National Electricity Market of Singapore

ANNUAL REPORT
2024

MARKET SURVEILLANCE & COMPLIANCE PANEL

CONTENTS

EXECUTIVE SUMMARY

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 2024, 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 2024, and how they compare to 2023.

Supply Indices

Following two consecutive years of decline, the average electricity supply in the National Electricity Market of Singapore (NEMS) rebounded in 2024. This, coupled with a relatively smaller increase in demand, meant that the supply cushion recovered slightly in 2024, driving wholesale electricity prices to lower levels compared to the preceding year.

- The average supply increased 4.28% from 7,122 megawatts (MW) in 2023 to 7,427MW in 2024, in line with a 44.93% drop in the average outage level from 2,352MW per period in 2023 to 1,295MW per period in 2024.
- The average supply cushion[1] improved from the record low of 11.51% in 2023 to 12.74% in 2024.
- The average capacity ratio[2] of the Combined Cycle Gas Turbine (CCGT), Steam Turbine (ST), Other Facilities Turbine (OT) and Open Cycle Gas Turbine (OCGT) generation types increased to 66.44%, 45.43%, 25.95% and 0.55% respectively in 2024. ST saw the most significant increase, leaping 37.38 percentage points from 2023 due to the de-registration of three partially retired facilities whose generation output was relatively low in the years prior to their exit from the market. The average capacity ratio of the Electricity Imports (Import) and Energy Storage Systems (ESS) generation types declined in 2024 to 0.82% and 9.19%, respectively.
- Based on metered energy quantity, the market concentration in the generation sector of the NEMS largely remained the same, with the combined market share of the three largest generation companies dipping marginally from 51.34% in 2023 to 51.11% in 2024.
- The average market share, as measured by metered energy quantity, of each generation type recorded only minor shifts from 2023. CCGT continued to be the predominant generation type in the NEMS, holding a relatively steady market share of 98.10% in 2024 compared to 98.09% in 2023. The market shares of the ST, OT, Import, OCGT and ESS generation types averaged 1.16%, 0.68%, 0.04%, 0.03% and 0.00% respectively in 2024.

Demand Indices

The average electricity demand in the NEMS rose 2.92% in 2024 to reach a new high for a third year in a row.

- The average demand climbed 2.92% to 6,486MW in 2024. The peak monthly average electricity demand also rose from 6,574MW in May 2023 to 6,642MW in May 2024.
- The accuracy of the real-time load forecast continued to improve in 2024. The average forecast error shrank 0.53 percentage point to 0.44% in 2024, the smallest forecast error recorded since market start.

Price Indices

In line with average supply expanding more than demand, the average Wholesale Electricity Price (WEP) eased to a four-year low.

- The WEP retreated below the $200 per megawatt hour (MWh) level to average $163.12/MWh in 2024, 33.89% down from $246.72/MWh in 2023. This was the lowest annual average level since the WEP fell close to $70/MWh in 2020.
- The falling WEP stood in contrast to the rise in the fuel oil price, which climbed from US$453.77 per metric tonne (MT) in 2023 to US$468.35/MT in 2024. However, it was in line with an overall stabilisation of prices following the introduction of the Temporary Price Cap (TPC) mechanism and a new vesting contract regime to the NEMS in the second half of 2023.
- The peak monthly WEP averaged $287.97/MWh in April 2024, coinciding with the second highest monthly demand of the year at 6,638MW. This was considerably lower than the peak monthly WEP for the preceding three years, which cleared above $480/MWh.
- The Uniform Singapore Energy Price (USEP) followed a similar trend to the WEP, falling 34.08% from $247.52/MWh in 2023 to $163.18/MWh in 2024. This was also reflected in lower monthly average prices, which cleared below $200/MWh for nine months of 2024 compared to four months of the previous year.
- The total reserve payment grew 24.81% from $61.13 million in 2023 to $76.30 million in 2024. This resulted from a 2.91% climb in the reserve requirement from 2023, combined with a tripling of the primary reserve price to $2.86/MWh and a 19.29% rise in the contingency reserve price to $19.70/MWh in 2024.

[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.

INTRODUCTION

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 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 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 has been a member of the MSCP since 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 Practice and Co-Head of the Cybersecurity & Data Protection Practice.

Dr Lai specialises in all forms of IP litigation and information technology disputes and is also a commercial/chancery litigator and arbitration counsel. 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. In the biomedical and pharmaceutical sectors, Dr Lai has substantial experience in advising on healthcare and medical IP and regulatory issues.

Dr Lai is currently the chairman of the Intellectual Property Office of Singapore, and the commissioner of the Government Procurement Adjudication Tribunal. Dr Lai is also a member of the Singapore International Arbitration Centre Panel of IP Arbitrators, and currently serves as the deputy president of the Copyright Tribunal. Dr Lai serves as a senior mediator of 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) in 2020, and the Public Service Star (Bintang Bakti Masyarakat) in 2024. In 2022, he received the Singapore Academy of Law Merit Award.

Dr Lai has been a member of the MSCP since 2022. Dr Lai's broad business law experience and special expertise in Competition Laws provide a further dimension of knowledge to the MSCP, involving the dynamic of different models of market structure, as well as the behaviour and interaction between market players applied to various markets in Singapore.

INTRODUCTION

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 and bid 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 2024 covers the period 1 January to 31 December 2024 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 23rd 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

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 2024 to incorporate new data, including data related to the solar generation forecast and the Temporary Price Cap (TPC) mechanism. The monitoring drivers in the Catalogue of Monitoring Indices were also re-evaluated to reflect developments in the market and the manner in which the monitoring indices are used for the MSCP's market monitoring and reporting purpose.

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 Power System Operator (PSO), and market participants) and is broadly categorised as facility characteristics data (belonging to the generation registered facility, generation settlement facility, load registered facility and import registered facility), transmission system data, supply data, demand data, price data and other data.

The latest Catalogue of Data was published and made effective on 1 September 2024.

Catalogue of Monitoring Indices

The Catalogue of Monitoring Indices adopted by the MSCP include market concentration indices, supply indices, demand indices, price indices and ancillary services indices, as listed below.

The latest Catalogue of Monitoring Indices was published and made effective on 1 September 2024.

MARKET MONITORING

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

TABLE 1: CATALOGUE OF MONITORING INDICES

Type of Index	No.	Monitoring Index	Means of Evaluation[3]
Market Concentration	1	Market Concentration Index	Market share by: (a) generation type; (b) generation licensee; and (c) generation registered facility
	2		Herfindahl-Hirschman Index (HHI)
	3		Pivotal supplier test
Supply	4	Price Setter Index	Trend of price setting generating units
	5	Utilisation Index	Capacity ratio: Ratio of a generation registered facility's (a) scheduled generation output to (b) maximum generation capacity
	6	Outage Index	Trend of outage volume
	7	Offer Index	Supply cushion: Ratio of (a) the difference between total offered volume and system demand to (b) total offered volume
			Available generation capacity: Capacity that is not offered to the market even though the generation units are not on planned nor unplanned maintenance
			Analysis of offer/bid variations or revisions to standing offers/bids exceeding offer/bid change limits
	8	Demand Response Index	Trend of demand response activation
Demand	9	Actual Demand Index	Trend of actual demand
	10	Load Forecast Index	Comparison of load forecast with real-time load forecast
			Comparison of real-time load forecast with metered generation quantity
Price	11	Energy Price Index	Trend of Uniform Singapore Energy Price ("USEP")
			Trend of Wholesale Electricity Price ("WEP")[4] and its correlation with vesting price, fuel oil price, electricity tariff
			Correlation between WEP and system demand
			Percentage of hours and quantity of load when WEP falls into a particular price range
			Comparison of latest available short-term schedule projected prices with real-time prices
Ancillary Services	12	Reserve Index	Trend of reserve prices
			Trend of reserve requirement and reserve payment
	13	Regulation Index	Trend of regulation prices and comparison of trends
			Trend of regulation availability
	14	Interruptible Load Index	Trend of interruptible load activations in the contingency reserve market
			Trend of interruptible load in provision of scheduled reserve

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.

[3] The means of evaluation is not exhaustive and is only intended to provide a list of examples under the monitoring index. This may be subject to change depending on market conditions, which would determine the evaluation that is best suited.

[4] The WEP comprises the USEP, the allocated regulation price (AFP), hourly energy uplift charge (HEUC), monthly energy uplift charge (MEUC), EMC fees and PSO fees.

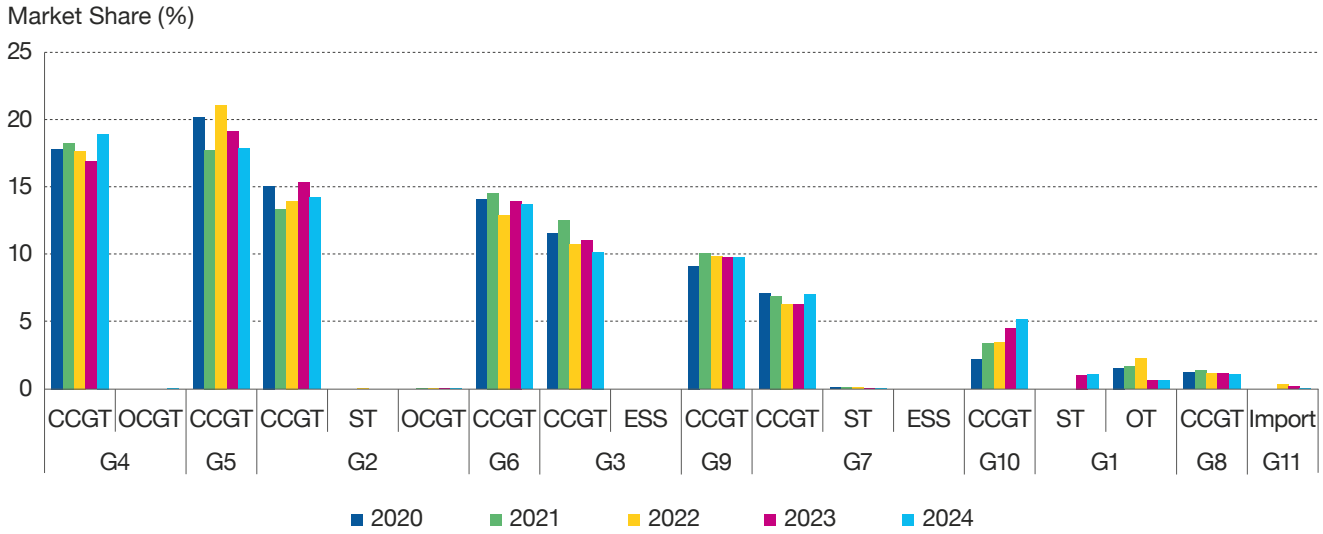
MARKET CONCENTRATION: MARKET SHARE

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 2024.

The market was dominated by the Combined Cycle Gas Turbine (CCGT) units, which registered a combined market share of 98.10% in 2024. This was followed by Steam Turbine (ST) units under G1, G2 and G7, Other Facilities (OT) units under G1, Electricity Imports (Import) under G11, and Open Cycle Gas Turbine (OCGT) units under G2 and G4, which accounted for 1.16%, 0.68%, 0.04% and 0.03% of the market respectively. Energy Storage Systems (ESS) units recorded net zero generation in 2024.

The market shares across the generation mix remained largely similar over the last five years, with a strong dependency on the more efficient CCGT units, which have accounted for more than 97% of the market since 2018. After experiencing large gains in 2023, the CCGT and ST market shares inched up slightly in 2024. The OT and OCGT market shares grew modestly after recording a decline in 2023. The market shares of ST units under G2, OCGT units under G2, and ESS units under G3 and G7, were too insignificant to be reflected in Chart 1.

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



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

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 2024 were G4, G5 and G2, which held a slightly lower combined market share of 51.11%. This was consistent with the trend of the past five years, where the top three generation companies held a total market share of 50% to 54%. In 2024, the overall ranking by market share of all 11 generation companies remained unchanged from the previous year, with the exceptions of G4 overtaking G5 as the top ranked by market share.

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

Year	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11
2020	1.57	15.00	11.55	17.85	20.19	14.12	7.18	1.20	9.13	2.21	-
2021	1.71	13.35	12.53	18.22	17.77	14.52	7.01	1.37	10.03	3.41	-
2022	2.25	14.13	10.75	17.67	21.08	12.91	6.43	1.20	9.83	3.42	0.34
2023	1.68	15.26	11.01	16.99	19.12	13.99	5.48	1.15	9.86	4.54	0.16
2024	1.80	14.25	10.20	18.95	17.92	13.70	7.11	1.13	9.74	5.17	0.04

Note: The percentages in this table may not add up to 100% due to rounding.
Due to a change in methodology, the market share based on metered energy quantity by generation company has been revised.

MARKET CONCENTRATION: MARKET SHARE

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

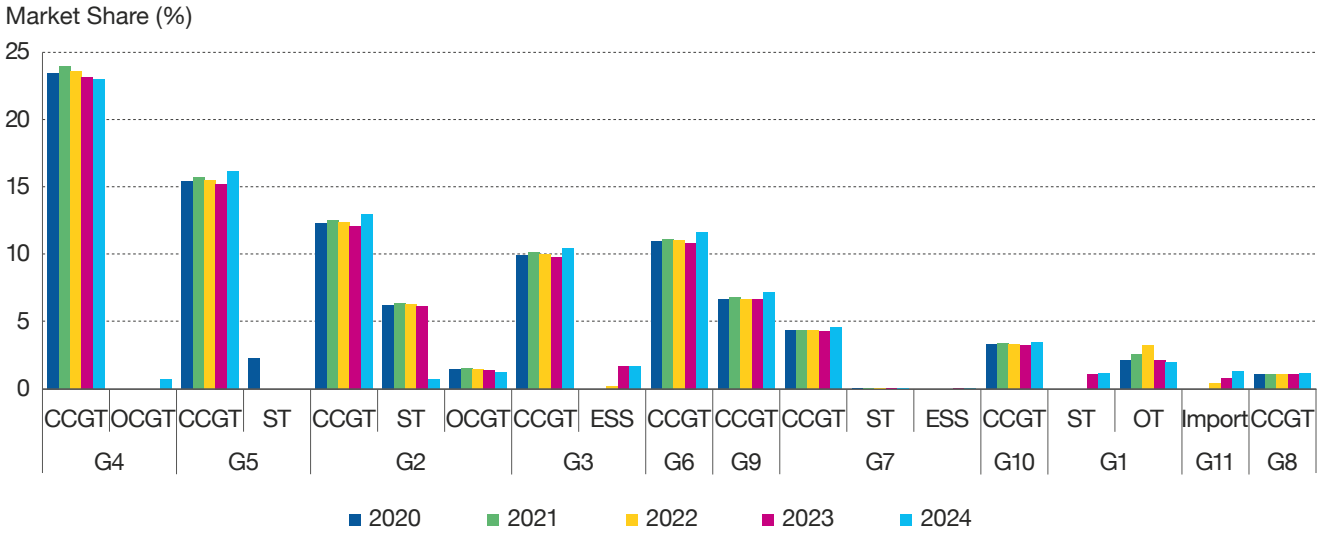


Chart 2 shows the market share based on maximum capacity by generation company. The generation companies are arranged in descending order according to their market share in 2024.

The market share of CCGT rose to a five-year high of 90.74% in 2024. CCGT was also the generation type with the largest year-on-year expansion in market share in 2024. Its growth of 4.25 percentage points came as the upward revision of registered capacities of two facilities outweighed the impact of the de-registration of another facility. This was followed by Import's 0.55 percentage point growth in market share due to the addition of two facilities in 2024 and marked the category's largest annual growth since its inception in 2022.

The market share of OCGT grew 0.53 percentage point, due to the de-registration of two facilities and the registration of two new facilities with comparatively higher capacities. The market share of ST plunged 5.30 percentage points while that of OT slipped 0.14 percentage point, due to the de-registration of three ST facilities and one OT facility. With the shifts in market shares for the various generation types, the market share of ESS[5] edged up 0.11 percentage point.

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

Year	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11
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
2024	3.17	15.05	12.20	23.73	16.22	11.60	4.75	1.17	7.26	3.48	1.37

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. The top three generation companies have consistently been G2, G4 and G5 (in no particular order) over the last five years. However, their combined market share shrank for a fourth consecutive year to 55.00% in 2024.

Compared to 2023, G2 saw the largest decline in market share of 4.77 percentage points due to the de-registration of five facilities in 2024. G1's market share dipped 0.07 percentage point due to the de-registration of one facility. On the other hand, G4's market share rose 0.56 percentage point following the registration of two new facilities and the de-registration of one facility, while G11's market share grew 0.55 percentage point with the registration of two new facilities. The market shares of G7 and G9 increased 0.34 and 0.64 percentage point respectively, due to the upward revision of registered capacities of one facility of G7 and one facility of G9.

[5] Actual capacities of the ESS facilities were used.

MARKET CONCENTRATION: HERFINDAHL-HIRSCHMAN INDEX

TABLE 4: HERFINDAHL-HIRSCHMAN INDEX

Year	Minimum	Maximum	Average	Maximum Share (%)
2020	1,350	1,534	1,441	20.19
2021	1,322	1,433	1,366	18.22
2022	1,326	1,512	1,407	21.08
2023	1,322	1,455	1,371	19.12
2024	1,293	1,463	1,369	18.95

Note: Due to a change in methodology, the market share based on metered energy quantity by generation company (on which the HHI is based) has been revised.

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.

