

# MARKET SURVEILLANCE & COMPLIANCE PANEL

ANNUAL REPORT

# 2021

nems National Electricity  
Market of Singapore





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The Market Surveillance and Compliance Panel (MSCP) Annual Report presents analysis of annual data and information about Singapore's wholesale electricity market. This edition of the report is based on market data and monitoring indices for the period 1 January to 31 December 2021, 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 is 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 2021, and how they compare to 2020.

### Supply Indices

Over the past year, the supply in the National Electricity Market of Singapore (NEMS) recovered from the decline observed in 2020. However, it did not improve to 2019 levels. With the increase in demand outpacing the growth in supply, the supply cushion registered lower levels in 2021 compared to 2020, with a consequent impact on wholesale electricity prices in Singapore.

- The average supply increased 2.79% to 7,935 megawatts (MW) in 2021 from 7,720MW in 2020, even though the outage level had risen from 1,206MW per period in 2020 to 1,260MW per period in 2021.
- The resultant average supply cushion<sup>1</sup> weakened to 22.19% in 2021 from 24.06% in 2020.
- Despite the weaker supply cushion, the capacity ratios<sup>2</sup> of the Combined Cycle Gas Turbine (CCGT), Open Cycle Gas Turbine (OCGT), and Steam Turbine (ST) units increased 2.81, 2.53, and 2.02 percentage points to annual averages of 64.80%, 2.57%, and 2.42% respectively. On the other hand, the capacity ratio of the Other Facilities Turbine (OT) units decreased 1.83 percentage points to an annual average of 41.86% in 2021.

- Based on metered energy quantity, the generation sector of the NEMS became less concentrated as the combined market share of the three largest generation companies was diluted to 50.55% in 2021 from 53.04% in 2020.
- CCGT continued to be the predominant generation type in the NEMS, holding a market share in terms of metered energy quantity of 98.10% in 2021 compared to 98.33% in 2020. The slight decrease in CCGT's market share was picked up by OT, whose market share rose to 1.71% in 2021 from 1.57% in 2020.

### Demand Indices

After a drop in 2020, electricity demand grew by 5.97% in 2021. This rebound in demand, pushing up wholesale electricity prices, represented the highest annual growth observed in the NEMS in the past decade, and came on the back of a gradual reopening of Singapore's economy as the Coronavirus Disease 2019 (Covid-19) restrictions were progressively eased.

- The actual average demand rose 5.97% to 6,117MW in 2021 from 5,772MW in 2020. This was the highest year-on-year (YOY) growth in demand observed in the NEMS in the past decade. The peak monthly average electricity demand also increased to 6,277MW, as observed in June 2021, compared to the previous year's peak of 5,984MW recorded in March 2020.
- The demand spike was mainly caused by the relaxation of measures put in place by the Singapore Government due to Covid-19 and the gradual reopening of Singapore's economy, after a period of operating at below business-as-usual conditions.
- Despite the uncertainty brought about by the Covid-19 pandemic, the accuracy of real-time load forecast in 2021 improved by a greater extent than in 2020. The average forecast error shrank a further 0.44 percentage

point to 1.72%, the smallest forecast error recorded since the market started.

### Price Indices

Higher demand —with the Singapore economy showing signs of recovery due to the easing of the Covid-19 restrictions— combined with low levels of supply cushion, pushed the annual average Wholesale Electricity Price (WEP) up to its third-highest level observed since the NEMS started, after 2012 and 2011. This was driven by movements in fuel oil prices and an increased amount of offer quantity at higher price tranches in 2021, compared to 2020.

In particular, the last quarter of 2021 saw significant fluctuations in the WEP, attributable to surging gas prices and a gas shortage in Singapore that was due in turn to the disruption of piped natural gas from Indonesia. The daily average Uniform Singapore Energy Price (USEP) registered a record of \$2,058.85 per megawatt hour (MWh) on 1 December, and the highest monthly average USEP since the NEMS started in 2003 was recorded in October at \$491.24/MWh.

- The WEP surged above \$100/MWh and averaged at \$195.62/MWh in 2021, 178.47% above 2020's average of \$70.25/MWh. This was the third-highest WEP observed since the NEMS started, after 2012's average WEP of \$223.55/MWh and 2011's \$215.77/MWh.
- The high WEP in 2021 was primarily driven by a 63.29% rise in the fuel oil price to US\$406.81/MT in 2021 from US\$249.13/MT in 2020, as well as growth in electricity demand as the Singapore economy gradually opened up with the easing of Covid-19 measures.
- The total reserve payment rose 42.97% to \$79.96 million in 2021 from \$55.93 million in 2020, reflecting an increase in the contingency reserve price from \$9.91/MWh to \$14.47/MWh.

1 Supply cushion measures supply adequacy, the level of capacity which was offered but not scheduled and could be called up if necessary. Details can be found in the [User Guide](#) of this report.

2 Capacity ratio measures the ratio of scheduled output to a generation registered facility's maximum generation capacity. Details can be found in the [User Guide](#) of this report.

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

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

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

When appropriate, the MSCP may exercise the enforcement powers conferred on it under the Market Rules and recommend remedial actions to mitigate the conduct and inefficiencies referred to the left. 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).

**Mr T P B Menon, Chairman, MSCP**

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

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

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

Mr Menon was chairman of the Disciplinary Committee of the Law Society appointed by the Chief Justice from 1991 to 2004 and a member of the Advisory Editorial Board of Halsbury's Laws of Singapore. He has published several articles and delivered papers at international conferences. Mr Menon was awarded a Pingat Bakti Masyarakat – Public Service Medal in 1993. He was also conferred the prestigious C. C. Tan Award in 2004 presented by the Law Society to a member of the Society who exemplifies the ideals of honesty, fair play, and personal integrity.

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

**Er Lee Keh Sai**

Er Lee Keh Sai is a registered professional electrical engineer (PEng) and a chartered engineer (CEng). He specialises in electrical power engineering, energy management and power quality solutions and is the Principal of K. S. Lee & Associates, which he established in 1970.

Er Lee was the chairman of the Professional Interviewing Panel for the Professional Engineers Board. He has also served in many professional associations, government agencies, and technical educational institutions (e.g., deputy chairman of the Singapore Polytechnic Board of Governors and board member of the Institute of Technical Education). He is also an accredited arbitrator and a member of the Engineering Expert Panel of the Institution of Engineers, Singapore (IES). He has been serving as a member of the Strata Titles Board and as an engineering expert on the MSCP.

Er Lee has regularly published technical papers in the IES Journal on topics such as energy efficiency and electrical protection systems and has been teaching Singapore Certified Energy Manager courses on "Motor Driven Systems" since 2010. He is also a certified trainer for the preparatory course for the registration examination of the Professional Engineer Board, Part II "Practice of Professional Engineering" in Electrical Engineering.

Er Lee has been a member of the MSCP since its formation in 2003. Er Lee's noteworthy expertise has added great value to the panel by bringing a technical expert angle from his more than 40 years of solid knowledge of power and energy systems, power plants operation, design, and optimisation. His invaluable expertise has provided a great understanding to the panel of complex technical matters and has supported the governing process and MSCP's determinations.

**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' behavior 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 and presently director of the Economic Growth Centre at the Nanyang Technological University (NTU) of Singapore. Professor Quah has been the longest-serving Head of Economics at NTU, serving for 15 years, and the only person to have been Head of

Economics at both the National University of Singapore (NUS) and NTU.

His academic career in NTU has included several senior administrative positions over the years, including chair of the School of Humanities and Social Sciences, vice-chair of the Sustainable Earth Office, chair of the Senate Committee on University Policies, and member of the University Teaching Council. Prior to joining NTU, Professor Quah was vice-dean of the Faculty of Arts and Social Sciences, deputy director of the Centre for Advanced Studies, deputy director of the Public Policy Program (now called the Lee Kuan Yew School of Public Policy), and head of the Department of Economics at the NUS.

Professor Quah is also the president of the Economic Society of Singapore. He is a member of the Social Science Research Council of Singapore and a board member of the Competition and Consumer Commission of Singapore.

In his continuing career as an economic advisor, Professor Quah has been an advisor to many government ministries and statutory boards in Singapore as well as to overseas organisations including the Asian Development Bank and the World Bank. He is a member of the Panel for the Bill and Melinda Gates Foundation, for the Overseas Development Institute of London, and has served as a Board of Trustees member of the Institute of Southeast Asian Studies, the EMA, and the Energy Studies Institute at NUS.

Professor Quah is also a prolific and well-cited writer who has published over 100 articles in academic journals and lead opinion pieces in the media. He is also the author of the bestselling "Principles of Economics" textbook with Gregory Mankiw, an Asian edition (into its third edition in 2020), and the "Cost-Benefit Analysis" book, which is well-known internationally (into its sixth edition in 2020). As a well-known environmental economist and cost-benefit analyst, Professor Quah's latest work and engagement were on the Economics of the 2015 Transboundary Haze Pollution and invited to be a Plenary Speaker at the US Society of Benefit-Cost Analysis 2022 Conference.

Professor Quah has been a member of the MSCP since 2015. Professor Quah's 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 (USEP) outliers enclosed in the MSCP Annual Report.

### Professor Walter Woon, Senior Counsel



Professor Woon, Senior Counsel, is the chairman of RHTLaw Asia, Lee Kong Chian Visiting Professor at the Singapore Management University and an Honorary Fellow of St John's College Cambridge. He is also a former David Marshall Professor at the Law Faculty of the National University of Singapore and former dean of the Singapore Institute of Legal Education.

In addition, Professor Woon is chairman of the Society of International Law Singapore and an Honorary Fellow of the Singapore Institute of Directors and Patron of the Gunong Sayang Association.

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 also written law books and novels.

Professor Woon was appointed a member of the MSCP in January 2016. 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 other Singapore laws. Professor Woon has also supported the panel acting as Chairman of the MSCP when required.

## Decisions of the MSCP

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

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

## Market Assessment Unit

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

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

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

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

## MSCP Annual Reporting

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

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

The MSCP Annual Report 2021 covers the period 1 January to 31 December 2021 and provides the MSCP with the opportunity to highlight significant outcomes on 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 20<sup>th</sup> 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 on the [Panel Reports section of the EMC website](#).



A person in a blue suit is holding a magnifying glass over a tablet. The magnifying glass is positioned over the tablet, which is held in their hands. The background is a blurred office setting. Overlaid on the image are several data visualization elements: a bar chart with vertical bars of varying heights in shades of green and blue, and a line graph with a white arrow pointing upwards and to the right. The overall color palette is dominated by blues and greens, with a warm yellowish glow in the upper left corner.

# MARKET MONITORING

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## 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 Catalogues of Data and Monitoring Indices were last reviewed by the MSCP in consultation with the industry and the regulator in 2020 and incorporated in the Market Surveillance and Compliance Panel Annual Report 2020.

### Catalogue of Data

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

### 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.

### Catalogue of Monitoring Indices

The catalogue of monitoring indices adopted by the MSCP includes supply indices, demand indices, and price indices, as listed in Table 1.

TABLE 1: CATALOGUE OF MONITORING INDICES

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

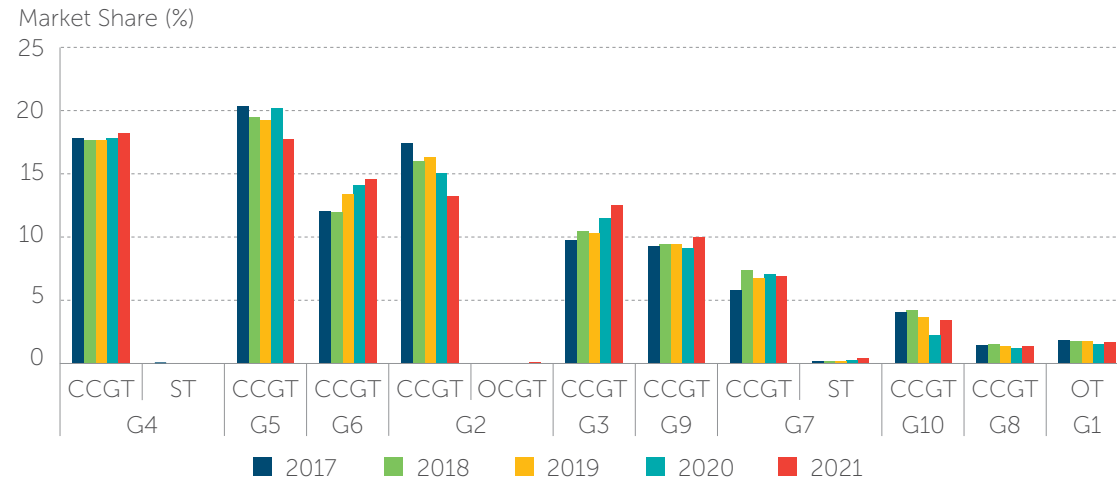
## MARKET CONCENTRATION: MARKET SHARE

Chart 1 shows the market share by generation type under 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 based on metered energy quantity in 2021.

The market is largely dominated by the Combined Cycle Gas Turbine (CCGT) units, which recorded a market share of 98.10% in 2021, while Other Facilities (OT) units under G1, Steam Turbine (ST) units under G7, and Open Cycle Gas Turbine (OCGT) units under G2 accounted for 1.71%, 0.12% and 0.07% of the market respectively. The market shares across the generation mix remained largely similar over the last five years, with strong dependency on the more efficient CCGT units of above 98% since 2017.

The OCGT and ST units under G2, G4 and G7 ran intermittently over the last five years and therefore were not significantly reflected in Chart 1.

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



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

Table 2 shows the yearly average market share of all generation companies in terms of metered energy quantity.

The top three generation companies with the largest market share by metered energy quantity in 2021 are G4, G5 and G6. While G4 and G5 are still in the top two positions, G5 lost its first place to G4, and G2 lost its third place to G6 when compared to 2020. The combined market share of the top three generation companies shrank to 50.55% in 2021 from 53.04% in 2020, and declined 5.06 percentage points over the past five years.

In the last five years, the largest reduction of market share was observed in G2, with a decline of 4.04 percentage points to 13.36% in 2021 from 2017. On the other hand, G3 and G6 made more distinctive gains in their market share over the same period, with an increase of 2.77 and 2.51 percentage points to 12.54% and 14.55% respectively.

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

Year	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
2017	1.86	17.40	9.77	17.84	20.37	12.04	5.83	1.46	9.31	4.11
2018	1.77	16.03	10.45	17.64	19.52	11.91	7.48	1.51	9.47	4.21
2019	1.74	16.36	10.35	17.66	19.29	13.36	6.81	1.38	9.41	3.64
2020	1.57	15.04	11.54	17.81	20.18	14.12	7.17	1.20	9.13	2.23
2021	1.71	13.36	12.54	18.24	17.75	14.55	7.02	1.37	10.03	3.41

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

## MARKET CONCENTRATION: MARKET SHARE

Chart 2 shows the market share based on maximum capacity by generation company. The generation companies were arranged in descending order according to their CCGT market share in 2021.

The annual average market share of all generation companies by CCGT, OCGT and OT generation types based on maximum capacity rose across the board in 2021. The total market share of the ST unit type fell 2.18 percentage points to 6.52% by 2021 from 8.69% in 2020 due to the deregistration of a ST unit in June 2020. The reduced market share of the ST unit type meant a corresponding rise in the proportion of generation capacity of the other generation facility types. Therefore, the total market share of the CCGT unit type grew 1.73 percentage points to 89.38% in 2021. Similarly, the market share of the OT unit type under G1 increased 0.42 percentage point to 2.57% in 2021 from 2.15% in 2020 because two new OT units were registered in 2021.

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

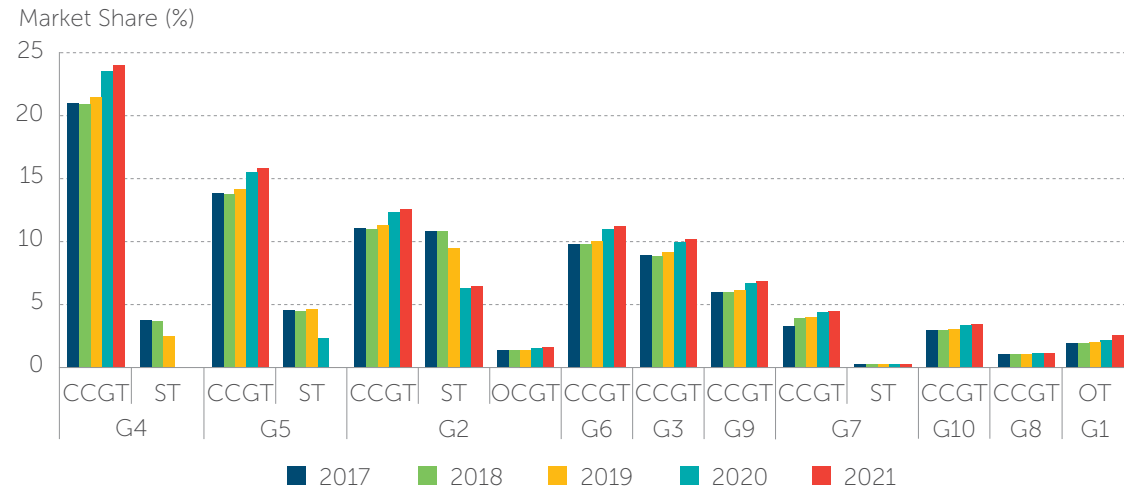


Table 3 consolidates the yearly average market share of all generation companies in terms of maximum capacity. There was no change in the position of the largest three generation companies based on their yearly average market share. In terms of market share by maximum capacity, the combined market share of the three largest generation companies shrank 1.14 percentage points to 60.20% in 2021 when compared to 2020. This was largely due to the reduction of capacity in the ST unit type for G5, as shown in Chart 2, which was then proportionately allocated to the rest of the generation types based on their maximum capacity.

