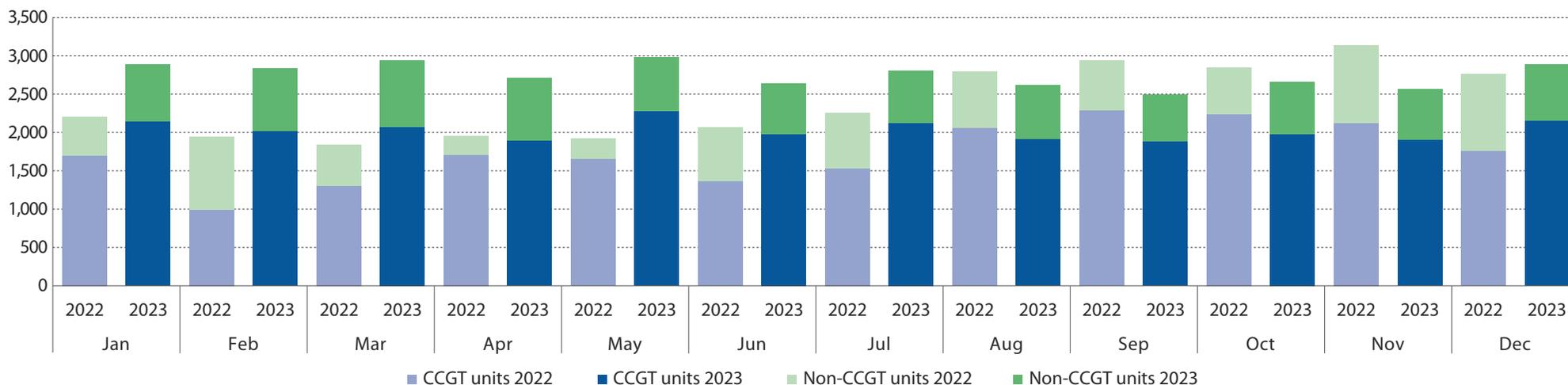


Chart 6 shows the available generation capacity on a monthly basis in 2022 and 2023. The available generation capacity refers to capacity that is not offered to the market even though the generation units are not on planned nor unplanned maintenance. Generally, the non-CCGT generation types have high available generation capacity as they are not baseload providers and are only likely to offer into the system under certain market conditions.

In 2022, the available generation capacity was comparatively lower in the first half of the year, before increasing steadily in the second half. In contrast, the available generation capacity in 2023 was slightly higher in the first two quarters. This was consistent with the higher gas curtailment observed in the first half of 2023 compared to the second half. Given that CCGT units mainly operate on natural gas, such gas curtailment occurrences may have resulted in a shortage of the main fuel for CCGT units, thus pushing the available generation capacity up.

Overall, the available generation capacity grew by 15.36% from 2022 to 2023, with that from CCGT and non-CCGT units' growing 17.44% and 9.90% respectively. The year-on-year increase was in line with the trend in PSO directions issued under the DSS, which decreased in both frequency and magnitude of the directed quantity compared to 2022.

⁴ Figures for 2022 may differ from the 2022 MSCP Annual Report as monthly registered maximum capacity figures are used in 2023's annual report.

SUPPLY INDICES: SUPPLY CUSHION

CHART 7: RELATIONSHIP BETWEEN SUPPLY CUSHION AND USEP

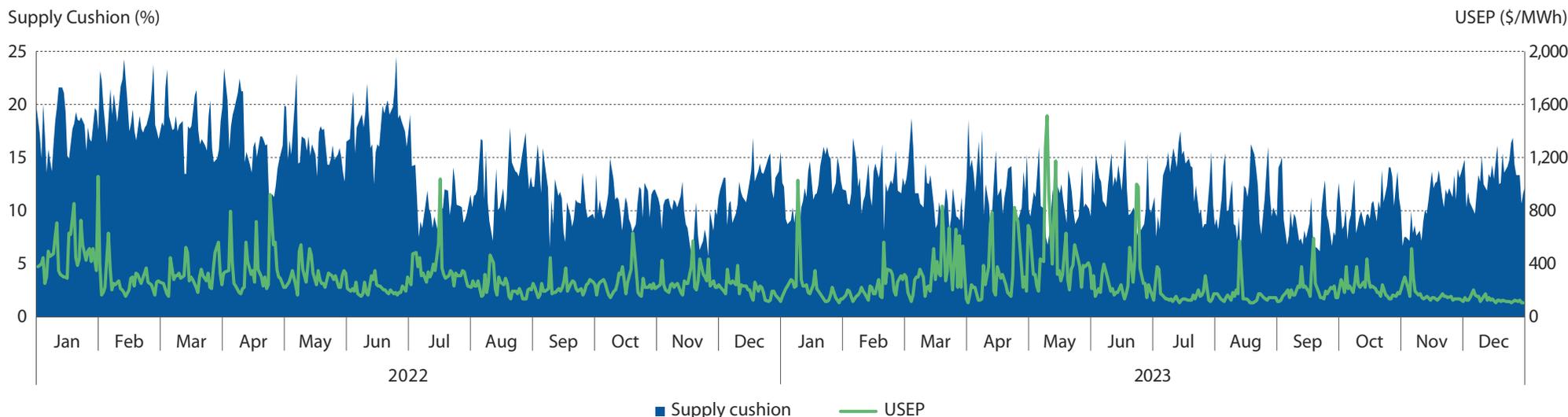


Chart 7 illustrates the relationship between the daily average USEP and the daily average supply cushion for 2022 and 2023. The supply cushion measures the level of spare capacity available after dispatch. Generally, the USEP and the supply cushion are inversely correlated. A lower supply cushion usually results in a higher USEP, as more expensive supply is dispatched to meet the demand during times of tight supply conditions.

The yearly average supply cushion in 2023 tightened 2.95 percentage points to 11.51%, the lowest annual average supply cushion since market start. However, the USEP also fell, dipping to \$247.52/MWh in 2023 from a yearly average of \$291.81/MWh in 2022.

The record low supply cushion was mainly driven by a contraction in energy supply, reflected in the higher levels of outages shown in Table 6, as well as the surge in available generation capacity seen in Chart 6.

Compared to 2022, the increased volatility in the USEP is particularly apparent in the first half of 2023. The daily average supply cushion plunged to 11.85% in H1 2023, from 17.71% in H1 2022. This was consistent with how the majority of energy shortfalls in 2023 occurred in the first half of the year.

Although the daily average supply cushion was relatively unchanged in the second half of the year at 11.18%, prices dampened significantly. This was in line with the implementation and activation of the TPC from July 2023, and relatively cheaper energy offers compared to 2022. The lower USEP could also be partly attributed to the directions under the DSS, which was utilised by the PSO to a much greater extent in the second half of 2023, and the new vesting regime framework which took effect from 1 July 2023.

BOX 1. TEMPORARY PRICE CAP (TPC) MECHANISM

As part of a suite of initiatives to strengthen Singapore's energy market, the Energy Market Authority (EMA) introduced the Temporary Price Cap (TPC) mechanism on 1 July 2023 as a short-term measure to mitigate extreme price volatility and risk aversion in the Singapore Wholesale Electricity Market.

The TPC is designed to activate only during periods of high and sustained volatility in energy prices. Once activated, prices may be capped at a level pre-determined by the EMA. Once volatility returns to normal levels, the TPC will be deactivated.

SUPPLY INDICES: SUPPLY CUSHION

CHART 8: RELATIONSHIP BETWEEN SUPPLY CUSHION AND USEP IN 2023

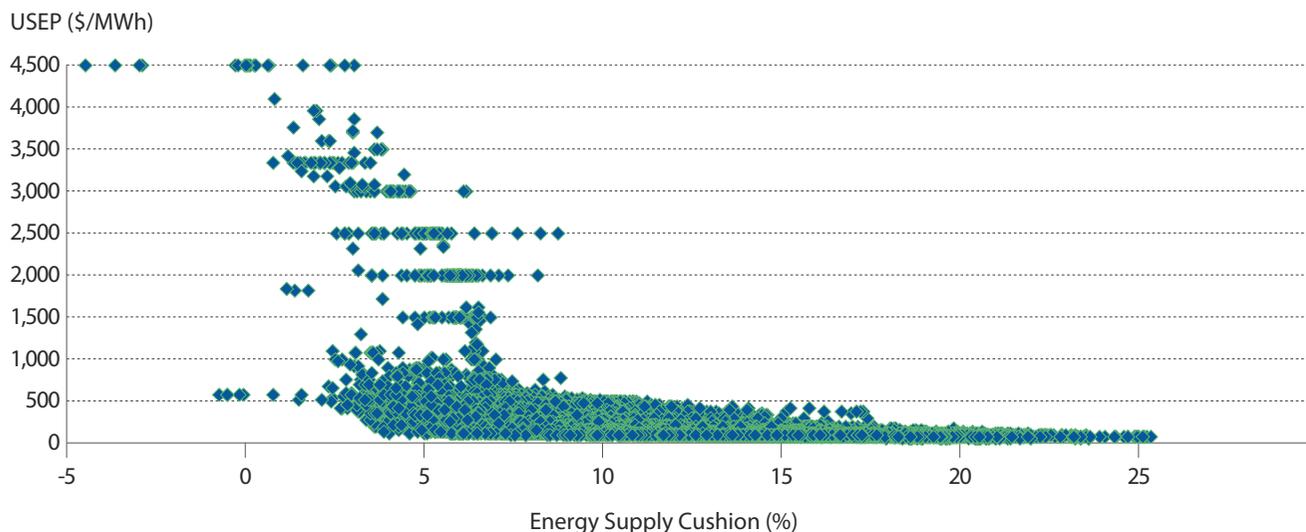


Chart 8 shows the relationship between the USEP and the supply cushion in 2023 across all dispatch periods.

The periodic USEP exceeded \$1,000/MWh on 320 instances in 2023, compared to 275 in 2022. Furthermore, the periodic USEP reached the price cap of \$4,500/MWh on 20 occasions in 2023 compared to once in 2022.

Notably, the supply cushion fell below zero in ten periods in 2023, as can be seen on the left side of Chart 8. This is only the second year since the start of the market that a negative supply cushion has been observed, the other being 2011, which saw two such periods. Of the 11 periods of negative supply cushion in 2023, six periods recorded energy shortfall, pushing the USEP to clear at \$4,500/MWh. For the remaining five periods, the USEP cleared at \$584.01/MWh despite the negative supply cushion, as the TPC had been activated in those periods. The Reference USEP for these affected periods was \$4,500/MWh, indicating that the USEP would have cleared at the price cap if the TPC had not been in effect.

TABLE 7: RELATIONSHIP BETWEEN SUPPLY CUSHION (%) AND USEP (\$/MWH)

Year	Supply Cushion < 15%			Supply Cushion ≥ 15%		
	Number of Periods	Average USEP	Max USEP	Number of Periods	Average USEP	Max USEP
2019	222	306.18	1,354.86	17,298	95.61	1,187.31
2020	848	167.28	1,254.04	16,720	65.07	570.72
2021	1,713	623.76	4,499.09	15,807	150.01	3,007.35
2022	10,703	348.60	4,500.00	6,817	202.64	2,847.83
2023	13,722	282.95	4,500.00	3,798	119.25	436.39

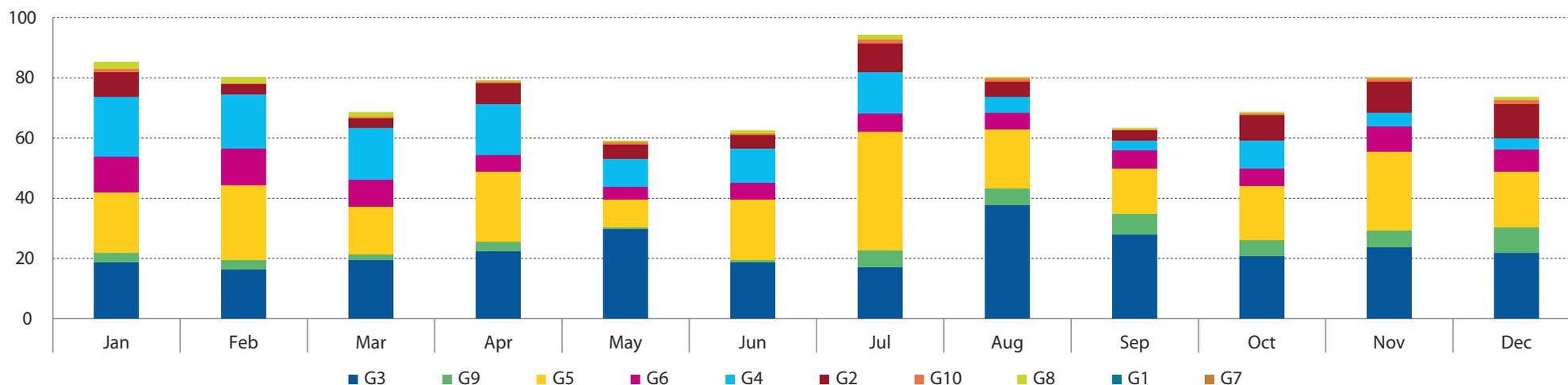
Table 7 summarises the yearly average USEP movements with a supply cushion of less than, and greater than or equal to, the 15% level over the past five years.

In line with Chart 7, the number of periods for which the supply cushion was below the 15% level rose significantly from 2022 to 2023. The periodic supply cushion fell below the 15% level 78.32% of the time in 2023, compared to 61.09% in 2022. In contrast, the average USEP during those periods fell to \$282.95/MWh in 2023 from \$348.60/MWh in 2022. The increased number of periods with tight supply conditions is in line with the higher outage levels in 2023. Furthermore, the USEP’s declining trend for periods with supply cushion below 15% since 2021 could be reflective of EMA’s measures to stabilise the market in recent years, such as PSO-directed dispatch instructions under the DSS since 2022, and the TPC from July 2023.

SUPPLY INDICES: PRICE SETTER

CHART 9: TREND OF PRICE SETTING GENERATION COMPANIES

Total Periods (%)



Note: Due to a change in methodology, the trend of price setting generation companies has been revised.

A price setter is a generation company which provides the block price quantity pair that fulfils the last marginal quantity to meet the entire system demand.

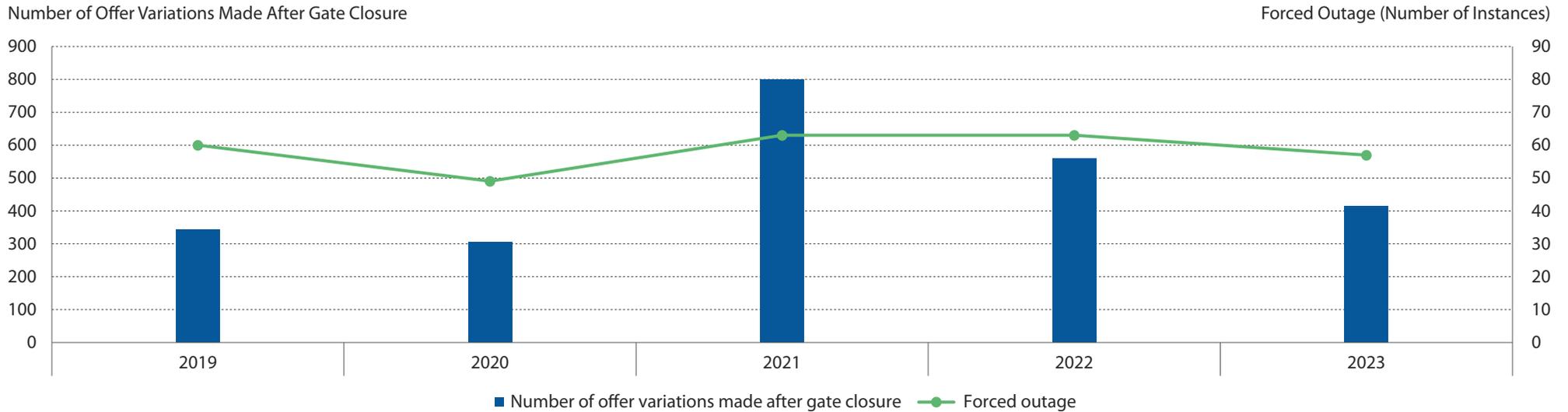
Chart 9 shows the number of periods in which each generation company was the price setter, expressed as a percentage of the total number of periods in the month.