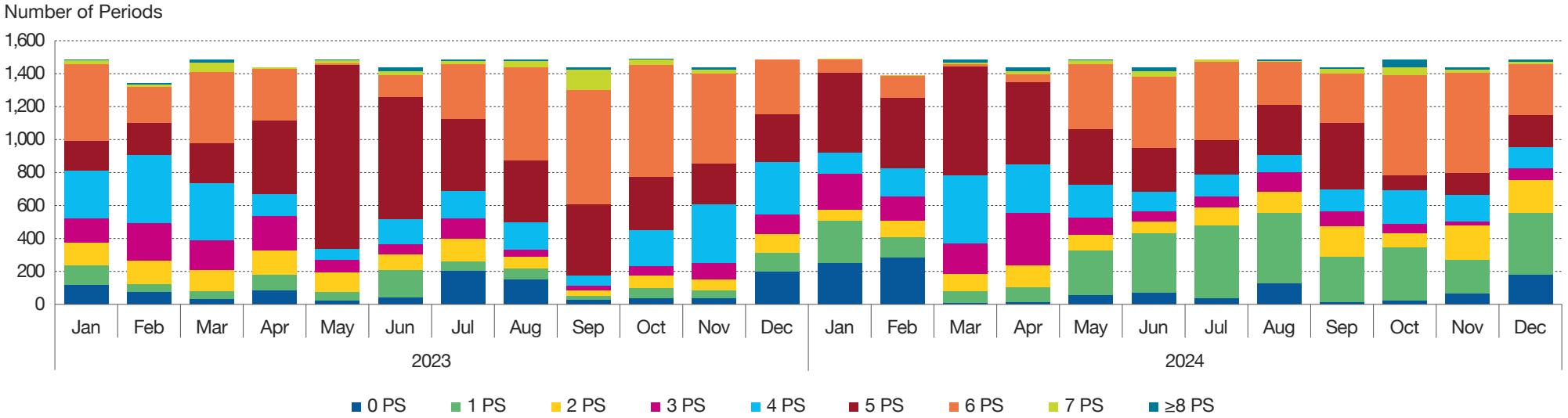
The HHI classifies the electricity market into three categories: in "unconcentrated markets" where the index is below 1,000, in "moderately concentrated markets" where the index is between 1,000 and 1,800, and in "highly concentrated markets" where the index is above 1,800. The classification is adopted 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 fell for a second consecutive year to 1,369 in 2024. This was in line with a drop in the maximum market share held by the generation company with the highest percentage of metered energy quantity from 19.12% in 2023 to 18.95% in 2024, as observed in Table 2. The range between the minimum and maximum HHI of 2024 widened from 134 in 2023 to 170 in 2024.

Overall, the NEMS remained moderately concentrated as there was no significant change in the proportion of metered generation quantity in the market in 2024. Over the last five years, the monthly HHI of the NEMS hovered between 1,300 and 1,500, 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



The pivotal supplier test is an indicator of structural market power in the NEMS, helping to identify suppliers which have the potential to influence market prices due to their critical role in meeting demand. 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 2023 and 2024.

The number of periods with one pivotal supplier increased the most by both magnitude and proportion, more than tripling from a total of 904 periods in 2023 to 3,234 periods in 2024. In contrast, the number of trading periods with six pivotal suppliers fell by the greatest magnitude, from a total of 4,725 periods in 2023 to 3,636 periods in 2024.

Between 2023 and 2024, the number of periods with zero to three pivotal suppliers increased 59.00%, while the number of periods with four or more pivotal suppliers decreased 20.67%. It was reasonable for fewer generation companies and for generation companies with mostly CCGT facilities to become pivotal suppliers in 2024. This was consistent with fewer periods with tighter supply cushion compared to 2023 as highlighted in Table 7, and a rise in the annual average market share of the CCGT generation type, which was the predominant generation type, as illustrated in Chart 2.

The number of periods with eight or more pivotal suppliers rose from 108 periods in 2023 to 154 periods in 2024. On the other hand, the number of such periods which also incurred a shortfall of energy and/or ancillary service dropped from 54 in 2023 to 31 in 2024.

The maximum number of pivotal suppliers recorded per period was 20 in 2024, similar to 2023. This maximum number surfaced in eight periods in 2024, slightly up from five periods in 2023. Of these periods, the number of such periods incurring energy and/or ancillary service shortfall was five in 2024, slightly up from three in 2023.

The shifts in structural market power from 2023 to 2024 reflect the easing of the supply cushion as well as the decreased frequency of energy and ancillary service shortfalls.

TABLE 5: CAPACITY RATIO BY GENERATION TYPE (%)

Year	CCGT	ST	OT	OCGT	Import	ESS
2023	63.79	8.05	21.62	0.21	9.68	10.08
2024	66.44	45.43	25.95	0.55	0.82	9.19
YOY Change	2.65	37.38	4.32	0.35	-8.85	-0.90

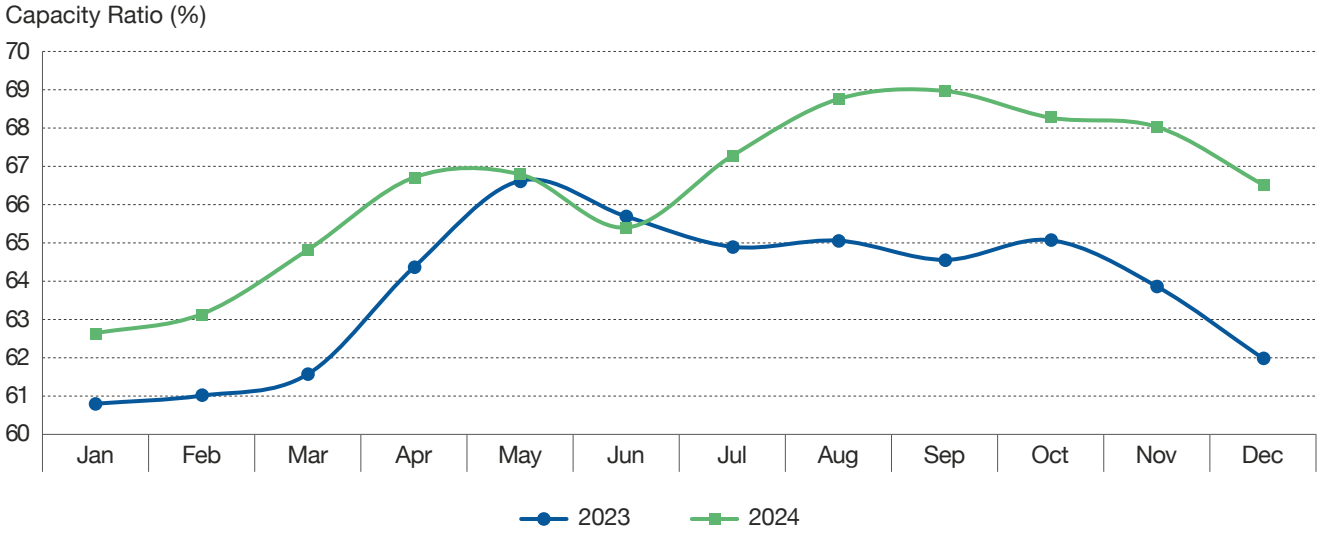
The capacity ratio represents the utilisation level of each generation type – its scheduled output to its maximum generation capacity. Table 5 compares the yearly average capacity ratio of the six generation types in 2023 and 2024.

In 2024, the capacity ratio for ST increased the most, by 37.38 percentage points. This was in line with the de-registration of three partially retired ST facilities, which had previously diluted the capacity ratio in 2023. For CCGT and OT, growth in their capacity ratios was consistent with their lower maximum capacities and higher output levels supported by lower outage levels. The capacity ratio for OCGT rose as its higher output level overshadowed the impact from higher maximum capacities. The overall higher capacity ratios, arising mostly from increased output levels to fulfil stronger demand, could explain the lower frequency and magnitude of dispatch directions[6] issued by the PSO in 2024 compared to 2023.

Although two new Import facilities joined the market in 2024 and recorded increasing scheduled output, the Import capacity ratio dropped 8.85 percentage points from 2023. This could be because the new facilities primarily ramped up operations only from Q4 2024. Amidst the shifts in capacity ratios for the various generation types as well as a higher ESS outage level, the capacity ratio for ESS slipped 0.90 percentage point.

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 RATIO OF CCGT UNITS



A monthly comparison of the capacity ratio of CCGT units in 2023 and 2024 is shown in Chart 4.

In 2024, the monthly average capacity ratio of CCGT units was higher than 2023 in all months except June. This was generally in line with lower levels of CCGT outage overall in 2024.

Against the backdrop of forecast demand rising to the second highest and highest monthly average demand in April and May respectively, the capacity ratio jumped from March to April and remained relatively constant in May in 2024. There was an upward revision of the maximum capacities of two CCGT facilities – one in April and another in May. The capacity ratio surged again in July when one CCGT facility was de-registered, and thereafter largely averaged higher than the first half of the year when forecast demand remained relatively high.

[6] EMA's measures to secure and stabilise the power system and market include the Directed Supply Scheme (DSS) and Standby Capacity Scheme (SCS). Under the DSS, the PSO pre-emptively directs generation companies to generate using their own fuel (either diesel or gas), or gas from the Standby Liquefied Natural Gas Facility (SLF), in the event of a projected supply shortfall in the NEMS. Under the SCS, the EMA further procures standby generation capacity from participating generation licensees, and when required, the participating licensees will be called upon to increase generation supply in the NEMS to enhance power system security, reliability and stability, and mitigate price volatility.

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	%		
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	0.00	50.76	2.16	2,351.90	3.11
2024	1,111.07	3.40	73.65	73.76	4.70	5.22	1,271.80	98.19	21.69	0.00	0.36	1.46	0.00	0.00	23.51	1.81	1,295.31	-44.93

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

In 2024, the planned and forced outage levels decreased for all generation types, with the exceptions of OCGT and ESS. The sharp declines of planned and forced outage levels for CCGT, ST and OT could reflect the retirement of several such facilities at the end of their economic life. In contrast, the OCGT planned and forced outage levels climbed to their respective highest levels over the past five years. The planned outage levels of Import eased, while that of ESS rose significantly. The forced outages of Import and ESS were insignificant in 2024.

Overall, the volume of annual average planned and forced outages per period plummeted 44.73% from 2,301.14MW in 2023 to 1,271.80MW in 2024, and 53.69% from 50.76MW in 2023 to 23.51MW in 2024, respectively. This resulted in the annual average of total outages plunging 44.93% to 1,295.31MW, the largest annual decline observed since market start.

CHART 5: PLANNED OUTAGES VS USEP

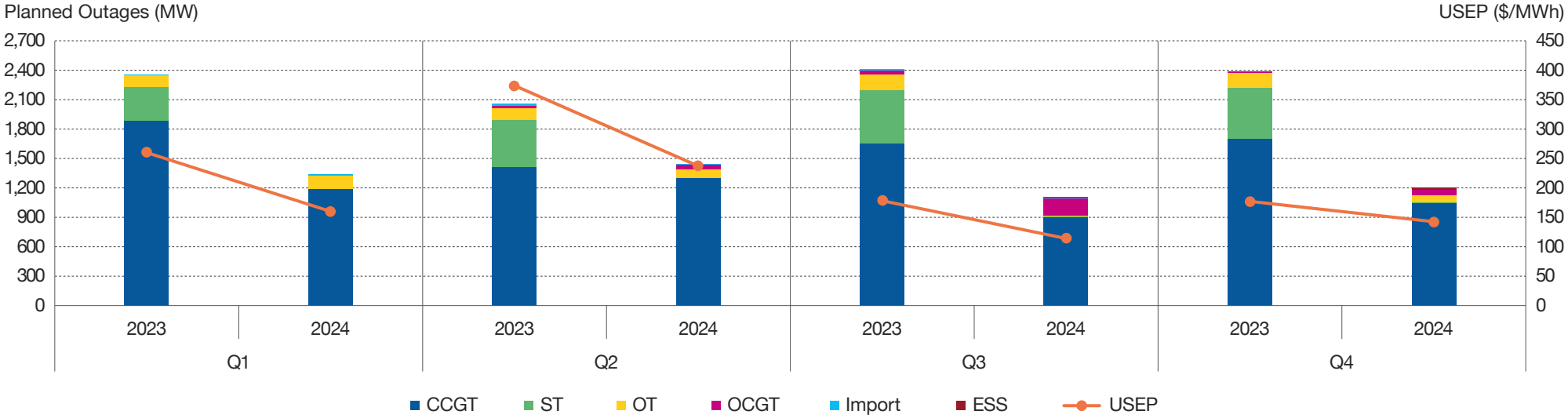


Chart 5 compares the quarterly average planned outages against the quarterly average USEP in 2023 and 2024.

The USEP is typically expected to move in tandem with planned outage volumes, as a higher level of planned outages usually coincides with a contraction in supply, which would generate upward pressure on prices. Chart 5 shows that year-on-year, the USEP moved in tandem with planned outage volumes in all quarters of 2024.

For the first three quarters, on a year-on-year basis, the fall in planned outage levels ranged between 29.85% (Q2) and 54.09% (Q3), while the decline in USEP correspondingly ranged between 36.02% (Q3) and 38.63% (Q1). However, in Q4 2024, the USEP fell a mere 19.75% despite a 49.41% drop in the planned outage level.

The relatively muted USEP since Q3 2023 coincided with measures to mitigate extreme price volatility in the NEMS and cheaper energy offers overall. Such measures include the TPC mechanism introduced by EMA on 1 July 2023 and the implementation of a five-year vesting regime framework from 1 July 2023 to 30 June 2028. The TPC is designed to be activated 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 is deactivated.

SUPPLY INDICES: AVAILABLE GENERATION CAPACITY

CHART 6: AVAILABLE GENERATION CAPACITY

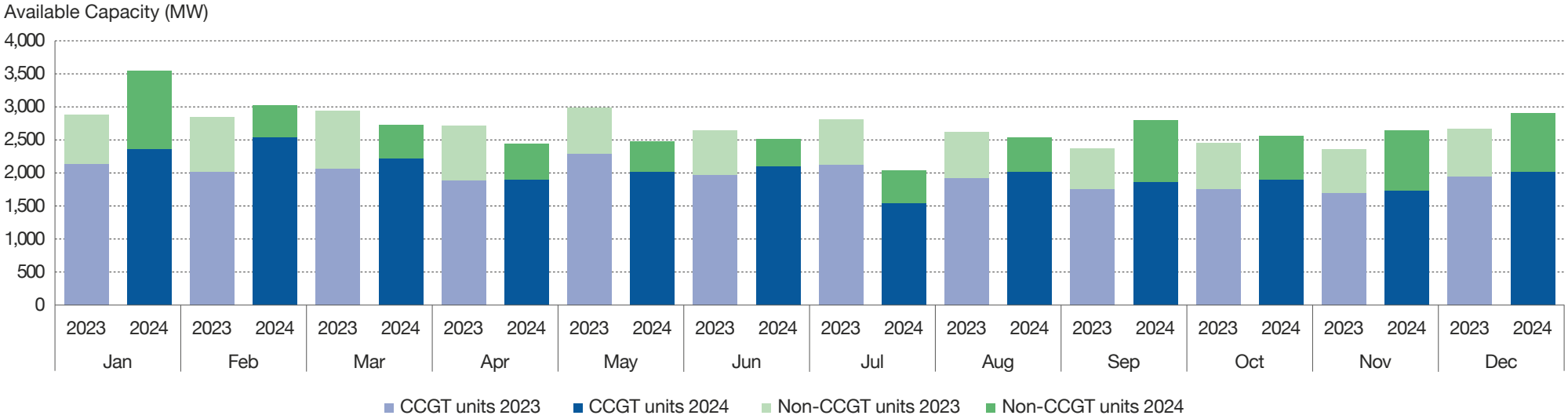


Chart 6 shows the available generation capacity on a monthly basis in 2023 and 2024. The available generation capacity refers to capacity that is not offered to the market even though the generation units are not on planned nor unplanned maintenance. Generally, the non-CCGT generation types have higher available generation capacity as they are not baseload providers and are only likely to offer into the system under certain market conditions.

From March to August 2024, available generation capacity in 2024 was lower compared to the corresponding months in 2023. This was mainly due to lower available generation capacity from non-CCGT units in those months, during which demand is also typically higher than the rest of the year. In contrast, the available generation capacity from CCGT units grew in all months except May and July.

Given that CCGT units mainly operate on natural gas, gas curtailment occurrences may result in a shortage of the main fuel for the CCGT units and contribute to available generation capacity. Overall, the available generation capacity in 2024 dipped 0.27% from the year before. This was consistent with less frequent gas curtailment in 2024 than in 2023.