Of the generation companies, G4 recorded the largest increase of 0.46 percentage point in market share to 23.95% in 2021 from 23.49% in 2020. On the other hand, G5 recorded the largest decrease of 2.00 percentage points in market share to 15.75% in 2021 from 17.75% in 2020, due to the loss of capacity in the ST unit type.

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

Year	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
2017	1.92	23.17	8.89	24.67	18.28	9.79	3.35	1.00	5.98	2.96
2018	1.91	23.02	8.83	24.51	18.16	9.73	3.97	0.99	5.94	2.94
2019	1.96	22.08	9.08	23.94	18.69	10.01	4.08	1.02	6.11	3.02
2020	2.15	20.10	9.95	23.49	17.75	10.96	4.47	1.12	6.69	3.31
2021	2.57	20.50	10.14	23.95	15.75	11.18	4.56	1.14	6.83	3.38

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

## MARKET CONCENTRATION: HERFINDAHL-HIRSCHMAN INDEX

TABLE 4: HERFINDAHL-HIRSCHMAN INDEX

Year	Minimum	Maximum	Average	Maximum Share (%)
2017	1,385	1,457	1,425	20.37
2018	1,342	1,413	1,372	19.52
2019	1,349	1,467	1,400	19.29
2020	1,350	1,534	1,441	20.18
2021	1,322	1,433	1,366	18.24

The Herfindahl-Hirschman Index (HHI) is a globally used measurement of market concentration in the 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 the annual electricity generation.

The HHI classifies the electricity market into three categories: in “unconcentrated markets” the index is below 1,000; in “moderately concentrated markets” the index is between 1,000 and 1,800; and in “highly concentrated markets” 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 fell to 1,366 in 2021 from 1,441 in 2020, in line with the fall in the maximum market share held by the generation company with the highest percentage of metered energy quantity to 18.24% in 2021 from 20.18% in 2020, as observed in Table 2. That generation company’s lower maximum market share meant a corresponding rise in the proportion of metered energy quantity of the other generation companies.

Despite this, the NEMS remained moderately concentrated as there was no significant change in the proportion of metered generation quantity in the market in 2021. Over the last five years, the monthly HHI of the NEMS hovered within the moderately concentrated range of 1,300 to 1,600.

## MARKET CONCENTRATION: 1-PIVOTAL SUPPLIER TEST

CHART 3: FREQUENCY OF GENERATION COMPANIES AS SINGLE PIVOTAL SUPPLIER

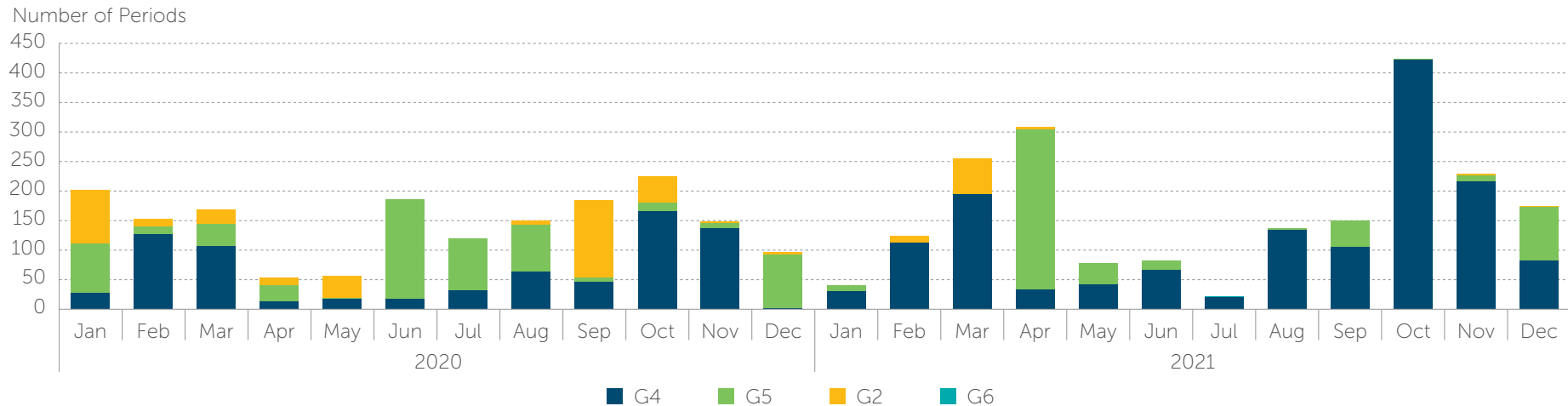


TABLE 5: FREQUENCY OF GENERATION COMPANIES AS SINGLE PIVOTAL SUPPLIER (NUMBER OF PERIODS)

Year	G4	G5	G2	G6	Total
2020	746	622	370	0	1,738
2021	1,452	483	79	1	2,015

The single pivotal supplier test is an indicator of structural market power in the NEMS. A single 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 number of periods where a single pivotal supplier is present in the market for each month in 2020 and 2021. The generation companies were arranged in descending order according to their total number of periods as the single pivotal supplier in 2021.

The total number of periods with a single pivotal supplier rose 15.94% to 2,015 periods in 2021 from 1,738 periods in 2020. The increase could be attributed to the tighter yearly average supply cushion in 2021, as the rise in demand outweighed the growth in supply. Given that there was no significant change in the market share based on maximum capacity by generation company in 2021, as shown in Table 3, and that there were more periods with tighter supply cushion in 2021 than 2020, it might have been easier for generation companies with larger market shares to become single pivotal suppliers.

Four generation companies were identified as single pivotal suppliers over the course of 2021, with the role of single pivotal supplier switching mainly between G2, G4, and G5. In 2021, the number of periods when G4 was the single pivotal supplier almost doubled, while the number of periods for which G5 and G2 were single pivotal suppliers fell compared to 2020. This is in line with the findings in Table 2: G4 overtook G5 to be the largest generation company based on metered energy quantity in 2021, and G6 replaced G2 in third place, while the market shares of G2 and G5 fell.

## SUPPLY INDICES: CAPACITY RATIO

CHART 4: COMPARISON OF CAPACITY RATIOS OF CCGT UNITS

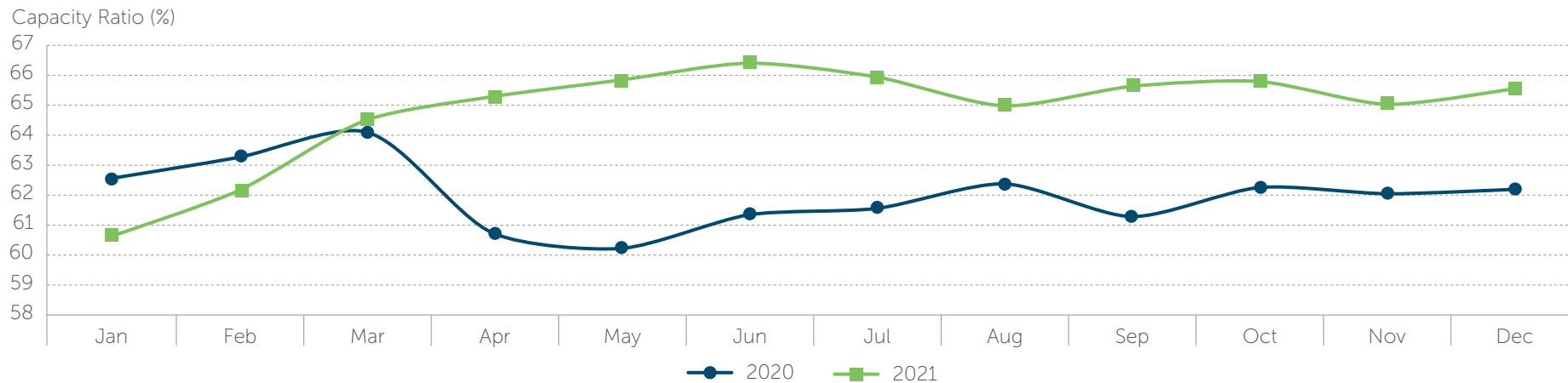


TABLE 6: CAPACITY RATIO BY GENERATION TYPE (%)

Year	CCGT	ST	OT	OCGT
2020	61.99	0.40	43.69	0.04
2021	64.80	2.42	41.86	2.57
YOY Change	2.81	2.02	-1.83	2.53

The capacity ratio represents the utilisation level of a generation type. Table 6 compares the yearly average capacity ratio of the four generation types in 2020 and 2021.

In 2021, the capacity ratios were higher for the CCGT, ST, and OCGT generation types compared to 2020. Despite being the less efficient and more expensive generation capacity types in the market, the utilisation rates of the ST and OCGT units increased. This is in line with the higher USEP levels observed in 2021, as ST and OCGT units usually have more expensive energy offers. Thus, the high USEP in 2021 may have incentivised the ST and OCGT units to increase their offer quantities. The OT units were the only generation type that registered a decline, which might be due to the higher planned maintenance level of the OT units.

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

A monthly comparison of the capacity ratio of CCGT units in 2020 and 2021 is shown in Chart 4. Overall, the yearly average capacity ratio for CCGT units increased 2.81 percentage points to 64.80% in 2021 from 61.99% in 2020.

A correlation is observed between the monthly average CCGT capacity ratio in Chart 4 and the movements in demand in Chart 13. In 2021, the monthly average capacity ratio of CCGT units was higher than it had been in 2020, except for the months of January and February. The lower capacity ratios observed since April 2020 were due to the countrywide Circuit Breaker measures implemented to contain the Coronavirus Disease (Covid-19) pandemic, which resulted in lower electricity consumption compared to 2021.

In 2021, the monthly average CCGT capacity ratio saw a significant increase from January to June, reflecting higher electricity consumption. This was in line with the recovery of economic activities<sup>3</sup>, following the relaxation of Covid-19 measures associated with the high vaccination rate of Singapore’s population.

3 Ministry of Trade and Industry press release, 3 January 2022: “Singapore’s GDP Grew by 5.9 Per Cent in the Fourth Quarter of 2021 and by 7.2 Per Cent in 2021”.

## SUPPLY INDICES: OUTAGES

TABLE 7: AVERAGE OUTAGES BY GENERATION TYPE (MW)

Year	Planned Outages						Forced Outages						Total Outages	YOY Change (%)
	CCGT	ST	OT	OCGT	Sum	%	CCGT	ST	OT	OCGT	Sum	%		
2017	743.74	322.02	21.72	32.62	1,120.10	98.76	13.79	0.04	0.20	0.00	14.02	1.24	1,134.12	2.25
2018	874.63	241.96	13.82	32.40	1,162.82	98.81	13.53	0.41	0.02	0.00	13.96	1.19	1,176.78	3.76
2019	961.64	299.29	5.82	14.43	1,281.18	94.57	73.51	0.02	0.06	0.00	73.59	5.43	1,354.77	15.13
2020	965.25	91.79	25.23	33.87	1,116.15	92.57	89.27	0.02	0.24	0.00	89.53	7.43	1,205.67	-11.01
2021	1,027.38	106.99	26.76	5.39	1,166.53	92.59	84.08	7.62	1.19	0.48	93.37	7.41	1,259.90	4.50

Table 7 provides an overview of the periodic outage volume by generation type for the last five years. The total outages rose year-on-year (YOY) from 2017 to 2021, except 2020, which was the only year recording an annual decline.

The planned outages in 2021 constituted 92.59% of the average outages volume, a slight decrease of 0.02 percentage point from 92.57% in 2020.

The CCGT units recorded the largest increase in planned outage volume from 965.25 megawatts (MW) to 1,027.38MW, while the OCGT units recorded the largest decline from 33.87MW to 5.39MW. The ST and OT units recorded minor changes in the volume of planned outages. The lower planned outage level of the OCGT units is in line with the findings in Table 6, where the OCGT saw a higher utilisation rate because of favourable market conditions in 2021.

In 2021, the volume of annual average forced outages per period of 93.37MW was the highest recorded over the past five years. It accounted for 7.41% of the total outage volume per period. The increase in forced outages could be due to requests from gas suppliers for generation companies to reduce their gas offtake. To cope with such requests, generation companies may attempt to perform fuel changeover operations, which are more likely to result in forced outages.



## SUPPLY INDICES: OUTAGES

CHART 5: PLANNED OUTAGES VS USEP

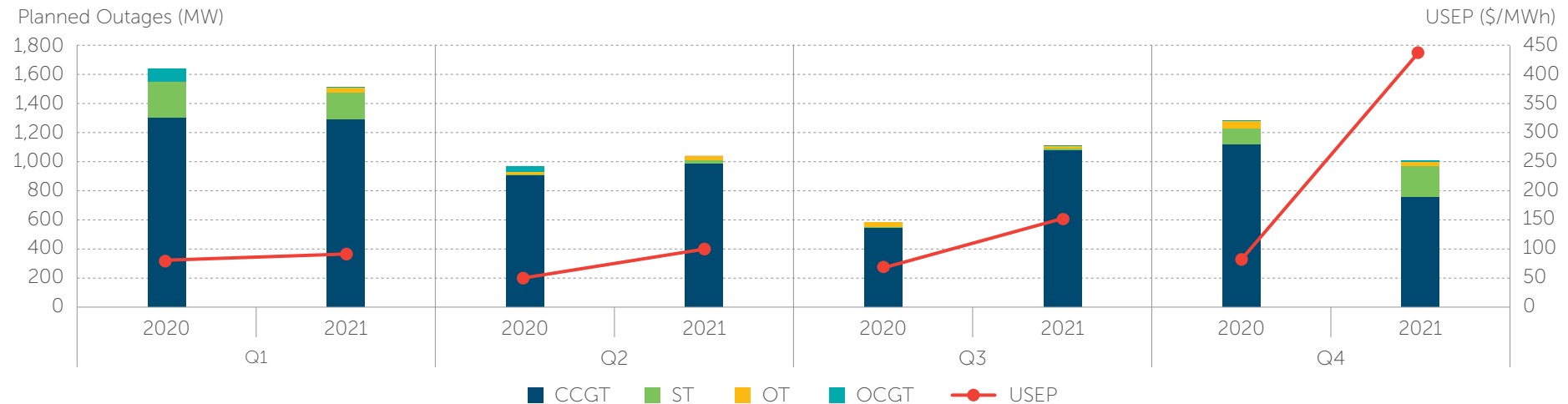


Chart 5 compares the quarterly average planned outages against the quarterly average USEP in 2020 and 2021. The USEP moved in tandem with the planned outage volumes in Q2 and Q3, as a higher level of planned outages usually coincides with a higher USEP due to the contraction in supply. However, in Q1 and Q4, the USEP rose despite lower planned outage volumes.

This could be due to the stronger impact of fuel oil price in Q1 and Q4 2021, overshadowing the impact of planned outage volumes on the USEP. The fuel oil price surged 26.91% and 66.00% respectively in Q1 and Q4 2021, from 2020 levels<sup>4</sup>. Likewise, the USEP in Q1 and Q4 2021 increased 13.02% and 436.47% respectively from 2020 levels.

In 2021, the quarterly average planned outages did not show significant correlation to the quarterly average USEP. The planned outage volume decreased from Q1 to Q3 2021, whereas the USEP increased.

Similarly, the impact of planned outages seemed to have been overshadowed by the fuel oil price as the USEP moved in tandem with the fuel oil price across all quarters in 2021. The fuel oil price in Q1, Q2, Q3 and Q4 2021 increased 30.22%, 8.24%, 10.90% and 6.24% respectively from the previous quarters. Likewise, the USEP in Q1, Q2, Q3 and Q4 2021 increased 12.14%, 9.02%, 53.69%, and 185.51% respectively from the previous quarters.

<sup>4</sup> All fuel oil prices mentioned in the MSCP Annual Report 2021 are based on the SGX Platts Singapore Fuel Oil 180cst Index Futures.

## SUPPLY INDICES: SUPPLY CUSHION

CHART 6: RELATIONSHIP BETWEEN SUPPLY CUSHION AND USEP

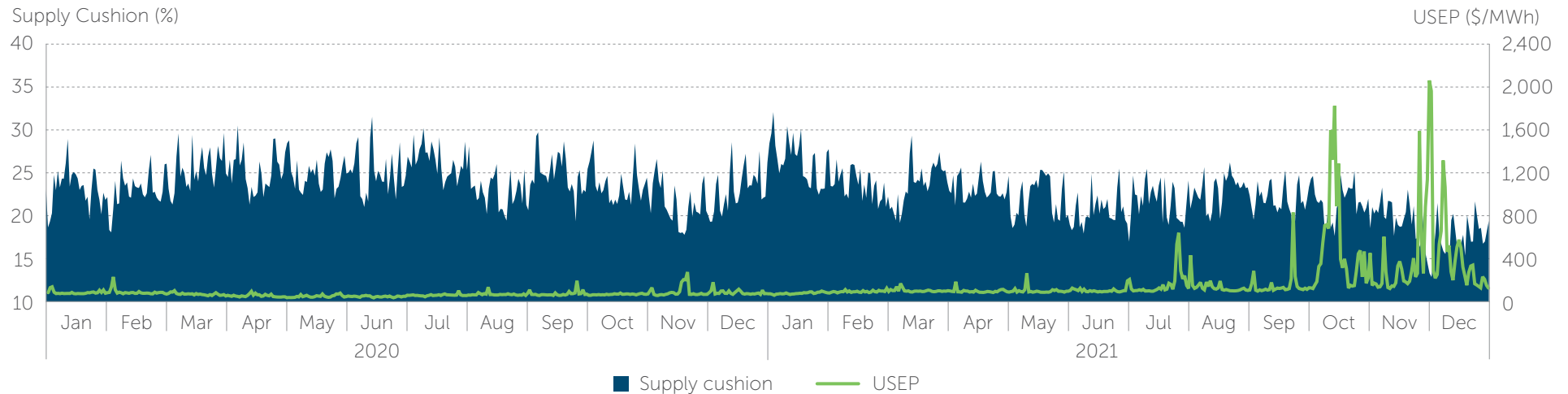


Chart 6 illustrates the relationship between the daily average USEP and the daily average supply cushion for 2020 and 2021. The supply cushion measures the level of spare capacity available after dispatch. Generally, the USEP and the supply cushion are inversely correlated. A lower supply cushion usually results in a higher USEP, due to the tight supply condition when more expensive supply is dispatched to meet the demand.