In 2023, the percentage of periods which had a price setter ranged from a low of 58.67% in May to a high of 94.22% in July.

The three generation companies most frequently identified as price setters in 2023 did so for 73.59% of the periods with a price setter, up from 65.77% in 2022. These top three generation companies, G3, G5 and G4, were the price setters for 30.99%, 27.86% and 14.73% respectively, of all periods with a price setter. They had also been the three most frequent price setters in 2022, though G3 displaced G5 to become the most frequent price setter of 2023. Nonetheless, G5 set the price for 39.11% of the periods in July 2023, the peak monthly level of any generation company in the year.

SUPPLY INDICES: OFFER/BID VARIATIONS

CHART 10: OFFER VARIATIONS MADE AFTER GATE CLOSURE



In accordance with the Market Rules, offers and bids should be submitted at least 65 minutes before the actual trading period. Offer and bid variations made within the gate closure window of 65 minutes are tracked and regularly reported to the MSCP for investigation.

Chart 10 compares the number of offer variations made after gate closure from 2019 to 2023 in relation to the number of forced outages.

From 2019 to 2023, the trend of forced outage occurrences correlated with the trend in the number of offer variations made after gate closure, with the exception of 2022. In 2021, the number of offer variations made after gate closure increased sharply, amidst a modest increase in the number of forced outages. This was the year a gas supply crunch resulted in acutely tight supply conditions in the NEMS. To cope with urgent upstream gas curtailment occurrences, generation companies may have made a higher than usual number of offer variations after gate closure.

In 2022, a rule change was effected to exempt Generation Registered Facilities (GRF) undergoing a fuel changeover directed by the PSO from the Automatic Financial Penalty Scheme (AFPS). For such cases, there was no need for a GRF to submit offer variations after gate closure, as they would no longer incur a penalty under the AFPS. This corresponded to the drop in offer variations made after gate closure, which fell from 799 in 2021 to 559 in 2022.

In 2023, the number of offer variations made after gate closure declined even further, in line with the fewer instances of forced outages. However, the number remains higher than pre-2021 levels, attributed in part to the cases of offer variations after gate closure in response to PSO's dispatch directions.

SUPPLY INDICES: OFFER/BID VARIATIONS

CHART 11: SUBMISSION TIME OF OFFER VARIATIONS MADE WITHIN GATE CLOSURE

Number of Offer Variations

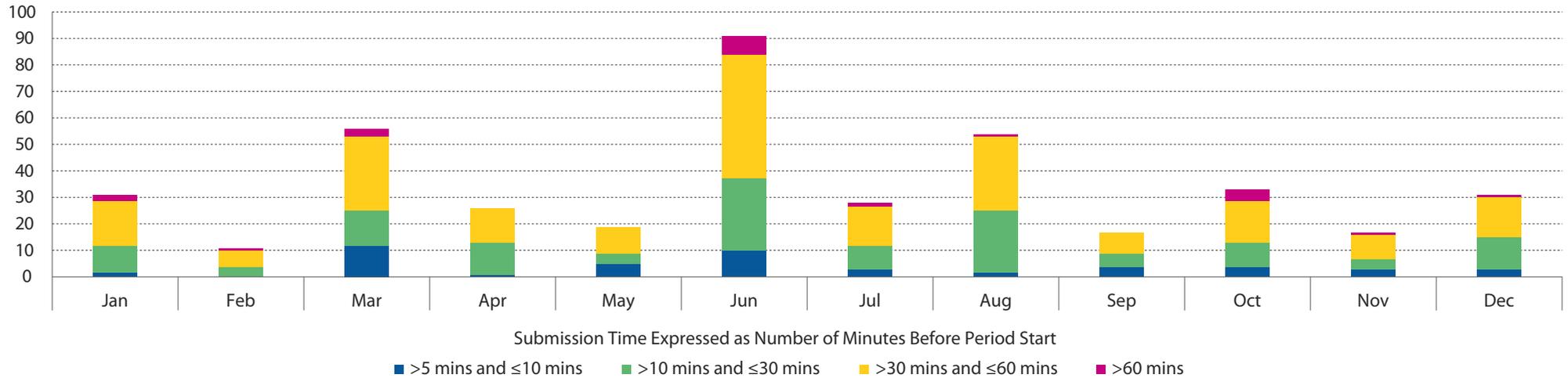


Chart 11 reflects monthly offer variations in 2023 submitted within the gate closure window or less than 65 minutes before the actual trading period, categorised by ranges of proximity of submission time to the actual trading period.

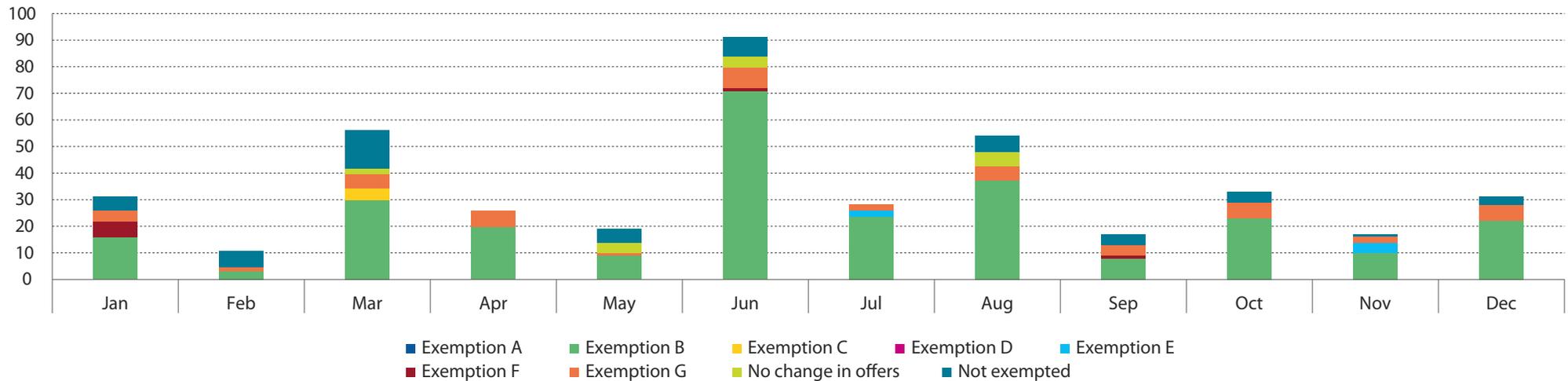
Notably, the number of offer variations made within the gate closure window increased significantly in the month of June 2023. This was largely driven by generation companies responding to forced outages, as well as dispatch directions issued by the PSO under the DSS.

Nevertheless, offer variations were submitted between ten minutes and 65 minutes before the actual trading periods in 88% of the total occurrences. This indicates that generation companies were still sufficiently able to respond before the start of the actual trading period, similar to the trend observed in 2022.

SUPPLY INDICES: OFFER/BID VARIATIONS

CHART 12: CASES OF OFFER VARIATIONS MADE AFTER GATE CLOSURE

Number of Offer Variations Made After Gate Closure



Under section 10.4.1 of Chapter 6 of the Market Rules, conditions have been set out as exemptions to the violation of the gate closure rules for Generation Registered Facilities and Load Registered Facilities (please refer to Box 2 for more details on exempted cases).

Chart 12 shows that of the 414 cases assessed by the MSCP in 2023, 344 cases were determined not to be in breach of the Market Rules as they were exempted under Exemptions A-G, and a further 15 cases were determined not to be in breach due to no changes in the offer submissions.

In line with Chart 11, Chart 12 shows an increased number of cases of violation of the gate closure rules in June 2023, reflecting generation companies making submissions of last-minute offer variations largely in response to forced outages.

The [MSCP determinations](#) on the gate closure violation cases assessed by the panel are included in the State of Compliance within the Wholesale Electricity Market section of this report and have been published on the EMC website.

SUPPLY INDICES: OFFER/BID VARIATIONS

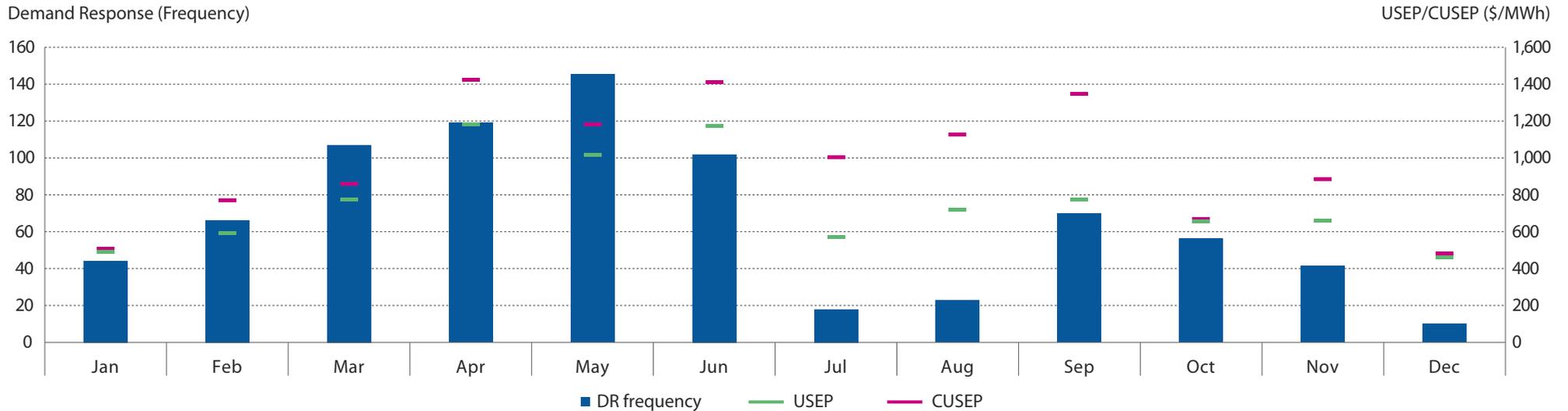
BOX 2. EXEMPTION CONDITIONS FOR CASES OF OFFER VARIATIONS MADE AFTER GATE CLOSURE

As provided by section 10.4.1 of Chapter 6 of the Market Rules, there are prescribed circumstances specified as exemptions for the assessment of offer variations made after gate closure, subjected to section 10.4.1.2. These exemptions are listed below:

- Exemption A** refers to section 10.4.1.1a. of Chapter 6 of the Market Rules, where an offer variation is intended for a generation registered facility, to reflect its expected ramp-up and ramp-down profiles during periods following synchronisation or preceding desynchronisation.
- Exemption B** refers to section 10.4.1.1b. of Chapter 6 of the Market Rules, where an offer variation is intended for a generation registered facility, to reflect its revised capability for the three consecutive dispatch periods immediately following a forced outage or its failure to synchronise.
- Exemption C** refers to section 10.4.1.1c. of Chapter 6 of the Market Rules, where an offer variation is intended for an import registered facility, to reflect its revised capability for the three consecutive dispatch periods immediately following a forced outage, including
- (i) a forced outage of the interties connecting the import register facility to the transmission system,
 - (ii) a forced outage or failure to synchronise of any constituent generating units in the interconnected system that form part of the import registered facility, or
 - (iii) a transmission constraint within the interconnected system.
- Exemption D** refers to section 10.4.1.1d. of Chapter 6 of the Market Rules, where an offer variation is intended to contribute positively to the resolution of an energy surplus situation pertaining to which Energy Market Company (EMC) has issued an advisory notice under section 9.3.1 of Chapter 6 of the Market Rules, by allowing for decreased supply of energy.
- Exemption E** refers to section 10.4.1.1e. of Chapter 6 of the Market Rules, where an offer variation is intended to contribute positively to the resolution of energy, reserve or regulation shortfall situations pertaining to which EMC has issued advisory notices under section 9.3.1 of Chapter 6 of the Market Rules, by allowing for increased supply of energy, reserve or regulation.
- Exemption F** refers to section 10.4.1.1f. of Chapter 6 of the Market Rules, where an offer variation is intended to contribute positively to the resolution of energy, reserve or regulation shortfall situations in that dispatch period, where:
- (i) the shortfall situations were indicated in a system status advisory notice issued by EMC in respect of a high-risk operating state or emergency operating state declared by the Power System Operator (PSO); and
 - (ii) at the time of submission of such offer variation or revised standing offer, EMC has not yet withdrawn, in respect of that dispatch period, such system status advisory notice by allowing for increased supply of energy, reserve or regulation.
- Exemption G** refers to section 10.4.1.1g. of Chapter 6 of the Market Rules, where an offer variation is intended for a load registered facility, to reflect its revised capability during a forced outage or following a decrease in energy withdrawal under sections 9.3.3 and/or 9.3.4 of Chapter 5 of the Market Rules.

SUPPLY INDICES: DEMAND RESPONSE

CHART 13: DEMAND RESPONSE FREQUENCY VS USEP



The EMA introduced the demand response (DR) programme in 2016 to enhance competition in the wholesale electricity market, ensure a means to allow electricity demand to be met effectively, and improve system reliability during periods of supply shortage.

The DR programme provides contestable consumers with the opportunity to voluntarily curtail their electricity demand in exchange for a share in system-wide benefits, in particular, from the reduction in the wholesale electricity price.

Licensed load providers are required to be compliant with 100% of the scheduled load curtailment to be paid. Moreover, penalties will be imposed on providers which are compliant with less than 95% of their scheduled curtailment.

The EMA enhanced the DR and interruptible load (IL) programmes through the Demand Side Management Sandbox, to be in effect from 1 January 2023 till 31 December 2024. The sandbox aims to encourage increased consumer participation through measures such as a relaxed penalty regime and lower compliance threshold.

The number of DR activations in the market were low in the early years of the programme – only 25 instances were recorded up to 2020. The frequency then rose significantly to 343 periods in 2021 and 883 periods in 2022. The increased number of activations coincided with a period of higher price volatility in the market.

As shown in Chart 13, the number of DR activations was notably higher in the first half of 2023, particularly in Q2, when market conditions were tighter. May was the month with the most DR activations, contributing 145 periods to the yearly total of 801 DR activations in 2023.

Chart 13 also shows the relatively large differences observed between the USEP and the Counterfactual USEP (CUSEP) during times of activation, highlighting how the DR programme has improved system reliability during periods of supply shortage and can deliver system-wide benefits through the cost savings which come with reduced wholesale energy prices.

DEMAND INDICES: METERED ENERGY QUANTITY

CHART 14: COMPARISON OF ACTUAL DEMAND

Metered Energy Quantity (MW)

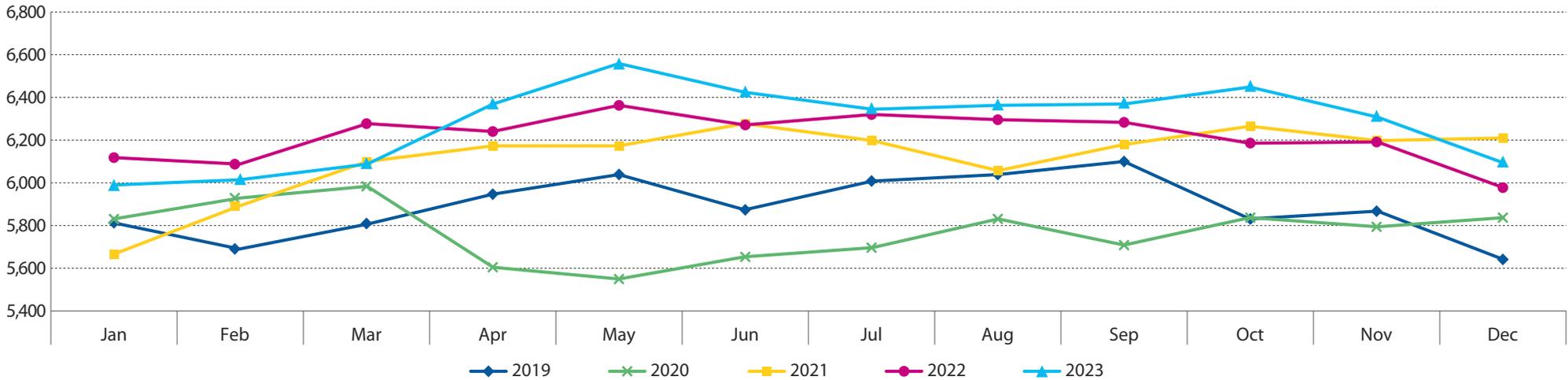


Chart 14 compares actual demand (computed from metered energy quantity) over the years 2019 to 2023. 2023's average demand was the highest since the NEMS started in 2003, rising 1.02% to 6,280MW from 6,218MW in 2022.