CHART 7: RELATIONSHIP BETWEEN SUPPLY CUSHION AND USEP

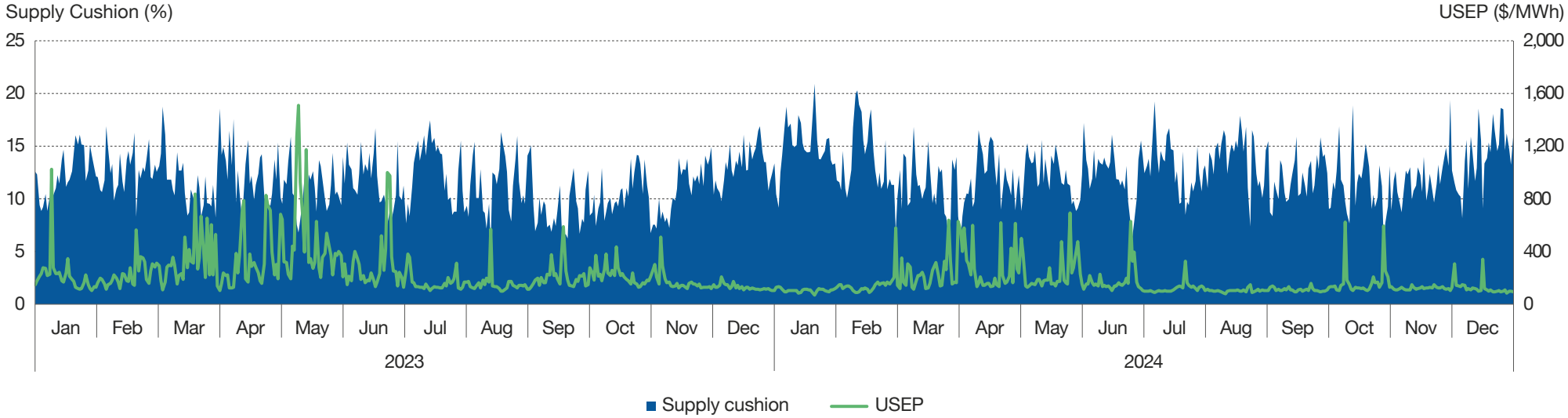


Chart 7 illustrates the relationship between the daily average USEP and the daily average supply cushion for 2023 and 2024. The supply cushion measures the level of spare capacity available after dispatch. Generally, the USEP and the supply cushion are inversely correlated. A lower supply cushion usually 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 recovered by 1.23 percentage points from 11.51% in 2023 to 12.74% in 2024. However, this remained the second lowest annual average supply cushion recorded since market start. The USEP tumbled 34.08% from $247.52/MWh in 2023 to $163.18/MWh in 2024, the lowest annual average USEP since 2021.

The supply cushion improvement was driven by a 4.28% increase in energy supply outpacing a 2.92% increase in demand. The expansion in energy supply was reflected in the lower levels of outages shown in Table 6, as well as a dip in available generation capacity seen in Chart 6.

Since Q3 2023, the USEP volatility has decreased significantly alongside slight improvement in the supply cushion. The relatively stable USEP could also be attributed to the introduction of the TPC mechanism from EMA to mitigate extreme price volatility, the implementation of a new five-year vesting regime framework, and overall cheaper energy offers over time. The decreased USEP volatility was also consistent with the lower frequency and magnitude of dispatch directions issued by the PSO in 2024, compared to 2023.

CHART 8: RELATIONSHIP BETWEEN SUPPLY CUSHION AND USEP IN 2024

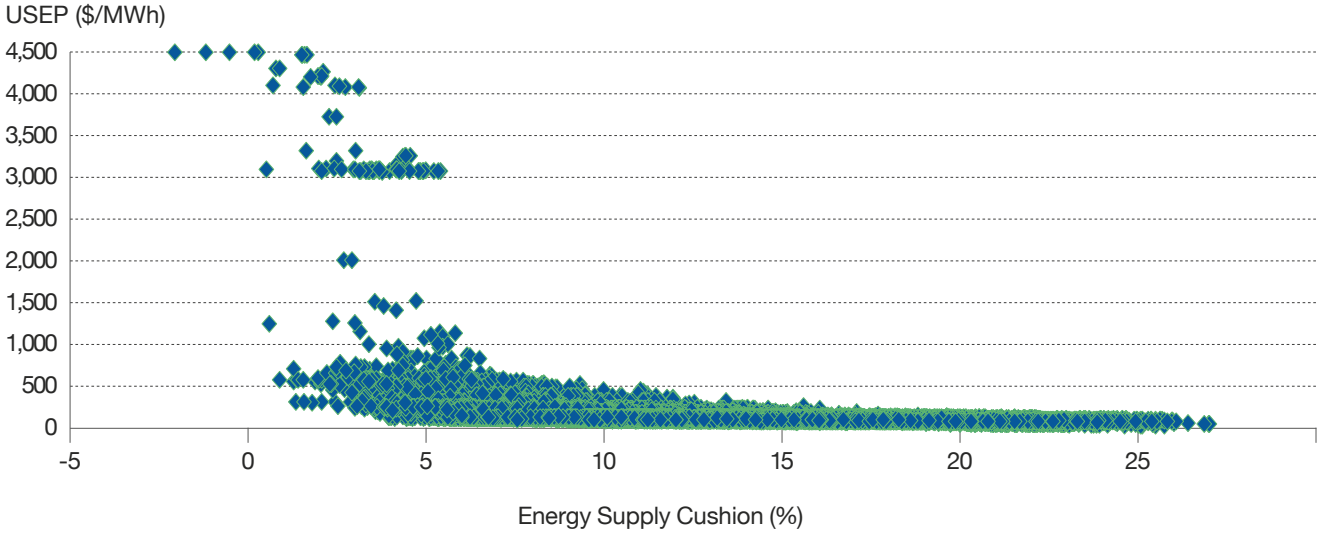


Chart 8 shows the relationship between the USEP and the supply cushion in 2024 across all dispatch periods.

The periodic USEP exceeded $1,000/MWh on 99 instances in 2024, compared to 320 in 2023. Furthermore, the periodic USEP reached the price cap of $4,500/MWh on five occasions in 2024 compared to 20 in 2023.

The supply cushion fell below zero in three periods in 2024, as can be seen on the left side of Chart 8. This is the second straight year, and the third year since market start, that a negative supply cushion has been observed. Of these three periods, two periods each recorded negative supply cushion following a CCGT unit undergoing forced outage. For the remaining period, changes in the offer pricing of generators led to a drop in energy supply, amidst relatively high demand for the day and several generation units on maintenance.

Of the five periods in 2024 with an energy shortfall, pushing the USEP to hit the price cap of $4,500/MWh, three periods registered negative supply cushion. For the remaining two periods, the supply cushion was at 0.28% and 0.18%, with supply only narrowly meeting demand. After taking into consideration transmission losses, energy shortfalls were incurred so as to fulfil both the system demand and requirement from transmission loss.

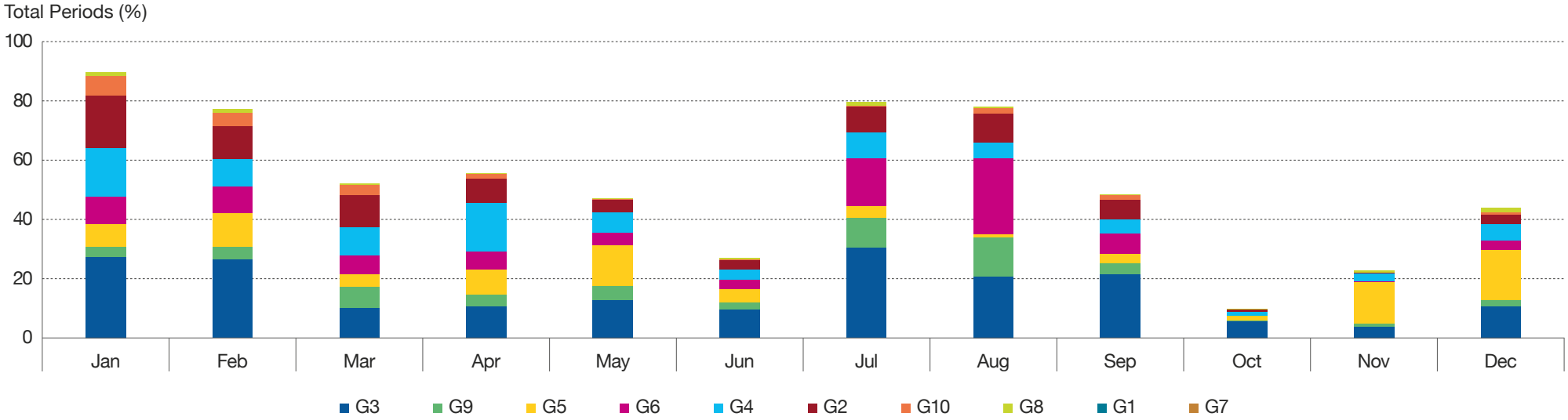
TABLE 7: RELATIONSHIP BETWEEN SUPPLY CUSHION (%) AND USEP ($/MWH)

Year	Supply Cushion < 15%			Supply Cushion ≥ 15%		
	Number of Periods	Average USEP	Max USEP	Number of Periods	Average USEP	Max USEP
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
2024	12,104	192.46	4,500.00	5,464	98.31	260.12

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.

The number of periods for which the supply cushion was below the 15% level decreased significantly from 2023 to 2024. The periodic supply cushion fell below the 15% level 68.90% of the time in 2024, less frequently than 78.32% in 2023. At the same time, the average USEP during those periods dropped 31.98% from $282.95/MWh in 2023 to $192.46/MWh in 2024. Similarly, the average USEP during the periods for which the supply cushion was greater than or equal to the 15% level fell 17.56% from $119.25/MWh in 2023 to $98.31/MWh in 2024. The USEP's declining trends for both categories of supply cushion levels were reflective of the decreased USEP volatility depicted in Chart 7.

CHART 9: TREND OF PRICE SETTING GENERATION COMPANIES



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

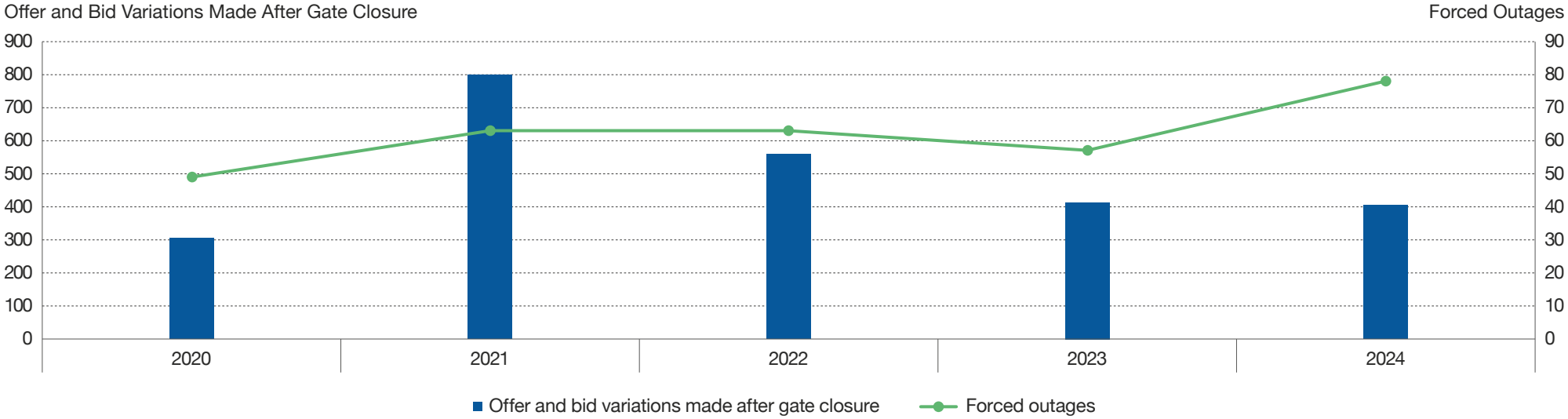
Chart 9 shows the number of periods in which each generation company was the price setter, expressed as a percentage of the total number of periods in the month.

In 2024, the percentage of periods which had a price setter ranged from a low of 9.81% in October to a high of 89.45% in January.

The three generation companies most frequently identified as price setters in 2024 did so for 63.65% of the periods with a price setter, down from 73.59% in 2023. These top three generation companies in 2024, G3, G5 and G4, were also the three most frequent price setters in 2023. G3 was the price setter for 31.23% of all periods with a price setter in 2024, up from 30.99% in 2023. G5 and G4 were the price setters for 18.36% and 14.06% of the time respectively in 2024, down from 27.86% and 14.73% respectively in 2023.

G5 set the price for 59.94% of the periods in November 2024, the peak monthly level of any generation company in the year. It had achieved this peak the year before too, setting the price for 39.11% of the periods in July 2023.

CHART 10: OFFER AND BID 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 and bid variations made after gate closure from 2020 to 2024 in relation to the number of forced outages.

Other than in 2022 and 2024, the number of offer and bid variations made after gate closure generally trended with the forced outage occurrences.

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 and bid variations made after gate closure, which fell from 799 in 2021 to 559 in 2022 when there was no change in forced outage occurrences.

In 2024, the number of forced outages rose from 57 in 2023 to 78 in 2024. However, the number of offer and bid variations made after gate closure dipped from 414 in 2023 to 405 in 2024. This smaller number of offer and bid variations coincided with a lower frequency of dispatch directions issued by the PSO.

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

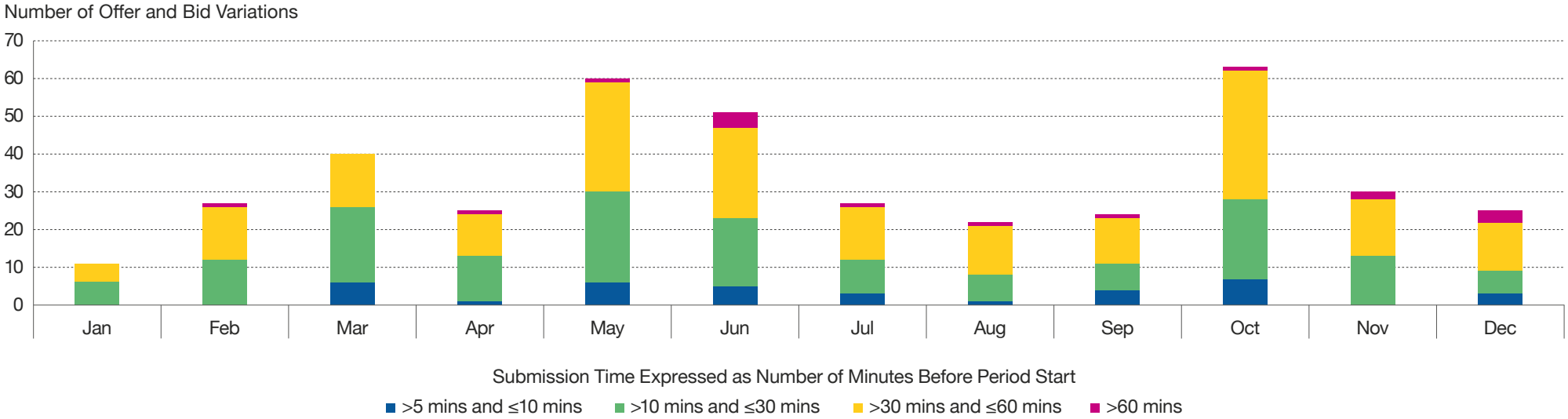


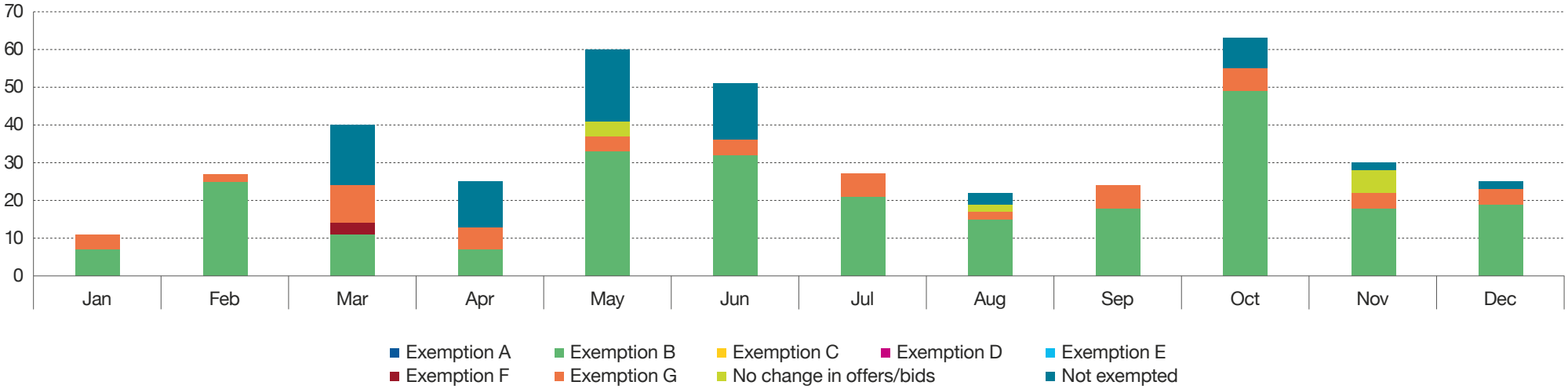
Chart 11 reflects monthly offer and bid variations in 2024 submitted within the gate closure window or less than 65 minutes before the actual trading period, categorised by ranges of proximity of submission time to the actual trading period. There were no bid variations submitted within the gate closure window in 2024.

Compared to the rest of the year, the number of offer variations made within the gate closure window was significantly higher in May and October. In each of these two months, most such offer variations were driven by generation companies responding to forced outages.

Nevertheless, offer variations were submitted between ten minutes and 65 minutes before the actual trading periods in 91.11% of the total occurrences. This indicates that generation companies were still sufficiently able to respond before the start of the actual trading period. This was also an improvement over the past five years when this proportion had hovered slightly under the 90% level.

CHART 12: CASES OF OFFER AND BID VARIATIONS MADE AFTER GATE CLOSURE

Number of Offer and Bid Variations Made After Gate Closure



Under section 10.4.1 and 10.4.2 of Chapter 6 of the Market Rules, conditions have been set out as exemptions to the violation of the gate closure rules for registered facilities (refer to Box 1 for more details on exempted cases).

Chart 12 shows that of the 405 cases of offer variations assessed by the MSCP in 2024, 316 cases were determined not to be in breach of the Market Rules as they were exempted under Exemptions A-G, and a further 12 cases were determined not to be in breach due to no changes in the offer submissions. Of the remaining 77 cases which were not exempted, most were directed by the EMA and the PSO under the Directed Supply Scheme (DSS) and the Standby Capacity Scheme (SCS) respectively and therefore deemed by the EMA to be non-breaches of the Market Rules.