This is reflected in Chart 6 as the yearly average supply cushion in 2021 tightened 1.86 percentage points to 22.19% – the lowest annual average supply cushion since the market started. Correspondingly, the yearly average USEP increased 180.45% from \$70.01/MWh in 2020 to \$196.33/MWh in 2021 – the third-highest annual USEP since the market started.

In particular, the USEP and supply cushion saw greater volatility in the months of October, November, and December 2021. This corresponded to a period of instability in the overall supply system. As the Ministry of Trade and Industry explained, the gas supply to Singapore from Indonesia's West Natuna was affected by an incident at the upstream gas production facility in July 2021, leading to a fall of about 3% in overall gas supply since September 2021.

MTI expected this to last until end-2021 as the facility underwent repair and upgrading. Gas pressure of the supply from South Sumatra had also been affected due to higher demand from gas users upstream. Apart from gas curtailment, the high daily average USEP observed in Q4 2021 could also be attributed to the high fuel oil price due to a conflation of shocks to the global energy market<sup>5</sup>.

<sup>5</sup> The Minister for Trade and Industry's "[Oral reply to PQs on Energy-related matters](#)", 1 November 2021.

## SUPPLY INDICES: SUPPLY CUSHION

CHART 7: RELATIONSHIP BETWEEN SUPPLY CUSHION AND USEP IN 2021

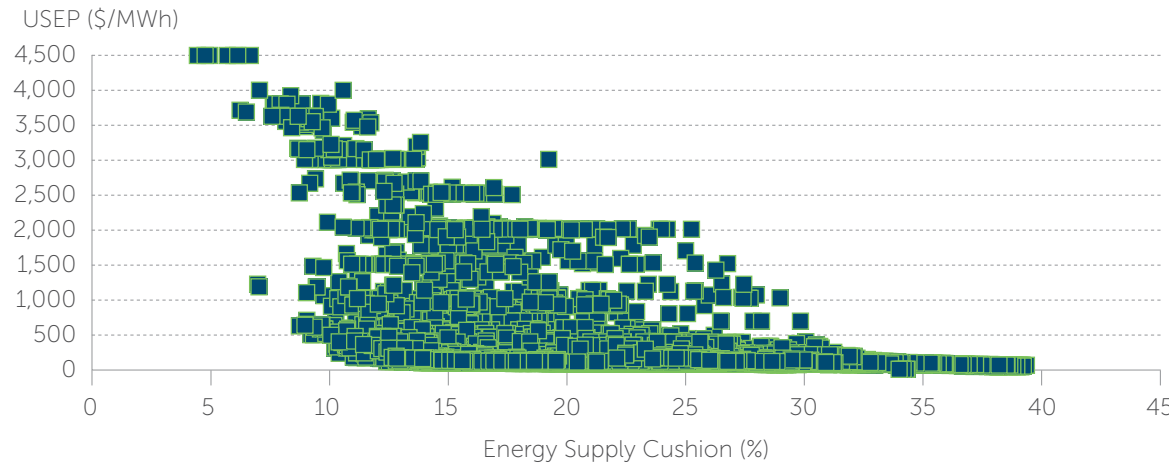


Chart 7 shows the relationship between the USEP and the supply cushion in 2021 across all dispatch periods. The periodic USEP exceeded \$400/MWh on 1,139 instances in 2021 compared to 60 in 2020.

Historically, it has been observed that price spikes occur when the supply cushion falls below the 15% level. However, in 2021, only 53% of the 1,139 instances where the periodic USEP exceeded \$400/MWh were observed when the supply cushion was below 15%, compared to 98% of the 60 instances in 2020. For these instances, the periodic supply cushion ranged between 5.03% and 14.99%, while the USEP ranged between \$86.89/MWh and \$4,499.09/MWh. For the other 47% of the 1,139 instances in 2021 where the periodic USEP exceeded \$400/MWh and the supply cushion was above 15%, the periodic supply cushion ranged between 15.00% and 39.49% while the USEP ranged between -\$5.05/MWh and \$3,007.35/MWh. This could be attributed to the increase in offer prices due to the instability of the overall supply system caused by the unplanned upstream gas curtailment, as mentioned in Chart 6, coupled with stronger growth in demand given the easing of Covid-19 restriction measures.

TABLE 8: 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
2017	1	902.94	902.94	17,519	80.87	732.52
2018	216	453.73	1,354.60	17,304	106.01	924.33
2019	222	306.18	1,354.86	17,298	95.61	1,187.31
2020	848	167.28	1,254.04	16,720	65.07	570.72
2021	1,727	621.02	4,499.09	15,793	149.89	3,007.35

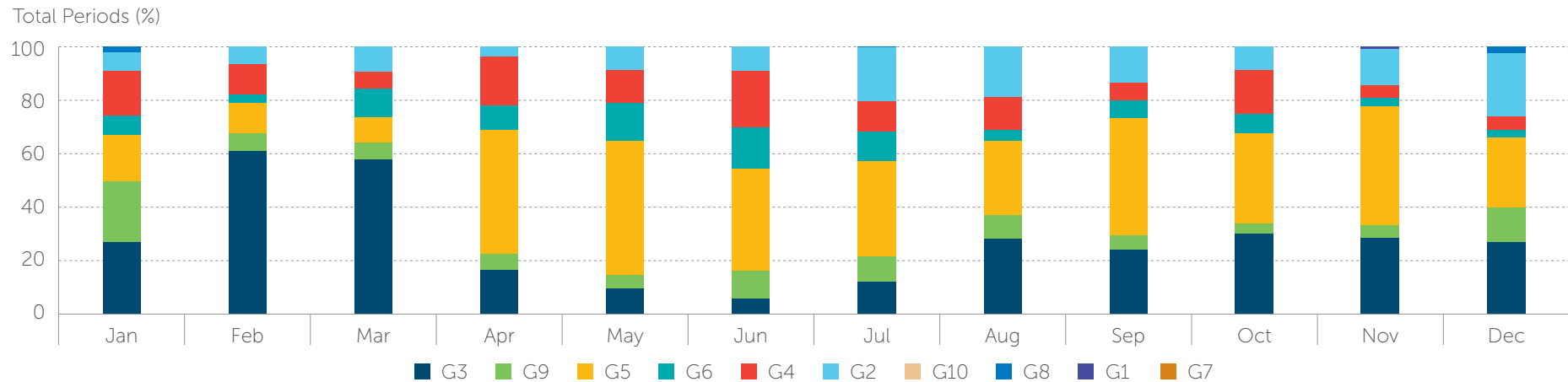
Table 8 summarises the yearly average USEP movements with a supply cushion of more or less than 15% over the past five years. In line with Chart 7, the number of periods for which the supply cushion was below 15% rose significantly from

2017 to 2021. 2021 registered a sharp spike in the number of periods with a supply cushion of under 15%, to a total of 1,727. Fewer such periods were registered before 2020.

According to Table 8, the yearly average USEP levels for both categories – supply cushion below and above 15% – were elevated in 2021. This indicates that the market cleared at higher price tranches under both relaxed and tight supply conditions. In particular, the average and maximum USEP for periods when the supply cushion was above 15% saw the highest levels over the last five years. This could be attributed to increased operation costs due to the high fuel oil price and the persistent gas curtailment in H2 2021, as generation companies switched from piped natural gas to more costly fuel alternatives to sustain their offer quantities. Therefore, the generation companies may have shifted their offer quantities to higher price tranches, even for periods when the supply cushion was above 15%. In addition, 2021 registered the highest yearly average demand since the market started. This may have contributed to the high USEP as marginal electricity prices were likely cleared at higher price tranches in 2021.

## SUPPLY INDICES: PRICE SETTER

CHART 8: TREND OF PRICE SETTING GENERATION COMPANIES



Price setter refers to the generation company which provides the block price quantity pair that fulfils the last marginal quantity to meet the entire system demand. As such, Chart 8 shows the market participants' ability and incentive to withhold capacity, as well as their ability to exercise market power.

In Chart 8, the number of periods in which each generation company is the price setter, is expressed as a percentage of the total number of periods in the month. In 2021, the three most frequent price setters contributed to 72.23% of the periods with a price setter. The three main generation companies identified to be price setters in 2021 were G2, G3 and G5, with averages of 12.64%, 25.86%, and 33.73% respectively, for all the periods with a price setter.

Among the top three generation companies, G5 was most frequently the price setter in 2021. This could be attributed to its relatively high market share based on metered energy quantity, as shown in Table 2. On a monthly level, it was observed that G3 was the key price setter for January to March, taking on that role for an average of 50.23% of the time, while G5 took over as the key price setter for April to December for an average of 37.96% of the time. This could have corresponded to a reduction in capacity due to planned or unplanned maintenance which might have reduced the volume of quantity that generation companies could offer in the market.

## SUPPLY INDICES: OFFER/BID VARIATIONS

CHART 9: OFFER VARIATIONS MADE AFTER GATE CLOSURE

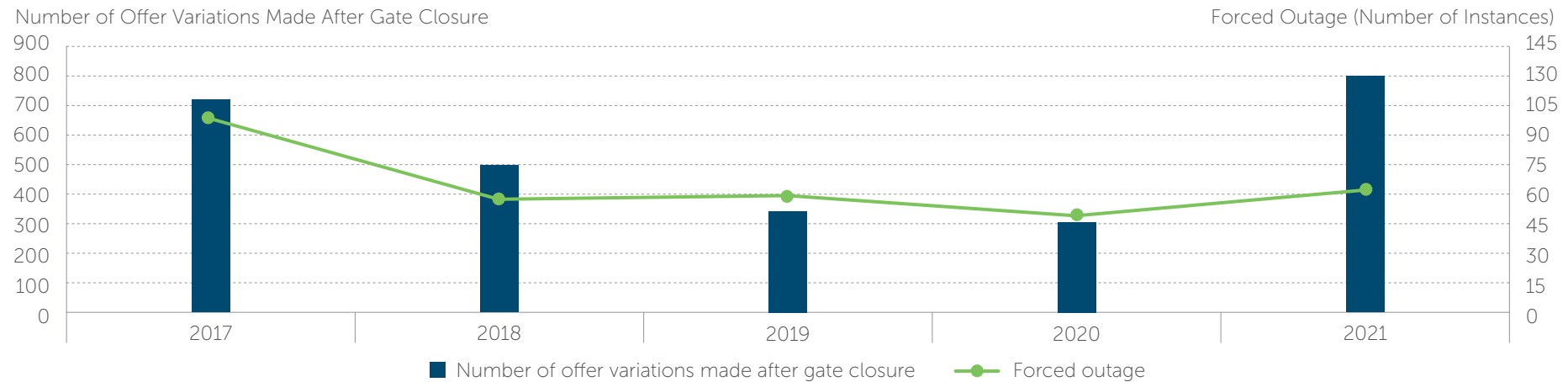


Chart 9 compares the number of gate closure variations made from 2017 to 2021 in relation to the number of forced outages. From 2017 to 2020, the trend of forced outage occurrences largely correlates with the number of cases where offer variations were made after gate closure.

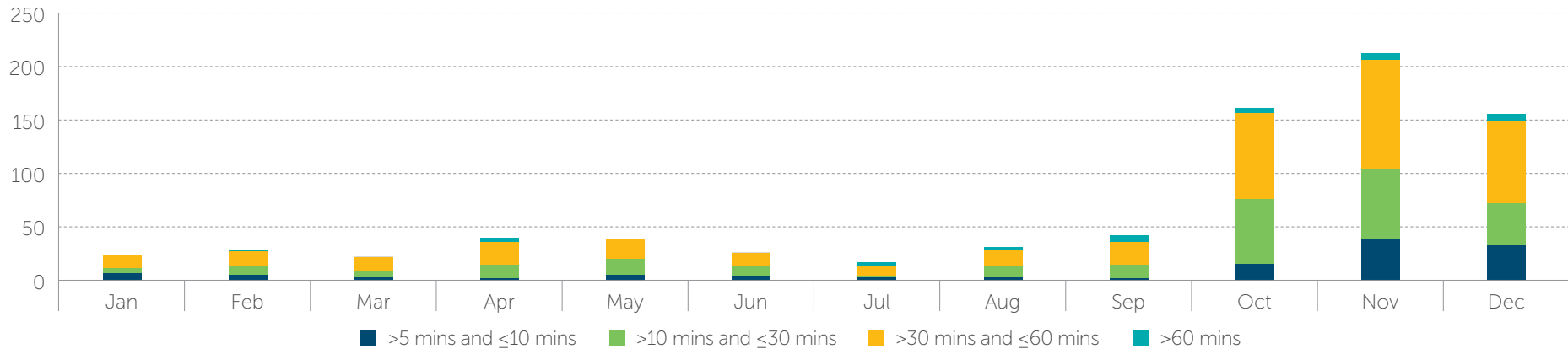
In 2021, however, the number of offer variations made after gate closure increased sharply, while the number of forced outages only rose slightly. The number of offer variations made after gate closure more than doubled from 306 in 2020 to 799 in 2021. However, the number of forced outages increased 28.57% from 49 instances in 2020 to 63 in 2021. This indicates that forced outage was not the primary reason for the offer variations after gate closure in 2021.

The spike in offer variations made after gate closure coincided with the period of gas supply constraints. This indicates that the significant increase in the number of offer variations made after gate closure could be due to reduced stability in the supply system in 2021, as a result of the unplanned upstream gas curtailment which led to generation companies making more operational changes to cope with the urgent upstream gas curtailment requests.

## SUPPLY INDICES: OFFER/BID VARIATIONS

CHART 10: SUBMISSION TIME OF OFFER VARIATIONS MADE BEFORE PERIOD STARTED

Number of Offer Variations Made Before Period Started



In the Market Rules, it is specified that generation companies should submit offers within a gate closure window of at least 65 minutes before the actual trading period. Offer or bid changes too close to the period are only allowed under specific reasons defined in the Market Rules – cases where the benefits to the market and/or system exceed the associated costs. Such offer variations in the system are regularly reported to the MSCP for investigation.

Chart 10 reflects monthly offer variations in 2021 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. This is a study of changes in generation capacity offers which may impact system security.

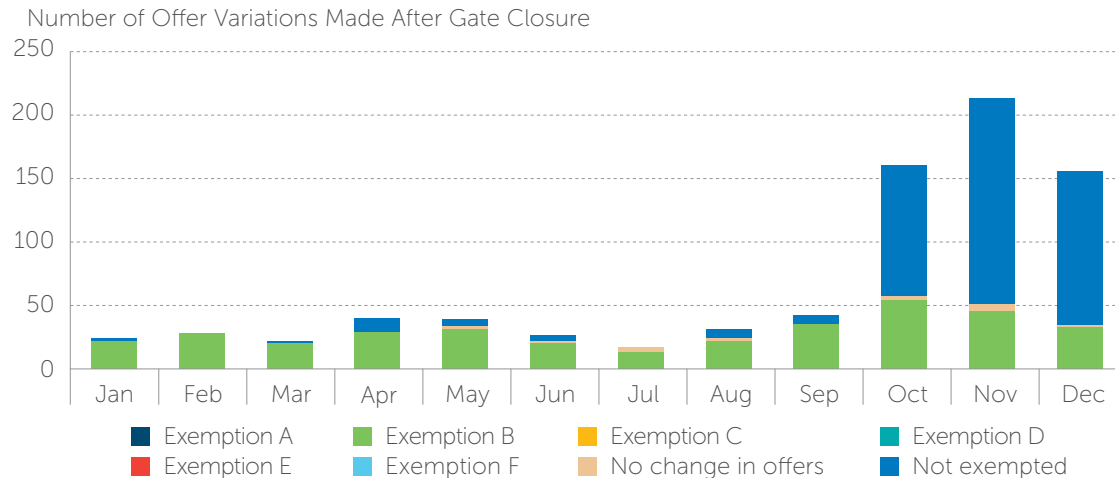
Notably, the number of offer variations made before the start of trading periods increased significantly across all categories of submission time ranges in the months of October, November, and December 2021, coinciding with the occurrences of unplanned piped natural gas curtailment, as explained in Chart 6. Given the instability of the overall supply system in those months, generation

companies needed to respond quickly to changes in upstream gas supply by adjusting and reflecting their actual physical capability of their generating units. Therefore, there was a significant increase in the total number of offer variations made before trading periods, especially from October to December 2021. This also corresponds with the sharp increase from 2020 to 2021 in offer variations made after gate closure, shown in Chart 9.