Every month in 2023, except for January, had an average demand above 6,000MW. The lower demand observed in January was in line with it being the month with the lowest temperature recorded for the year.

Average demand increased sharply from March to May 2023, and May was the month with the highest average demand for the year of 6,557MW. The stronger demand was largely due to the higher temperature observed during this period.

From April to December 2023, average demand was higher than each corresponding month in 2022. For all of those nine months, except for December 2023, average demand stayed above 6,300MW. In contrast, for the first three months of 2023, average demand was lower than 2022's levels. This could be due to the lower temperature and lower level of manufacturing activity during that period.

DEMAND INDICES: ACCURACY OF PRE-DISPATCH, SHORT-TERM AND REAL-TIME LOAD FORECASTS

TABLE 8: VARIATION IN LOAD FORECAST (MW)

Year	Variation between PDS & Real-time		Variation between STS & Real-time	
	Mean	Standard Deviation	Mean	Standard Deviation
2019	55.78	40.42	15.58	11.30
2020	53.98	40.13	14.94	11.01
2021	75.33	49.72	20.86	13.55
2022	61.58	42.58	17.41	14.22
2023	53.85	44.03	14.96	12.12

The accuracy of the load forecast used in generating real-time dispatch and pricing schedules is important for efficient pricing outcomes and system stability. Three forecast schedules with different forecast horizons are made available to market participants in the NEMS, namely the Market Outlook Scenario (MOS), the Pre-dispatch Schedule (PDS), and the Short-term Schedule (STS). The MOS is updated every day with a forecast horizon of six days, the PDS is updated every two hours with a forecast horizon of 12 to 36 hours, and the STS is updated every half hour with a forecast horizon of six hours.

Table 8 shows the accuracy of the forecast schedules from 2019 to 2023, measured by the mean and standard deviation of the load variations in the PDS and the STS when compared to the real-time dispatch schedule⁵. As the STS is generated more frequently and closer to the real-time dispatch period than the PDS, the load variation between the STS and the real-time dispatch schedule tends to be smaller than that between the PDS and the real-time dispatch schedule.

The mean load variation between the PDS and the real-time dispatch schedule was 53.85MW, translating to 3.60 times as large as that between the STS and the real-time dispatch schedule in 2023.

Likewise, the standard deviation of the load variation between the PDS and the real-time dispatch schedule in 2023 was 44.03MW, which was 3.63 times as large as that between the STS and the real-time dispatch schedule. With a smaller average and a narrower spread in variation, the STS was more reflective of the real-time market conditions than the PDS.

The mean load variation between the PDS and real-time dispatch schedule in 2023 was 12.56% lower than that in 2022, indicating greater accuracy in the PDS. The mean load variation between the STS and real-time dispatch schedule fell 14.11% in 2023, indicating that there was improved accuracy in the STS as well.

TABLE 9: VARIATION IN REAL-TIME LOAD FORECAST (%)

Year	Variation between Real-time Load Forecast & Actual Demand	YOY Change
2019	2.46	-0.12
2020	2.16	-0.30
2021	1.72	-0.44
2022	1.48	-0.23
2023	0.94	-0.54

For real-time dispatch schedules, the accuracy of the load forecast is crucial as the load forecast is used to determine dispatch instructions and market prices. The more accurate the load forecast is, the more reflective the dispatch instructions and market prices are of actual system conditions. Therefore, maintaining an exacting load forecast is thus indispensable for achieving system stability and optimising pricing outcomes.

A slight variance between the real-time load forecast and the actual demand is to be expected. There are a few factors contributing to this variation. For example, the real-time load forecast includes the station and auxiliary loads, while the metered energy quantity, which is based on settlement data furnished by the Market Support Services Licensee, omits these components. This difference in methodology creates a variation between the real-time load forecast and actual demand, with the real-time load forecast being higher than actual demand. Additional factors contributing to this variance may include metering errors and transmission losses.

Table 9 presents the variation between the real-time load forecast and actual demand, which indicates the average load forecast deviation. This deviation has remained below 2.50% for the past five years and has been on a downward trend. The lower variation signifies enhanced accuracy in real-time load forecasts, with lower variance correlating to more precise load predictions.

In 2023, the variation between the real-time load forecast and actual demand decreased 0.54 percentage point to 0.94%, from 1.48% in 2022. This was the lowest variation observed since the NEMS started, suggesting that the real-time load forecast in 2023 was the most accurate thus far.

⁵ The real-time dispatch schedule is generated 30 seconds before each dispatch period and covers the associated dispatch period.

PRICE INDICES: ANNUAL VESTING PRICE AND WHOLESALE ELECTRICITY PRICE

CHART 15: AVP VS MONTHLY VOLUME-WEIGHTED AVERAGE WEP (VWA-WEP)

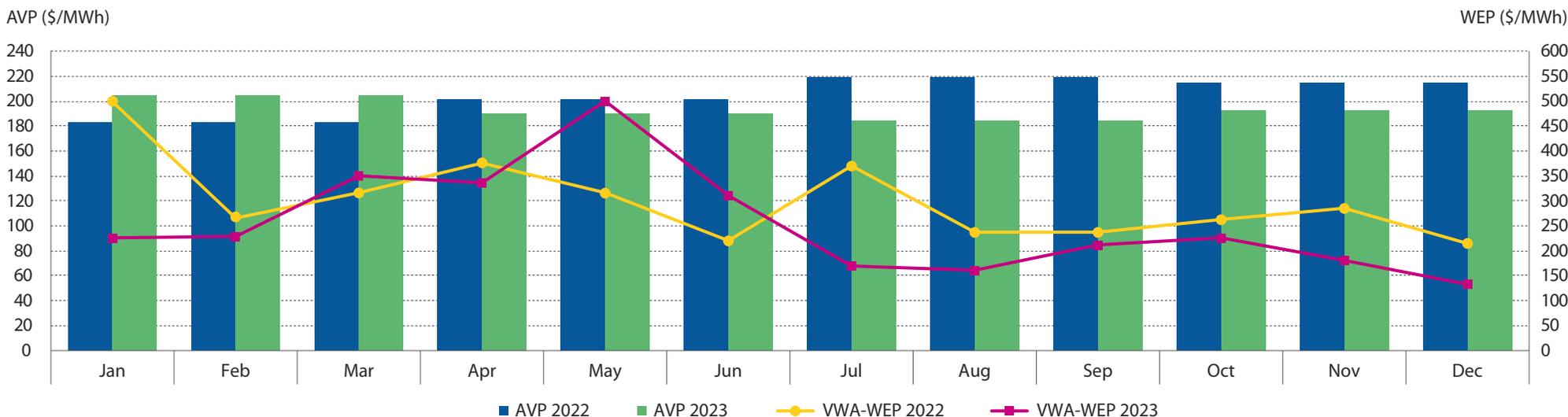


Chart 15 illustrates the Annual Vesting Price (AVP)⁶ and the monthly volume-weighted average Wholesale Electricity Price (WEP) for 2022 and 2023. In an efficient market, the WEP is expected to closely track the AVP, which reflects the long run marginal cost of a generation facility. Notably, certain months in 2023 witnessed a divergence between the volume-weighted average WEP and the AVP, potentially influenced by market price volatility due to constrained supply, weather fluctuations, and increased fuel costs.

In 2023, the monthly volume-weighted average WEP was higher than that in 2022 for three months of the year – March, May and June. This was mainly driven by a conflation of factors like the tighter supply cushion, higher demand and warmer weather conditions in 2023, compared with 2022. The highest WEP in 2023 was observed in May, in line with the highest demand and temperature for the year being recorded that month.

As for the remaining months, the monthly volume-weighted average WEP was lower than that in 2022. For January, February and April, this could be attributed to the lower supply cushion and higher proportion of cheaper energy offers. Whereas from July onwards, the lower WEP recorded could be attributed to the introduction of the TPC mechanism from EMA as a short-term measure to mitigate extreme price volatility and the implementation of a new five-year vesting regime framework⁷.

Given the prolonged duration of lower WEP in 2023, the yearly volume-weighted average WEP fell 51.68% to \$253.02/MWh in 2023 from \$300.07/MWh in 2022. On the other hand, the AVP dipped marginally by 5.61% to \$193.13/MWh in 2023, from \$204.62/MWh in 2022. This resulted in the yearly volume-weighted average WEP registering 31.01% higher than the yearly average AVP in 2023.

BOX 3. FIVE-YEAR VESTING REGIME FRAMEWORK

EMA has implemented a new vesting regime framework for non-contestable consumer load effective from 1 July 2023 to 30 June 2028.

This new framework allows EMA to issue vesting contracts through the Market Support Services Licensee for hedging energy prices from the Singapore Wholesale Electricity Market. The framework comprises schemes such as the Base Vesting Scheme, Tender Vesting Scheme, and Residual Vesting Scheme.

⁶ The AVP for 2023 was made up of LNG Vesting Price (LVP) in Q1 and Q2 2023 and Base Vesting Price (BVP) in Q3 and Q4 2023 while the AVP 2022 was made up of only LVP.

⁷ EMA | Vesting Contracts

PRICE INDICES: CORRELATION BETWEEN AVP, WEP, FUEL OIL PRICE AND ELECTRICITY TARIFF

CHART 16: INDEX OF AVP, WEP, FUEL OIL PRICE AND ELECTRICITY TARIFF

Index (base = 2019)

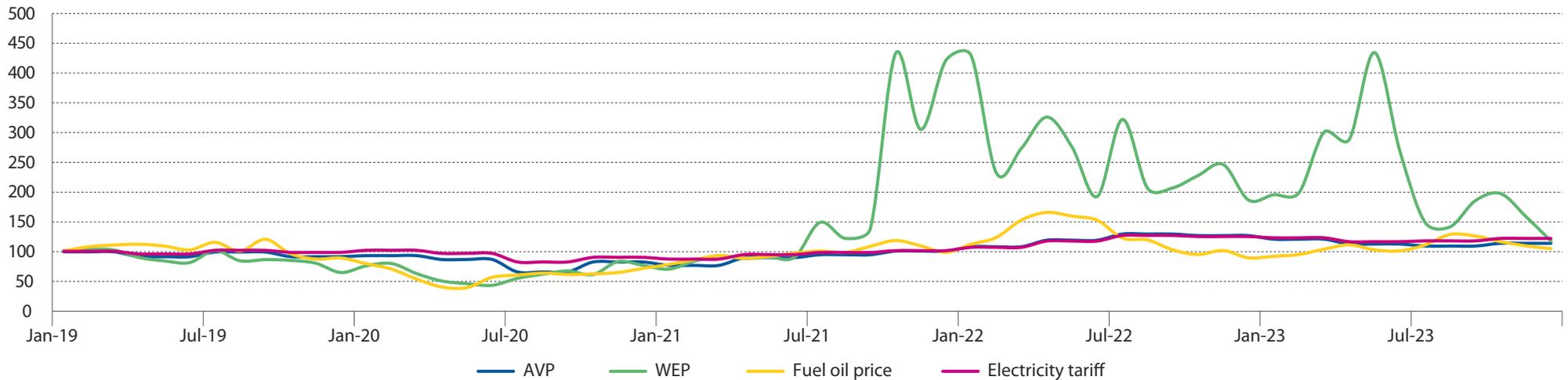


Chart 16 plots the indices of fuel oil price, AVP⁸, WEP and electricity tariff over the past five years, using 2019 as the base year. It graphically shows the correlation between the four prices as the indices measure the relative changes in these four prices over the five years.

Before June 2021, it was observed that the WEP closely followed the changes in fuel oil prices, implying that fuel oil price is a strong driver of the WEP. The AVP and electricity tariff mostly moved in tandem. Subsequently, there was volatility in the WEP, which could be due to tighter supply conditions and higher frequency of gas curtailment.

In the first half of 2023, a higher WEP was observed despite the higher supply cushion and lower fuel cost compared to the second half of the year. This could likely be due to the lower proportion of cheaper energy offers. A spike in the WEP in May was due to increased demand resulting from the warmer weather as compared to other months. The reduced WEP in the second half of the year could be attributed to the implementation of the TPC to mitigate price volatility.

For a yearly comparison, fuel oil prices traded at an average of US\$453.77 per metric tonne (MT) in 2023, a decrease of 13.19% from 2022. The WEP also dropped 15.77% to \$246.72/MWh in 2023 while the yearly average electricity tariff maintained at \$0.30/kWh for 2022 and 2023, despite slight fluctuations between the quarters.

⁸ The AVP for 2023 was made up of LNG Vesting Price (LVP) in Q1 and Q2 2023 and Base Vesting Price (BVP) in Q3 and Q4 2023 while the AVP before 2023 was made up of only LVP.

PRICE INDICES: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY

TABLE 10: MONTHLY AVERAGE CORRELATION COEFFICIENT OF WEP AND METERED ENERGY QUANTITY

Month	2022			2023		
	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	0.63	0.39	24	0.74	0.55	28
Feb	0.67	0.45	22	0.79	0.62	27
Mar	0.64	0.41	21	0.70	0.49	22
Apr	0.54	0.30	19	0.55	0.31	20
May	0.59	0.35	21	0.49	0.24	20
Jun	0.75	0.56	28	0.49	0.24	17
Jul	0.69	0.48	25	0.58	0.34	21
Aug	0.78	0.60	27	0.28	0.08	6
Sep	0.74	0.54	25	0.35	0.13	10
Oct	0.81	0.65	30	0.44	0.19	15
Nov	0.80	0.63	27	0.54	0.29	20
Dec	0.83	0.68	28	0.60	0.36	20
Average/Sum	0.71	0.50	297	0.55	0.32	226

Table 10 displays the correlation coefficient (r) assessing the strength of the association between WEP and the metered energy quantity, ranging from -1 to 1. A positive r signifies a positive relationship (e.g., as demand increases, WEP also increases), while a negative r indicates an inverse relationship (e.g., as demand rises, WEP decreases). A larger r , whether positive or negative, implies a strong correlation between the variables. The square of the correlation coefficient (r^2) represents the proportion of WEP variance explained by demand variations.

In 2023, the monthly correlation coefficient (r) ranged from 0.28 to 0.79, indicating a weaker relationship between WEP and the metered energy quantity compared to 2022, when the range was 0.54 to 0.83. The annual average r value declined to 0.55 in 2023 from 0.71 in 2022, with the number of days where r exceeded 0.5 decreasing to 226 days in 2023 from 297 days in 2022. This suggests that the correlation between WEP and metered energy quantity weakened in 2023, with fewer instances of both variables moving in tandem compared to 2022.

The r^2 value dropped to 0.32 in 2023 from 0.50 in 2022, indicating that 31.90% of the WEP variance in 2023 could be explained by demand variations, as opposed to 50.50% in 2022.