In line with Chart 11, Chart 12 shows a higher number of cases of violation of the gate closure rules in May and October compared to the rest of the year, particularly those exempted under Exemption B for Generation Registered Facilities, reflecting generation companies making offer variations 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.

BOX 1. EXEMPTION CONDITIONS FOR CASES OF OFFER AND BID 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 registered 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.

As provided by section 10.4.2 of Chapter 6 of the Market Rules, there are prescribed circumstances specified as exemptions for the assessment of bid variations made after gate closure, subjected to section 10.4.2.2. These exemptions are listed below:

Exemption A refers to section 10.4.2.1a. of Chapter 6 of the Market Rules, where a bid 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.

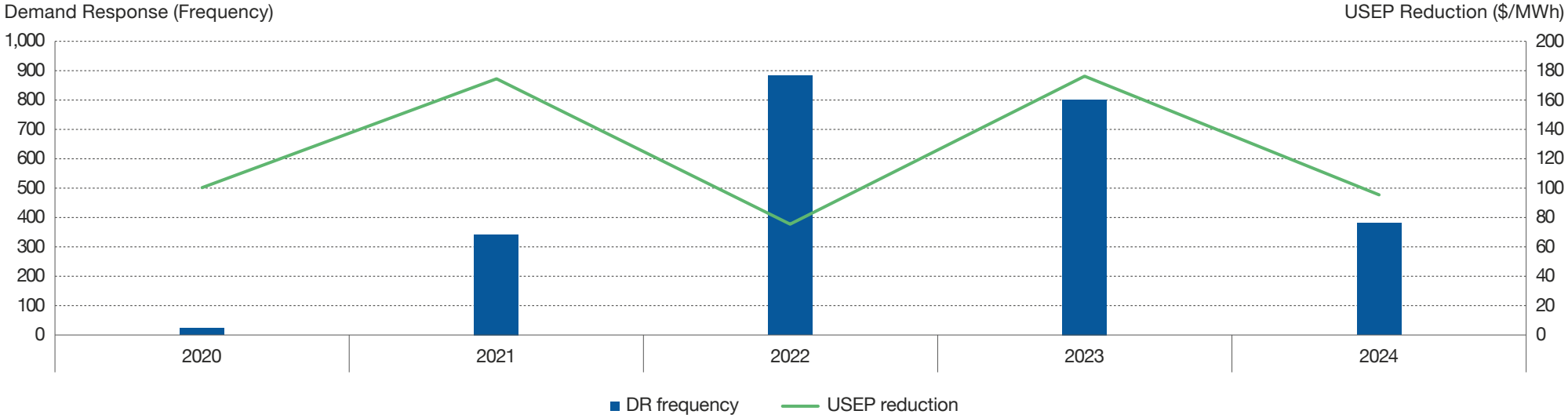
Exemption B refers to section 10.4.2.1b. of Chapter 6 of the Market Rules, where a bid variation is intended to contribute positively to the resolution of energy shortfall situations pertaining to which EMC has issued advisory notices under section 9.3.1 of Chapter 6 of the Market Rules, by allowing for increased quantities in its energy bids.

Exemption C refers to section 10.4.2.1c. of Chapter 6 of the Market Rules, where a bid variation is intended to contribute positively to the resolution of energy 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 PSO; and

(ii) at the time of submission of such bid variation or revised standing bid, EMC has not yet withdrawn, in respect of that dispatch period, such system status advisory notice by allowing for increased quantities in its energy bids.

CHART 13: DEMAND RESPONSE FREQUENCY VS USEP REDUCTION



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 more 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.

Chart 13 shows the frequency of DR activations and the associated average reduction in USEP during periods with DR activations. The USEP reduction is the spread between the Counterfactual USEP (CUSEP)[7] and USEP, or between the CUSEP and the Reference USEP (RUSEP)[8] when the TPC is also activated.

The number of DR activations in the market was low in the early years of the programme, before spiking to 883 in 2022 and 801 in 2023 amidst increased USEP volatility and a higher number of DR bid submissions in the market. However, despite the increased frequency of DR activations, the average USEP reduction plummeted from 2021 to 2022, mainly due to a lower CUSEP. In 2024, the number of activations more than halved to 382 alongside a smaller USEP reduction, in line with fewer occurrences of high USEP and fewer DR bid submissions.

[7] CUSEP is calculated by the market clearing engine (MCE) with the assumption that there is no dispatchable energy bid, i.e. CUSEP is the price that would have cleared had there been no DR in that period.
[8] During periods when the TPC is activated, USEP is capped at the TPC energy price cap when the RUSEP is above the TPC energy price cap, i.e. RUSEP is the price that would have cleared if no energy price cap was imposed as a result of the TPC mechanism. From 1 July 2023, when the TPC mechanism was introduced, the RUSEP is used as a comparison to CUSEP so as to reflect the true contribution of DR in lowering prices.

CHART 14: TOTAL CURTAILED LOAD VS TOTAL SAVINGS

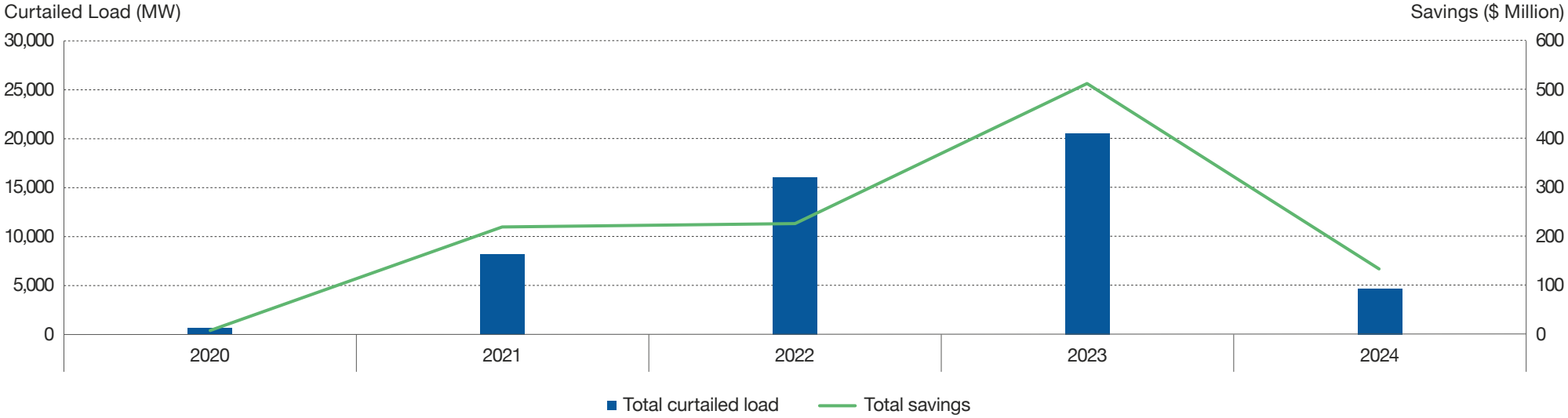


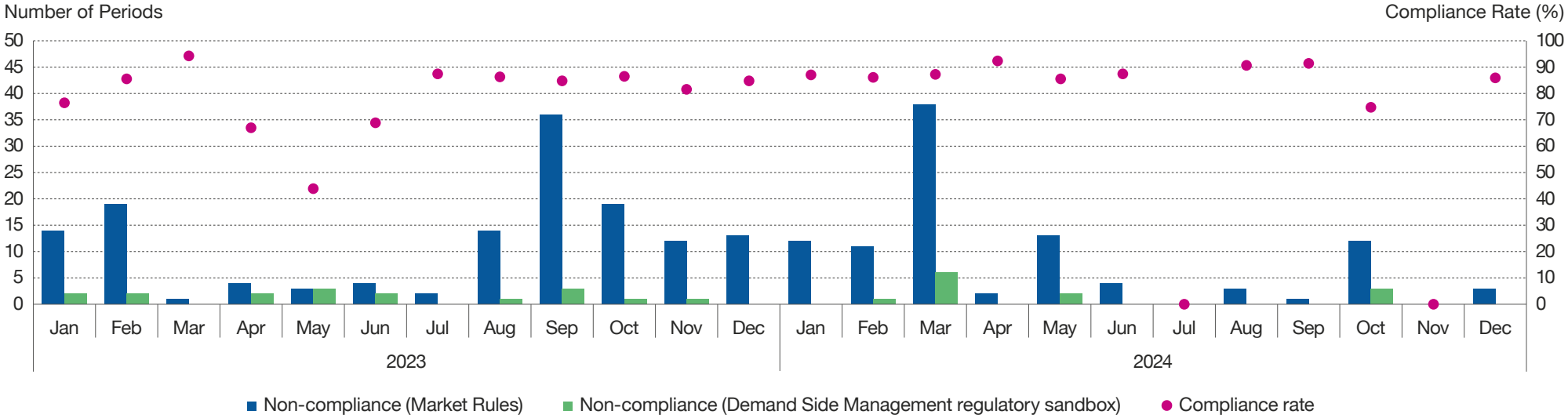
Chart 14 shows the total curtailed load and the total savings that arise from reduced USEP during the periods with DR activations.

The total curtailed load seen in Chart 14 moved in tandem with the frequency of DR activations over the past five years as reflected in Chart 13, with the exception of 2023. Between 2022 and 2023, Chart 13 shows the number of DR activations fell by 82, a 9.29% decline.

On the other hand, the total curtailed load climbed 28.36%, which was reflective of the higher total energy bid quantity available in the market. In particular, the total curtailed load per period peaked at 44MW for four periods in 2022 but exceeded 44MW for 185 periods in 2023.

The total savings shown in Chart 14 trended with the USEP reduction over the past five years as seen in Chart 13, with the exception of 2022. In 2022, the average USEP reduction plummeted from 2021 to 2022 due to a lower CUSEP as seen in Chart 13, while the total savings rose marginally, suggesting lower consumption levels arising from higher curtailed load during DR activation.

CHART 15: FREQUENCY OF NON-COMPLIANCE VS AVERAGE RATE OF COMPLIANCE IN DEMAND RESPONSE PROGRAMME



The DR programme enables Load Registered Facilities (LRF) to reduce their electricity consumption during periods of high wholesale electricity prices in exchange for incentive payments. LRFs must submit energy bids reflecting their willingness to curtail load when activated for DR, or consume load when not scheduled for activation. Non-compliance in the DR programme results in financial penalties if:

1. A facility is scheduled for load curtailment and the actual load reduction is less than 95% of the load curtailment quantity.
2. A facility is not scheduled for load curtailment, and the actual energy consumption is less than 95% of its scheduled energy consumption.

The EMA enhanced the DR programme through the Demand Side Management (DSM) regulatory sandbox, which was in effect from 1 January 2023 till 31 December 2024. The sandbox aimed to encourage increased consumer-side participation through measures such as a relaxed penalty regime and lower compliance threshold.

During the sandbox period, the threshold for non-compliance was lowered from 95% to 80%. The penalty regime was further relaxed such that no penalties were imposed for the first two instances of non-compliance. Upon the fifth instance of non-compliance, the DR facility is administratively suspended from the sandbox.

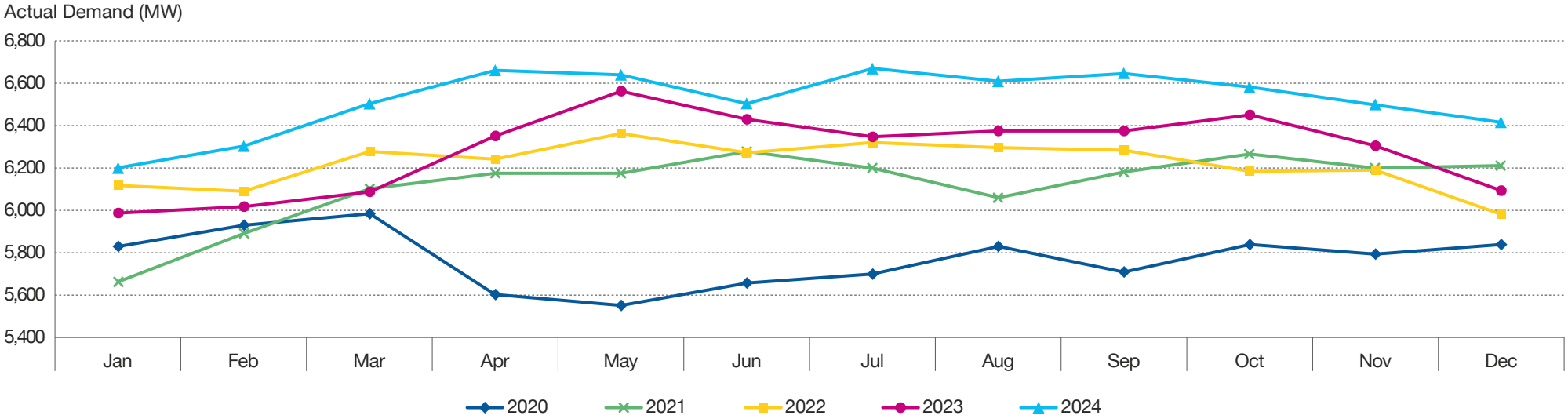
During the sandbox period, the total registered load curtailment capacity in the NEMS increased from 53.2MW in 2022 to 76MW in 2023, and the number of DR facilities rose from four in 2022 to seven in 2023. By the end of 2024, the number of DR providers registered in the market increased from three to five, the number of DR facilities rose to 12, and the total registered load curtailment capacity expanded to 108.1MW.

Chart 15 compares the frequency of non-compliance under the current Market Rules (with the compliance threshold of 95%) and the sandbox conditions (with the relaxed threshold of 80%), as well as the average compliance rate of LRFs during the sandbox period.

Between 2023 and 2024, despite the significantly lower frequency of DR activations indicated in Chart 13, the number of periods of non-compliance under the sandbox conditions dipped from 17 to 12. At the same time, the annual average compliance rate improved from 83.01% to 85.56%. On a month-on-month basis, the non-compliance frequency generally declined.

For the first six months of the sandbox, the compliance rate fluctuated between 40% and 95%. The frequency of non-compliance under the sandbox conditions relative to the current Market Rules saw mixed results, with compliance improving at the start likely due to the relaxed conditions, before declining in April to June 2023. Thereafter, the compliance rate largely stabilised between 80% and 90%, and the non-compliance frequency under the sandbox conditions was observed to be consistently much lower than that under the current Market Rules. In particular, there was zero non-compliance under the sandbox conditions for a total of ten months since July 2023.

CHART 16: COMPARISON OF ACTUAL DEMAND



Note: The actual demand for 2023 has been corrected.

Chart 16 compares the actual demand over the years 2020 to 2024. Average demand for the year increased 3.77% from 6,282MW in 2023 to 6,519MW in 2024. This was the highest yearly average demand since the start of the NEMS, and extends the steady growth trend observed since 2020.

Every month in 2024 had a higher average demand than in 2023, and all except January had an average demand that surpassed 6,200MW. The lowest monthly demand was observed in January and corresponded with the lowest monthly recorded temperature of 2024.

Average demand increased steadily from January to April 2024 before declining in May and June and peaking at 6,670MW in July. This trend closely mirrored temperature fluctuations, except in April when an inverse relationship was observed.

From August to October 2024, the average monthly demand consistently exceeded 6,500MW. These changes aligned with temperature variations, except in September, when the increase in demand was likely influenced by higher manufacturing activity.

DEMAND INDICES: METERED ENERGY QUANTITY AND SOLAR GENERATION

CHART 17: ACTUAL DEMAND VS SOLAR GENERATION

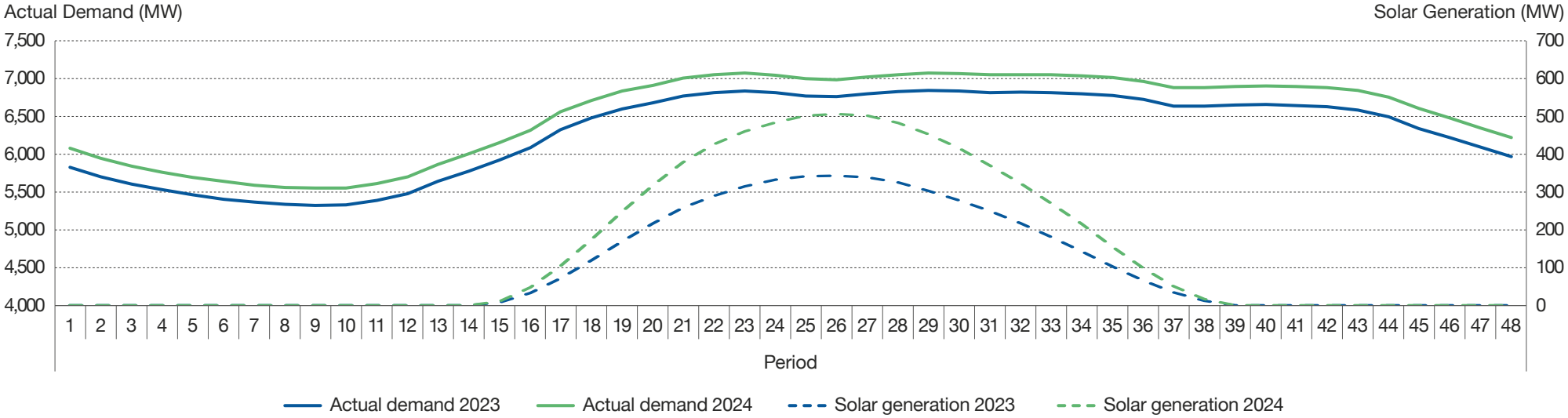


Chart 17 shows the periodic average profile of actual demand and solar generation for 2023 and 2024.