Nevertheless, offer variations were submitted between ten minutes to 65 minutes before the actual trading periods for close to 85% of total occurrences. This indicates that the generation companies were still sufficiently able to respond before the start of the actual trading period, as they did in 2020.

## SUPPLY INDICES: OFFER/BID VARIATIONS

CHART 11: CASES OF OFFER VARIATIONS MADE AFTER GATE CLOSURE



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

Chart 11 shows that of the 799 cases assessed by the MSCP in 2021, 353 cases were determined not to be in breach of the Market Rules as they were exempted under Exemption B, and 19 cases were determined not to be in breach due to offer submissions with no changes in offer. The remaining 427 cases were not exempted.

In line with Chart 10, Chart 11 reflects an increased number of cases of violation of the gate closure rules in October, November and December 2021 due to the instability of the overall supply system in those months, which had prompted generation companies to make more last-minute offer variations.

The [MSCP determinations](#) on the gate closure violation cases assessed by the panel have been published on the EMC website.

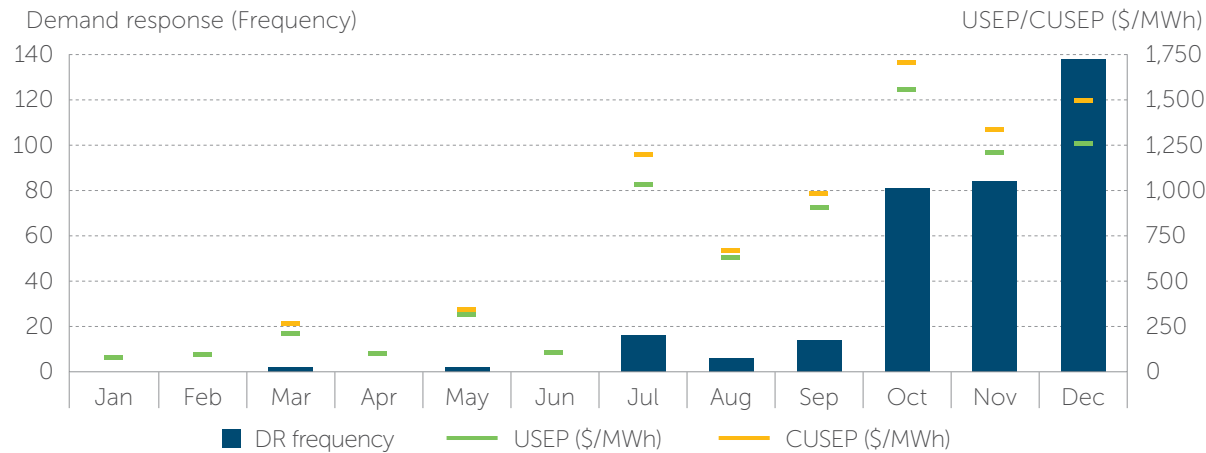
**BOX 1. EXEMPTION CONDITIONS FOR CASES OF OFFER VARIATIONS MADE AFTER GATE CLOSURE**

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

- Exemption A** refers to section 10.4.1.1a. of Chapter 6 of the Market Rules, where an offer variation is intended for a generation registered facility, to reflect its expected ramp-up and ramp-down profiles during periods following synchronisation or preceding desynchronisation.
- Exemption B** refers to section 10.4.1.1b. of Chapter 6 of the Market Rules, where an offer variation is intended for a generation registered facility, to reflect its revised capability for the three consecutive dispatch periods immediately following a forced outage or its failure to synchronise.
- Exemption C** refers to section 10.4.1.1c. of Chapter 6 of the Market Rules, where an offer variation is intended 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 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 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 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 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 F** refers to section 10.4.1.1f. of Chapter 6 of the Market Rules, where an offer variation is intended for a load registered facility, to reflect its revised capability during a forced outage or following a decrease in energy withdrawal under sections 9.3.3 and/or 9.3.4 of Chapter 5 of the Market Rules.

## SUPPLY INDICES: DEMAND RESPONSE

CHART 12: DEMAND RESPONSE FREQUENCY VS USEP



The Energy Market Authority (EMA) introduced the demand response (DR) programme in 2016 to enhance competition in the wholesale electricity market, ensure a means to allow electricity demand to be met effectively, and improve system reliability during periods of supply shortage. The DR programme provides contestable consumers with the opportunity to voluntarily curtail their electricity demand in exchange for a share in system-wide benefits, in particular from the reduction in the wholesale electricity price.

The licensed load providers are required to be compliant with at least 100% of the scheduled load curtailment to be paid. Licensed load providers which only partially comply with their scheduled curtailment will not be entitled to any incentive payments. Penalties will be imposed on licensed load providers which are compliant with less than 95% of their scheduled curtailment.

TABLE 9: DEMAND RESPONSE ACTIVATIONS IN 2021

Month	Frequency	USEP <sup>6</sup> (\$/MWh)	CUSEP <sup>7</sup> (\$/MWh)
Jan	0	77.81	0
Feb	0	92.91	0
Mar	2	216.99	268.19
Apr	0	97.86	0
May	2	318.51	320.13
Jun	0	100.61	0
Jul	16	1,041.20	1,207.95
Aug	6	624.44	667.95
Sep	14	910.97	985.21
Oct	81	1,575.39	1,726.04
Nov	84	1,202.77	1,330.37
Dec	138	1,260.73	1,498.35

Since the introduction of DR in the market, there have only been two successful activations in 2018, none in 2019, and 23 in 2020. However, in 2021, DR was activated for a total of 343 periods the majority of which occurred from October to December 2021. Table 9 displays the DR activations in 2021 by month. There was a significant increase in the frequency of DR activations in the last three months of 2021, coinciding with instability in the overall supply system then, as explained in Chart 6.

As shown in Table 9, DR activation brought about cost savings with reduced wholesale energy prices, as the USEP was usually lower than the counterfactual USEP (CUSEP). The activation of DR improved system reliability during periods of supply shortage and delivered system-wide benefits, especially in 2021.

<sup>6</sup> For months with DR activations, the USEP is the average USEP of periods with DR activations. For months without demand response activations, the USEP is the average USEP of all periods in the month.

<sup>7</sup> The market clearing engine shall, for each solution which involves at least one restricted bid energy, re-solve the linear program to determine a counterfactual solution for the dispatch period. The CUSEP (in \$/MWh) is calculated by the market clearing engine on the assumption that there is no dispatchable energy bid.



## DEMAND INDICES: METERED ENERGY QUANTITY

CHART 13: COMPARISON OF ACTUAL DEMAND

Metered Energy Quantity (MW)

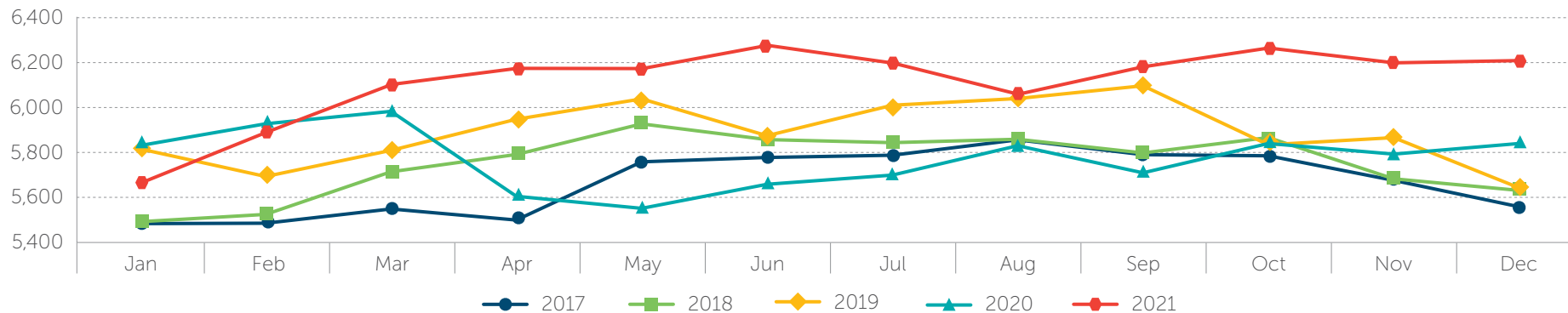


Chart 13 compares the actual demand (computed from metered energy quantity) between 2017 and 2021. Based on the yearly average, the demand rose 5.97% from 5,772MW in 2020 to 6,117MW in 2021. This was the highest yearly average demand and the second-largest jump in the yearly average demand since the NEMS started in 2003; the largest was 8.75% in 2010.

The monthly average demand increased from March onwards, effectuating the high yearly average demand for 2021. The monthly average demand in 2021 was highest in the past five years for most of the months – from March to December. In particular, the demand of 6,277MW in June 2021 was the highest monthly average demand since 2003.

The strengthened demand from January to June 2021 was due to the easing of Covid-19 restrictions from Phase 2 to Phase 3 from 28 December 2020. The reopening allowed more people to return to workplaces and expanded capacity for various activities. The slump in demand from July to August 2021 was largely because of new Covid-19 pandemic measures put in place following a surge in Covid-19 cases in the community. In July 2021, the Singapore Government announced the start of Phase 2 (Heightened Alert) and implemented tighter preventive measures to curb the spread of the disease.

In September 2021, the monthly average demand rose to 6,182MW with the relaxation of the Covid-19 measures announced by the Singapore Government. As Singapore moved from Phase 2 (Heightened Alert) to the Preparatory Stage, businesses had restrictions lifted and more employees were allowed to return to workplaces. Demand thus rose to 6,265MW in October 2021, the second-highest level in the year after the dip in July 2021.

The demand in November 2021 was 6,199MW, 7.00% higher than the 5,793MW observed in November 2020. As demand tends to move in tandem with temperature, the higher demand in November 2021 was likely due to the higher temperature of 29.4°C, compared to 28.4°C observed in November 2020.

In 2021, the high YOY increases in demand of 10.17%, 11.23% and 10.94% were recorded in the months of April, May, and June respectively, coming off the lower bases for those months in 2020 due to the Circuit Breaker triggering a sharp decline in demand then.

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

TABLE 10: VARIATION IN LOAD FORECAST (MW)

Year	Variation between PDS & Real-Time		Variation between STS & Real-Time	
	Mean	Standard Deviation	Mean	Standard Deviation
2017	59.89	39.26	16.70	10.85
2018	57.97	40.67	16.82	14.31
2019	55.78	40.42	15.58	11.30
2020	53.98	40.13	14.94	11.01
2021	75.33	49.72	20.86	13.55

Three forecast schedules with different forecast horizons are made available to market participants, namely the Market Outlook Scenario (MOS), the Pre-dispatch Schedule (PDS), and the Short-term Schedule (STS). As the STS is generated more frequently and closer to the real-time dispatch period than the PDS, the load variation between the STS and the real-time dispatch schedule tends to be smaller than that between the PDS and the real-time dispatch schedule. The MOS is updated every day with a forecast horizon of six days, the PDS is updated every two hours with a forecast horizon of 12 to 36 hours, and the STS is updated every half hour with a forecast horizon of six hours.

Table 10 shows the accuracy of the forecast schedules for the past five years, measured by the mean and standard deviation of the load variations in the PDS and the STS, when compared to the real-time dispatch schedule<sup>8</sup>. The accuracy of the forecast schedules is essential for the efficient operation of the market, as it determines the responsiveness of generation facilities to real-time demand conditions.

The mean load variation between the PDS and the real-time dispatch schedule in 2021 was 75.33MW, translating to 3.61 times as large as that between the STS and the real-time dispatch schedule. Likewise,

the standard deviation of the load variation between the PDS and the real-time dispatch schedule in 2021 was 49.72MW, which was 3.67 times as large as that between the STS and the real-time dispatch schedule.

In 2021, the mean load variation between the PDS and real-time dispatch schedule was 39.57% higher than that in 2020. The mean load variation between the STS and real-time dispatch schedule also went up by 39.68% in 2021. This could be attributed to the price volatility observed in 2021.

TABLE 11: VARIATION IN REAL-TIME LOAD FORECAST (%)

Year	Variation between Real-Time Load Forecast & Actual Demand	YOY Change
2017	2.26	-0.44
2018	2.58	0.32
2019	2.46	-0.12
2020	2.16	-0.30
2021	1.72	-0.44

For real-time dispatch schedules, the accuracy of the load forecast is crucial as the load forecast is used to determine dispatch instructions and market prices. The more accurate the load forecast is, the more reflective the dispatch instructions and market prices are of actual system conditions. Therefore, it is important to maintain an accurate load forecast to achieve system stability and efficient pricing outcomes.

Some variation between the real-time load forecast and actual demand is expected. There are a few factors contributing to this variation. The real-time load forecast includes the station and auxiliary loads, while the actual demand does not. This difference in methodology creates a variation between the real-time load forecast and the actual demand, with the real-time load forecast being higher than the actual demand. Other possible reasons for the variation between the real-time load forecast and the actual demand are metering errors and transmission losses.

Table 11 presents the variation between the real-time load forecast and the actual demand for the past five years. The variation between the real-time load forecast and the actual demand decreased 0.44 percentage point to 1.72% in 2021, from 2.16% in 2020. This was the lowest variation observed since the NEMS started, suggesting that the real-time load forecast in 2021 was the most accurate thus far.

Since 2019, the variation between the real-time load forecast and the actual demand has been on a downward trend, showing improvement in the real-time load forecast – the lower the variation, the more accurate the load forecast must have been.

<sup>8</sup> The real-time dispatch schedule is generated 30 seconds before each dispatch period and covers the associated dispatch period.

## PRICE INDICES: LNG VESTING PRICE AND WHOLESAL ELECTRICITY PRICE

CHART 14: LVP VS MONTHLY VOLUME-WEIGHTED AVERAGE WEP

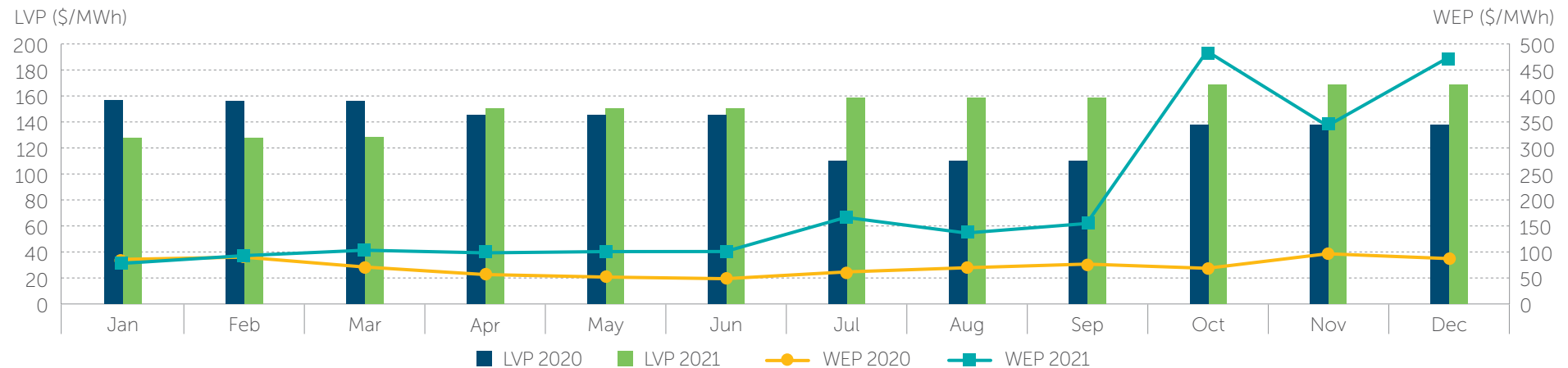


Chart 14 shows the LNG Vesting Price (LVP)<sup>9</sup> and the monthly volume-weighted average Wholesale Electricity Price (WEP) for 2020 and 2021. As the LVP reflects the long run marginal cost of a generation facility, the WEP should follow the LVP closely in an efficient market.

The monthly volume-weighted average WEP in 2021 was higher than that in 2020 for a significant part of the year – from February to December. This was mainly driven by the growth in electricity demand as Singapore’s economy began to recover on the back of the relaxation of Covid-19 restrictions applied in 2020. Another driver of the higher monthly volume-weighted average WEP was the spike in fuel oil prices in 2021.

The largest YOY hike in the WEP was in October, when the WEP increased sevenfold to \$486.83/MWh, from \$68.31/MWh in October 2020. This was the highest monthly recorded WEP since the NEMS started in 2003. The rocketing WEP was due to the global energy crunch<sup>10</sup> which sent fuel prices spiralling upwards, as well as the disruption to Singapore’s piped natural gas supply.

As for the remaining months, the monthly volume-weighted average WEP showed YOY increases of 256.04% and 444.45% in November and December respectively. This was likely caused by multiple periods of high energy prices in November and December 2021, where the market was affected by the global energy crunch. Additionally, the monthly average supply cushion for November and December was the narrowest observed thus far.

Given the prolonged duration of higher WEP in 2021, the yearly volume-weighted average WEP surged 178.47% to \$195.62/MWh in 2021 from \$70.25/MWh in 2020. The yearly volume-weighted average WEP was 27.20% higher than the yearly average LVP in 2021.

The LVP increased 10.64% to \$153.10/MWh in 2021 from \$138.38/MWh in 2020 while the volume-weighted average WEP was higher than the LVP as the WEP increased by a greater magnitude from July to December.

9 The Vesting Contract Hedge Price (VCHP) was made up of the Balance Vesting Price (BVP) and the LVP, which are differentiated based on the primary fuel source (piped natural gas or liquefied natural gas (LNG)). However, since the Balance Vesting Quantity was reduced to zero and the BVP was removed accordingly on 1 July 2019, the VCHP has depended solely on the LVP.