PRICE INDICES: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY

CHART 17: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY IN 2023

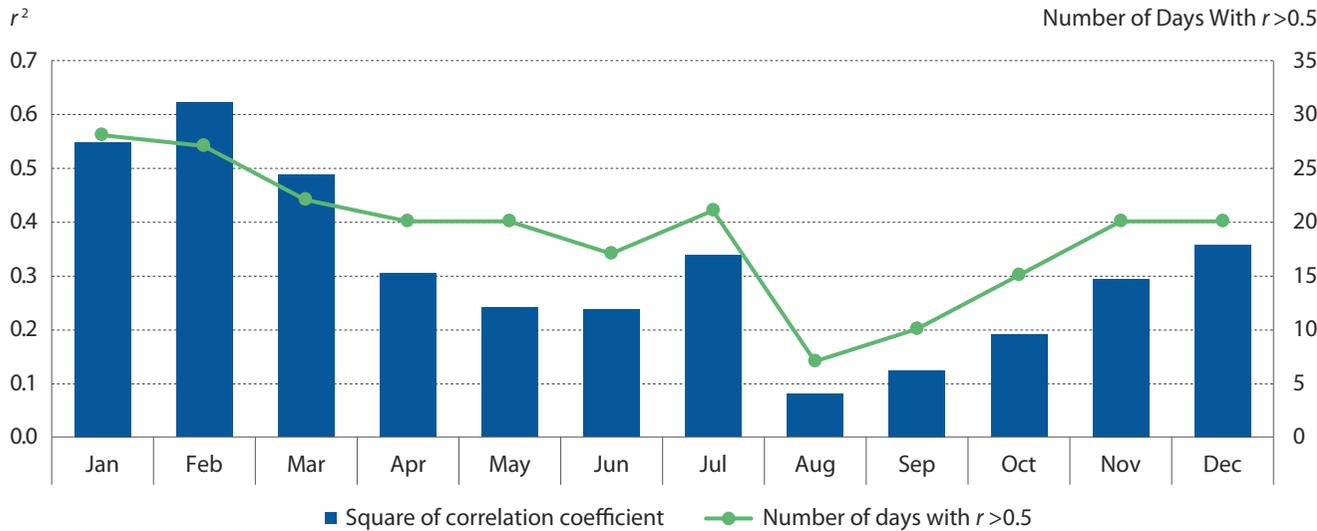


Chart 17 illustrates the correlation between the monthly WEP and the metered energy quantity in 2023. Generally, the r^2 value positively correlates to the number of days when the r value is greater than 0.5.

The peak r^2 value recorded in 2023 was 0.62 in February 2023, when there were 27 out of 28 days with r value greater than 0.5. This suggests that the observed WEP in February 2023 was predominantly influenced by fluctuations in demand. Conversely, the lowest r^2 value in 2023 was recorded at 0.08 in August, where the r value surpassed 0.50 for seven days.

From April to December 2023, there were fewer than 21 days with an r value greater than 0.50 and an r^2 value less than 0.50. Given that WEP is influenced by factors such as fuel oil price, outage level, supply cushion, generators' offers and EMA's initiative, movements in these variables may have mitigated the impact on WEP, resulting in a weaker correlation during this period.

CHART 18: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY FOR 2019–2023

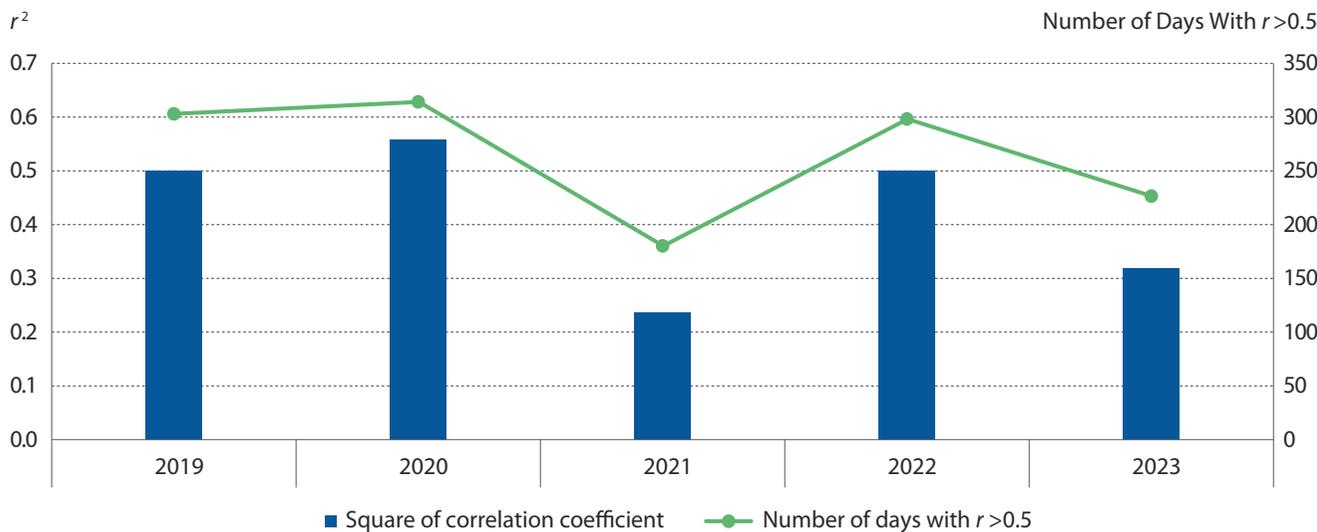


Chart 18 displays the correlation between the WEP and the metered energy quantity for the past five years. It was observed that from 2019 to 2023, the r^2 value and the number of days with r value greater than 0.50 moved in tandem. In 2023, the r^2 value dipped to 0.32 and the number of days with an r value greater than 0.50 reduced to 226, indicating the weakening in the influence of demand on energy prices.

Significant changes were observed over the five years from 2019 to 2023 due to several events that impacted results – Covid-19 in 2020, gas curtailment in 2021 and 2022, and the introduction of TPC in 2023.

In 2019, the number of days with an r value greater than 0.5 were 302 days. This increased to 314 days in 2020, before dipping to 180 days in 2021. Subsequently, it rose to 297 days in 2022 and fell to 226 days in 2023. Given an r^2 value of 0.32 in 2023, changes in demand could account for about 31.90% of the WEP's movements in 2023. This was a reduction from the previous year's r^2 value of 0.50.

PRICE INDICES: FREQUENCY DISTRIBUTION OF WEP BY (A) PERCENTAGE OF HOURS OF OCCURRENCE AND (B) PERCENTAGE OF ENERGY QUANTITY AFFECTED

CHART 19: PERCENTAGE OF HOURS WHEN THE WEP FALLS INTO A PARTICULAR PRICE RANGE

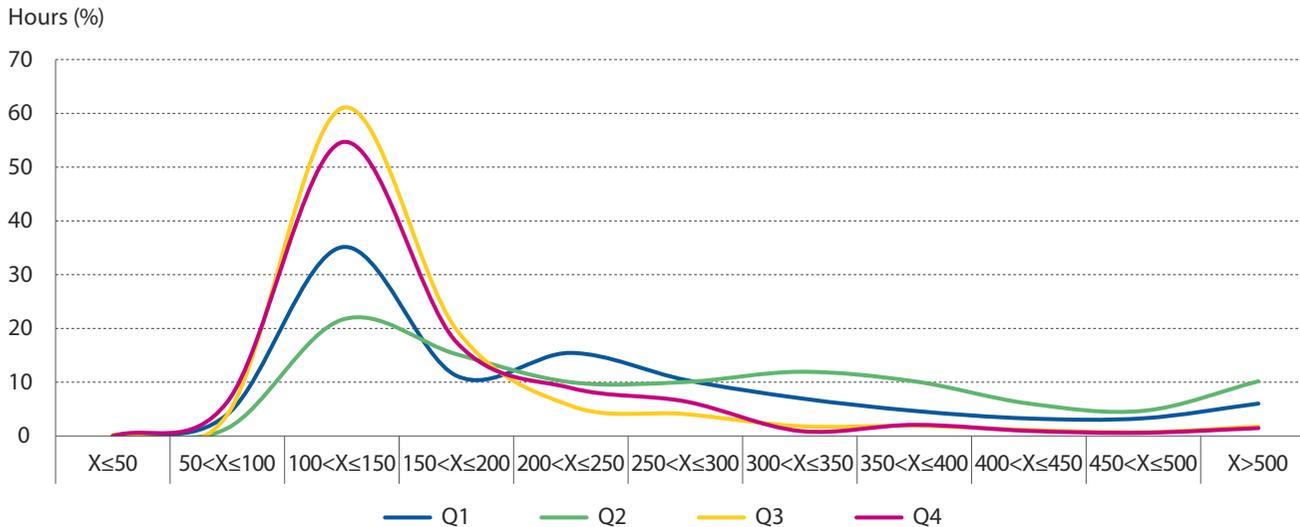


Chart 19 illustrates the distribution of WEP across different price ranges, represented as a percentage of the total hours in each quarter of 2023. The price distribution exhibited a flattening trend from Q1 to Q2 2023 and progressively shifted leftward during Q3 and Q4 2023. This trend can mainly be attributed to the higher portion of cheaper energy offer prices during the second half of 2023, in addition to the implementation of the TPC, a short-term measure aimed at mitigating extreme price volatility.

In all quarters, the distribution of the WEP remained within the \$100/MWh to \$150/MWh tranche for a majority of the time. In Q2 2023, the percentage of WEP distribution in the above \$500/MWh tranche was the highest among all quarters. In Q3 and Q4 2023, the percentage of WEP distribution in the above \$500/MWh tranche reduced greatly; the WEP fell mostly into the \$100/MWh to \$150/MWh tranche.

CHART 20: PERCENTAGE OF ENERGY QUANTITY WHEN THE WEP FALLS INTO A PARTICULAR PRICE RANGE

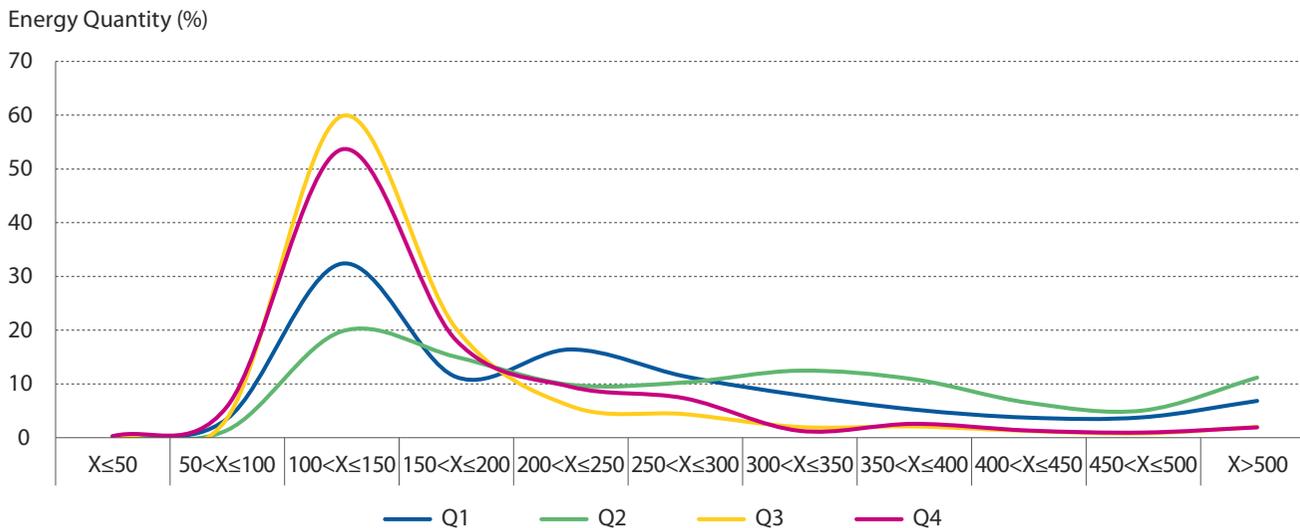


Chart 20 shows the frequency of the WEP in various price ranges, measured as a percentage of the total metered energy quantity in each quarter of 2023. The price distribution has a similar trend to the one seen in Chart 19, reflecting the narrow range of the metered energy quantity seen in the NEMS.

PRICE INDICES: FREQUENCY DISTRIBUTION OF WEP BY (A) PERCENTAGE OF HOURS OF OCCURRENCE AND (B) PERCENTAGE OF ENERGY QUANTITY AFFECTED

CHART 21: PERCENTAGE OF HOURS WHEN THE WEP FALLS INTO A PARTICULAR PRICE RANGE

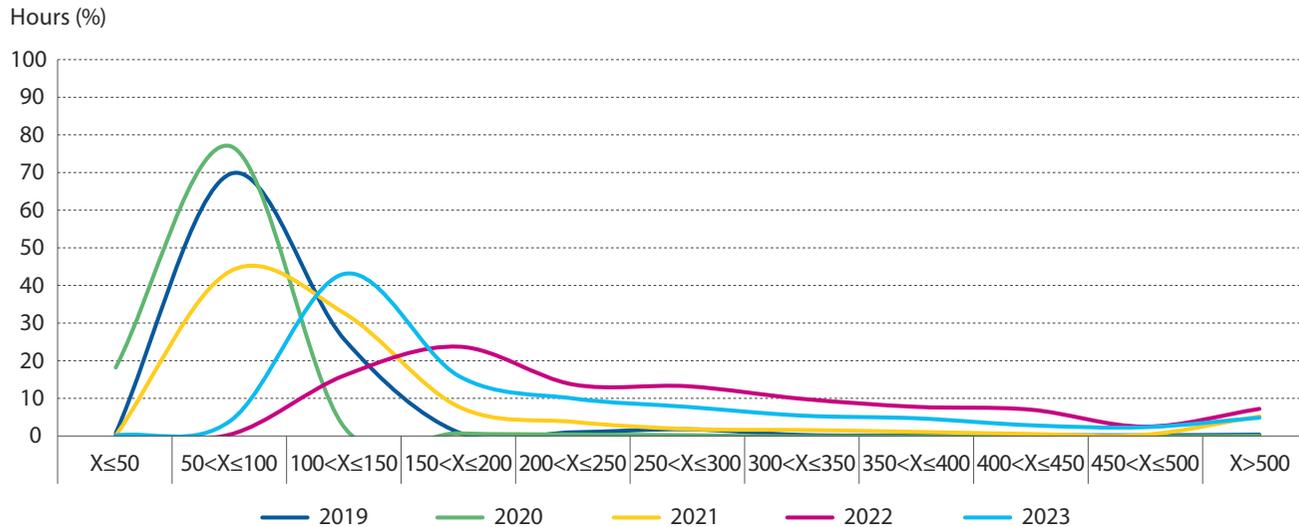


Chart 21 shows the historical price distribution for the past five years expressed as a percentage of the total number of hours in each year, to examine longer term trends.

In 2019, the WEP cleared in the \$50/MWh to \$100/MWh and \$100/MWh to \$150/MWh tranches for the majority of the time. However, in 2020, the distribution of the WEP shifted leftward to a lower price tranche, largely clearing at or below \$50/MWh and between \$50/MWh and \$100/MWh.

For 2021 and 2022, the distribution of the WEP shifted rightward. The WEP in 2021 cleared mostly within the \$50/MWh to \$100/MWh and \$100/MWh to \$150/MWh tranches, while a significantly flatter curve was observed in 2022, with the frequency of the WEP clearing above \$500/MWh being the highest of the five years.

In 2023, the distribution of the WEP shifted leftward and a higher distribution of the WEP cleared between \$100/MWh and \$150/MWh. There was also a slight increase in the distribution of the WEP clearing between \$50/MWh and \$100/MWh as compared to 2022.