In the past, the demand profile was typically characterised by a distinct peak in the middle of the day. With the introduction of solar generation and its increasing contribution to the market in recent years, the peak of the demand profile has not only flattened overall but also exhibits a dip during the midday period. Chart 17 shows this decline occurs between period 24 and 28, which aligns closely with the peak in solar generation.

In 2023, the highest average actual demand of 6,844MW was observed in period 29, while the highest average solar generation 343MW occurred in period 26. In 2024, the highest average actual demand of 7,073MW occurred in period 29, while the highest average solar generation of 506MW was recorded in period 26.

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

TABLE 8: VARIATION IN LOAD FORECAST

Year	Variation between PDS & Real-time		Variation between STS & Real-time	
	Mean (MW)	Standard Deviation (MW)	Mean (MW)	Standard Deviation (MW)
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
2024	54.09	46.26	15.05	12.69

Note: The mean (MW) and the standard deviation (MW) are calculated in absolute terms.

Accurate load forecasting is essential for generating real-time dispatch and pricing schedules, ensuring efficient pricing outcomes and system stability. In the NEMS, three forecast schedules with varying forecast horizons are provided to market participants: the Market Outlook Scenario (MOS), the Pre-dispatch Schedule (PDS), and the Short-term Schedule (STS). The MOS is updated daily with a six-day forecast horizon. The PDS is updated every two hours with a forecast horizon of 12 to 36 hours. The STS, updated every half hour, has a shorter forecast horizon of six hours.

Table 8 details the accuracy of the PDS and STS forecasts from 2020 to 2024, measured by the means and standard deviations of the load variations (in absolute terms). As the STS is updated more frequently and closer to the real-time dispatch period, it typically exhibits smaller load variations from the real-time dispatch schedule than the PDS. In 2024, the mean load variation between the PDS and the real-time dispatch schedule was 54.09MW, which was 3.59 times larger than the variation between the STS and the real-time dispatch schedule of 15.05MW. Similarly, the standard deviation of the load variation for the PDS for 2024 was 46.26MW, 3.64 times as large as that for the STS.

The mean load variation between the PDS and the real-time dispatch schedule rose 0.46% in 2024 compared to 2023, indicating a year-on-year decrease in forecasting accuracy. In contrast, the mean load variation between the STS and the real-time dispatch schedule rose 0.61% in 2024, similarly indicating reduced accuracy from the previous year. As expected, the STS generally demonstrated higher accuracy compared to the PDS, as reflected in its lower mean and narrower spread in variation.

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

Year	Variation between Real-time Load Forecast & Actual Demand	YOY Change
2020	2.16	-0.30
2021	1.72	-0.44
2022	1.48	-0.23
2023	0.94	-0.54
2024	0.44	-0.53

The accuracy of the load forecast used in real-time dispatch schedules is critical, as it directly influences dispatch instructions and market prices. An accurate load forecast ensures that dispatch instructions and market prices align closely with actual system conditions, thereby contributing to system stability and optimised pricing outcomes. Maintaining a precise load forecast is therefore essential for the efficient operation of the market.

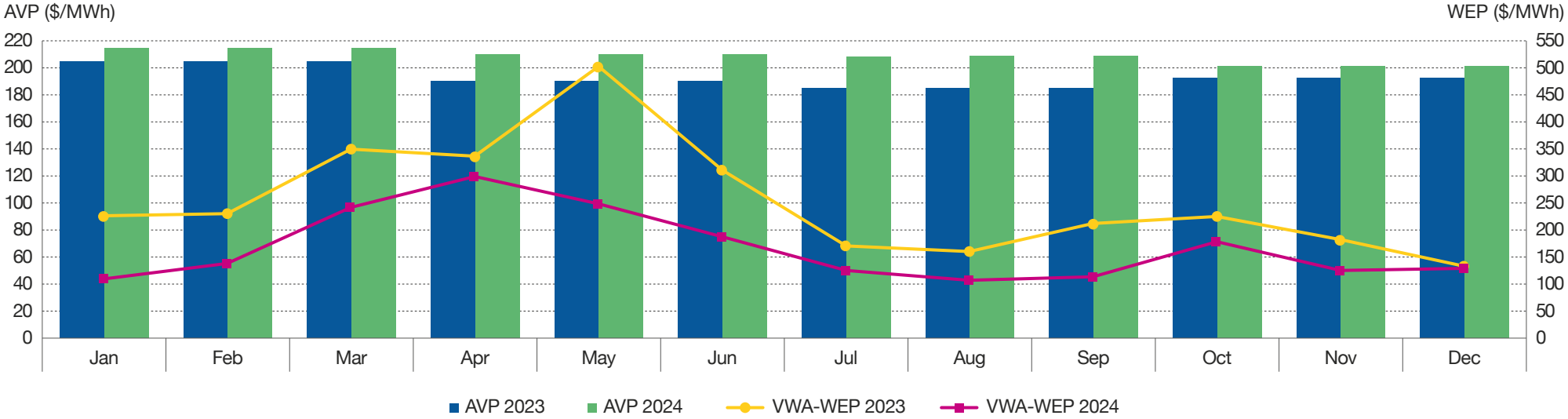
A slight variance between the real-time load forecast and the actual demand is inevitable due to several factors. For instance, the real-time load forecast includes station and auxiliary loads, while the metered energy quantity, based on settlement data provided by the Market Support Services Licensee (MSSL), excludes these components. This methodological difference results in the real-time load forecast typically being higher than the actual demand. Additional contributors to this variance include metering errors and transmission losses.

Table 9 highlights the variation between the real-time load forecast and actual demand, indicating the average load forecast deviation over the past five years. This deviation has consistently remained below 2.50% and shown a downward trend, reflecting improved accuracy in real-time load forecasts. A lower deviation corresponds to more precise load predictions, which is essential for effective market operations.

In 2024, the variation between the real-time load forecast and actual demand decreased 0.53 percentage point to 0.44% from 0.94% in 2023. This marks the lowest variation recorded since the start of the NEMS, signifying that the 2024 real-time load forecast was the most accurate to date.

PRICE INDICES: ANNUAL VESTING PRICE AND WHOLESALE ELECTRICITY PRICE

CHART 18: AVP VS MONTHLY VOLUME-WEIGHTED AVERAGE WEP (VWA-WEP)



To address the volatility in the prices over the past few years, the EMA implemented a new vesting regime framework[9] effective from 1 July 2023 to 30 June 2028. This framework enables EMA to issue vesting contracts through the Market Support Services Licensee (MSSL) to hedge energy prices in the Singapore Wholesale Electricity Market (SWEM). It serves to mitigate extreme price fluctuations and includes a five-year vesting regime with three schemes: the Base Vesting Scheme, Tender Vesting Scheme, and Residual Vesting Scheme.

Chart 18 illustrates the Annual Vesting Price (AVP)[10] and the monthly volume-weighted average Wholesale Electricity Price (WEP) for 2023 and 2024. In an efficient market, the WEP is expected to closely align with the AVP, which represents the long run marginal cost of a generation facility. However, certain months in 2024 displayed a divergence between the WEP and the AVP, likely influenced by market price volatility driven by factors such as constrained supply, weather fluctuations, and rising fuel costs. The AVP may not be closely aligned with the WEP as a tighter supply cushion tends to be associated with higher WEP, while cooler weather contributes to lower WEP.

In 2024, the monthly volume-weighted average WEP dropped below $200/MWh for nine months and was lower than 2023 for all months. The highest WEP in 2024 was recorded in April, which also had the second highest monthly actual demand and temperature that year. Despite this, the lower WEP throughout 2024 resulted in a 34.14% year-on-year decline in the annual volume-weighted average WEP to $166.64/MWh from $253.02/MWh in 2023. In contrast, the AVP rose a marginal 7.92% from $193.13/MWh in 2023 to $208.43/MWh in 2024. As a result, the yearly volume-weighted average AVP in 2024 was 25.07% higher than the WEP.

[9] EMA | Vesting Contracts
[10] The AVP for 2023 was made up of LNG Vesting Price (LVP) in Q1 and Q2 2023 and Base Vesting Price (BVP) from Q3 2023 onwards.

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

CHART 19: INDEX OF AVP, WEP, FUEL OIL PRICE AND ELECTRICITY TARIFF

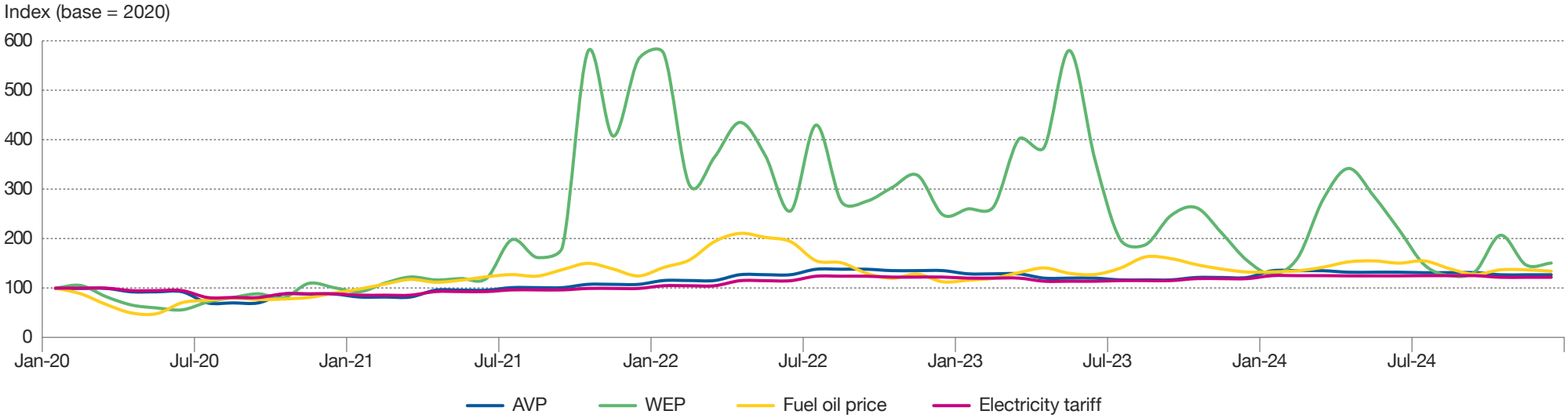


Chart 19 presents the indices of fuel oil price, Annual Vesting Price (AVP), Wholesale Electricity Price (WEP), and electricity tariff over the past five years, with 2020 as the base year. The chart highlights the relative changes in these indices and their correlations during this period.

Between January 2020 and June 2021, the WEP closely tracked fuel oil prices, indicating that fuel oil prices significantly influenced the WEP during this period. Meanwhile, the AVP and electricity tariff exhibited a more consistent correlation, moving largely in tandem over the five years.

From July 2021 onwards, the WEP experienced increased volatility, likely driven by tighter supply conditions and more frequent gas curtailment. Following the implementation of the Temporary Price Cap (TPC) in July 2023, the WEP eased, reflecting the TPC effectiveness in mitigating price volatility.

In 2024, higher WEP levels were observed between March and May due to a tighter supply cushion, warmer weather, and higher fuel costs compared to most other months of the year. Thereafter, the WEP stabilised, with a slight increase in October caused by tighter supply conditions.

On an annual basis, fuel oil prices averaged US$468.35/MT in 2024, marking a 3.21% increase from 2023. Despite this, the WEP declined 33.89%, averaging $163.12/MWh in 2024, while the yearly average electricity tariff increased 6.15% to reach $0.32/kWh.

PRICE INDICES: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY

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

Month	2023			2024		
	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	0.74	0.59	28	0.74	0.57	27
Feb	0.79	0.64	27	0.54	0.32	19
Mar	0.69	0.54	22	0.58	0.35	20
Apr	0.55	0.37	20	0.63	0.42	22
May	0.49	0.34	20	0.59	0.39	22
Jun	0.49	0.33	17	0.52	0.33	16
Jul	0.58	0.41	21	0.27	0.12	3
Aug	0.29	0.19	7	0.41	0.23	15
Sep	0.35	0.18	10	0.41	0.20	8
Oct	0.44	0.24	15	0.46	0.23	11
Nov	0.54	0.33	20	0.54	0.31	19
Dec	0.55	0.37	21	0.42	0.20	7
Average/Sum	**0.54**	**0.38**	**228**	**0.51**	**0.31**	**189**

Note: Due to a change in methodology, the trend of correlation between WEP and metered energy quantity has been revised.

Table 10 presents the correlation coefficient (*r*), which measures the strength and direction of the relationship between the WEP and the metered energy quantity over time. The correlation coefficient ranges from -1 to 1, where a positive value indicates a direct relationship (e.g., higher demand leads to higher WEP), and a negative value signifies an inverse relationship (e.g., higher demand leads to lower WEP). The closer the *r* value is to -1 or 1, the stronger the correlation. Additionally, the square of the correlation coefficient (r^2) represents the proportion of WEP variance attributable to variations in demand.

In 2024, the monthly correlation coefficient (*r*) ranged from 0.27 to 0.74, slightly narrower than the range of 0.29 to 0.79 observed in 2023. The annual average *r* value declined from 0.54 in 2023 to 0.51 in 2024. Furthermore, the number of days where *r* exceeded 0.5 decreased from 228 days in 2023 to 189 days in 2024. This decline indicated a slightly weaker overall correlation between the WEP and metered energy quantity in 2024, with fewer days where both variables exhibited strong positive movement in tandem.

The r^2 value also decreased from 0.38 in 2023 to 0.31 in 2024. This suggests that only 30.69% of the variance in the WEP in 2024 could be explained by demand variations, compared to 37.63% in 2023.

PRICE INDICES: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY

CHART 20: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY IN 2024

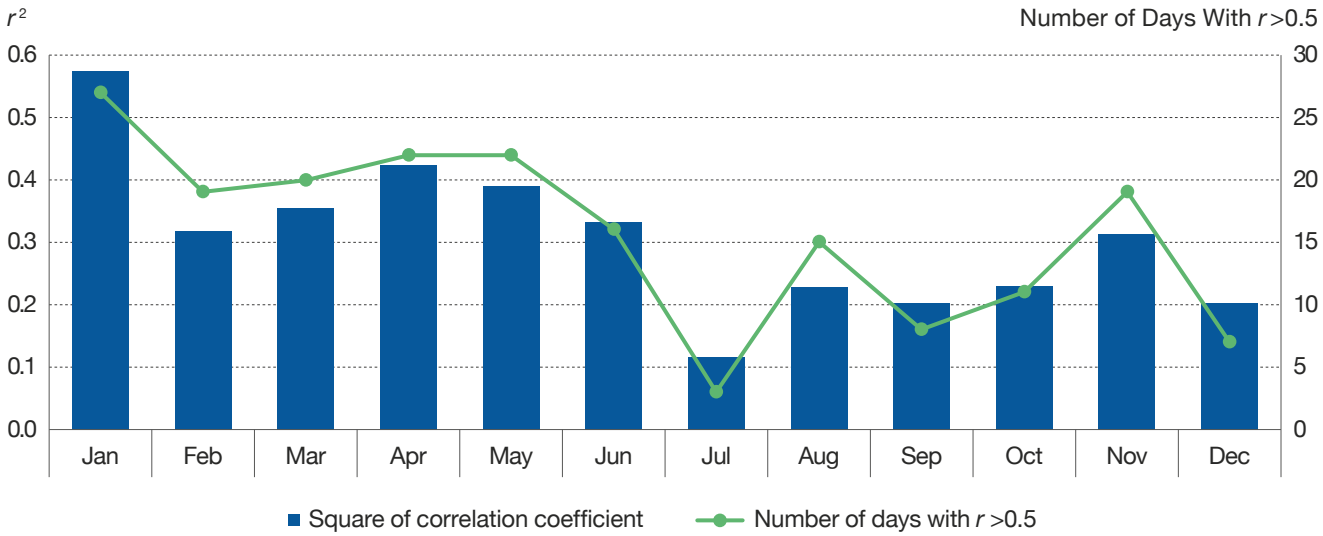


Chart 20 illustrates the correlation between the monthly WEP and the metered energy quantity in 2024. Generally, the r^2 value tends to correlate positively with the number of days when the correlation coefficient (r) exceeds 0.5, indicating a stronger relationship between the two variables on those days.

The highest r^2 value recorded of 0.57 was observed in January, when 27 out of 31 days showed an r value greater than 0.5, indicating that the WEP was predominantly influenced by demand fluctuations. In contrast, the lowest r^2 value of 0.12 occurred in July, with three out of 31 days exceeding an r value of 0.5, suggesting a very weak relationship between demand and WEP.

From February to December 2024, the r^2 values remained below 0.50, with no more than 22 days in any months showing an r value greater than 0.5. This weakening correlation can be attributed to external factors such as fluctuations in fuel oil prices, generator outages, the supply cushion and market interventions by the EMA. These variables likely mitigated the impact of demand on WEP, resulting in a reduced correlation.