10 Energy Market Authority media release, 19 October 2021, "[Pre-emptive Measures to Enhance Singapore’s Energy Security and Resilience](#)".

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

CHART 15: INDEX OF LVP, WEP, FUEL OIL PRICE AND ELECTRICITY TARIFF

Index (base = 2017)

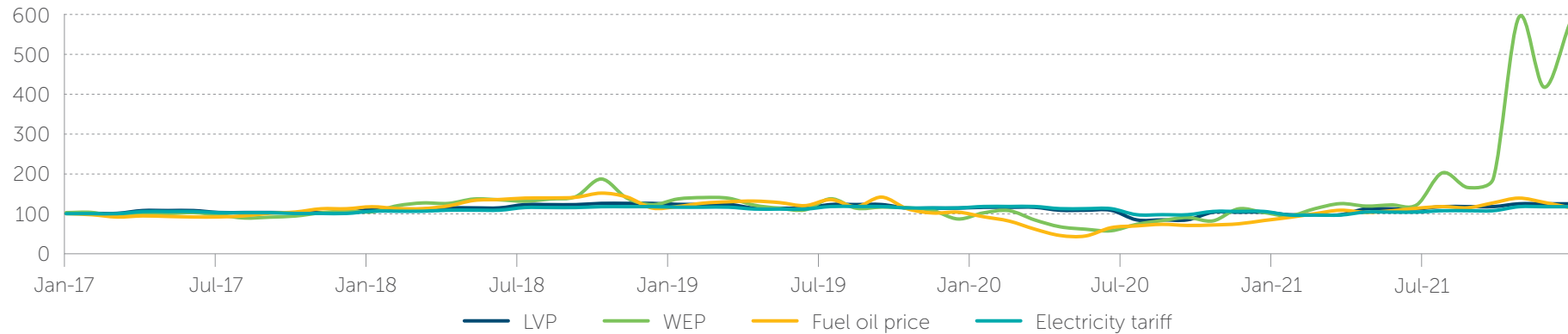


Chart 15 shows the relative changes in the LVP, the WEP, the fuel oil price and the electricity tariff for the past five years, expressed as indices against the prices in the base year 2017.

The WEP moved in tandem with the fuel oil price throughout the review period from 2017 to June 2021, implying that the fuel oil price was a factor which could account for changes in the WEP. Comparing the recent two years, the fuel oil price surged 63.29% to US\$406.81/MT in 2021, from US\$249.13/MT in 2020, and the WEP soared 178.47% to \$195.62/MWh in 2021, from \$70.25/MWh in 2020, the highest YOY increase thus far.

The spike from July to December 2021 was due to tighter supply conditions that resulted in multiple periods of high energy prices. In particular, the supply cushion for November and December was the lowest monthly average supply cushion recorded thus far over the past five years.

Since the LVP and the electricity tariff are representations of the cost of generating electricity in the NEMS, it is expected that these two prices move in the same direction, as seen from 2017 to 2021. The electricity tariff gradually increased 16.16% to \$0.26/kWh in Q4 2021 from \$0.22/kWh in Q1 2021.

## PRICE INDICES: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY

TABLE 12: MONTHLY AVERAGE CORRELATION COEFFICIENT OF WEP AND METERED ENERGY QUANTITY

Month	2020			2021		
	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	0.85	0.72	25	0.79	0.63	29
Feb	0.66	0.44	23	0.67	0.45	25
Mar	0.79	0.62	27	0.72	0.52	28
Apr	0.61	0.37	21	0.27	0.07	6
May	0.64	0.40	22	0.11	0.01	4
Jun	0.91	0.83	29	0.43	0.19	16
Jul	0.84	0.70	29	0.49	0.24	17
Aug	0.72	0.52	30	0.36	0.13	15
Sep	0.77	0.59	27	0.39	0.15	12
Oct	0.82	0.68	31	0.42	0.18	11
Nov	0.57	0.33	23	0.44	0.20	13
Dec	0.71	0.50	27	0.26	0.07	4
Average/Sum	0.74	0.56	314	0.45	0.24	180

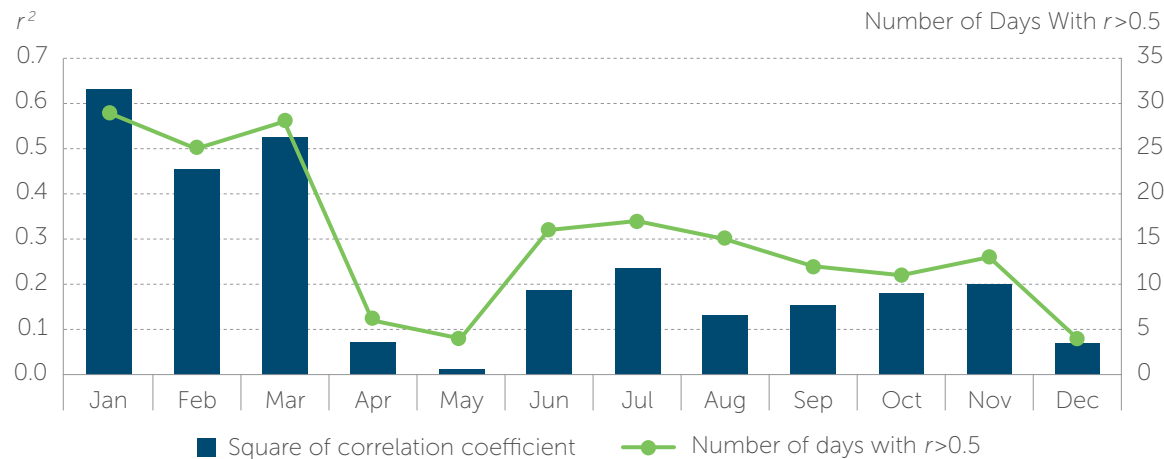
The correlation coefficient  $r$  in Table 12 measures the strength of the relationship between the WEP and the metered energy quantity (actual demand) and ranges from -1 to 1. A high positive  $r$  indicates that as demand rises, the WEP also rises; a high negative  $r$  indicates that as demand decreases, the WEP decreases as well. A low  $r$  in either direction indicates a weak correlation between the WEP and demand. The square of the correlation coefficient  $r^2$  is the proportion of the variance in the WEP which could be explained by variations in demand.

The relationship between the WEP and demand became less pronounced in 2021 compared to 2020. The yearly average  $r$  value dropped to 0.45 in 2021 from 0.74 in 2020 and the number of days when  $r$  was greater than 0.5 went down to 180 days in 2021 from 314 days in 2020.

The  $r^2$  value decreased to 0.24 in 2021 from 0.56 in 2020. This meant that about 24% of the variance in the WEP in 2021 could be attributed to variations in the demand, compared to about 56% in 2020.

## PRICE INDICES: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY

CHART 16: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY IN 2021

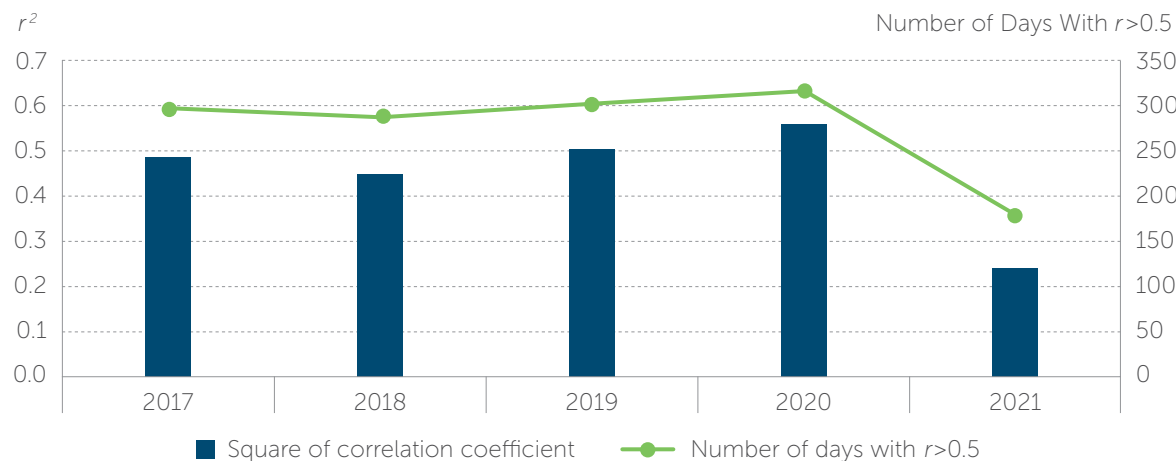


The correlation between the WEP and the metered energy quantity in 2021 is illustrated in Chart 16. Generally, the  $r^2$  value positively correlates to the number of days when the  $r$  value is greater than 0.5.

The highest  $r^2$  value recorded in 2021 was 0.63 in January, when there were 29 days with  $r$  value greater than 0.5, only two days shy of a complete month. This indicates that the WEP observed for most of the days of January 2021 was driven by the metered energy quantity.

From April to December 2021, there were fewer than 20 days on which the  $r^2$  value was greater than 0.5. The lowest  $r^2$  value in 2021 was observed in May at 0.01, with only four days when the  $r$  value was greater than 0.5. The lower  $r^2$  value implies that a lower proportion of variance in the WEP could be explained by variations in demand as the WEP is also dependent on factors such as fuel oil price, outage level, supply cushion and generators' offers.

CHART 17: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY FOR 2017–2021



The correlation between the WEP and the metered energy quantity for the past five years is shown in Chart 17. In 2021, the  $r^2$  value fell and the number of days with an  $r$  value greater than 0.5 dipped to 180, indicating the shrinking influence of demand on energy prices.

This contrasts with what was observed from 2017 to 2020, when the number of days with an  $r^2$  value greater than 0.5 almost hit 300 in 2017 and 2018, before exceeding 300 in 2019 and 2020. Given an  $r^2$  value of 0.56 in 2020, changes in demand could account for about 56% of the WEP's movements in 2020. The  $r^2$  value went down to 0.24 in 2021, which meant that changes in demand could only explain as much as 24% of the WEP's movements in 2021.

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

CHART 18: PERCENTAGE OF HOURS WHEN THE WEP FALLS INTO A PARTICULAR PRICE RANGE

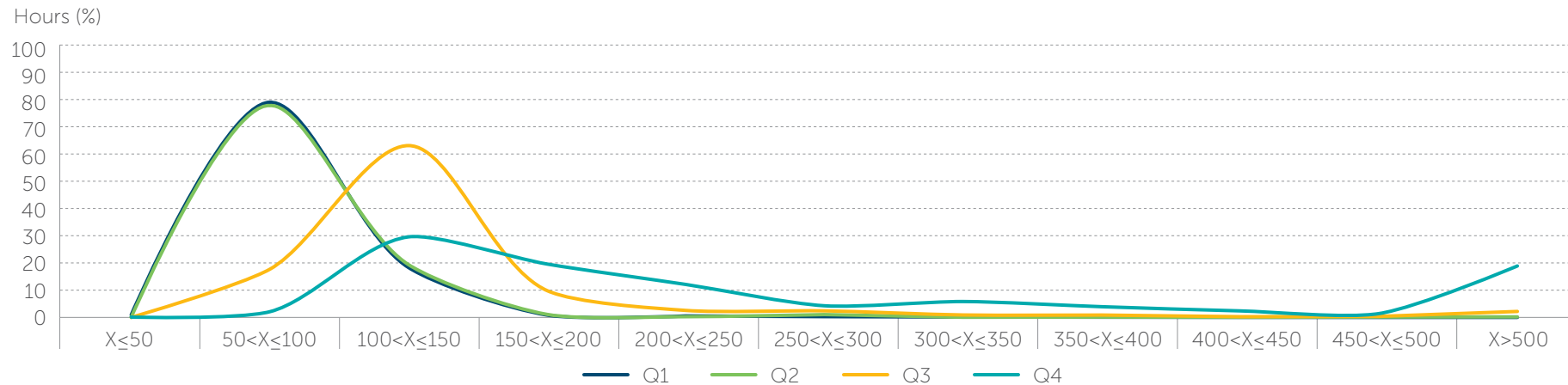


Chart 18 shows the frequency of the WEP in various price ranges, measured as a percentage of the total number of hours in each quarter of 2021. The price distribution for Q1 and Q2 2021 overlapped with each other before moving rightward in Q3 and Q4 2021, reflecting the impact of the Covid-19 pandemic and the global energy crunch on the energy prices in the NEMS as the fuel oil price spiked in Q3 and Q4 2021.

In Q1 2021, the distribution of the WEP remained within the \$50/MWh to \$100/MWh tranche for 78.91% of the time, averaging at \$79.38/MWh. The WEP exceeded \$400/MWh for one period which occurred on 6 March 2021, but stayed below \$450/MWh for the rest of the quarter and averaged at \$91.36/MWh. The monthly average WEPs for January and February stood at \$77.98/MWh and \$92.74/MWh respectively, registering the two lowest monthly average WEPs observed in 2021.

The WEP in Q2 2021 settled between \$50/MWh and \$100/MWh for 77.70% of the time. It did rise above \$200/MWh for 1.83% of the time and averaged at \$337.76/MWh. The WEP also exceeded \$500/MWh for a total of eight periods on 5 April and 11 May 2021.

The distribution of the WEP moved rightward in Q3 2021, leading to a higher quarterly average WEP of \$152.51/MWh, 67.05% above what it was in Q1. This was because the WEP remained in the \$100/MWh to \$150/MWh price tranche for 63.02% of the time. The WEP exceeded \$500/MWh for a total of 96 periods and averaged at \$1,185.68/MWh.

In Q4 2021, the peak of the distribution of the WEP rose as the WEP stayed above \$200/MWh for 48.71% of the time and averaged at \$745.85/MWh. There were 833 periods where the WEP surged beyond \$500/MWh, the highest frequency among the quarters in 2021. The peak periodic WEP of \$4,534.10/MWh was recorded on 2 December 2021. Therefore, the WEP averaged at \$434.64/MWh for Q4, the highest quarterly WEP in 2021.

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

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

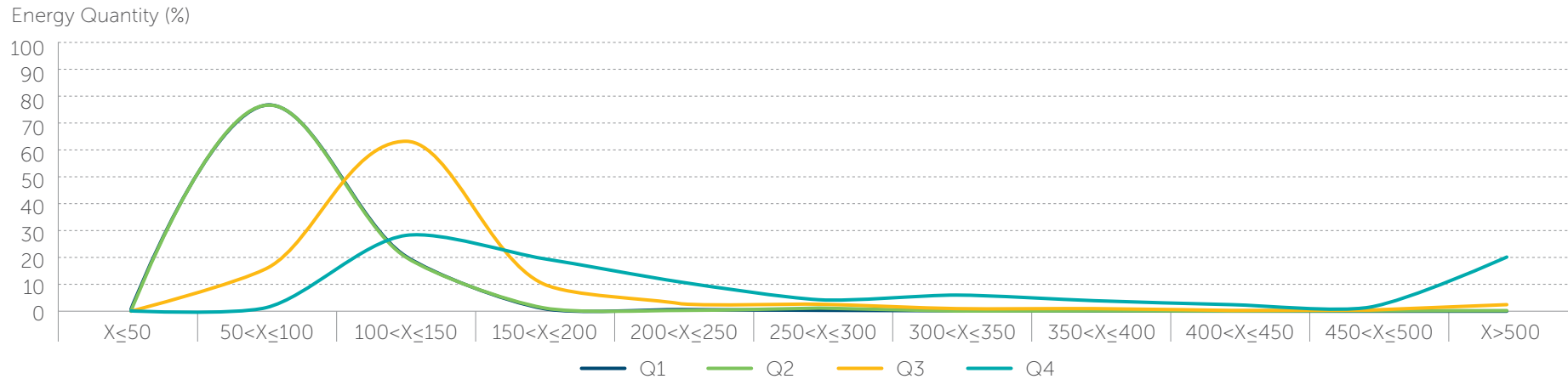


Chart 19 shows the frequency of the WEP in various price ranges, measured as a percentage of the total metered energy quantity in each quarter of 2021. The behaviour of the price distribution was very much like the one described in Chart 18 – the price distribution for Q1 and Q2 2021 overlapped with each other before moving rightward in Q3 and Q4 2021 due to the effect from the global energy crunch on the energy prices in the NEMS and the impact of the Covid-19 pandemic.

In Q1 and Q2 2021, 76.74% of the total energy quantity in 2021 was priced between \$50/MWh and \$100/MWh. In Q3 2021, 16.30% of the total energy quantity was priced between \$50/MWh and \$100/MWh, and 63.27% of the total energy quantity was priced between \$100/MWh and \$150/MWh. The percentage of total energy quantity priced between \$50/MWh and \$100/MWh in Q4 2021 shrank to 1.75% and 20.15% of the total energy quantity was priced above \$500/MWh. Consequently, the WEP of \$434.64/MWh in Q4 2021 was the highest quarterly average WEP observed in 2021.