CHART 22: PERCENTAGE OF ENERGY QUANTITY WHEN THE WEP FALLS INTO A PARTICULAR PRICE RANGE

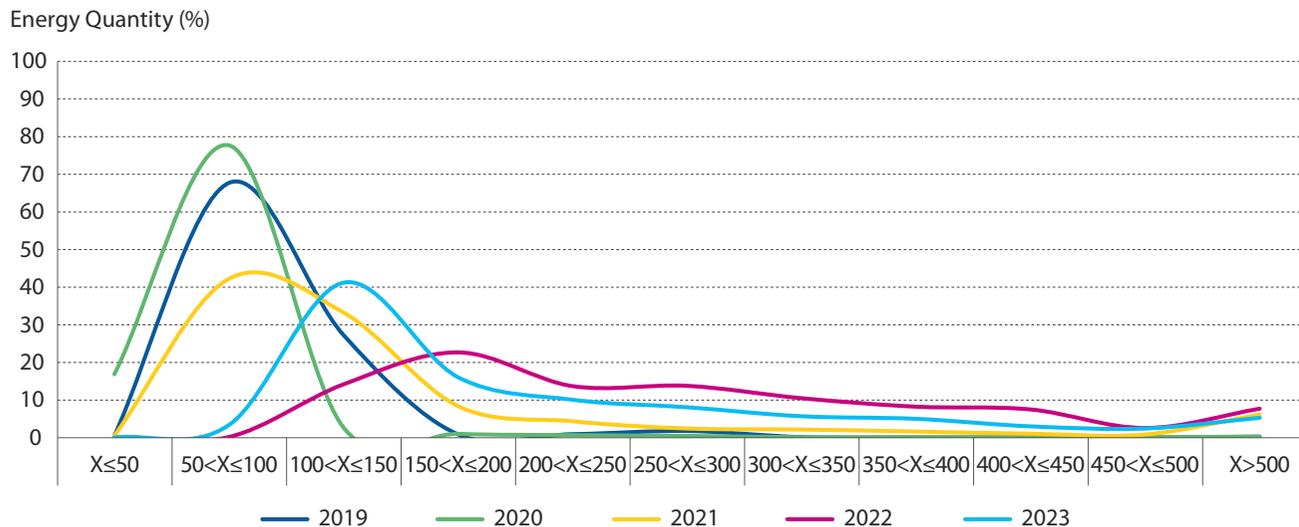


Chart 22 shows the historical price distribution for the past five years, based on the percentage of the total metered energy quantity. The behaviour of the price distribution based on energy quantity closely followed the trend shown in Chart 21, as the variability in the metered energy quantity for each year is relatively low.

In 2019, 2020 and 2021, the highest occurrences in the price distribution were observed in the \$50/MWh to \$100/MWh range. The price distribution then shifted rightward in 2022, mainly clearing in the higher price tranche of \$150/MWh to \$200/MWh. Subsequently the trend shifted leftward in 2023, mostly clearing in the price tranche of \$100/MWh to \$150/MWh.

PRICE INDICES: ACCURACY OF SHORT-TERM PRICE FORECAST

TABLE 11: VARIATION IN REAL-TIME USEP IN 2023 (\$/MWH)

Month	Variation between STS & Real-time
Jan	8.34
Feb	-16.95
Mar	-3.07
Apr	5.19
May	19.86
Jun	-3.26
Jul	-0.86
Aug	0.56
Sep	-9.50
Oct	6.93
Nov	4.43
Dec	-0.29

Table 11 shows the difference in the USEP produced in the STS and the real-time dispatch schedule as a monthly average variation in 2023. A positive variation means the real-time dispatch schedule has a higher USEP than the STS, while a negative variation means the real-time dispatch schedule has a lower USEP than the STS.

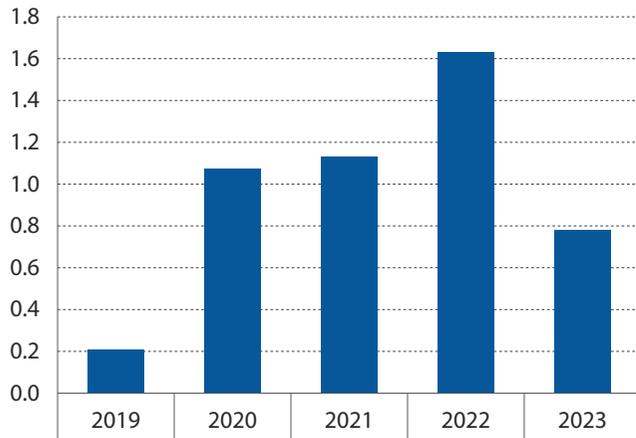
The forecast prices generated in the STS were closest to the real-time USEP in December 2023 – \$0.29/MWh above the real-time USEP on average. May 2023 recorded the largest monthly average variation in the USEP – the real-time USEP was \$19.86/MWh higher than the forecast USEP. This could be due to the less predictive weather in May 2023, which was the third warmest May since the market began.

Overall, the average variation between the USEP in the STS and that in the real-time dispatch schedule in 2023 was \$6.60/MWh, which meant that the forecast USEP in the STS is less indicative of the real-time USEP compared to the previous year, when the average variation was \$5.68/MWh. As variation between the STS's forecast USEP and the real-time dispatch schedule's USEP could be significantly affected by unpredictable weather conditions and forced outages of facilities, the higher planned and unplanned outages of facilities in 2023 could have contributed to the rise in the variation.

ANCILLARY SERVICE INDICES: RESERVE PRICES

CHART 23: PRIMARY RESERVE PRICE

Reserve Price (\$/MWh)



⁹ As required in section A.2 of Appendix 5A of the Market Rules.

Chart 23 shows the average primary reserve price in the NEMS from 2019 to 2023.

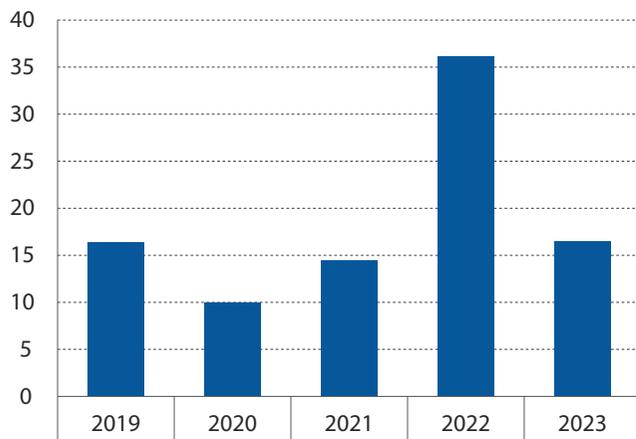
Each registered facility offering primary reserve in the NEMS must be capable of achieving its scheduled megawatt response automatically without further instruction from the PSO within nine seconds of being triggered by any contingency event, and must be able to maintain that scheduled megawatt response for ten minutes from the time it was triggered⁹.

2023 marks the first year that the primary reserve price cleared below \$1/MWh since 2020. Despite the primary reserve requirement remaining largely similar to 2022's, the average primary reserve price dropped 52.09% to \$0.78/MWh in 2023 from \$1.64/MWh in 2022. This could be attributed to the cheaper primary reserve offers available in the market as energy prices stabilised, as well as an expansion in the total primary reserve offer quantity. There were no primary reserve shortfalls in 2023.

In the last five years, the primary reserve price was the highest in 2022 at \$1.64/MWh, where there were a few instances of primary reserve shortfalls in a context of high price volatility during the year.

CHART 24: CONTINGENCY RESERVE PRICE

Reserve Price (\$/MWh)



¹⁰ As required in section A.2 of Appendix 5A of the Market Rules.

Chart 24 shows the average contingency reserve price in the NEMS for the past five years.

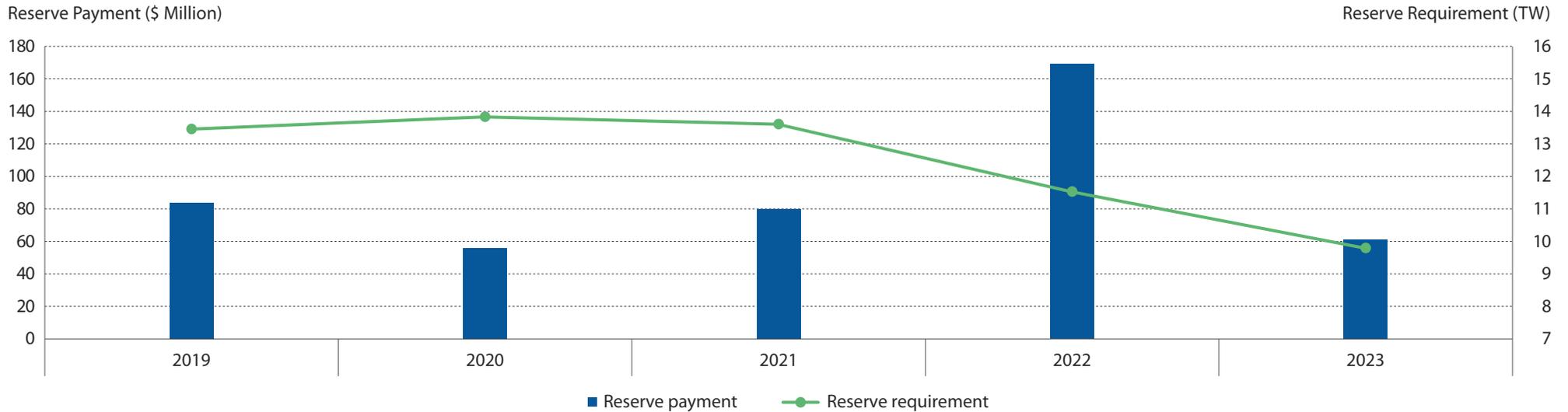
Each registered facility offering contingency reserve has to be capable of achieving its scheduled megawatt response within ten minutes of being instructed to do so, and has to be able to maintain its scheduled megawatt response for not less than 30 minutes¹⁰.

The yearly average contingency price was below \$20/MWh from 2019 to 2021. However, in 2022, the average contingency reserve price increased to \$36.11/MWh, which was the highest level seen since the market started.

Similar to the price trend observed for primary reserve, the average contingency price decreased 54.28% to \$16.51/MWh in 2023 from \$36.11/MWh in 2022 and was in line with the lower contingency reserve requirement. The lower contingency reserve requirement was due to the reduction in the Risk Adjustment Factor (RAF) for contingency reserve requirement to 1.0 from 8 July 2022. The RAF remained at 1.0 in 2023. This also coincided with the fall in the number of contingency reserve shortfalls in the NEMS to 81 periods in 2023 from 680 periods in 2022.

ANCILLARY SERVICE INDICES: RESERVE PRICES

CHART 25: RESERVE PAYMENT VS REQUIREMENT



Note: GST is not included in the calculation for reserve payment.

Chart 25 shows the total payment and requirement for primary and contingency reserve in the NEMS between 2019 and 2023.

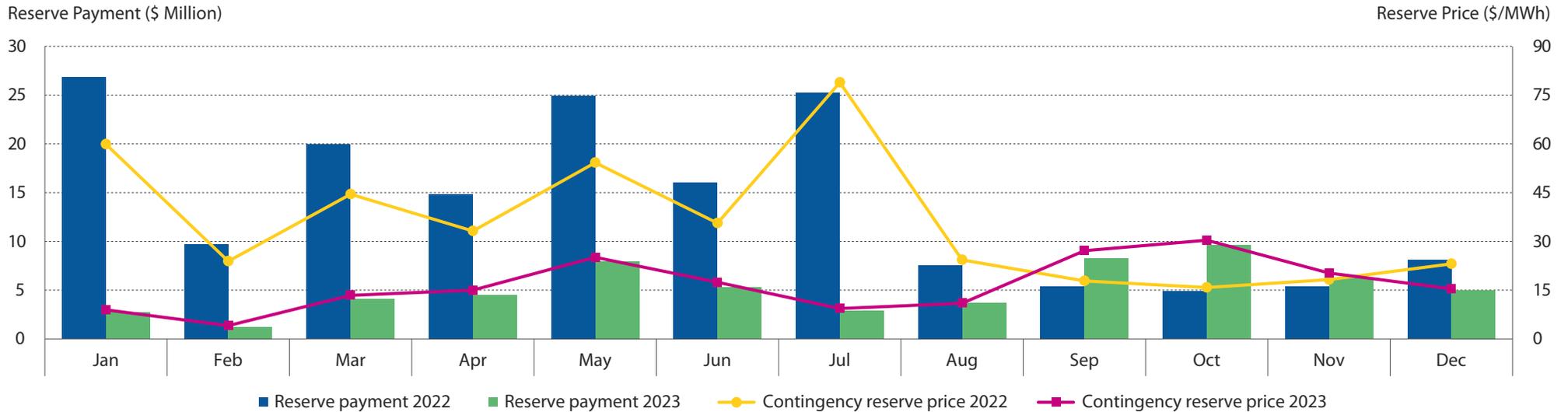
Overall, the reserve requirement fell 15.10% from 2022 – specifically, the primary reserve requirement rose marginally by 0.85% while the contingency reserve requirement fell 20.34% in 2023. This significant reduction in the contingency reserve requirement was due to a downward revision of the Risk Adjustment Factor (RAF) for contingency reserve, from 1.5 to 1.0, from 8 July 2022.

2023 was also the first year that the market observed a fall in the reserve payment since 2020. From the record high of \$169.06 million in 2022, reserve payment fell to \$61.13 million in 2023. This fall was the result of the shrinking reserve requirement, coupled with a decrease in the respective primary reserve and contingency reserve prices.

It is also noteworthy that the reserve requirement moved in tandem with the reserve payment in 2023, reversing the trend of them moving in opposite directions since 2020.

ANCILLARY SERVICE INDICES: RESERVE PRICES

CHART 26: RESERVE PAYMENT VS CONTINGENCY RESERVE PRICE



Note: GST is not included in the calculation for reserve payment.

Chart 26 compares the reserve payment against the contingency reserve price between 2022 and 2023 on a monthly average basis.

The main driver of the total reserve payment was the contingency reserve price, which ranged from \$4.20/MWh in February to \$30.27/MWh in October in 2023. The primary reserve price, which remained below \$2/MWh for all months, contributed minimally to the total reserve payment. Hence, the monthly reserve payment was largely influenced by movements in the contingency reserve price.

There were nine months in 2023 for which the contingency reserve price was lower than that in 2022; a lower total reserve payment was correspondingly reported in those months. On the other hand, for the months of September, October and November, the contingency reserve prices in 2023 were higher than 2022, and the total reserve payment for those months was also higher year-on-year.

ANCILLARY SERVICE INDICES: INTERRUPTIBLE LOAD

TABLE 12: IL ACTIVATIONS FOR CONTINGENCY RESERVE MARKET

Month	2022		2023	
	Instances of IL Activation	Number of Periods of IL Activation	Instances of IL Activation	Number of Periods of IL Activation
Jan	1	1	2	2
Feb	0	0	0	0
Mar	0	0	2	3
Apr	0	0	3	5
May	0	0	0	0
Jun	0	0	8	8
Jul	2	7	1	2
Aug	3	7	2	3
Sep	2	3	1	1
Oct	1	2	2	2
Nov	3	5	0	0
Dec	1	2	2	2
Sum	13	27	23	28

Table 12 compares the interruptible load (IL)¹¹ activations to provide contingency reserve between 2022 and 2023.

There were more instances of IL activations in 2023 than in 2022 – 23 compared to 13 activations in 2022.

The duration of the activations, measured by the number of periods of IL activations, increased marginally to 28 periods in 2023 from 27 in 2022. The duration of the IL activations in 2023 was either for one or two periods across each of the 23 instances, compared to a longer duration of five periods observed on 27 July 2022. These IL activations likely occurred to make up for the tight supply in the system, during periods when high numbers of facilities faced outages.

¹¹ An IL provider offers its load or the load of its customers to be interrupted in exchange for reserve payments under the interruptible load scheme. An IL provider is required to hold a Wholesaler (Demand Side Participation) Licence issued by the Energy Market Authority.