CHART 21: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY FOR 2020–2024

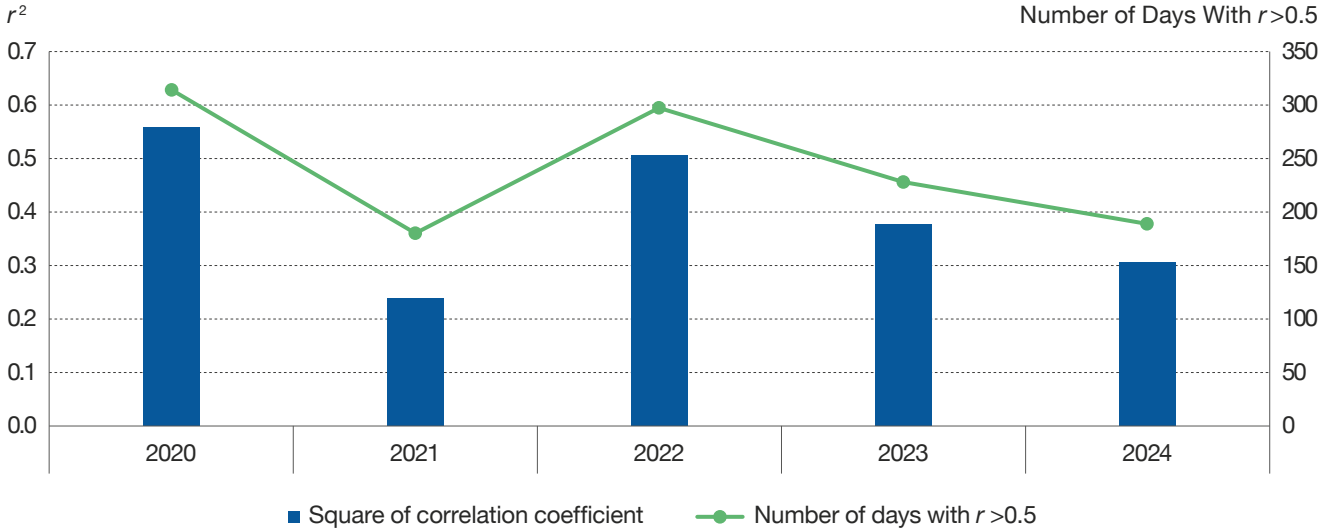


Chart 21 presents the correlation between the WEP and the metered energy quantity from 2020 to 2024. Over this period, both the r^2 value and the number of days with an r value greater than 0.5 showed a corresponding trend. In 2024, the r^2 value decreased to 0.31, and the number of days with an r value above 0.5 fell to 189, indicating a weakening relationship between demand and energy prices compared to previous years.

Several factors contributed to these fluctuations, including major events such as the gas curtailments in 2021 and 2022, and the implementation of the TPC in 2023. These significantly impacted market conditions and the correlation patterns observed.

In 2020, 314 days had an r value greater than 0.5, but this decreased to 180 days in 2021. It rebounded to 297 in 2022 before declining to 228 days in 2023, and falling further to 189 days in 2024. With an r^2 value of 0.31 in 2024, about 30.69% of the WEP's movements could be explained by demand changes, down from 37.63% in 2023, reflecting a continued weakening impact of demand on energy prices.

Note: Due to a change in methodology, the trend of correlation between WEP and metered energy quantity since 2023 has been revised.

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

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

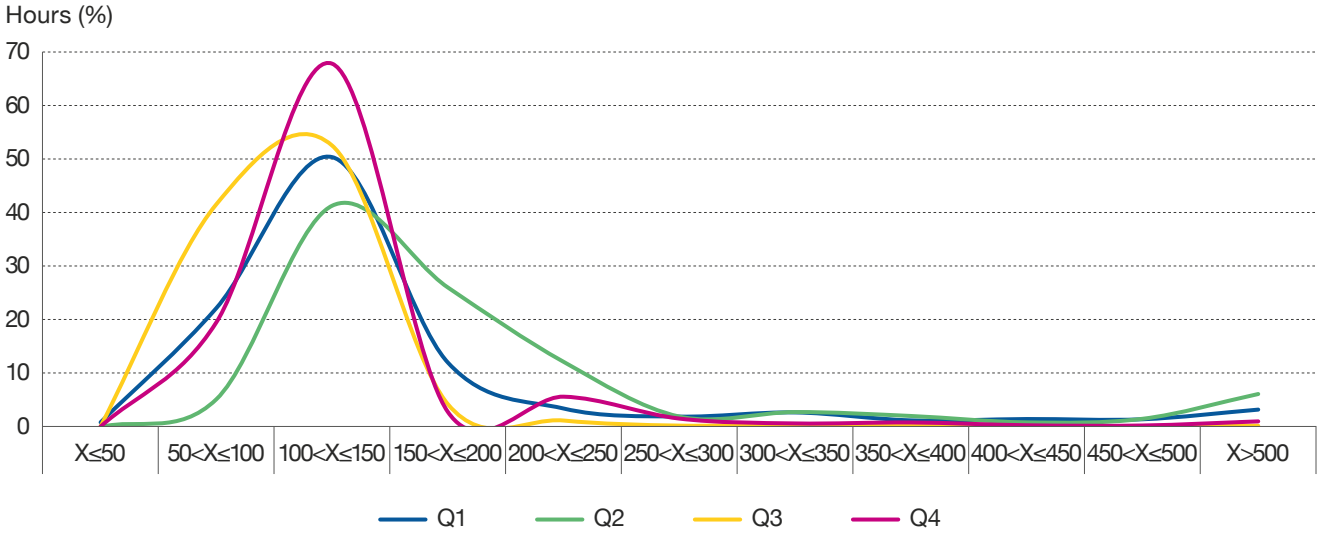


CHART 23: PERCENTAGE OF ENERGY QUANTITY WHEN THE WEP FALLS INTO A PARTICULAR PRICE RANGE

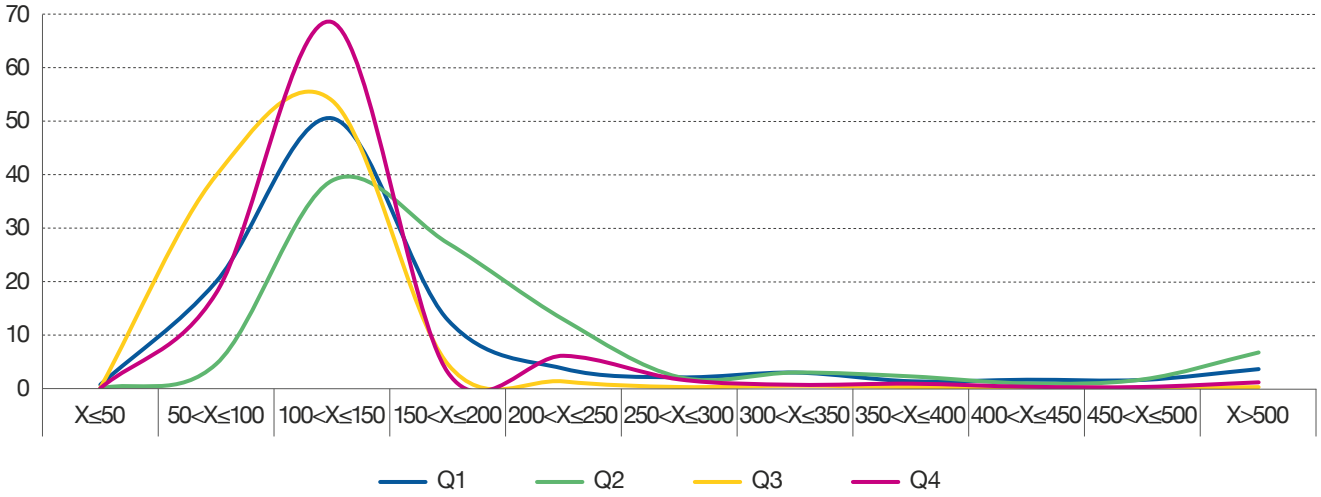


Chart 22 illustrates the distribution of the WEP across different price ranges, represented as a percentage of the total hours in each quarter of 2024. The price distribution shifted rightward from Q1 to Q2 2024, before moving leftward in Q3 and rightward in Q4. This trend can largely be attributed to the higher proportion of lower-priced energy offers in the second half of 2024, which coincided with an increase in available supply compared to the first half of the year.

Across all quarters, the highest distribution of the WEP consistently remained within the $100/MWh to $150/MWh range for the majority of the time. In Q1 2024, the percentage of WEP distribution equal to or less than $50/MWh was at 0.76%, compared to none in the rest of the quarters. This coincided with the highest supply cushion observed in Q1 2024. In Q2 2024, the highest WEP distribution was seen within the $100/MWh to $150/MWh range. Additionally, it was observed that the Q2 2024 WEP distribution above $500/MWh recorded was the highest among all quarters. In Q3 and Q4 2024, over 80% of the WEP distribution was priced within the $50/MWh to $150/MWh range.

Chart 23 presents the frequency of the WEP in various price ranges, expressed as a percentage of the total metered energy quantity for each quarter of 2024. The trend of the price distribution mirrors that seen in Chart 22, reflecting the narrow range of the metered energy quantity in the NEMS.

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

CHART 24: PERCENTAGE OF HOURS WHEN THE WEP FALLS INTO A PARTICULAR PRICE RANGE

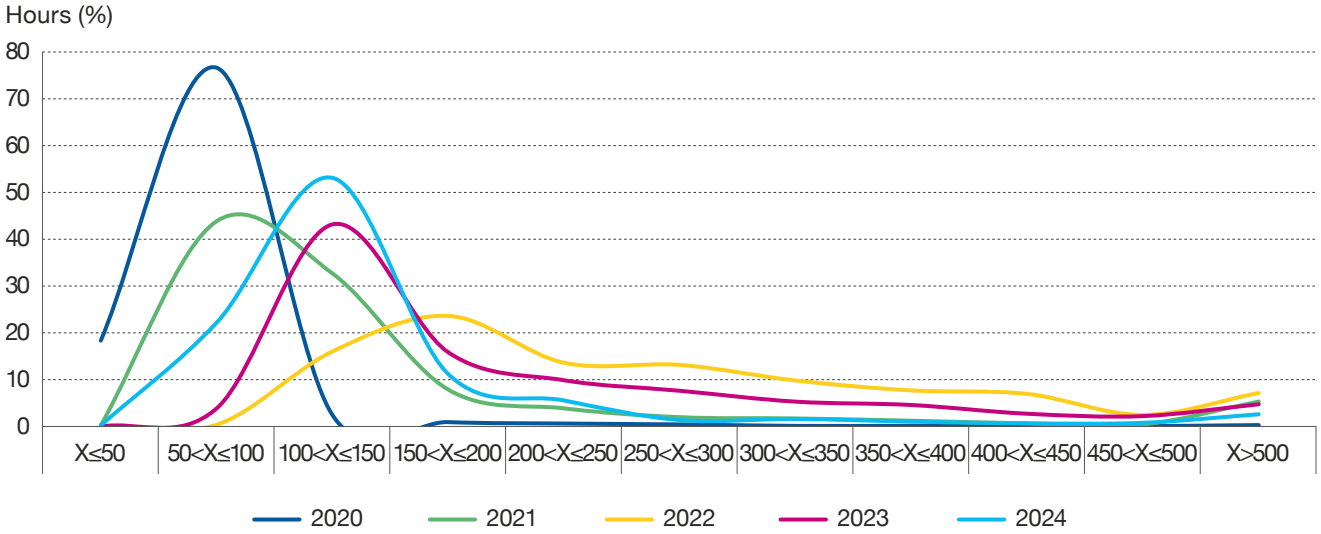


CHART 25: PERCENTAGE OF ENERGY QUANTITY WHEN THE WEP FALLS INTO A PARTICULAR PRICE RANGE

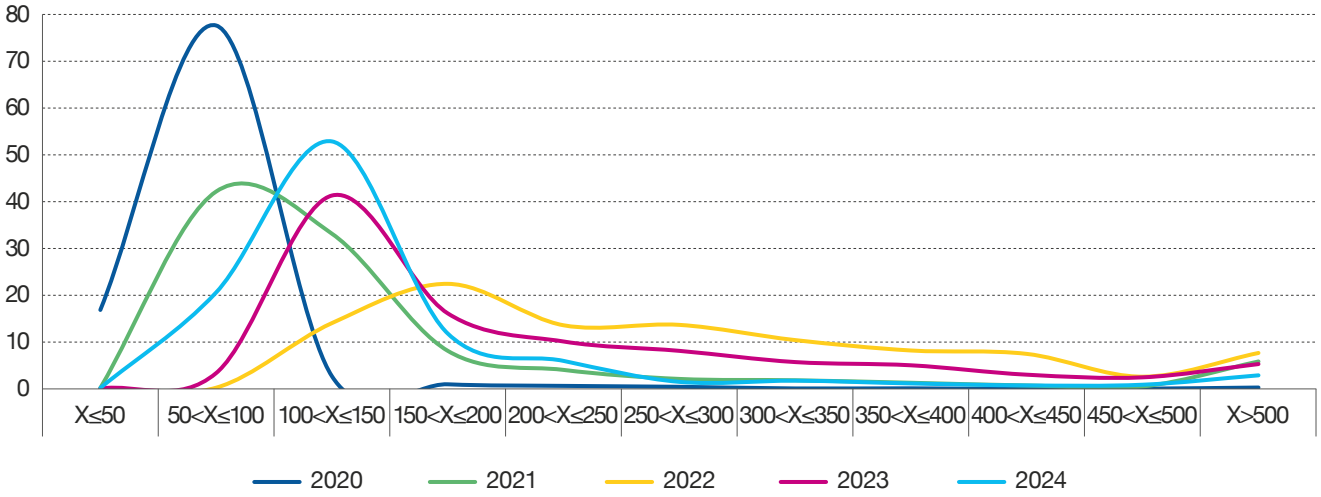


Chart 24 displays the historical price distribution over the past five years, expressed as a percentage of the total number of hours in each year, to assess longer-term trends.

In 2020, the WEP predominantly cleared within the $50/MWh to $100/MWh and $100/MWh to $150/MWh ranges. In 2021 and 2022, the distribution of the WEP shifted rightward, indicating higher prices. In 2021, the WEP most often cleared between the $50/MWh to $100/MWh and $100/MWh to $150/MWh ranges. In 2022, the WEP cleared predominantly between the $100/MWh to $150/MWh and $150/MWh to $200/MWh ranges, resulting in a flatter curve for that year.

The distribution of the WEP in 2023 shifted leftward, with a significant portion clearing between $100/MWh and $150/MWh. Additionally, there was a slight increase in the distribution of the WEP clearing between $50/MWh and $100/MWh, compared to the previous year.

In 2024, the distribution of the WEP shifted further leftward, with more than 85% of the WEP clearing at or below $200/MWh. This resulted in a reduction in the share of higher prices compared to the previous year.

Chart 25 shows the historical price distribution for the past five years, based on the percentage of total metered energy quantity. The behaviour of the price distribution by energy quantity closely followed the trend observed in Chart 24, as the variability in metered energy quantity across each year has remained relatively low.

ANCILLARY SERVICE INDICES: RESERVE PRICES

CHART 26: PRIMARY RESERVE PRICE

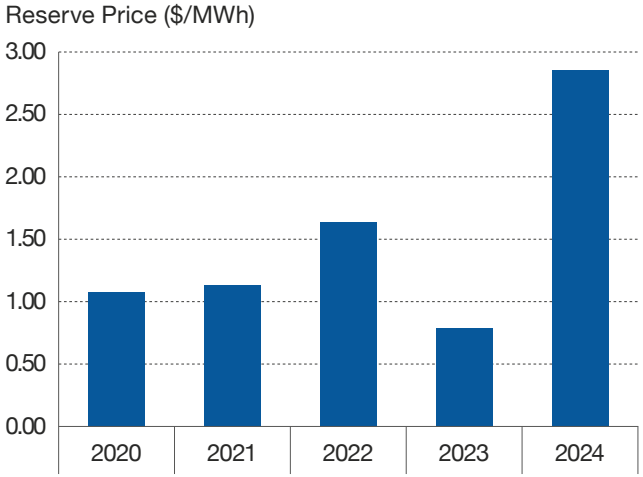


Chart 23 shows the average primary reserve price in the NEMS from 2020 to 2024.

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 maintaining that scheduled megawatt response for ten minutes from the time it was triggered[11].

Between 2023 and 2024, the primary reserve requirement increased 3.51%, while the price more than tripled from $0.78/MWh in 2023 to $2.86/MWh in 2024. This could be attributed to more expensive primary reserve offers available in the market outweighing a moderate expansion of the total primary reserve offer quantity. Additionally, there were no primary reserve shortfalls in 2023 and 2024. The primary reserve price of $2.86/MWh in 2024 was the highest annual average level since 2008.

CHART 27: CONTINGENCY RESERVE PRICE

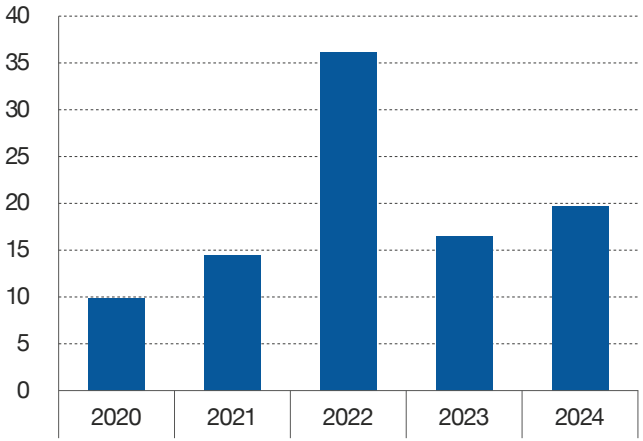


Chart 27 shows the average contingency reserve price in the NEMS for the past five years.

Each registered facility offering contingency reserve must be capable of achieving its scheduled megawatt response within ten minutes of being instructed to do so and maintaining its scheduled megawatt response for not less than 30 minutes[12].