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

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

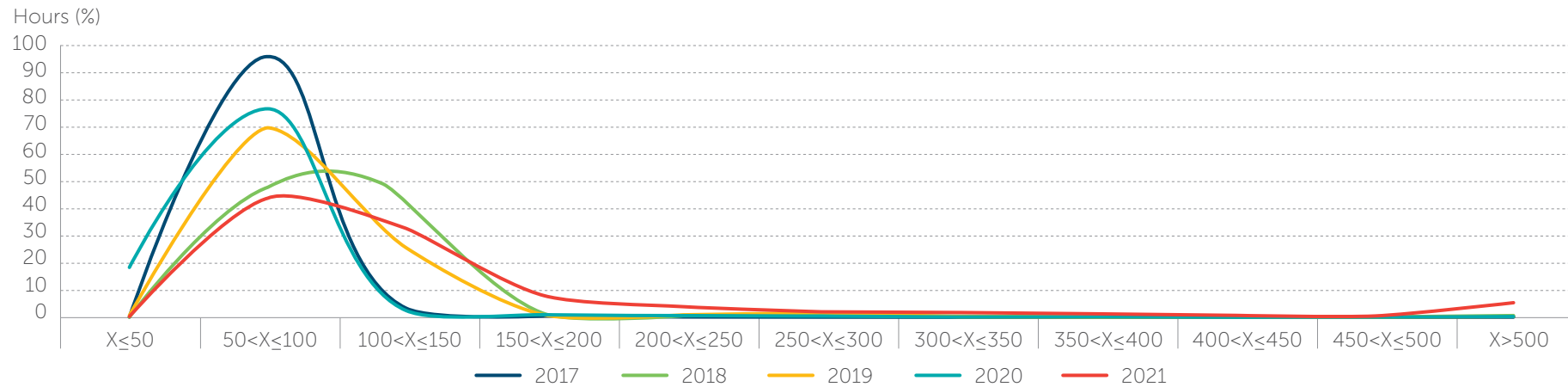


Chart 20 shows the historical price distribution for the past five years expressed as a percentage of the total number of hours in each year, to examine longer term trends.

In 2017 and 2018, the distribution of the WEP shifted rightward as the WEP increased. The WEP cleared between \$50/MWh and \$100/MWh 95.90% of the time and between \$100/MWh and \$150/MWh 3.31% of the time for 2017. The yearly average WEP stood at \$81.19/MWh in 2017 and then further increased to \$110.50/MWh in 2018. The frequency with which the WEP ranged between \$50/MWh and \$100/MWh fell to 47.82% of the time and the frequency with which the WEP ranged between \$100/MWh and \$150/MWh rose to 48.16% of the time in 2018.

In 2019 and 2020, the distribution of the WEP shifted leftward as the frequency with which the WEP ranged between \$50/MWh and \$100/MWh stood at 69.72% and 76.70% of the time respectively. The frequency with which the WEP cleared below or at \$50/MWh rose to 18.34%, while it ranged between \$100/MWh and \$150/MWh a lower 2.45% of the time in 2020, down from 25.55% in 2019. Consequently, the yearly average WEP for 2020 fell to \$70.25/MWh.

In 2021, the distribution of the WEP shifted rightward and the WEP cleared between \$50/MWh and \$100/MWh 43.81% of the time and between \$100/MWh and \$150/MWh 32.67% of the time. The yearly average WEP of \$195.62/MWh in 2021 was the highest in the past five years.

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

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

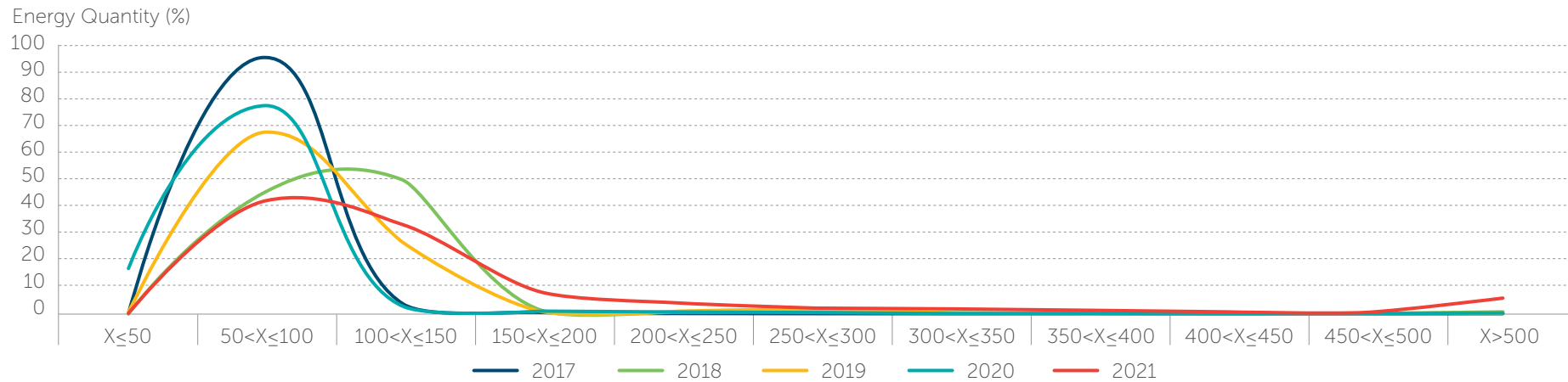


Chart 21 shows the historical price distribution for the past five years, based on the percentage of the total metered energy quantity in each year.

The behaviour of the price distribution based on energy quantity would be identical to Chart 20 – the price distribution shifted rightward in 2017 and 2018 before moving leftward in 2019 and 2020 and shifted rightward again in 2021.

In 2017, 95.53% of the total energy quantity was priced between \$50/MWh and \$100/MWh, while 3.61% was priced between \$100/MWh and \$150/MWh. In 2018, the percentage of the total energy quantity clearing between \$50/MWh and \$100/MWh fell to 45.52% and that between \$100/MWh to \$150/MWh rose to 50.05%. Correspondingly, the WEP in 2018 was 36.09% higher than that in 2017 since a higher volume of electricity was cleared within higher price ranges.

The yearly average WEP in 2019 then decreased 10.74% from that in 2018. This fall was due to more energy quantity, 67.72% of the total, being cleared within the lower \$50/MWh to \$100/MWh tranche in 2019, while a smaller 27.31% of energy quantity was cleared within the higher \$100/MWh to \$150/MWh tranche.

In 2020, the energy quantities which cleared at or below \$50/MWh and within the \$50/MWh and \$100/MWh tranche were higher than the quantities in 2019, at 16.88% and 77.61% respectively. Only 2.72% of the total energy quantity in 2020 cleared between \$100/MWh and \$150/MWh. The resultant WEP in 2020 declined 28.78% from the WEP observed in 2019.

For 2021, the yearly average WEP rose 78.47% due to a higher percentage of 33.15% being cleared within the \$100/MWh to \$150/MWh tranche than in 2020. It is relevant to highlight that 5.85% of the total energy quantity was cleared at or above \$500/MWh – the highest percentage recorded since 2017.

## PRICE INDICES: ACCURACY OF SHORT-TERM PRICE FORECAST

TABLE 13: VARIATION IN REAL-TIME USEP IN 2021 (\$/MWH)

Month	Variation between STS & Real-Time
Jan	0.12
Feb	1.56
Mar	0.64
Apr	1.36
May	0.15
Jun	0.47
Jul	10.39
Aug	-9.84
Sep	7.77
Oct	122.96
Nov	49.25
Dec	68.34

The difference in the USEP produced in the STS and the real-time dispatch schedule as a monthly average variation in 2021 is shown in Table 13. A positive variation means the real-time dispatch schedule has a higher USEP than the STS, while a negative variation means the real-time dispatch schedule has a lower USEP than the STS.

The forecast prices in the STS produced in January 2021 were very close to the real-time USEP – only \$0.12/MWh above the real-time USEP on average. The largest monthly average variation in the USEP was observed in October 2021, when the real-time USEP was \$122.96/MWh more than the forecast USEP. Overall, the average variation between the USEP in the STS and that in the real-time dispatch schedule in 2021 was \$21.10/MWh, which meant that the forecast USEP in the STS is less indicative of the real-time USEP.

## ANCILLARY SERVICE INDICES: RESERVE PRICES

CHART 22: PRIMARY RESERVE PRICE

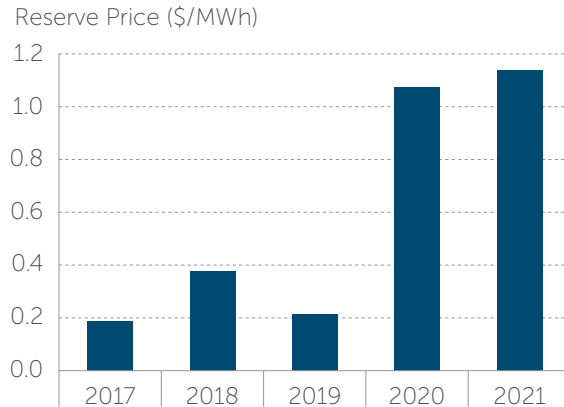


Chart 22 shows the average primary reserve<sup>11</sup> price in the NEMS from 2017 to 2021.

Each registered facility offering primary reserve in the NEMS has to 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 has to be able to maintain that scheduled megawatt response until ten minutes from the time it was triggered.

From 2017 to 2019, the yearly average primary reserve price remained below \$1/MWh, supported by the declining primary reserve requirement since 2017. During this period, the primary reserve price was at its lowest level of \$0.19/MWh in 2017.

Despite the lower primary reserve requirement in 2021, the primary reserve price cleared at \$1.14/MWh, an increase of 6.15% from \$1.08/MWh in 2020. The higher primary reserve price was due to the greater price volatility observed in 2021.

<sup>11</sup> With effect from 1 October 2017, the primary and secondary reserve classes were combined into a single primary reserve class.

CHART 23: CONTINGENCY RESERVE PRICE

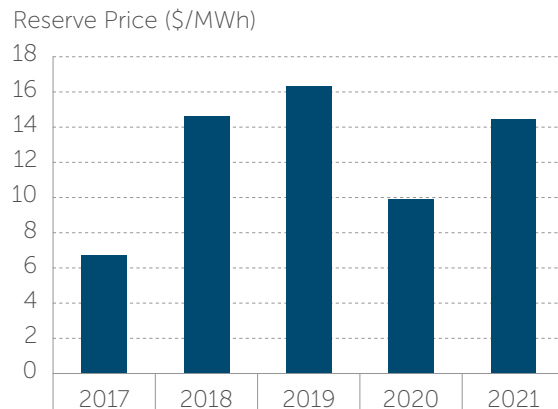


Chart 23 shows the average contingency reserve price in the NEMS for the past five years.

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

From 2017 to 2019, the yearly average contingency reserve price went up from \$6.74/MWh to \$16.30/MWh, which was the highest level seen since \$17.52/MWh in 2009. The contingency reserve price fell to \$9.91/MWh in 2020; this was the first decrease since 2016.

The contingency reserve requirement increased by 1.49% in 2021 from 2020. Consequently, the yearly average contingency reserve price went up to \$14.47/MWh, an increase of 46.03% from \$9.91/MWh in 2020. The contingency reserve price peaked at \$628.20/MWh in 2021, while it reached \$300.00/MWh in 2020.

## ANCILLARY SERVICE INDICES: RESERVE PRICES

CHART 24: RESERVE PAYMENT AND REQUIREMENT

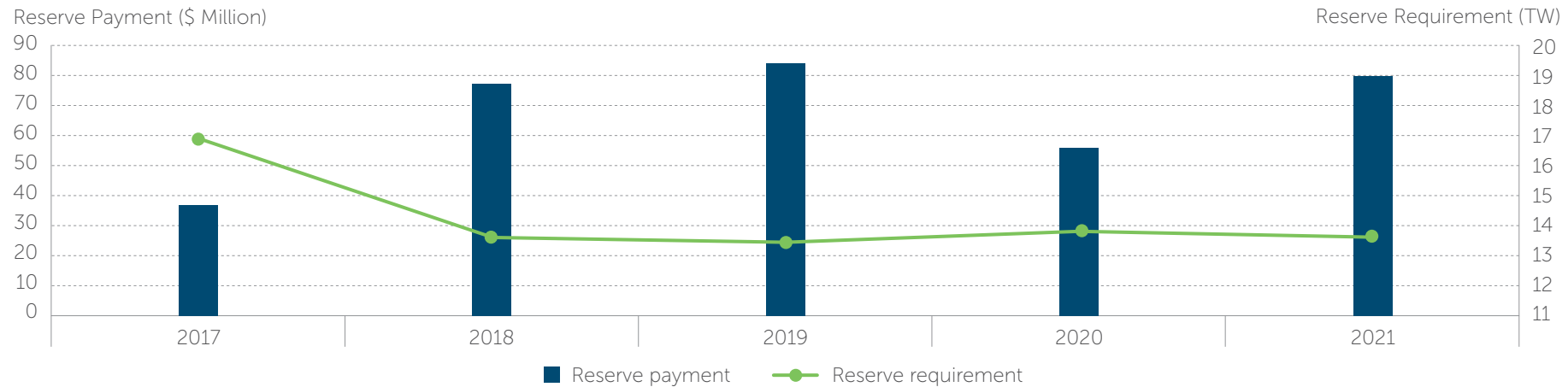


Chart 24 shows the total payment and requirement for primary and contingency reserves in the NEMS between 2017 and 2021.

The reserve payment had been increasing every year since 2017, before falling 33.50% from \$84.10 million in 2019 to \$55.93 million in 2020 due to the decrease in the contingency reserve price. Although the reserve requirement decreased in 2021, the primary reserve price and the contingency reserve price rose by a larger magnitude, resulting in a higher reserve payment of \$79.96 million for the year as compared to 2020.

In contrast, the reserve requirement had been on a downward trend since 2017, including a reduction of 19.24% in 2018 that was mainly due to the removal of the secondary reserve class. Thereafter, the primary reserve requirement fell by 10.30% and the contingency reserve requirement rose by a marginal 1.49% in 2021. The lower reserve requirement was due to a significant reduction in the primary reserve requirement.

## ANCILLARY SERVICE INDICES: RESERVE PRICES

CHART 25: RESERVE PAYMENT AND CONTINGENCY RESERVE PRICE

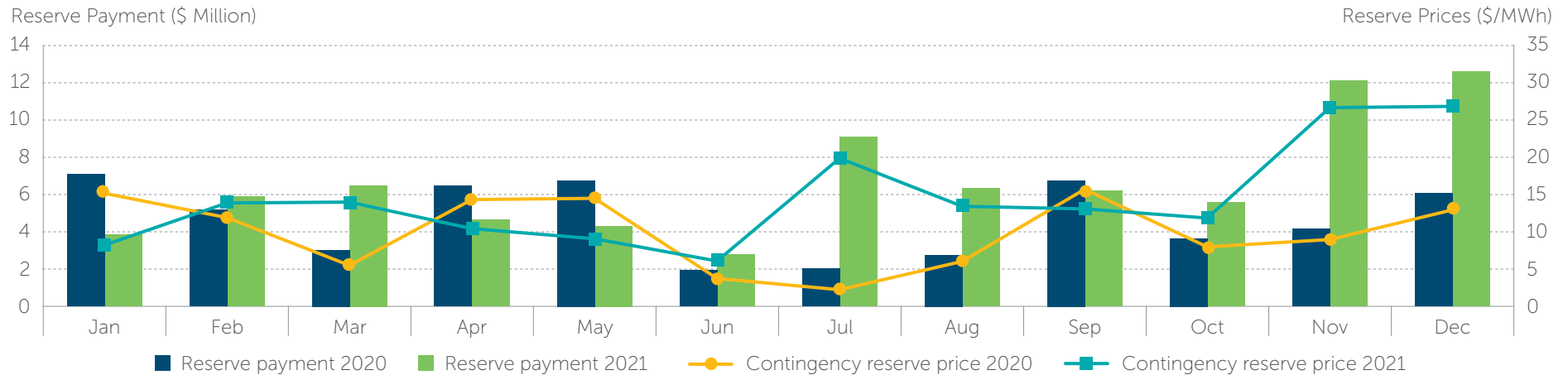


Chart 25 compares the reserve payment against the contingency reserve price between 2020 and 2021 on a monthly average basis.

The contingency reserve payment, which ranged from \$5/MWh to \$20/MWh, was the main contributor to the total reserve payment. The primary reserve price, which remained below \$2/MWh all the time, contributed minimally to the total reserve payment. Hence, changes in the monthly reserve payment are largely influenced by movements in the contingency reserve price.

There were eight months in 2021 for which the contingency reserve price was higher than that in 2020. Correspondingly, a higher total reserve payment was reported for all eight months. The reserve payment tripled in November 2021 compared to November 2020 and rose fourfold in July 2021 as compared to July 2020. The contingency reserve price increased from \$2.24/MWh to \$19.88/MWh in July and tripled from \$8.98/MWh to \$26.68/MWh in November. This was due to the high prices in the energy market observed in November.

The remaining four months of 2021 recorded a lower reserve payment due to a lower contingency reserve price compared to 2020. The largest YOY decrease of 45.46% in the reserve payment was from January 2020 to January 2021, coinciding with the largest drop of 45.83% in the contingency reserve price from \$15.18/MWh to \$8.22/MWh.

## ANCILLARY SERVICE INDICES: INTERRUPTIBLE LOAD

TABLE 14: IL ACTIVATIONS FOR CONTINGENCY RESERVE MARKET

Month	2020		2021	
	Instances of IL Activation	Number of Periods of IL Activation	Instances of IL Activation	Number of Periods of IL Activation
Jan	0	0	0	0
Feb	0	0	0	0
Mar	1	2	0	0
Apr	0	0	0	0
May	0	0	0	0
Jun	0	0	1	1
Jul	0	0	0	0
Aug	1	1	0	0
Sep	1	1	1	1
Oct	0	0	1	2
Nov	0	0	1	2
Dec	0	0	0	0
Sum	3	4	4	6

Note: Due to adjustment in calculation methodology, the number of periods of IL activation for 2020 and 2021, and the instances of IL activation for 2021 have been revised.