ANCILLARY SERVICE INDICES: INTERRUPTIBLE LOAD

CHART 27: PERCENTAGE CONTRIBUTION FROM IL FOR THE TWO CLASSES OF SCHEDULED RESERVE

IL Contribution to Total Scheduled Reserve (%)

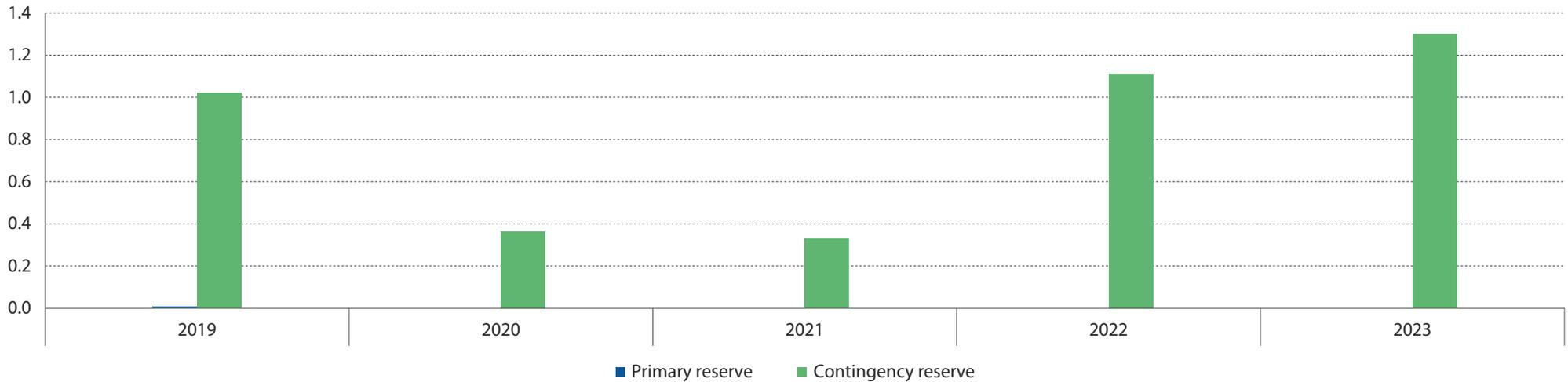


Chart 27 shows the contribution of IL to primary and contingency reserves in the past five years¹². The changes in IL contribution to primary and contingency reserves occurred in the context of the addition of ESS to the market from 2022, specifically from two 100MW ESS facilities.

As shown in Chart 27, the contribution of IL to primary reserve had been minimal at 0.01% in 2019 before dropping to 0% as there have been no IL facilities providing primary reserve from 2020 onwards.

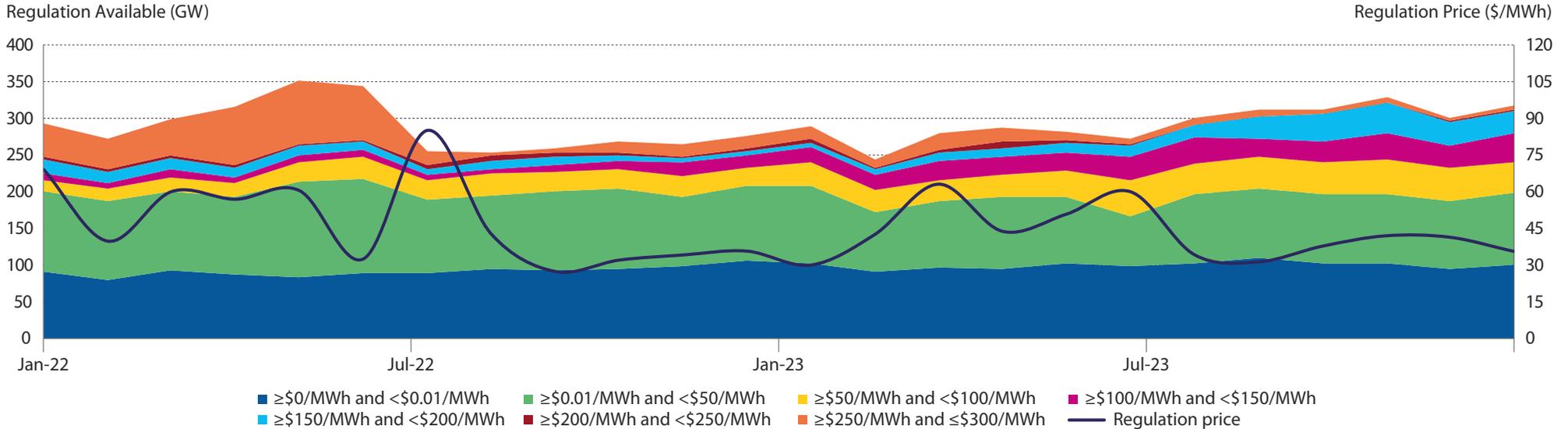
IL’s percentage contribution to the contingency reserve class, on the other hand, rose to its highest in five years in 2023 – 1.29%. The percentage contribution of IL to the contingency reserve had been on a downward trend from 1.02% in 2019 to 0.37% in 2020 and 0.33% in 2021, before it rebounded to 1.17% in 2022 and 1.29% in 2023.

The contribution of IL to the contingency reserve in 2023 increased 0.13 percentage point year-on-year due to an increase in the number of periods of IL activation to 28 periods in 2023 from 27 periods in 2022.

¹² The 2022 percentage contribution from IL to contingency reserve has been updated from 1.17 in the MSCP Annual Report 2022 to 1.11 in this report.

ANCILLARY SERVICE INDICES: REGULATION PRICES

CHART 28: REGULATION AVAILABILITY VS REGULATION PRICE



The monthly aggregated regulation quantity offered at various price ranges and the monthly regulation price for 2022 and 2023 are shown in Chart 28. The yearly average regulation price fell in 2023 as energy prices were more stable in 2023. The monthly regulation price ranged from \$30.06/MWh to \$63.10/MWh in 2023, stabilising from 2022's wider range of \$27.44/MWh to \$85.04/MWh.

The regulation availability rose 2.13% while the regulation requirement decreased 1.73%. As a result of stronger supply amidst a lower requirement for regulation, the yearly average regulation price fell 11.39% to \$42.71/MWh in 2023 from \$48.20/MWh in 2022. This was attributed to the price volatility observed in the first half of 2022.

The largest increase for 2023 was recorded in the “ $\geq \$100/\text{MWh}$ and $< \$150/\text{MWh}$ ” tranche, where the proportion of offers was 169.97% higher than in 2022. In contrast, the largest decrease was observed in the “ $\geq \$250/\text{MWh}$ and $\leq \$300/\text{MWh}$ ” tranche, where the proportion of offers was 70.76% lower than in 2022. The regulation offers from the higher price tranches (above \$200/MWh) were redistributed to the middle price tranches (between \$50/MWh and \$200/MWh).

The total number of periods with regulation shortfall fell to 49 in 2023 from 112 in 2022. All instances of regulation shortfall happened in the first half of the year, namely in January, March, May and June 2023. March had the highest number of 19 shortfall periods. The regulation shortfalls were due to tighter supply. This was accompanied by higher prices for those months. The regulation price in 2023 peaked at \$63.10/MWh in March amidst a 6.36% drop in regulation availability compared to March 2022 and more expensive regulation offers.

An aerial night view of Singapore's Gardens by the Bay and Marina Bay Sands. The image shows the illuminated Supertrees, the Helix Bridge, and the city skyline in the background. The text 'ECONOMETRIC MODEL AND OUTLIER PRICES' is overlaid on the right side of the image.

ECONOMETRIC MODEL AND OUTLIER PRICES

To identify and analyse outlier occurrences of the Uniform Singapore Energy Price (USEP), the Market Surveillance and Compliance Panel (MSCP) uses an econometric model¹³ as a means of estimating the dependent variable USEP through the use of various independent variables, such as the energy supply cushion, supply by generation type, energy offers below \$200 per megawatt hour (MWh), reserve cushion, and lagged fuel oil prices.

In 2023, the MSCP engaged the services of Assistant Professor Wang Wenjie from the Economics department of the School of Social Sciences at Nanyang Technological University (NTU), along with PhD candidate Li Wenzhe and Master's student Cai Jinbo. The NTU team sought to enhance the resilience of the econometric model and suggest pertinent variables and methodologies for pinpointing USEP outliers. The revised econometric model was approved by the MSCP and has been integrated into the MSCP Annual Report since 2023.

Table 13 shows the estimation results for the three most significant explanatory variables detected by the revised econometric model for January 2003 to December 2023.

A positive coefficient indicates a direct relationship between the variable and the USEP; when the variable increases, the USEP rises as well. A negative coefficient indicates an inverse relationship between the variable and the USEP; when the variable increases, the USEP falls instead.

Given that all variables are log-transformed, Table 13 provides the following observations for January 2003 to December 2023:

- a 1% increase in supply cushion lowers the USEP by 5.08%;
- a 1% increase in offers below \$200/MWh lowers the USEP by 2.71%; and
- a 1% increase in lagged fuel oil price raises the USEP by 1.77%.

TABLE 13: ESTIMATION RESULTS

Variable	Coefficient
	Jan 2003–Dec 2023
Constant	10.594
LOG (Supply Cushion)	-5.075
LOG (Offers Below \$200/MWh)	-2.707
LOG (Lagged Fuel Oil Price)	1.768

TABLE 14: MODEL DIAGNOSTICS

Model Diagnostics	Jan 2003–Dec 2023
R^2	0.896
Number of Observations	7,612

The level of statistical significance of the variables, measured as the P-value for the three coefficients in Table 13, is less than 0.01. This indicates that the three selected variables play a significant role in explaining variations in the USEP as the value represents a less than 1% chance of the variables not explaining the changes in the USEP from 2003 to 2023.

Table 14 shows the model diagnostics represented by R^2 for the period of January 2003 to December 2023.

The R^2 value measures the proportion of the variation in the dependent variable (USEP) explained by the independent variables (e.g., supply cushion, offers below \$200/MWh and lagged fuel oil price).

The econometric model analysed 7,612 observations spanning January 2003 to December 2023, resulting in an R^2 value of 0.896. This signifies that 89.6% of the fluctuations in the USEP can be attributed to changes in the model's explanatory variables such as supply cushion, offers below \$200/MWh, lagged fuel oil price, and others. In a comparative study against the previous econometric model, the R^2 value experienced a 4.60 percentage point increase, indicating a notable enhancement in the revised model's explanatory power.

¹³ Further details on the revised econometric model are available in [Econometric Model Design, Approach and Methodology Report – 2023 Review](#).

IDENTIFICATION OF OUTLIER PRICES

CHART 29: ACTUAL VS PREDICTED LOG USEP WITHIN THREE STANDARD DEVIATIONS

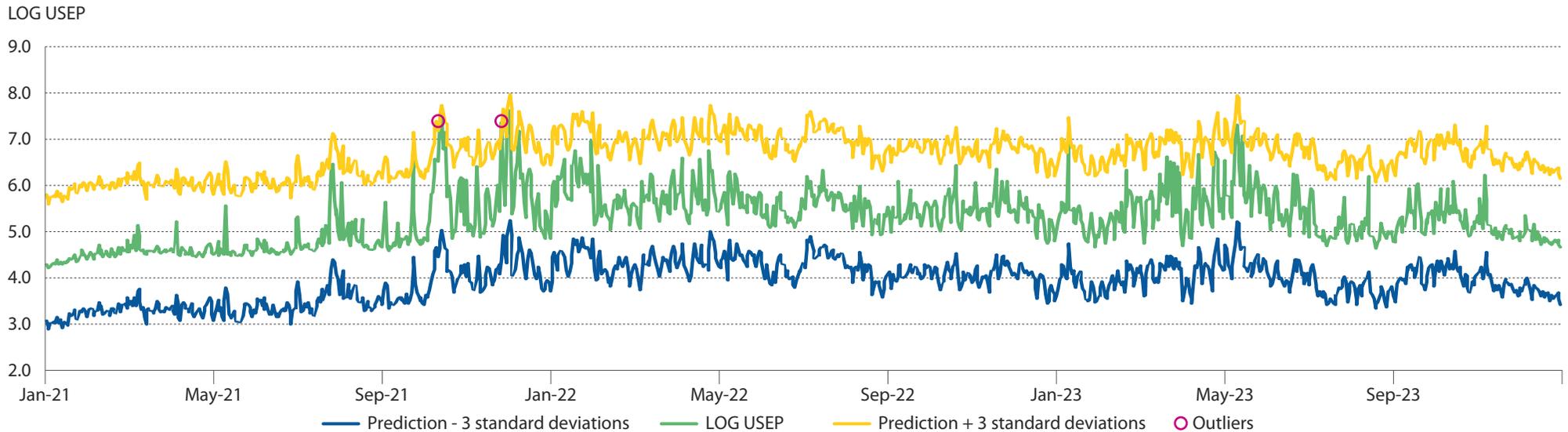


Chart 29 shows the actual daily average USEP, the upper and lower bands of the model's predicted daily average USEP, which are three standard deviations above and below the predicted USEP, and the outliers identified by the revised econometric model from January 2021 to December 2023, expressed on a logarithmic scale.

Identification of Outliers in 2021–2023

In the previous model, seven outliers were identified in 2021, with an additional outlier detected in 2022. Using the revised model, two outliers were found in 2021, and none in 2022 or 2023. This reduction in outlier detection can be attributed to the increased explanatory power of the revised model, as evidenced by the higher R^2 value.

The outliers detected on 12 October 2021 and 26 November 2021 could be attributed to the global energy crunch that started in late 2021. These outliers surpassed the upper bound of the predicted USEP by \$35.80/MWh and \$371.13/MWh respectively. No outliers were identified in 2022 and 2023, owing to the revised model's enhanced explanatory power. This improvement is also partly attributable to the addition of more independent variables to the model in 2023, such as EMA's recent measures to stabilise the market through the Directed Supply Scheme and Temporary Price Cap.



INVESTIGATIONS

SUMMARY OF INVESTIGATION ACTIVITIES

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

Any investigation initiated by the MSCP is undertaken by the Market Assessment Unit at the direction of the MSCP, in accordance with the investigation process outlined in the Singapore Electricity Market Rules (Market Rules).

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 market, or within the jurisdiction of another party.

Table 15 reflects the position regarding investigation and enforcement activities from the start of the market on 1 January 2003 to 31 December 2023, with the last column focusing on the period under review.

Determinations of breach made by the MSCP are **published** in accordance with the Market Rules.

Highlights of Enforcement Activities in 2023

- The MSCP reviewed 451 cases of offer variations after gate closure in 2023 and determined 30 cases to be in breach of the Market Rules. Of the 30 cases in breach, the MSCP took enforcement action on 19 cases and no further action on 11 cases. The remaining 421 cases of offer variations after gate closure were assessed by the MSCP to be not in breach of the Market Rules.
- Regarding other cases, the MSCP completed six investigations in the year.
- In 2023, the MSCP issued nine rule breach determinations on 19 cases of offer variations after gate closure and two other cases.
- There were no suspension or termination hearings conducted in relation to an event of default in 2023.
- A total of \$238,000 in financial penalties¹⁴ was imposed across three rule breach determinations, with \$160,000 being the highest financial penalty imposed on a party in breach. A non-compliance letter from the MSCP was issued for the remaining cases.
- The MSCP imposed an investigation cost of \$7,000 for two rule breach determinations respectively and \$2,000 for each of the remaining nine rule breach determinations. A total of \$26,000 in costs was imposed on the parties in breach in 2023.

¹⁴ Financial penalties imposed by the MSCP are returned to the market as a component of the monthly energy uplift charge.

TABLE 15: INVESTIGATION AND ENFORCEMENT STATISTICS

Rule Breaches	Calendar Year 2003–2023	Calendar Year 2023
(A) Total number of offer variations after gate closure received	39,196	414
Total number of cases closed	39,115	451
• cases in which the MSCP determined a breach	247	19
• cases in which the MSCP determined no breach	18,780	421
• cases in which the MSCP took no further action	20,088	11
(B) Origin of cases (excluding offer variations after gate closure)	222	3
• self-reports	179	2
• referrals or complaints	36	1
• initiated by the MSCP	7	0
Total number of cases closed	221	6
• cases in which the MSCP determined a breach	148	4
• cases in which the MSCP determined no breach	14	0
• cases in which the MSCP took no further action	48	2
• cases in which the MSCP made a determination on an event of default	11	0
- suspension orders	6	0
- other orders	2	0
- termination orders	2	0
(C) Total number of MSCP hearings	19	0
• suspension hearings	10	0
• termination hearings	1	0
• investigation hearings	8	0
(D) Enforcement action		
• highest financial penalty imposed on a party in breach	\$842,861	\$160,000
• total financial penalties imposed on parties in breach	\$2,594,861	\$238,000
(E) Costs		
• highest award of costs imposed on a party in breach	\$43,750	\$7,000
• total costs imposed on parties in breach	\$408,525	\$26,000
Market Efficiency and Fairness		
Total number of cases	8	0
• referrals or complaints	3	0
• initiated by the MSCP	5	0
Total number of cases closed	8	0

An aerial night photograph of a city park, likely the Singapore Botanic Gardens. The image shows a dense canopy of trees illuminated with warm yellow and orange lights. Several large, circular, illuminated structures are visible, some with intricate patterns. The background is a dark blue sky with a subtle wave pattern of light blue lines. The overall scene is vibrant and modern.