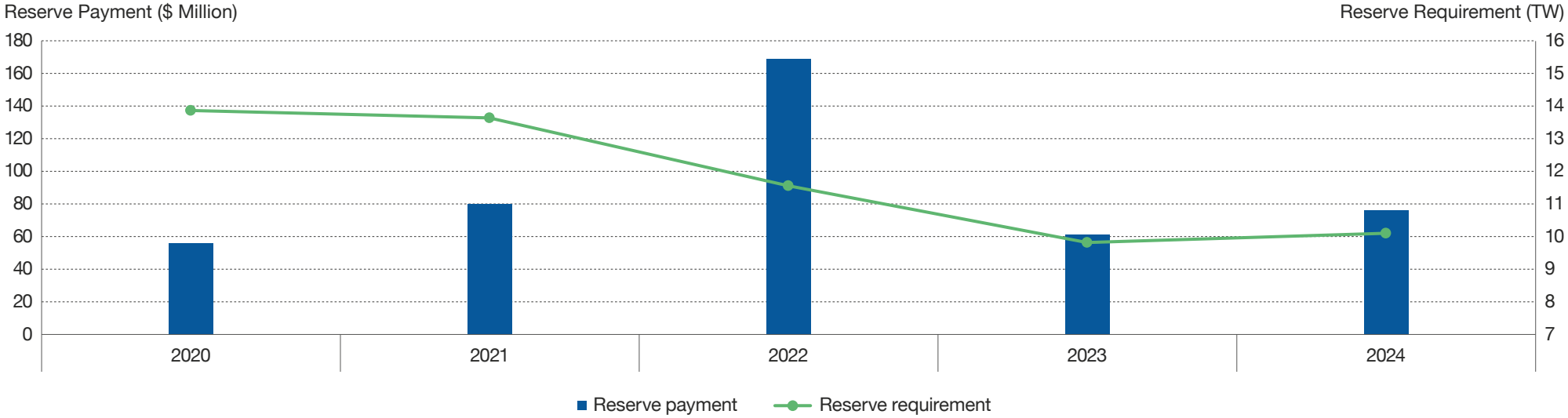
The yearly average contingency reserve price was below $20/MWh from 2019 to 2021. However, in 2022, the average contingency reserve price increased to $36.11/MWh, the highest level seen since market start. This was attributed to the frequency of contingency reserve shortfall hitting a historic high of 680 periods amidst the tight supply cushion in 2022, more than ten times that of 2021. In 2023, the contingency reserve price plummeted 54.28% to $16.51/MWh, due to a 20.34% lower requirement and a drastic drop in the frequency of periods with contingency reserve shortfall to 81 periods.

Despite the frequency of contingency reserve shortfall falling to 58 periods in 2024, the average contingency reserve price increased 19.29% from $16.51/MWh in 2023 to $19.70/MWh in 2024. This was in line with a 2.27% higher contingency reserve requirement, as well as more expensive contingency reserve offers against a mild increase in total contingency reserve offer quantity.

[11, 12] As required in section A.2 of Appendix 5A of the Market Rules.

ANCILLARY SERVICE INDICES: RESERVE PRICES

CHART 28: RESERVE PAYMENT VS REQUIREMENT



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

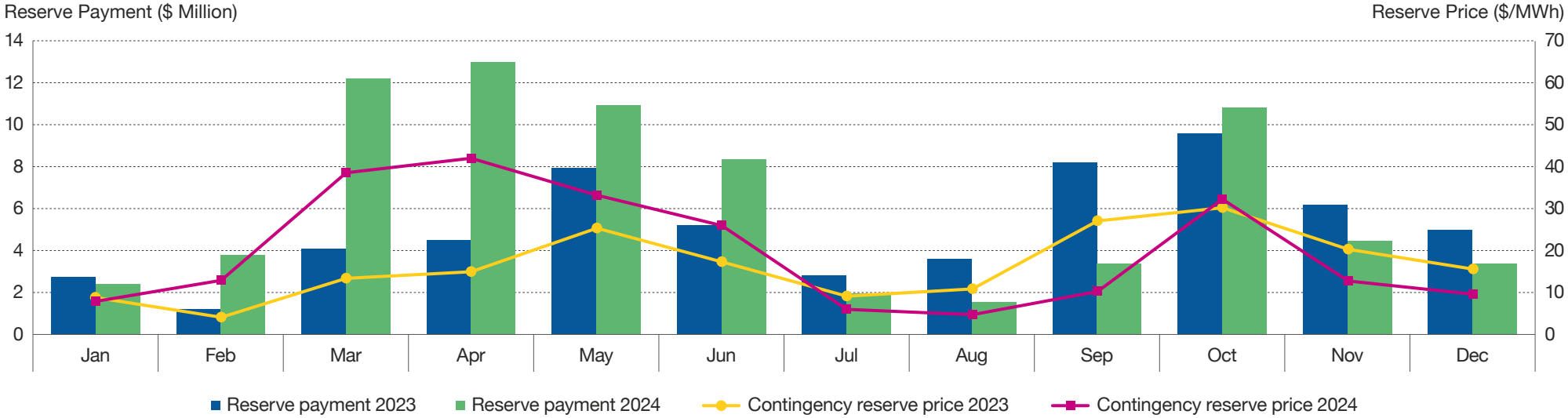
Chart 28 shows the total payment and requirement for primary and contingency reserve in the NEMS between 2020 and 2024.

The reserve payment continued to move in tandem with the reserve requirement in 2024. Overall, the reserve requirement increased 2.91% from 2023, arising from a 3.51% higher primary reserve requirement and a 2.27% rise in contingency reserve requirement in 2024. Coupled with higher primary reserve and contingency reserve prices, the reserve payment grew 24.81% to $76.30 million in 2024.

The reserve requirement trended in the opposite direction of the reserve payment in 2021 and 2022. Although the reserve requirement decreased in 2021, the reserve prices rose by a larger magnitude due to fewer offers in cheaper tranches, pushing the reserve payment up from 2020. From 2021 to 2022, the significant reduction in the reserve requirement was primarily due to a downward revision of the Risk Adjustment Factor[13] for contingency reserve requirement from 1.5 to 1.0 since 8 July 2022. In contrast, the reserve prices rose in the context of high price volatility and an increased frequency of reserve shortfall.

[13] For each reserve class, a Risk Adjustment Factor (RAF) is specified by the PSO and provided to EMC for use by its market clearing engine for determining reserve requirement in dispatch schedules.

CHART 29: RESERVE PAYMENT VS CONTINGENCY RESERVE PRICE



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

Chart 29 compares the reserve payment against the contingency reserve price between 2023 and 2024 on a monthly average basis.

Contrary to the primary reserve price averaging below $2/MWh for all months in 2023, the primary reserve price ranged from a low of $0.29/MWh in January to a high of $6.87/MWh in October in 2024. This indicated a greater contribution to the total reserve payment in 2024. Nonetheless, the monthly reserve payment remained largely influenced by movements in the contingency reserve price, which ranged from $4.71/MWh in August to $42.05/MWh in April in 2024.

There were six months in 2024 in which the contingency reserve price averaged higher than that in 2023; an increased total reserve payment was correspondingly reported in those months. For the contingency reserve price and the total reserve payment, the greatest year-on-year increases were recorded in April, while the largest month-on-month increases occurred in March. In 2024, the highest total reserve payment was recorded in March and April, during which the year-on-year increase in the contingency reserve price was the largest in magnitude.

TABLE 11: IL ACTIVATIONS FOR CONTINGENCY RESERVE MARKET

Month	2023		2024	
	Instances of IL Activation	Number of Periods of IL Activation	Instances of IL Activation	Number of Periods of IL Activation
Jan	2	2	0	0
Feb	0	0	1	2
Mar	2	3	3	13
Apr	3	5	3	4
May	0	0	2	2
Jun	8	8	4	4
Jul	1	2	1	1
Aug	2	3	1	1
Sep	1	1	2	2
Oct	2	2	2	3
Nov	0	0	2	3
Dec	2	2	4	6
Sum	**23**	**28**	**25**	**41**

Table 11 compares the interruptible load (IL)[14] activations to provide contingency reserve between 2023 and 2024.

There were slightly more instances of IL activations in 2024 than in 2023 – 25 compared to 23 activations in 2023. This was in line with the higher number of forced outages in 2024.

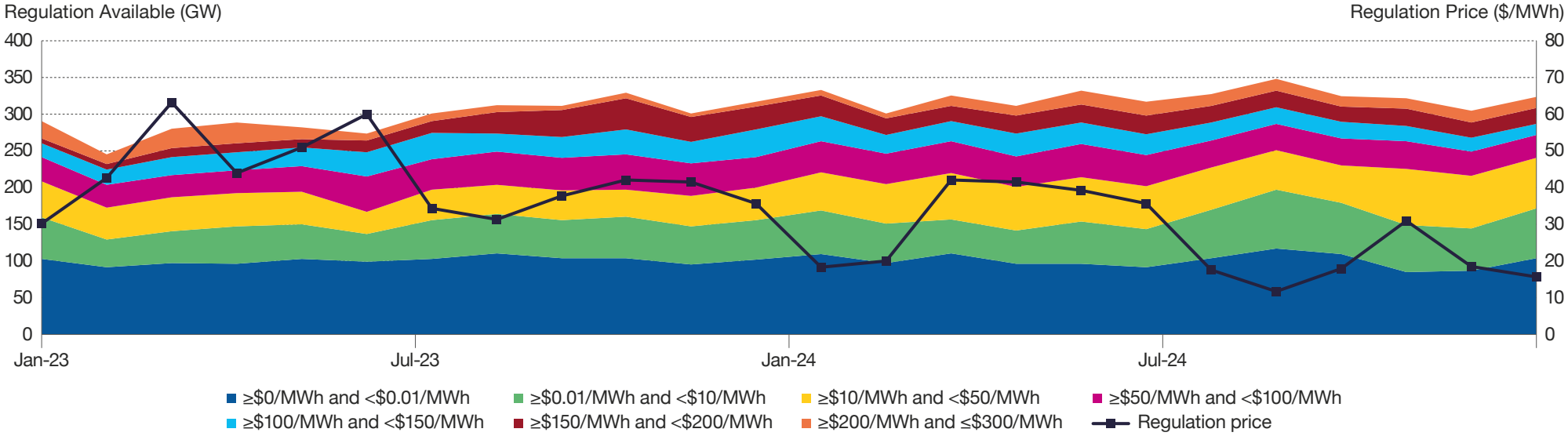
The duration of the activations, measured by the number of periods of IL activations, increased significantly from 28 periods in 2023 to 41 periods in 2024. The duration of the IL activations in 2023 was either for one or two periods across each of the 23 instances. In 2024, most of the activations lasted for fewer than three periods, with the longest duration of ten periods observed on 27 March 2024.

IL activations usually occur to make up for sudden tight supply in the system, during periods when multiple facilities face outages. For instance, on 27 March 2024, one CCGT facility was on partial planned outage while three other CCGT facilities were on full planned outage. IL was activated in Period 33 following the forced outage of one other CCGT facility. Thereafter, energy and ancillary service shortfalls were incurred for several periods, during which the power system was in a high-risk operating state[15] and an emergency operating state[16] for several periods. IL was subsequently restored in Period 43.

[14] 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.
[15] Circumstances when a high-risk operating state is declared are specified in section 2.2 of Chapter 5 of the Market Rules.
[16] Circumstances when an emergency operating state is declared are specified in section 2.3 of Chapter 5 of the Market Rules.

ANCILLARY SERVICE INDICES: REGULATION PRICES

CHART 30: REGULATION AVAILABILITY VS REGULATION PRICE



The monthly aggregated regulation quantity offered at various price ranges and the monthly regulation price for 2023 and 2024 are shown in Chart 30.

The yearly average regulation price fell 39.77% to $25.72/MWh in 2024 on the back of a 3.43% lower average regulation requirement and a 9.55% higher regulation quantity offered. The monthly regulation price range shifted downward to range between $11.65/MWh and $41.96/MWh in 2024, from its range of $30.06/MWh to $63.10/MWh in 2023.

Year-on-year, the largest increase for 2024 was recorded in the "≥$150/MWh and <$200/MWh" tranche in January, where the proportion of offers was 323.48% higher than in 2023. The largest decrease was observed in the "≥$200/MWh and ≤$300/MWh" tranche in January as well, where the proportion of offers was 69.29% lower than in 2023. From 2023 to 2024, the regulation offers from the "<$0.01/MWh" and "≥$50/MWh and <$150/MWh" tranches were redistributed to the rest of the price tranches.

The total number of periods with regulation shortfall fell from 49 in 2023 to 20 in 2024. Of these 20 periods, a total of 17 periods was registered in March, April, May and June 2024, during which the supply cushion was relatively tighter than the rest of the year. The monthly supply cushion ranged between 11.30% and 12.38% in those months, as compared to the range of 11.30% to 15.03% for all months of 2024.


ECONOMETRIC
MODEL AND
OUTLIER PRICES

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 model[17] 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 Wenze 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 12 shows the estimation results for the three most significant explanatory variables detected by the revised econometric model for January 2003 to December 2024.

A positive coefficient indicates a direct relationship between the explanatory variable and the USEP; when the variable increases, the USEP rises as well, and vice versa. A negative coefficient indicates an inverse relationship between the variable and the USEP; when the variable increases, the USEP is expected to fall instead, and vice versa.

Given that all variables are log-transformed, Table 12 provides the following observations for January 2003 to December 2024:

- a 1% increase in supply cushion lowers the USEP by 5.15%;
- a 1% increase in offers below $200/MWh lowers the USEP by 2.82%; and
- a 1% increase in lagged fuel oil price raises the USEP by 1.94%.

TABLE 12: ESTIMATION RESULTS

Variable	Coefficient
	Jan 2003 – Dec 2024
Constant	10.800
LOG (Supply Cushion)	-5.145
LOG (Offers Below $200/MWh)	-2.822
LOG (Lagged Fuel Oil Price)	1.935

TABLE 13: MODEL DIAGNOSTICS

Model Diagnostics	Jan 2003 – Dec 2024
R^2	0.893
Number of Observations	7,978

The level of statistical significance of the variables, measured as the P-value for the three variables stated in Table 12 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 2024.

Table 13 shows the model diagnostics represented by R^2 for the period of January 2003 to December 2024.

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 7,978 observations spanning January 2003 to December 2024, resulting in an R^2 value of 0.893. This signifies that 89.3% 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. The R^2 value dipped 0.003 from 2023, suggesting a negligible change in the explanatory power of the model in 2024.

[17] Further details on the revised econometric model are available in Econometric Model Design, Approach and Methodology Report – A Review of the Current Methodology.

ECONOMETRIC MODEL AND OUTLIER PRICES

IDENTIFICATION OF OUTLIER PRICES

CHART 31: ACTUAL VS PREDICTED LOG USEP WITHIN THREE STANDARD DEVIATIONS

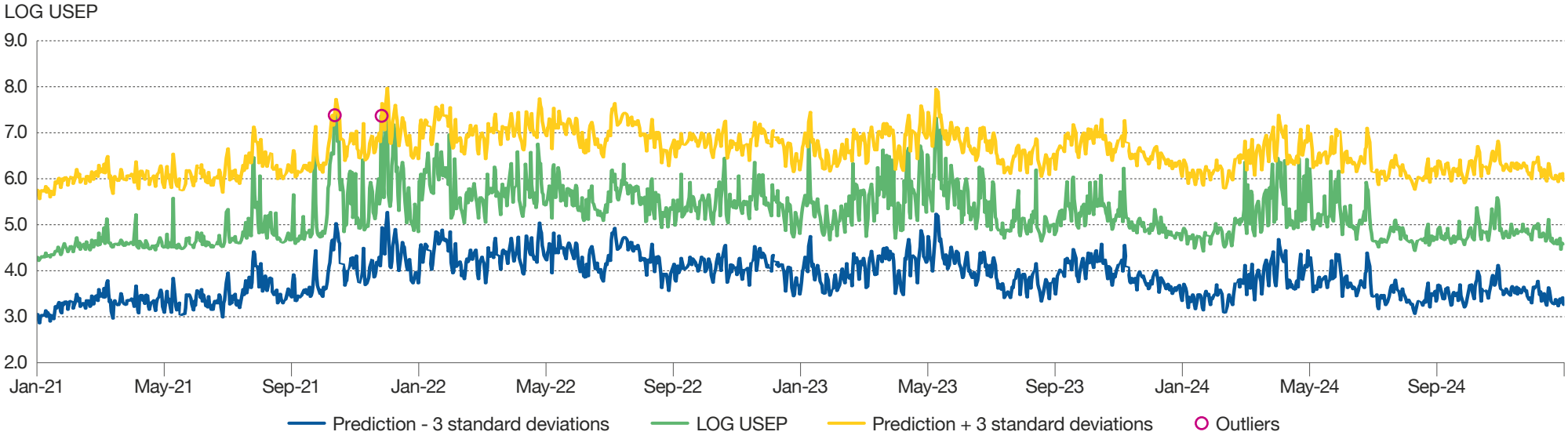


Chart 31 shows the actual daily average USEP, the upper and lower bands of the model's predicted daily average USEP, which are three standard deviations above and below the predicted USEP, and the outliers identified by the revised econometric model from January 2021 to December 2024, expressed on a logarithmic scale.

Identification of Outliers in 2021-2024

Using the same model as in 2023, two outliers were found in 2021 and none from 2022 to 2024. 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 $59.21/MWh and $363.94/MWh respectively.

In 2024, there was no outlier detected by the model. This could indicate the model's strong explanatory power, and that the USEP movements throughout 2024 were relatively predictable based on the market forces and various market stabilisation schemes put in place.


INVESTIGATIONS

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 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 14 reflects the position regarding investigation and enforcement activities from the start of the market on 1 January 2003 to 31 December 2024, 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 2024

- The MSCP reviewed 368 cases of offer variations after gate closure in 2024 and determined 21 cases to be in breach of the Market Rules. Of the 21 cases in breach, the MSCP took enforcement action on 12 cases and no further action on nine cases. The remaining 347 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 one investigation in the year which was determined to be a breach of the Market Rules.
- The MSCP issued seven rule breach determinations in the year. Six rule breach determinations were for 12 cases of offer variations after gate closure and one determination was in relation to a case regarding the disclosure of confidential information.
- There were no suspension or termination hearings conducted in relation to an event of default in 2024.
- A total of $17,000 in financial penalties[18] was imposed across two rule breach determinations, with $10,000 being the highest financial penalty imposed on a party in breach. A non-compliance letter from the MSCP was issued for the remaining rule breaches.
- A total of $22,200 in investigation costs was imposed on the market participants in breach, in the nine investigation cases conducted.