Table 14 compares the Interruptible Load (IL)<sup>12</sup> activations to provide contingency reserve between 2020 and 2021.

There were more IL activations in 2021 than in 2020 – four compared to 2020’s three activations.

The duration of the activations, measured by the number of periods of IL activations, increased even further to six in 2021. The IL activations lasted for the longest duration of two periods on 14 October and 7 November. These IL activations likely occurred to make up for the compromised supply in the system when high numbers of facilities were on outage.

Notably, a larger number of outages was experienced in October and November 2021 when the highest number of IL activations was observed during the year, as compared to June and September 2021.

<sup>12</sup> An IL provider offers its load or the load of its customers to be interrupted in exchange for reserve payments under the interruptible load scheme. An IL provider is required to hold a Wholesaler (Demand Side Participation) Licence issued by the Energy Market Authority.

## ANCILLARY SERVICE INDICES: INTERRUPTIBLE LOAD

CHART 26: PERCENTAGE CONTRIBUTION FROM IL FOR THE TWO CLASSES OF SCHEDULED RESERVE

IL Contribution to Total Scheduled Reserve (%)

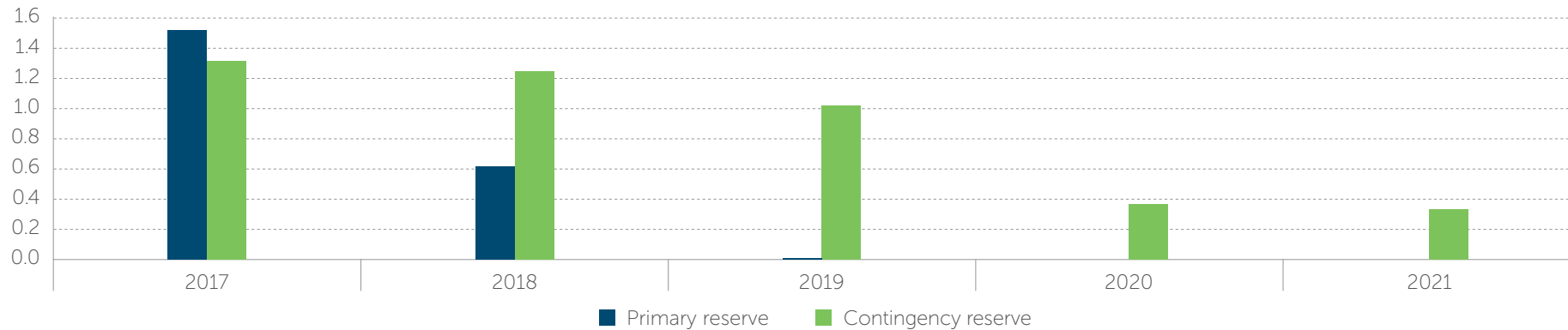


Chart 26 shows the contribution of IL to primary and contingency reserves in the past five years.

In 2017, the contribution of IL to primary reserve was 1.52%. It then contracted to 0.62% in 2018, 0.01% in 2019 and eventually 0% in 2020 and 2021. The decreased contribution since 2017 was due to a reduction in the number of IL facilities which were eligible to provide primary reserve, from two to one. That remaining IL facility did not submit offers into the market for most of 2019 and eventually de-registered from the NEMS on 5 October 2019. Hence, there was no IL facility providing primary reserve in 2020 and 2021.

In 2017, the percentage contribution of IL to the contingency reserve class was at its highest level among the five years at around 1.32%. Since then, IL had been providing a dwindling level of contingency reserve, moving from 1.25% in 2018, to 1.02% in 2019, then 0.37% in 2020 and down to 0.33% in 2021. The lower contribution of IL to contingency reserve in 2021 was because of the increased contribution of contingency reserve from generation facilities.



## ANCILLARY SERVICE INDICES: REGULATION PRICES

CHART 27: REGULATION AVAILABILITY VS REGULATION PRICE

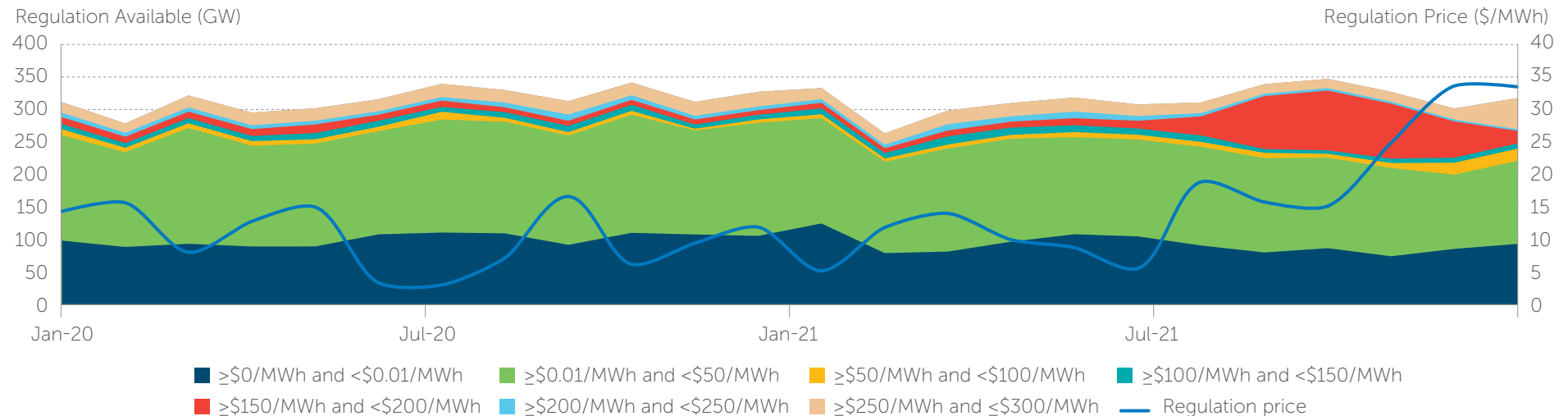


Chart 27 shows the aggregated regulation quantity offered at various price ranges and the regulation price throughout 2020 and 2021, expressed as monthly averages. The yearly average regulation price rose in 2021 despite the fluctuations. The regulation price ranged from \$3.01/MWh to \$16.62/MWh in 2020; this range shifted up to between \$5.19/MWh and \$33.60/MWh in 2021.

In 2021, the regulation availability shrank 0.33% and the regulation requirement decreased 6.91%. Notwithstanding the weaker supply and demand for regulation, the yearly average regulation price rose 60.98% to \$16.46/MWh in 2021 from \$10.22/MWh in 2020. This was attributed to the price volatility in the last quarter of the year.

The largest increase was observed in the “≥\$150/MWh and <\$200/MWh” tranches, where the proportion of offers was threefold higher than in 2020. The largest decrease was observed in the “≥\$0.01/MWh and <\$50/MWh” tranches, where the proportion of offers was 12.84% lower than in 2020.

On a month-on-month basis, the average regulation price typically moved in the opposite direction from regulation availability in 2021. In November 2021, when the regulation price peaked at \$33.60/MWh, the regulation availability for the month fell. In contrast, the monthly regulation availability improved in September 2021 when the regulation price was a lower \$15.12/MWh.

# ECONOMETRIC MODEL AND OUTLIER PRICES

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To identify and analyse outlier occurrences of the Uniform Singapore Energy Price (USEP), the Market Surveillance and Compliance Panel (MSCP) uses an econometric model<sup>13</sup> as a means of estimating the dependent variable USEP through the use of independent variables, including the Combined Cycle Gas Turbine (CCGT) supply, Steam Turbine (ST) supply, energy supply cushion, offers below \$100 per megawatt hour (MWh), energy demand, reserve cushion and lagged fuel oil prices. The model is also adjusted to distinguish planned and forced outages between generation types, and address seasonality.

In 2020, the MSCP engaged the Head of Economics of the School of Social Sciences at Nanyang Technological University (NTU), Associate Professor Feng Qu, and PhD candidate Zhou Shihao to improve the robustness of the econometric model and propose relevant variables and approaches for the identification of USEP outliers. The revised econometric model was approved by the MSCP and incorporated in the Market Surveillance and Compliance Panel Annual Report 2020.

Table 15 shows the estimation results for the three most explanatory variables detected by the revised econometric model for the periods January 2003 to December 2020 and January 2003 to December 2021, as well as the model diagnostics represented by  $R^2$ .

A positive coefficient indicates a direct relationship between the variable and the USEP; when the variable increases, the USEP rises as well. A negative coefficient indicates an inverse relationship between the variable and the USEP; when the variable increases, the USEP falls instead. The  $R^2$  value measures the proportion of

TABLE 15: ESTIMATION RESULTS

Variable	Coefficient	
	Jan 2003 – Dec 2020	Jan 2003 – Dec 2021
Constant	8.89	12.11
LOG (Supply Cushion)	-1.54	-1.69
LOG (Demand)	0.74	0.59
LOG (Offers Below \$100/MWh)	-0.56	-0.49
<b>Model Diagnostics</b>		
$R^2$	0.87	0.84
Number of Observations	6,329	6,694

the variation in the dependent variable (USEP) explained by the independent variables (e.g., supply cushion, demand and offers below \$100/MWh).

Given that all variables are log-transformed, Table 15 provides the following observations for Jan 2003 – Dec 2021:

- a 1% increase in supply cushion lowers the USEP by 1.69%;
- a 1% increase in demand raises the USEP by 0.59%; and
- a 1% increase in offers below \$100/MWh lowers the USEP by 0.49%.

After the inclusion of new data from 2021, the impact of supply cushion on the USEP strengthened as 2021 recorded more days with higher USEP accompanied by lower supply cushion, as shown in Chart 6. However, the impact of demand and offers below \$100/MWh on the USEP weakened, as those two

variables may have been overshadowed by the tight supply cushion or supply constraints given the tight supply cushion experienced in 2021.

The econometric model studied 6,694 observations, using data from January 2003 to December 2021, and yielded an  $R^2$  value of 0.84, which meant that 84% of the changes in the USEP could be explained by changes in the supply cushion, demand and offers below \$100/MWh. Despite the additional 365 observations, the  $R^2$  value fell 2.19 percentage points, which implies that the explanatory power of the econometric model weakened slightly after the inclusion of new data from 2021. This could be attributed to the more volatile USEP seen in 2021. Nevertheless, the P-value for the three coefficients in Table 15 is less than 0.01 (less than 1% chance of the variable not explaining a change in the USEP), indicating that the three selected variables play a significant role in explaining variations in the USEP. The inclusion of new data from 2021 and the adjustment in the coefficients of the variables, as shown in Table 15, are expected to improve the accuracy of the model for future estimations.

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

## IDENTIFICATION OF OUTLIER PRICES

CHART 28: ACTUAL VS PREDICTED LOG USEP WITHIN THREE STANDARD DEVIATIONS

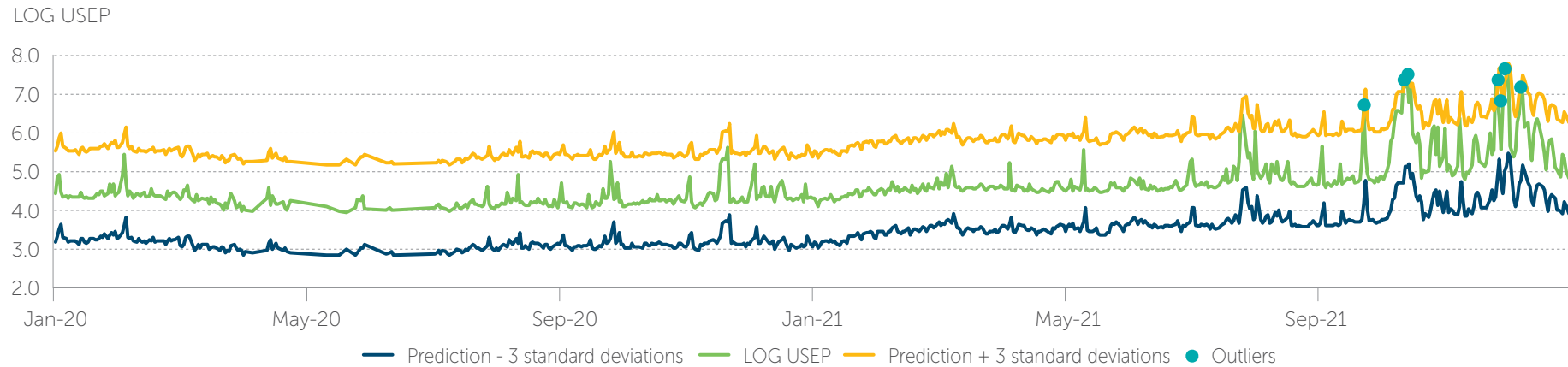


Chart 28 shows the actual daily average USEP, the upper and lower bands of the predicted daily average USEP, and the outliers identified by the revised econometric model from January 2020 to December 2021, expressed on a logarithmic scale.

No outlier price was detected by the model in 2020 and the first half of 2021, indicating that the USEP movements throughout 2020 and the first half of 2021 were largely predictable by the model through key variables such as supply cushion, demand and proportion of offers below \$100/MWh.

Seven outliers were detected in the second half of 2021, as shown in Table 16, and all of them were concentrated in the months of September, October, November, and December. Given that the supply cushion is one of the more impactful variables on the USEP, as shown in Table 15, the model may have detected the selected days as outliers because they

corresponded to some of the highest daily average USEPs since the market started, yet majority of them had relatively high supply cushions of above 15%. This is contradictory to the general understanding that the USEP and the supply cushion are inversely correlated.

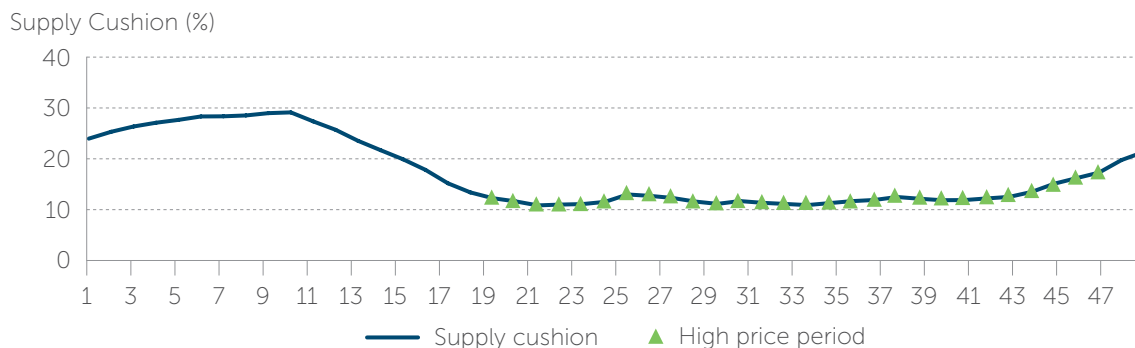
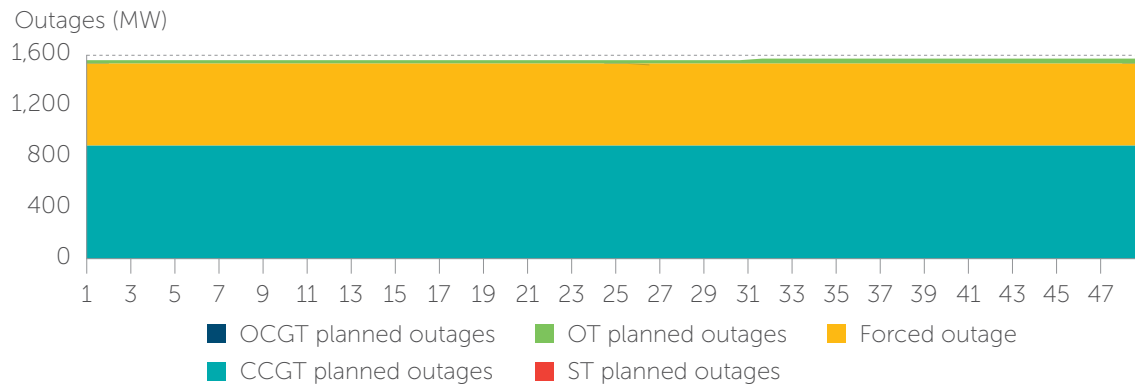
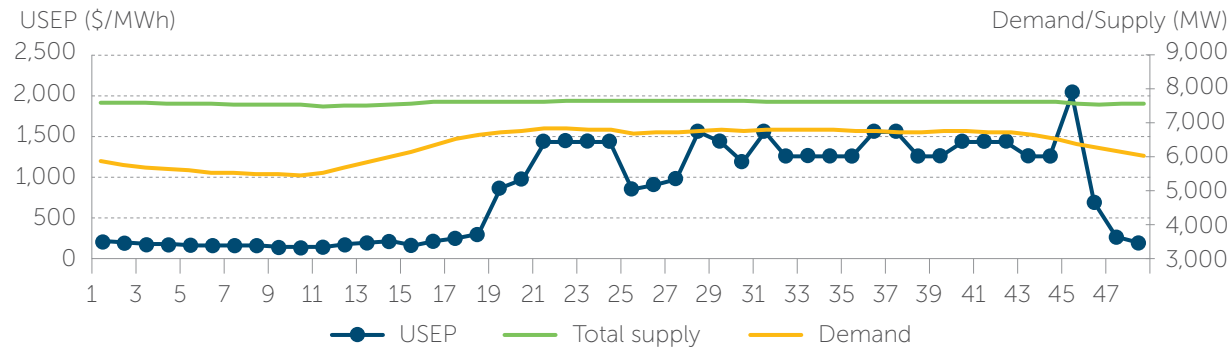
It was also observed that the record high daily average of the outliers largely coincided with the occurrences of gas curtailment from September to December 2021. The seven outliers are analysed in detail and explained in this report.