SECTIONS 50 & 51 OF THE ELECTRICITY ACT

Competition-Related Provisions in the Electricity Act

The Energy Market Authority (EMA) is responsible for enforcing the electricity sector-specific anti-competitive agreements and abuse of dominance provisions contained in sections 50 and 51 of the Electricity Act, Chapter 89A.

Section 50 of the Electricity Act prohibits agreements, decisions, or concerted practices by persons, which have as their object or effect the prevention, restriction, or distortion of competition in any wholesale electricity market or the retail electricity market in Singapore. The prohibition applies, in particular, to agreements, decisions, or concerted practices which:

- directly or indirectly fix purchase or selling prices or any other trading conditions of electricity in Singapore;
- limit or control generation of electricity, any wholesale electricity market, the retail electricity market, technical development or investment in the electricity industry in Singapore;
- share markets or sources of supply of electricity in Singapore;
- apply dissimilar conditions to equivalent transactions with other trading parties, thereby placing them at a competitive disadvantage;
- make the conclusion of contracts subject to acceptance by the other parties of supplementary obligations which, by their nature or according to commercial usage, have no connection with the subject of such contracts; or
- provide for the acquisition, directly or indirectly, of shares in or the assets of an electricity licensee.

Section 51 of the Electricity Act prohibits any conduct on the part of one or more persons, which amounts to the abuse of a dominant position in any wholesale electricity market or the retail electricity market in Singapore, if it may affect trade within Singapore.

Conduct constitutes an abuse if it consists of:

- directly or indirectly imposing unfair purchase or selling prices or other unfair trading conditions of electricity in Singapore;
- limiting generation of electricity, any wholesale electricity market, the retail electricity market or technical development in the electricity industry in Singapore to the prejudice of consumers;
- applying dissimilar conditions to equivalent transactions with other trading parties, thereby placing them at a competitive disadvantage; or
- making the conclusion of contracts subject to acceptance by the other parties of supplementary obligations which, by their nature or according to commercial usage, have no connection with the subject of such contracts.

Reports to the EMA

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 received or any information 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.

The MAU, on behalf of the MSCP, also develops ad hoc reports on abnormal trends identified in the Uniform Singapore Energy Price, including a comprehensive analysis of the market drivers and other factors that may have contributed to the movements. While monitoring and carrying out investigative activities from January to December 2023, the MAU and the MSCP did not identify any possibility of anti-competitive agreements or the abuse of a dominant position and, therefore, did not submit any report to the EMA.

The MAU developed a report analysing the generation companies' offer behaviour and net position in March 2023 when their facilities were on maintenance. The report discusses the generation companies' management of the short-term negative net position through an off-market bilateral contract-for-difference with other generation companies when they are unable to fulfil their contractual obligations during their facilities' maintenance period. The report was submitted to the EMA in August 2023.

The MAU/MSCP has also been actively working with the EMA to promote closer collaboration and streamline the market monitoring functions on the National Electricity Market of Singapore.

Information Requirements to Assist the EMA

The Singapore Electricity Market Rules¹⁵ (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 EMA in fulfilling 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, 3 April 2012, 22 August 2016 and 12 August 2020, with the latest modification made and published on 15 March 2023.

The latest modification clarifies the means of provision of items 1 to 3 below to indicate that the information will continue to be provided via electronic mail but is now from Energy Market Company (EMC) to EMA.

The MAU regularly provides data to the EMA according to the information requirements, as shown in the table below.

TABLE 16: INFORMATION REQUIREMENTS TO ASSIST THE AUTHORITY TO FULFIL ITS OBLIGATIONS WITH RESPECT TO COMPETITION AND ABUSE OF A DOMINANT POSITION UNDER SECTIONS 50 AND 51 OF THE ELECTRICITY ACT

No.	Description	Frequency of Collection	Means of Provision to EMA
1	Maximum capacity for primary reserve, contingency reserve, regulation, generation and load curtailment of each registered facility	Once and upon change	Electronic mail from EMC to EMA
2	Maximum combined generation capacity and reserve capacity of each registered facility	Once and upon change	Electronic mail from EMC to EMA
3	Maximum ramp-up and/or ramp-down rate of each registered facility	Once and upon change	Electronic mail from EMC to EMA
4	Offers and bids for energy, primary reserve, contingency reserve and regulation (prices and quantities) submitted by all market participants that are used in each dispatch run	Every two hours	Secure file transfer protocol (SFTP)* from EMC to EMA
5	All offer and bid variations and revisions to standing offers and bids for energy, primary reserve, contingency reserve and regulation	Every two hours	SFTP from EMC to EMA
6	Scheduled dispatch and load curtailment volumes by registered facility/market participants for all dispatch schedules, scenarios and re-runs	Every two hours	SFTP from EMC to EMA
7	Half-hourly market energy price (MEP) at all market network nodes (MNN) for all dispatch schedules, scenarios and re-runs	Every two hours	SFTP from EMC to EMA
8	Half-hourly prices and requirements for energy, primary reserve, contingency reserve, regulation and load curtailment for all dispatch schedules, scenarios and re-runs	Every two hours	SFTP from EMC to EMA
9	Metered injection and withdrawal quantities by registered facility/market participants, date and period	Daily	SFTP from EMC to EMA
10	Uplift charges by date and period	Daily	SFTP from EMC to EMA
11	Advisory notices reported by time, day and type	Daily	SFTP from EMC to EMA
12	Intertie quantities and prices by date and period	Daily	SFTP from EMC to EMA
13	Vesting contract reference prices by market participants, date and period	Monthly	SFTP from EMC to EMA

Note: SFTP is a direct link established between EMC and the EMA's databases to allow information to be transmitted directly from EMC to the EMA.

¹⁵ Section 4.3.10 of Chapter 3 of the Singapore Electricity Market Rules.

A nighttime aerial photograph of Singapore, showing the Marina Bay Sands hotel with its iconic three towers and skybridge, the Gardens by the Bay with its illuminated Supertrees, and the city skyline reflected in the water. The image is set against a dark blue background with white text and a thin orange horizontal line.

ASSESSMENT OF THE WHOLESALE ELECTRICITY MARKET

STATE OF COMPETITION AND INDUSTRY AND MARKET EFFICIENCY

Under the Singapore Electricity Market Rules (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 market. The MSCP's assessment for 2023 is as follows:

Market Structure and Competition

Entry of New Market Participants

Three new market participants were registered in the National Electricity Market of Singapore (NEMS) in 2023:

Wholesale Market Traders:

- 2 March 2023: BEWGI-UE NEWater
- 16 May 2023: HSBC Institutional Trust Services (Singapore) (in its capacity as trustee of AIMS APAC REIT)

Retail Electricity Licensee:

- 6 September 2023: Engie South East Asia

New Facilities in the Market

In 2023, 11 new facilities joined the market.

Of the 11 facilities, five were intermittent generation sources (IGS). Engie South East Asia, and HSBC Institutional Trust Services (Singapore) each registered their first facility since they joined in the market in 2023. The remaining three IGS facilities were from Sembcorp Solar Singapore, Singapore District Cooling, and Terrenus Energy SL1X. This brings the total number of IGS facilities in the NEMS to 60, with an increment in total registered generation capacity from 373.159 megawatts (MW) to 420.267MW.

Additionally, three load facilities were registered in the NEMS in 2023. One is an interruptible load facility belonging to Diamond Electric which provides 2MW contingency reserve, and the other two are demand response facilities from Singapore District Cooling (SDC), with capacities of 2.2MW and 3.6MW as at the end of the year after their capacities were revised.

SDC also registered a 4.9MW maximum generation capacity energy storage systems (ESS) facility in the NEMS. That facility previously belonged to Sunseap Energy Ventures, which exited the market on 30 June 2023. This raised the total number of ESS facilities in the market to four, including facilities belonging to PSA Corporation (a 1.7MW ESS facility) and Sembcorp Cogen (two 100MW ESS facilities).

Separately, two non-exporting embedded intermittent generation facilities (NEIGF) were registered in the market. BEWGI-UE NEWater registered a 1.54MW NEIGF facility on 6 March 2023, its first facility since it joined the market. LYS Genco Beta registered a 1.4MW NEIGF facility on 11 April 2023, before de-registering said facility on 30 June 2023.

Revision of Facilities' Capacities in the Market

There were 17 facilities which revised their capacities in 2023 – three Combined Cycle Gas Turbine (CCGT)/cogen/trigen facilities, eight IGS facilities, four load facilities and two ESS facilities.

Notably, the maximum generation capacity of the CCGT/cogen/trigen facility from PacificLight Power was raised from 400MW to 415MW. A CCGT/cogen/trigen facility from Keppel Merlimau Cogen also raised its generation capacity from 410MW to 420MW.

Withdrawal of Market Participants and De-registration of Facilities in the Market

In 2023, six market participants withdrew their participation in the NEMS:

- Enel X Singapore on 15 May 2023;
- Sunseap Energy Ventures on 30 June 2023;
- Best Electricity Supply on 30 June 2023;
- GreenCity Energy on 30 June 2023;
- Sunseap VPower on 17 November 2023; and
- MSD International GmbH (Singapore Branch) on 26 December 2023.

With the above withdrawals, the following six facilities were also de-registered from the NEMS:

- one 1.9MW interruptible load facility from Enel X Singapore;
- two 4.8MW generation facilities from MSD International GmbH (Singapore Branch);
- one 4.9MW ESS facility from Sunseap Energy Ventures (note: said facility has been transferred to Singapore District Cooling);
- one 0.1MW interruptible load facility from Sunseap VPower; and
- one 1.4MW NEIGF from LYS Genco Beta.

STATE OF COMPETITION AND INDUSTRY AND MARKET EFFICIENCY

Market Price Behaviour

Electricity Prices Fell in 2023 Despite Weakened Supply Cushion

The Uniform Singapore Energy Price (USEP) fell in 2023, reversing its upward trend since 2020. The USEP decreased 15.18% to an annual average of \$247.52 per megawatt hour (MWh) in 2023 from \$291.81/MWh in 2022, while the Wholesale Electricity Price (WEP) dropped 15.77% to an annual average of \$246.72/MWh in 2023, from \$292.91/MWh in 2022.

The decrease in the electricity market price was contrary to the movements of demand and supply in the market. Despite a decrease in annual average supply to 7,122MW in 2023 from 7,374MW in 2022, and a marginal increase in annual average demand to 6,302MW from 6,300MW, which resulted in the supply cushion contracting to 11.51% from 14.44%, both the USEP and WEP fell from their respective levels in 2022.

The fall in electricity market prices was mainly driven by cheaper offers in the market as fuel oil prices fell to an annual average of US\$453.77 per metric tonne (MT) in 2023, from US\$522.73/MT in 2022. This also coincided with the implementation of the Temporary Price Cap (TPC) mechanism and new vesting contract regime, both of which came into effect in July 2023.

Industry and Market Efficiency of the Electricity Markets

Market Concentration

Market concentration measures the intensity of competition in the market by looking at the level of market share between market players. The less concentrated a market is, the more competitive it is.

The market share based on maximum capacity for the top three market players decreased from 59.33% to 58.22% in 2023. The dilution of the market concentration level could be attributed to the revision of some CCGT/cogen/trigen facilities in the market during the year, as well as the inclusion of ESS facilities and Electricity Imports (Import) since 2022.

In terms of metered energy quantity, the market share held by the three largest players in the NEMS dropped 1.50 percentage points to 51.34% in 2023 from 52.84% in 2022. The composition of the top three market players in 2023 remained the same as 2022.

The decrease in the generation companies' market share in terms of metered energy quantity could be attributed to the increased participation from ESS facilities. Under the Directed Supply Scheme from the Energy Market Authority (EMA), ESS facilities were directed by the Power System Operator (PSO) a few times throughout the year to increase their generation supply during instances of tight supply in the market. This could have impacted the generation facilities' generation levels.

Productive Efficiency

The market share in terms of metered energy quantity of the most efficient generation technology, the CCGT units, rose 0.93 percentage point to 98.09% in 2023 from 97.16% in 2022. On the other hand, there were notable decreases in the market share of Open Cycle Gas Turbine (OCGT) units which dropped to 0% in 2023 from 0.06% in 2022, as well as the market share of Import which fell to 0.16% in 2023 from 0.34% in 2022.

The market share of CCGT units based on maximum generation capacity decreased 1.61 percentage points to 86.48% in 2023 from 88.09% in 2022. The drop in contribution from CCGT units to the total market generation capacity was picked up by ESS facilities, Steam Turbine units and Import which increased their market shares by 1.45, 1.00 and 0.36 percentage points respectively. Other Facilities Turbine units and OCGT units also saw their market shares by maximum generation capacity shrink to 2.12% and 1.49% respectively.

STATE OF COMPETITION AND INDUSTRY AND MARKET EFFICIENCY

Pricing Efficiency

In 2023, we observed that prices in the NEMS were not consistent with the demand and supply conditions in the market. While there was a lower supply amidst a fairly similar demand level, the USEP dropped to \$247.39/MWh from \$291.81/MWh. In particular, the demand rose 0.03% to 6,302MW from 6,300MW while the supply shrunk 3.42% to 7,122MW from 7,374MW. As a result, supply cushion dropped 4.05 percentage points to 11.51% in 2023 from 14.44% in 2022, marking the lowest annual average supply cushion since the market started.

The electricity market prices' trend coincided with the implementation of the TPC mechanism and new vesting contract regime, both of which came into effect in July 2023.

In 2023, 78.32% of the periodic supply cushion fell below 15% level, compared to 61.09% in 2022. Notwithstanding the higher instances of low supply cushion over the year, the average periodic USEP when supply cushion was below the 15% level cleared at a lower level at \$282.95/MWh in 2023, compared to \$348.60/MWh in 2022. This indicates that, compared to 2022, the market cleared at relatively lower price tranches under tighter supply conditions in 2023, in the context of the TPC mechanism and the new vesting contract regime.

Actual or Potential Design or Other Flaws and Inefficiencies in the Market Rules and Overall Structure of the Wholesale Electricity Markets Identified by the MSCP

Issues Submitted to the Rules Change Panel

In 2023, the MSCP submitted its comments on the concept paper regarding the holistic review of the Market Rules related to cessation of business, liquidation, and insolvency. The MSCP supported the proposed arrangement to handle insolvency-related defaults by introducing an automatic suspension framework for such cases as it is critical to safeguard the financial integrity of the market. The potential rule change will be beneficial to the market as market participants will be aware and notified of their obligations. The MSCP also highlighted that it is not appropriate for it to be the body requesting action from the EMA to issue a direction either prohibiting or authorising the MSCP to proceed with the issuance of the suspension order to a generation or importer licensee, as the MSCP will not be involved in the automatic suspension cases.

Arising from the MSCP's monitoring and investigation work, the following proposals from the MSCP/Market Assessment Unit (MAU) were considered in the 2023 Rules Change Panel work plan exercise:

- a review of the definition of forced outages in gate closure exemptions; and
- a review of the obligation to act within five minutes when an action is to be taken "promptly" or "immediately".

Looking Ahead

Performance Bonds Regime

The EMA has launched the performance bonds regime as part of its Enhancements to the Regulatory Regime for Electricity Retailers. Under the regime, retailers were required to provide performance bonds to cover their projected residual unhedged load quantities, and additional performance bonds should the retailer's forecasted retail load differ significantly from its actual load.