[18] Financial penalties imposed by the MSCP are returned to the market as a component of the MEUC.

TABLE 14: INVESTIGATION AND ENFORCEMENT STATISTICS

Rule Breaches	Calendar Year 2003–2024	Calendar Year 2024
(A) Total number of offer and bid variations after gate closure received	**39,601**	**405**
Total number of cases closed	**39,483**	**368**
• cases in which the MSCP determined a breach	259	12
• cases in which the MSCP determined no breach	19,127	347
• cases in which the MSCP took no further action	20,097	9
(B) Origin of cases (excluding offer and bid variations after gate closure)	**222**	**0**
• self-reports	179	0
• referrals or complaints	36	0
• initiated by the MSCP	7	0
Total number of cases closed	**222**	**1**
• cases in which the MSCP determined a breach	149	1
• cases in which the MSCP determined no breach	14	0
• cases in which the MSCP took no further action	48	0
• 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	$10,000
• total financial penalties imposed on parties in breach	$2,611,861	$17,000
(E) Costs		
• highest award of costs imposed on a party in breach	$43,750	$5,000
• total costs imposed on parties in breach	$430,725	$22,200
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**


SECTIONS
50 & 51 OF THE
ELECTRICITY ACT

SECTIONS 50 AND 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.

Information Requirements to Assist the EMA

The Singapore Electricity Market Rules[19] (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 MAU regularly provides data to the EMA according to the information requirements, as shown in the table below.

[19] Section 4.3.10 of Chapter 3 of the Market Rules.

SECTIONS 50 AND 51 OF THE ELECTRICITY ACT

TABLE 15: 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.

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. The MAU and the MSCP did not identify any possibility of anti-competitive agreements or the abuse of a dominant position while conducting its monitoring activities from January to December 2024.

While carrying out its investigative activities in 2024, the MSCP informed the EMA of an investigation that it was conducting related to the possibility of anti-competitive agreements or the abuse of a dominant position contrary to sections 50 or 51 of the Electricity Act. A copy of the referral, including all relevant information received as part of the investigation, was submitted to the EMA.

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

ASSESSMENT OF THE WHOLESALE ELECTRICITY MARKET

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 2024 is as follows:

Market Structure and Competition

Entry of New Market Participants
Four new market participants were registered in the National Electricity Market of Singapore (NEMS) in 2024:

Wholesale Market Traders:

- 29 February 2024: Sunseap Commercial Assets
- 18 April 2024: Terrenus Energy SR3

Generation Licensees:

- 30 October 2024: Meranti Power
- 12 December 2024: Linde Gas Singapore

New Facilities in the Market
In 2024, 15 new facilities joined the market.

Of the 15 facilities, six were Intermittent Generation Sources (IGS) belonging to Engie South East Asia, Sembcorp Solar Singapore, Sunseap Commercial Assets, Sunseap Leasing, Terrenus Energy SR3 and Union Power. The total number of IGS facilities in the NEMS remains at 60, with a total registered generation capacity of 1,005.542 megawatts (MW), up from 420.267MW in 2023.

Additionally, five load facilities were registered in the NEMS in 2024. The five load facilities were from Crystal Clear Environmental, Diamond Electric and Keppel Electric. Three of the five facilities registered load curtailment capacity of 12.3MW while the remaining two facilities added 3.9MW of contingency reserve capacity to the market.

Keppel Electric and Sembcorp Power also each registered one Electricity Imports (Import) facility in the market. This is the second Import facility from Keppel Electric with a maximum generation capacity of 200MW. The 50MW Import facility from Sembcorp Power is its first Import facility entering the NEMS.

Two Open Cycle Gas Turbine (OCGT) facilities from Senoko Energy were registered in the market with a maximum generation capacity of 131MW each.

Revision of Facilities' Capacities in the Market
15 facilities revised their capacities in 2024 – three Combined Cycle Gas Turbine (CCGT) facilities, one OCGT facility, eight IGS facilities and three load facilities.

Regarding the three CCGT facilities which revised their generation capacities in 2024, two increased their maximum generation capacity — ExxonMobil Asia Pacific's from 110MW to 118MW, and PacificLight Power's from 400MW to 415MW. The revision in capacity from the OCGT facility was from one of the new OCGT facilities belonging to Senoko Energy; its maximum generation capacity fell from 131MW to 129MW.

Withdrawal of Market Participants and De-registration of Facilities in the Market
In 2024, one market participant withdrew its participation in the NEMS:

- Sunseap Leasing Beta on 29 February 2024.

14 facilities were also de-registered from the NEMS, six of which were IGS facilities. The remaining eight facilities were namely:

- one 47.8MW Other Turbine (OT) facility from National Environment Agency;
- one 425MW CCGT facility from Senoko Energy;
- one 5.902MW generation settlement facility from Public Utilities Board; and
- two 90MW OCGT facilities and three 250MW Steam Turbine (ST) facilities from YTL PowerSeraya.

Market Price Behaviour

Electricity Prices Continue to Dip in 2024 as Supply Cushion Strengthened
The Uniform Singapore Energy Price (USEP) continued to decline in 2024. The USEP decreased 34.08% to an annual average of $163.18/MWh in 2024, from $247.52/MWh in 2023, while the Wholesale Electricity Price (WEP) dropped 33.89% to an annual average of $163.12/MWh in 2024, from $246.72/MWh in 2023.

The decrease in the electricity market price was aligned with the stronger supply cushion. While annual average demand rose 2.92% to 6,486MW, the 4.28% expansion in the annual average supply from 7,122MW to 7,427MW outpaced demand growth, thereby strengthening the supply cushion 1.23 percentage points to 12.74%. This resulted in a drop in both the USEP and WEP from their respective levels in 2023.

The fall in electricity market prices 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 to 55.00% in 2024. The dilution of the market concentration level could be attributed to the de-registration of ST facilities in the market.

In terms of metered energy quantity, the market share held by the three largest players in the NEMS continue to drop 0.27 percentage point to 51.11% in 2024. The composition of the top three market players in 2024 remained the same as 2023.

The decrease in the generation companies' market share in terms of metered energy quantity was attributed to the increased generation from Embedded Generation (EG), which comprise of facilities generating and supplying electricity primarily for internal use.

Productive Efficiency
The market share in terms of metered energy quantity of the most efficient generation technology, the CCGT units, rose 0.01 percentage point to 98.10% in 2024. On the other hand, there was a notable decrease in the market share of Import units which dropped to 0.04% in 2024 from 0.16% in 2023.

The market share of CCGT units based on maximum generation capacity increased to 90.74% in 2024. OCGT units, Import facilities and Energy Storage Systems (ESS) units also saw their market shares by maximum generation capacity rising to 2.02%, 1.37%, and 1.77% respectively. On the other hand, ST units and OT units saw a drop in their market shares by 5.30 and 0.14 percentage points respectively.

Pricing Efficiency
In 2024, prices in the NEMS were consistent with demand and supply conditions in the market. Specifically, the 4.28% increase in annual average supply outpaced the 2.92% expansion in annual average demand, resulting in a stronger supply cushion which grew 1.23 percentage points to 12.74%.

In 2024, 68.90% of the periodic supply cushion fell below 15% level, compared to 78.32% in 2023. Conversely, this implied an increase in the proportion of periods with periodic supply cushion greater than or equal 15% from 21.68% in 2023 to 31.10% in 2024. As a result, electricity prices dropped in 2024, with USEP and WEP falling to annual averages of $163.18/MWh and $163.12/MWh respectively.

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
Arising from the MSCP's monitoring and investigation work, the following proposal from the MSCP/MAU was considered in the 2024 Rules Change Panel (RCP) work plan exercise:

- a review of the obligation to act within five minutes when an action is to be taken "promptly" or "immediately".

The MSCP continues its efforts in assessing whether there is actual or potential design or other flaws and inefficiencies in the Market Rules and overall structure of the wholesale electricity market and to recommend actions to the RCP to mitigate such efficiencies.

Looking Ahead

Modelling of Energy Storage Systems and Incorporation of State-of-Charge in Market Clearing Engine Modelling of Energy Storage System
Energy Market Company (EMC) proposed a mechanism to incorporate state-of-charge (SoC) data in the market clearing engine (MCE), which acts as a constraint that improves the deliverability of scheduled quantities for ESS. Such SoC data will be provided by the Power System Operator (PSO) to the EMC via the network status file before each period before it is modelled into the MCE.

Two rule change proposals were considered and supported by the RCP, and subsequently approved by the Energy Market Authority (EMA). The proposals are pending implementation in the NEMS.

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.

In June 2024, the EMA held a request for proposal launched under its Centralised Process for procuring new generation capacity. The EMA awarded PacificLight Power the right to build, own and operate a new hydrogen-ready CCGT generating unit that is expected to be at least 600MW in generation capacity and ready to commence operations in 2029.

Harnessing 6GW Power from Electricity Imports by 2035
Following continued strong interest from the market to participate in electricity import projects and to ensure adequate supply to meet Singapore's future energy needs, the EMA has announced that Singapore is seeking to import around 6GW of low-carbon electricity by 2035. This is a 50% increase from the initial target of 4GW set in 2021.

Electricity imports are expected to make up around one-third of Singapore's energy demand by 2035, with commercial operations under some of these import contracts potentially commencing from 2028.

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 and Bid Variations After Gate Closure

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

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

Table 16 compares the number of offer and bid variations after gate closure submitted by market participants in 2024 with those of previous years.

TABLE 16: OFFER AND BID VARIATIONS MADE AFTER GATE CLOSURE

Year	Number of Offer and Bid Variations Made After Gate Closure	YOY Change (%)
2020	306	-10.53
2021	799	161.11
2022	559	-30.04
2023	414	-25.94
2024	405	-2.17

The number of offer and bid variations after gate closure continued its downward trend since 2021, falling 2.17% year-on-year to 405 cases in 2024.

The significant number of offer and bid variations after gate closure cases 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 requires 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 Directed Supply Scheme (DSS), this statistic dropped from 799 cases in 2021 to 405 cases in 2024. The drop in the number of cases coincided with fewer EMA/PSO directions issued under the DSS and the Standby Capacity Scheme (SCS) in 2024. Given that these were 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.

Compared to 2023, the number of offer and bid variations after gate closure dipped marginally by 2.17% despite the number of forced outage occurrences rising from 57 to 78 in 2024. Despite the increase in the number of forced outages, it was observed that the volume of forced outages per period dropped 53.69% from 50.76MW in 2023 to 23.51MW in 2024.

Must-Schedule Requirement for Electricity Imports

One of the obligations of Import facilities is 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 this requirement in 2024.

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. The AFPS was subsequently extended to include all load registered facilities (LRFs) when the Demand Response (DR) programme was introduced on 28 April 2016.

In 2024, 11 generation companies were issued automatic financial penalties amounting to a total sum of $269,110.13. The market also saw total penalties of $475,053.82 imposed on four DR and Interruptible Load (IL) providers under the AFPS. To date, a total sum of $1,143,551.15 was eligible to be refunded to the participating LRFs providing DR under the Demand Side Management (DSM) regulatory sandbox.

There was a 35.09% decrease in the amount of financial penalties imposed under the AFPS to $744,163.95 in 2024 from $1,146,444.37 in 2023. In 2024, 139 periods were penalised under the AFPS, compared to 208 periods the previous year.

TABLE 17: FINANCIAL PENALTIES IMPOSED UNDER THE AFPS ($)

Year	Amount of 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
2024	744,163.95

Demand Side Management Regulatory Sandbox

The DSM regulatory sandbox was launched by the EMA from 1 January 2023 to 31 December 2024. The aim is to enhance the DR and IL programmes in the Singapore Wholesale Electricity Market to incentivise companies to optimise their energy usage by reducing their electricity consumption in the context of high prices or tight supply.

Under the DSM regulatory sandbox, several features of the DR programme were fine-tuned or modified. Notably, the compliance threshold for participating facilities was lowered from 95% to 80%, the penalty formula was revised, and the penalty regime was further relaxed such that no penalties were imposed for the first two instances of non-compliance. Upon the fifth instance of non-compliance, the DR facility is administratively suspended from the sandbox.

During the sandbox, all LRFs continue to be subject to the existing 95% compliance threshold and penalty amounts via the AFPS. If the participant assesses that it should not have been penalised (e.g. due to the sandbox's exemptions for the first two instances of non-compliance, or due to fulfilling the sandbox's lowered compliance threshold of 80%) or that the penalty amount should have been lower under the DSM regulatory sandbox (e.g. the sandbox penalty is less than the AFPS amount due to the sandbox's revised penalty formula), it can submit a request to EMC to initiate a full or partial penalty refund.

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

MSCP Determinations Issued

For the period 1 January to 31 December 2024, the MSCP issued seven determinations regarding rule breaches and one determination regarding the appeal for refund of financial penalty under the AFPS.

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
Six MSCP rule breach determinations were issued in 2024 across three market participants in relation to 12 offer variations after gate closure events:

- YTL PowerSeraya's offer variations after gate closure on 10 April 2024;
- Senoko Energy's offer variations after gate closure on 6 May 2024;
- YTL PowerSeraya's offer variations after gate closure on 22 May 2024;
- Tuas Power Generation's offer variations after gate closure on 3 June 2024;
- Tuas Power Generation's offer variations after gate closure on 6 June 2024; and
- Tuas Power Generation's offer variations after gate closure on 28 August 2024.

Failure to Comply with the Market Operation Responsibilities under the Market Rules
EMC was served one rule breach determination from the MSCP in 2024.

- Energy Market Company's disclosure of confidential information.

Appeal for Refund of Financial Penalties Under the Automatic Financial Penalty Scheme
The MSCP received one appeal for refund of financial penalty under the AFPS in 2024.

- ExxonMobil Asia Pacific's appeal for refund of financial penalty for non-compliance event on 23 February 2024.

There were no suspension or termination orders issued by the MSCP in 2024, as in 2023.

Similar to past years, the majority of the rule breach determinations issued in 2024 were related to failure to comply with gate closure rules.

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

The MSCP receives information from EMC when a notice of default[20] 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 circumstances when a default notice has been issued[21], 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 2024, there were no default notices issued by EMC, same as 2023. 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.

[20] 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.
[21] Circumstances when an event of default is declared are specified in section 7.3.1 of Chapter 3 of the Market Rules.


CONCLUSION

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 2024.

The MSCP issued seven rule breach determinations during the year, compared to nine in 2023. Six of the seven determinations were in relation to offer variations after gate closure, as compared to five such determinations made in 2023. This was in line with the decrease in the number of cases related to offer variations submitted after gate closure from 414 in 2023 to 405 in 2024.

Volatility in wholesale electricity prices continued to ease in 2024, falling 33.89% to a yearly average of $163.12 per megawatt hour (MWh). While wholesale prices trended in the opposite direction to the fuel oil price in 2024, it was in line with the lower prices observed since the Energy Market Authority (EMA) implemented the Temporary Price Cap (TPC) mechanism and a new vesting contract regime to the NEMS in July 2023. The trend in electricity prices also occurred amidst supply climbing in 2024 after two consecutive years of decline and recording the strongest year-on-year growth (in percentage terms) of the last ten years.

With regards to market concentration, the three largest generation companies remained the same as in 2023. Their combined market share by metered energy quantity dipped slightly in 2024, signalling an improvement in market competitiveness. This was observed in the context of a moderately concentrated market.

In 2024, four new market participants joined the NEMS, of which two are Wholesale Market Traders and two are Generation Licensees. Additionally, 15 new facilities registered in the market in 2024. Intermittent Generation Sources (IGS) facilities accounted for six of the 15 new facilities, raising the total generation capacity of IGS more than twofold from the previous year to 1,005.54MW. The entry of the second and third Electricity Imports (Import) facilities to the NEMS added a combined 250MW, while two Open Cycle Gas Turbine (OCGT) facilities contributed an additional 260MW generation capacity. Lastly, five new load facilities collectively added 12.3MW load curtailment capacity and 3.9MW contingency reserve capacity to the market. One market participant withdrew their participation in the NEMS in 2024, while 14 facilities were de-registered from the market. As at the end of 2024, the total maximum generation capacity registered in the NEMS amounted to 12,316.25MW, while maximum load curtailment capacity increased to 108.1MW.

In July 2024, the MSCP initiated an update of the Catalogue of Data for the inclusion of information related to solar generation forecast and the TPC mechanism. Additionally, the Catalogue of Monitoring Indices was refreshed, and a new monitoring indicator for the available capacity of generation facilities was added. These updates were made to facilitate the effective monitoring of a continually evolving and complex market. The new Catalogue of Data and Catalogue of Monitoring Indices were made effective on 1 September 2024 after the MSCP considered all comments received during the consultations.

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. 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 the year, the MSCP provided its views for the concept paper on enabling Embedded Generation facilities to participate in the Demand Response and Interruptible Load programmes, and supported the proposal to publish additional data to the market in relation to the TPC mechanism. The MSCP also submitted its views for the consultation paper issued by the Ministry of Trade and Industry and EMA on proposed legislative updates aimed at supporting and facilitating Singapore's energy transition efforts.

The MSCP remains highly satisfied with the knowledge and technical expertise of the Market Assessment Unit 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.

Professor Walter Woon
Chairman
Market Surveillance and Compliance Panel

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.

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

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