The rule change proposal came into effect on 1 February 2024.

New Generation Capacity Procured under Centralised Process Framework

As part of the EMA's guardrails announced in 2022 to strengthen the existing competitive market structure and ensure that Singapore is well-positioned to navigate the energy transition, the EMA introduced a centralised process to plan and coordinate capacity building at the system level.

YTL PowerSeraya has been awarded the right to build, own and operate a new hydrogen-ready CCGT unit with a capacity of at least 600MW. The new CCGT unit is expected to be commissioned by end-2027.

New Emission Standards for Power Generation Units

The EMA will be putting in place emission standards for new and repowered fossil fuel-fired power generation units to facilitate the deployment of clean and efficient power generation units in Singapore. EMA will consult the industry on the new Code of Practice to enforce the emission standards from 2024.

STATE OF COMPLIANCE WITHIN THE WHOLESALE ELECTRICITY MARKET

Ensuring compliance is important in the operation of a competitive and reliable electricity market. Market participants 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 market is set out below.

Offer Variations After Gate Closure

Currently, the Singapore wholesale electricity market has a gate closure period of 65 minutes. Any offer variation data that is submitted within 65 minutes of the beginning of a dispatch period will be reported by Energy Market Company (EMC) to the MSCP for investigation.

However, not all offer variations after gate closure are prohibited under the Market Rules. Specified circumstances are provided for in the Market Rules as exceptions that allow offer variations to be submitted after gate closure.

Table 17 compares the number of offer variations after gate closure submitted by market participants in 2023 with those of previous years.

The number of offer variations after gate closure dropped 25.94% in 2023 to 414 cases. The significant number of offer variations after gate closure cases observed in 2021 was observed in the later months of the year, and coincided with occurrences of unplanned piped natural gas curtailment (the shortage of gas required generation companies to conduct a fuel changeover from gas to diesel oil) and a volatile electricity spot price situation. Following the introduction of the EMA's measures to stabilise the power system and market under the

TABLE 17: OFFER VARIATIONS MADE AFTER GATE CLOSURE

Year	Number of Offer Variations Made After Gate Closure	YOY Change (%)
2019	342	-31.19
2020	306	-10.53
2021	799	161.11
2022	559	-30.04
2023	414	-25.94

Directed Supply Scheme (DSS), this statistic has dropped from 799 cases in 2021 to 559 cases in 2022 and 414 cases in 2023. The drop in the number of cases from 2022 could be due to fewer EMA/PSO directions issued under the DSS and the Standby Capacity Scheme (SCS) in 2023. Given that these offer variations were as directed by the EMA and the PSO under the SCS and DSS schemes respectively, they were deemed by the EMA to be treated as non-breaches of the Market Rules.

Must-Schedule Requirement for Electricity Imports

One of the obligations of electricity imports include having to ensure that its energy schedule for every hour is no less than the minimum scheduled quantity set by the EMA, save for prescribed circumstances, namely whether the import registered facility or any part of the interties is on outage and if it had been ordered, directed or instructed by the PSO to be scheduled at a different level. Any breach of the foregoing requirement will be reported to the MSCP for investigation.

The MSCP did not receive any reports of breaches of the foregoing requirement in 2023.

Demand Side Management Sandbox

The Demand Side Management (DSM) sandbox was launched by the EMA from 1 January 2023 to 31 December 2024. The aim is to enhance the demand response (DR) and interruptible load programmes in the Singapore Wholesale Electricity Market to incentivise companies to reduce their electricity consumption in the context of high prices or tight supply.

Under the DSM, the compliance thresholds and penalty amount for DR are lowered to encourage more companies to optimise their energy usage. During the period of the sandbox, all Load Registered Facilities will continue to be subject to the existing compliance thresholds and penalty amounts via the automatic financial penalty scheme. If the participant assesses that it should not have been penalised or the penalty amount should have been lower under the DSM, it can submit the penalty refunds requests to EMC.

As part of the monitoring for the DSM, MAU provides to the EMA a report of the demand response monitoring, which comprises the non-compliance count, the periods of compliance, the penalty amount imposed under the current Market Rules, and the expected refund amount for the individual facility as per the requirements under the two-year sandbox scheme.

STATE OF COMPLIANCE WITHIN THE WHOLESALE ELECTRICITY MARKET

Rule Breach Determinations Issued

For the period 1 January to 31 December 2023, the MSCP issued nine determinations regarding rule breaches.

The determinations issued by the MSCP are the result of the MAU's investigation and examination for the MSCP's deliberation. The MSCP's determinations are listed by breach type under the following subheadings:

Failure to Comply with Gate Closure Rules

Five MSCP rule breach determinations were issued in 2023 across three market participants in relation to 19 offer variations after gate closure events:

- **Senoko Energy's** offer variations after gate closure on 10 December 2022;
- **Diamond Electric's** offer variations after gate closure in February and March 2023;
- **Diamond Electric's** offer variations after gate closure on 21 March 2023;
- **Senoko Energy's** offer variations after gate closure on 26 June 2023; and
- **Keppel Merlimau Cogen's** offer variations after gate closure on 1 August 2023.

Failure to Comply with PSO's Directions

YTL PowerSeraya was served three rule breach determinations from the MSCP in 2023 for its failure to comply with the PSO's directions issued under the Directed Supply Scheme.

- **YTL PowerSeraya's** SERG3 failure to comply with PSO's directions on 17 May 2022;
- **YTL PowerSeraya's** SERG2's failure to comply with PSO's directions on 20 May 2022; and
- **YTL PowerSeraya's** SERG2's failure to comply with PSO's directions on 1 August 2022.

Failure to Immediately Submit Offer Variations

Keppel Electric was served one rule breach determination from the MSCP in 2023. This was the first rule breach determination against an Import facility in the NEMS.

- **Keppel Electric's** failure to submit offer variations for LTMS1 on 27 July 2022, 12 September 2022, 20 October 2022 and 21 February 2023.

There were no suspension or termination orders issued by the MSCP in 2023, as in 2022.

Similar to past years, the majority of the rule breach determinations issued in 2023 were related to failure to comply with gate closure rules. Of the five investigations on failure to comply with gate closure rules, the MSCP determined two instances to have been the result of human error on the part of the market participant. In the case of Senoko Energy's breach of the gate closure rules on 10 December 2022, the MSCP considered that there was a significant impact on the market, as evidenced by high prices and the declaration of the respective high-risk and emergency operating states during the relevant periods, and imposed a financial penalty of \$160,000. This was the highest financial penalty imposed on a market participant in 2023.

STATE OF COMPLIANCE WITHIN THE WHOLESALE ELECTRICITY MARKET

MSCP’s Role to Safeguard the Financial Integrity of the Wholesale Electricity Market

The MSCP receives information from EMC when a notice of default¹⁶ is issued. Such a notice is issued by EMC to a defaulting market participant in accordance with section 7.3.3 of Chapter 3 of the Market Rules and provides detailed information to the MSCP on the alleged event of default.

Under the circumstances¹⁷ when a default notice has been issued, the MAU and the MSCP remain vigilant for further information and confirmation by EMC about the default event’s remedy. If a default is not remedied, EMC takes the steps required by the Market Rules, which include issuing a request to the MSCP for a suspension hearing.

Subsequently, the MAU works closely with EMC to make sure that all relevant information about the defaulting market participant’s financial situation is provided in order to prepare the facts that will form the basis for the MSCP’s decision, along with the evidence presented to the panel on the day of the hearing. All decisions and orders issued by the MSCP after a suspension hearing are made in accordance with the Market Rules, to minimise the market’s financial risk exposure and ultimately to safeguard the financial integrity of the NEMS.

In 2023, there were two default notices issued by EMC, compared to four notices of default issued in 2022. The MSCP and MAU continue to be vigilant and committed in their monitoring and actions in accordance with the Market Rules in order to safeguard the financial integrity of the wholesale electricity market.

Automatic Financial Penalty Scheme

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

In 2023, ten generation companies were issued automatic financial penalties amounting to a total sum of \$417,954.80. The market also saw total penalties of \$728,489.57 imposed on three demand response and interruptible load providers under the AFPS. A total sum of \$687,691.62 has been refunded to the participating Load Registered Facilities providing DR under the DSM sandbox.

There was a 11.51% increase in the amount of financial penalties imposed under the AFPS to \$1,146,444.37 in 2023 from \$1,028,132.45 in 2022. In 2023, 208 periods were penalised under the AFPS, compared to 95 periods the previous year.

TABLE 18: FINANCIAL PENALTIES IMPOSED UNDER THE AFPS (\$)

Year	Financial Penalties Imposed Under the AFPS
2015 (from 17 Nov)	82,262.00
2016	544,846.25
2017	530,283.45
2018	401,146.29
2019	338,636.02
2020	288,401.00
2021	558,186.77
2022	1,028,132.45
2023	1,146,444.37

¹⁶ A default notice is a notice issued by EMC to a market participant pursuant to section 9.2.1.1 of Chapter 2 or section 7.3.3.1 of Chapter 3 of the Market Rules, and has, where applicable, the extended meaning ascribed thereto in section 9.1.5 of Chapter 2 of the Market Rules.

¹⁷ Circumstances when an event of default is declared are specified in section 7.3.1 of Chapter 3 of the Market Rules.

CONCLUSION



The Market Surveillance and Compliance Panel (MSCP) is fairly satisfied with the state of compliance in the National Electricity Market of Singapore (NEMS) in 2023. The MSCP issued nine rule breach determinations over the year, a reduction from 14 in the previous year.

Five of the nine determinations were in relation to offer variations after gate closure, as compared to ten determinations made in the previous year. This was partly due to the decrease in the number of cases related to offer variations submitted after gate closure from 559 in 2022 to 414 in 2023. While there were fewer cases, the highest financial penalty was imposed for a rule breach in respect of offer variations after gate closure resulting in a significant impact on the market.

Three rule breach determinations in 2023 arose from referrals from the Power System Operator (PSO) and were related to dispatch instructions for incidents in 2022. These cases were investigated by the Market Assessment Unit (MAU) and expert external advice was sought in two cases to validate and support the MAU's assessment of the technical aspects of the investigations.

After the price volatility of the past few years, the MSCP observed that the introduction of the Temporary Price Cap mechanism and the new vesting contract regime by the Energy Market Authority (EMA), coupled with a drop in fuel oil price, have helped to stabilise electricity prices in the NEMS. The measures introduced by EMA will strengthen the market and safeguard Singapore's energy security.

Combined Cycle Gas Turbine units continued to be dominant in 2023 as they are the most efficient generation technology in Singapore in terms of both energy output and maximum capacity. The level of market concentration in electricity generation has diminished in recent years as the combined market share of the three largest generation companies in terms of both metered energy quantity and maximum capacity continues to decrease, signalling an improvement in market competitiveness. This was observed in the context of a moderately concentrated market.

As for the market's composition, three new market participants joined the NEMS in 2023. The NEMS' total registered capacity also increased with 11 new facilities entering the market, bringing the total number of registered facilities in the NEMS to 129 units, with a collective maximum generation capacity of 12,597.775 megawatts (MW) and maximum load curtailment capacity of 76MW. The total number of intermittent generation sources facilities increased by five to a total of 60 units in 2023, with a collective maximum generation capacity of 420.267MW, an additional 47.108MW. Three load facilities – one for provision of 2MW contingency reserve and two demand response facilities with capacities of 2.2MW and 3.6MW each – entered the market. Six market participants withdrew their participation in the NEMS, leading to the deregistration of five facilities and the transfer of one facility.

In the last quarter of 2022, the MSCP initiated an update in the Catalogue of Data to accommodate the inclusion of new types of electricity generation technology registered in the market, including import facilities, energy storage systems, and intermittent generation facilities. The new Catalogue of Data was made effective on 1 February 2023 after the MSCP considered all comments provided during the consultation.

In 2023, the MSCP also engaged the services of Assistant Professor Wang Wenjie from the Economics department of the School of Social Sciences at Nanyang Technological University (NTU), assisted by Li Wenzhe and Master's student Cai Jinbo. The NTU team was tasked to enhance the resilience of the econometric model and suggest pertinent variables and methodologies for pinpointing Uniform Singapore Energy Price outliers. The revised econometric model was approved by the MSCP and has been integrated into the MSCP Annual Report in 2023.

As part of its monitoring work, the MSCP released quarterly reports describing its day-to-day monitoring, cataloguing and evaluation activities and analyses of current market conditions and their impact on wholesale electricity prices. Additionally, the MSCP also published its determinations issued in cases of non-compliance, in order to promote transparency and

accountability and to provide confidence to market participants regarding enforcement of relevant rules and regulations.

During 2023, the MSCP provided its views on the concept paper regarding the holistic review of the Market Rules related to cessation of business, liquidation, and insolvency. The MSCP supported the proposed arrangement to handle insolvency-related defaults by introducing an automatic suspension framework for such cases as it is critical to safeguard the financial integrity of the market.

The MSCP remains highly satisfied with the knowledge and technical expertise of the MAU in undertaking monitoring and surveillance activities, the investigation of alleged breaches of the Market Rules, and the advisory functions to the MSCP on enforcement actions to be taken against market participants.

Finally, the MSCP acknowledges and thanks Mr T P B Menon for his long service in the MSCP as a member and his leadership as Chairman from 2016 to 2021.



Professor Walter Woon
Chairman
Market Surveillance and Compliance Panel

An aerial, night-time photograph of the Gardens by the Bay in Singapore. The image is a 360-degree panoramic view, showing the central Supertrees Grove with its illuminated, tree-like structures in various colors (purple, blue, green). The Helix Bridge is visible on the right, illuminated with blue lights. The surrounding area is lit up with warm yellow and orange lights, reflecting on the water. The sky is a deep blue, and the overall scene is vibrant and modern.

USER GUIDE

Data

- Due to rounding, numbers presented throughout this report may not add up precisely to the totals indicated, and percentages may not precisely reflect the absolute figures for the same reason.
- All real-time and forecast prices and settlement data are provided by Energy Market Company.
- Annual Vesting Prices are provided by SP Services as the Market Support Services Licensee on the [Open Electricity Market website](#) every quarter, based on a list of long run marginal cost parameters of a combined cycle gas turbine (CCGT) unit from the Energy Market Authority, including capital cost, non-fuel operating cost, carbon price and fuel oil price.
- Data for forecast demand and outages is compiled from reports prepared by the Power System Operator (PSO), including advisory notices.
- Throughout this report, demand figures are based on the forecast demand supplied by the PSO, except where metered energy quantities are indicated.
- Metered energy quantities are supplied by SP Services. All metered data used in this report is final data, derived after any settlement re-runs.
- CCGT units refer to all generating units clustered under the CCGT/cogen/trigen umbrella.

TABLE 19: 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: Market Support Services Licensee

Supply Indices

- Capacity ratio indicates the utilisation of a generation facility as a ratio of its scheduled output of energy, reserves and regulation to its maximum generation capacity.
- Supply cushion is the ratio between (a) the difference between supply and demand and (b) supply. Supply cushion measures supply adequacy, the level of capacity which was offered but not scheduled and could be called up if necessary. The supply is the sum of offers submitted by generation companies. Demand refers to the forecast demand used by the PSO to determine the real-time dispatch schedule.
- The maximum generation capacity for each generation company is the maximum generation capacity in the standing capability data.
- Under the Singapore Electricity Market Rules (Market Rules) and the System Operation Manual (SOM), outages of generation registered facilities are defined as follows:
 - 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 outage and supply related figures in the Market Surveillance and Compliance Panel (MSCP) Annual Report and the National Electricity Market of Singapore (NEMS) Market Report due to differing methodologies. The energy storage systems (ESS) figures used in this report will be based on actual capacity instead of modelled capacity, used in the NEMS Market Report.

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.

Names of Business Entities

The MSCP Annual Report refers to business entities by their commonly used names instead of the full names registered with the Accounting and Corporate Regulatory Authority. Specifically, information related to company ownership is not reflected, e.g., exempt private company, private/public company limited by shares, public company limited by guarantee, etc.

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