TABLE 16: OUTLIERS IDENTIFIED IN 2021

Outliers	Prediction – 3 Standard Deviations	LOG USEP	Prediction + 3 Standard Deviations
23 Sep	4.15	6.72	6.50
12 Oct	4.72	7.38	7.06
14 Oct	5.11	7.51	7.45
26 Nov	4.35	7.37	6.70
29 Nov	4.42	6.78	6.77
1 Dec	5.13	7.63	7.48
8 Dec	4.77	7.18	7.12

## IDENTIFICATION OF OUTLIER PRICES

CHART 29: DEMAND AND SUPPLY CONDITIONS – 23 SEPTEMBER 2021



Date	Thursday 23 Sep 2021	All Thursdays in Sep 2021
Daily USEP (\$/MWh)	829.55	269.71
Max USEP (\$/MWh)	2,036.02	2,036.02
No. of USEP ≥ \$1,000/MWh	22	22
Demand (MW)	6,410	6,342
Supply Cushion (%)	17.16	20.46
Offers ≤ \$100/MWh (%)	76.99	77.16

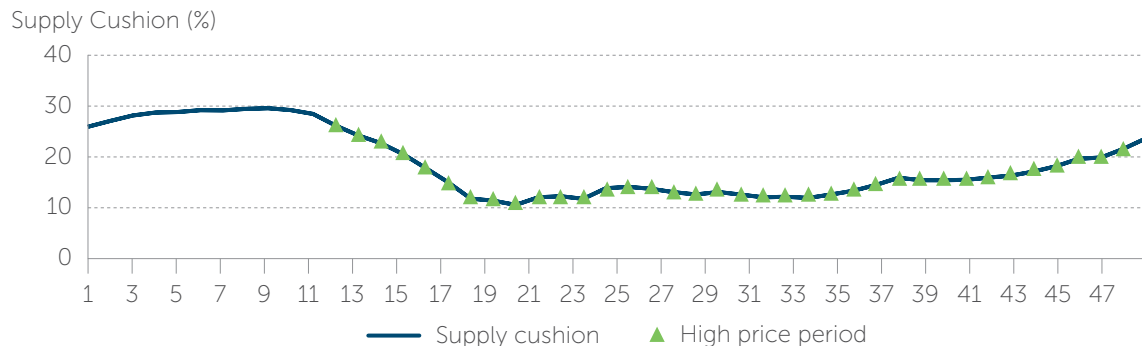
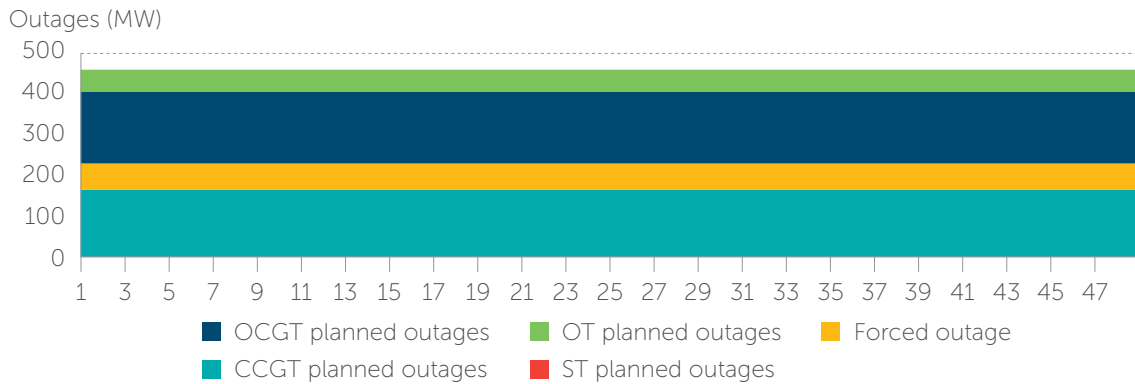
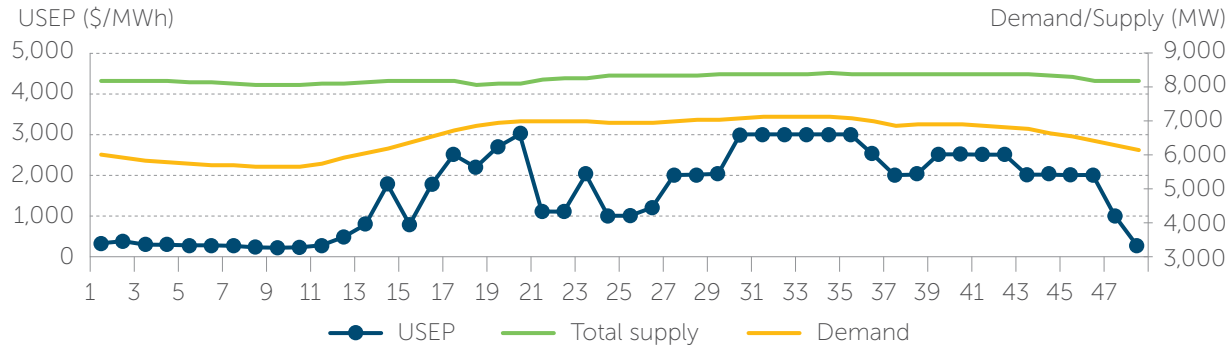
### Summary

On Thursday, 23 September 2021, the USEP rose above \$400/MWh for 28 periods, including 22 periods in which the price spiked above \$1,000/MWh. This was the 16<sup>th</sup>-highest daily average USEP since the market started.

The high prices were largely due to contracted total supply, as four CCGT units and two Other Facilities Turbine (OT) units were on planned and unplanned maintenance. In addition, there was an upstream gas curtailment of between 6% and 10%. The supply cushion averaged 12.72% during the periods of high USEP. DR activations were scheduled in Periods 21 to 25, 27, 31 and 34.

## IDENTIFICATION OF OUTLIER PRICES

CHART 30: DEMAND AND SUPPLY CONDITIONS – 12 OCTOBER 2021



Date	Tuesday 12 Oct 2021	All Tuesdays in Oct 2021
Daily USEP (\$/MWh)	1,597.26	656.67
Max USEP (\$/MWh)	3,008.25	3,008.25
No. of USEP ≥ \$1,000/MWh	33	43
Demand (MW)	6,640	6,463
Supply Cushion (%)	18.96	21.35
Offers ≤ \$100/MWh (%)	75.12	73.64

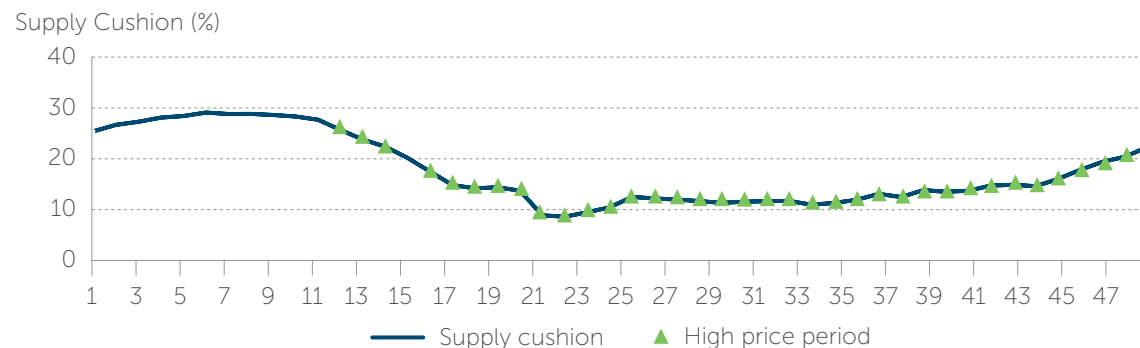
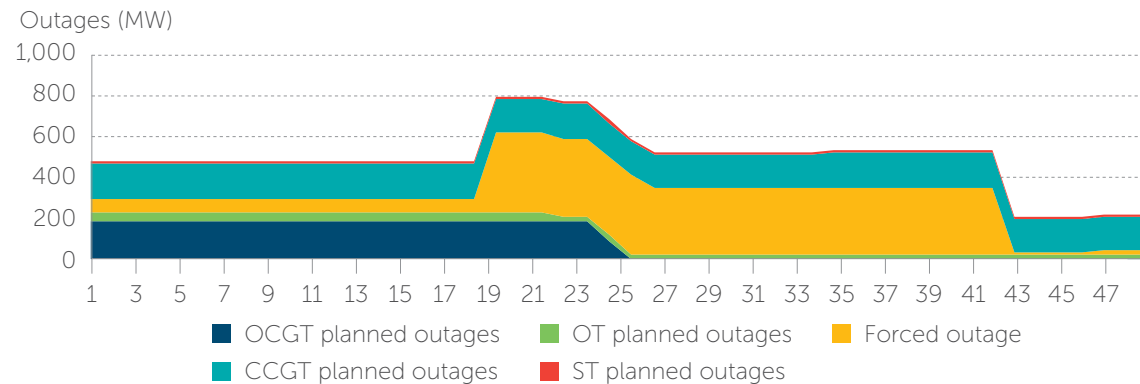
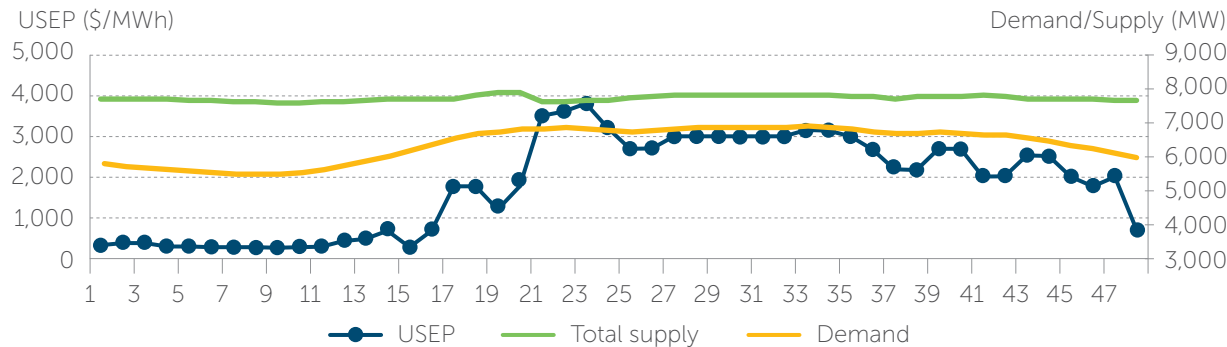
### Summary

On Tuesday, 12 October 2021, the USEP rose above \$400/MWh for 36 periods, of which 33 periods saw the price rising above \$1,000/MWh. This was the fourth-highest daily average USEP since the market started.

The high prices were largely due to high demand, which was 2.74% higher than the average for Tuesdays in October 2021. This was the second-highest daily average demand since the market started. An upstream gas curtailment of between 1% and 5% was observed as well. The supply cushion averaged 15.86% during the periods of high USEP. DR activations were scheduled in Periods 19 to 22, 28 to 32 and 37.

## IDENTIFICATION OF OUTLIER PRICES

CHART 31: DEMAND AND SUPPLY CONDITIONS – 14 OCTOBER 2021



Date	Thursday 14 Oct 2021	All Thursdays in Oct 2021
Daily USEP (\$/MWh)	1,821.60	632.40
Max USEP (\$/MWh)	3,811.16	3,811.16
No. of USEP ≥ \$1,000/MWh	31	34
Demand (MW)	6,654	6,442
Supply Cushion (%)	17.97	21.29
Offers ≤ \$100/MWh (%)	74.60	73.73

### Summary

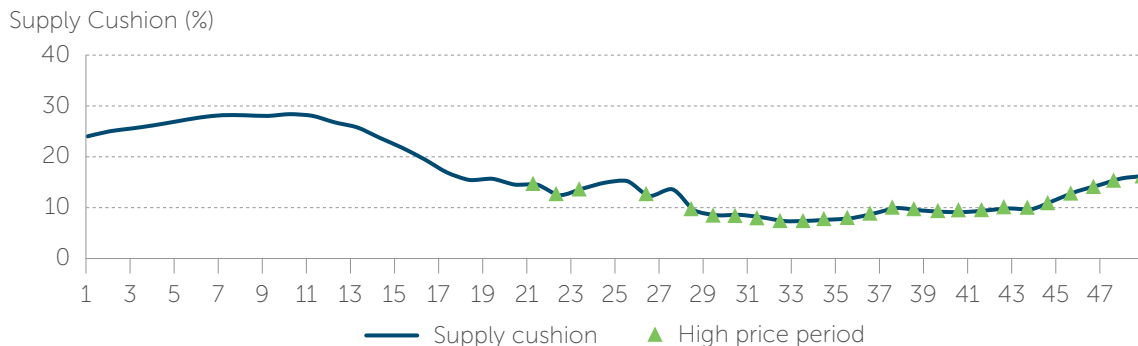
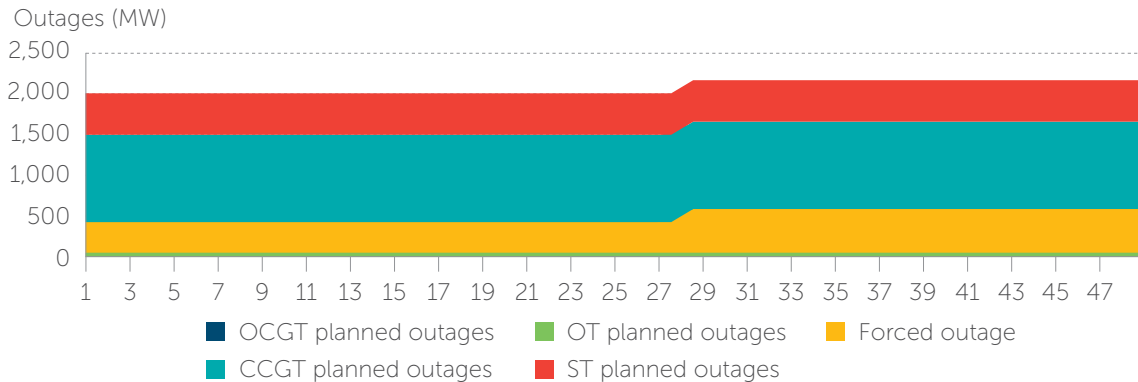
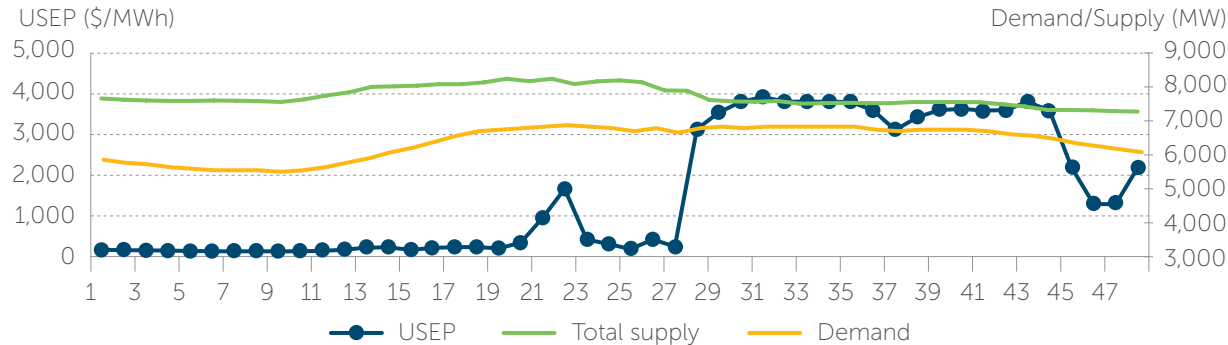
On Tuesday, 14 October 2021, the USEP rose above \$400/MWh for 36 periods, of which 31 periods saw the price rising above \$1,000/MWh. This was the third-highest daily average USEP since the market started.

The high prices were largely due to higher demand, which was 3.28% higher than the average demand on Tuesdays in October 2021. This was the highest daily average demand since the market started. The forced outage of a CCGT unit drove the USEP up from period 19 onwards, as shown in Chart 31. The supply cushion averaged 14.95% during the periods of high USEP.

The PSO advised that the power system was in a high-risk operating state in Period 21, and in an emergency operating state in Period 22. DR activations were scheduled in Periods 23 to 30, 32, 34, 35, 38 and 41.

## IDENTIFICATION OF OUTLIER PRICES

CHART 32: DEMAND AND SUPPLY CONDITIONS – 26 NOVEMBER 2021



Date	Friday 26 Nov 2021	All Fridays in Nov 2021
Daily USEP (\$/MWh)	1,586.44	512.17
Max USEP (\$/MWh)	3,921.79	3,921.79
No. of USEP ≥ \$1,000/MWh	22	22
Demand (MW)	6,402	6,371
Supply Cushion (%)	17.11	20.35
Offers ≤ \$100/MWh (%)	73.71	73.18

### Summary

On Friday, 26 November 2021, the USEP rose above \$400/MWh for 25 periods, of which 22 periods saw the price rising above \$1,000/MWh. This was the fifth-highest daily average USEP since the market started.

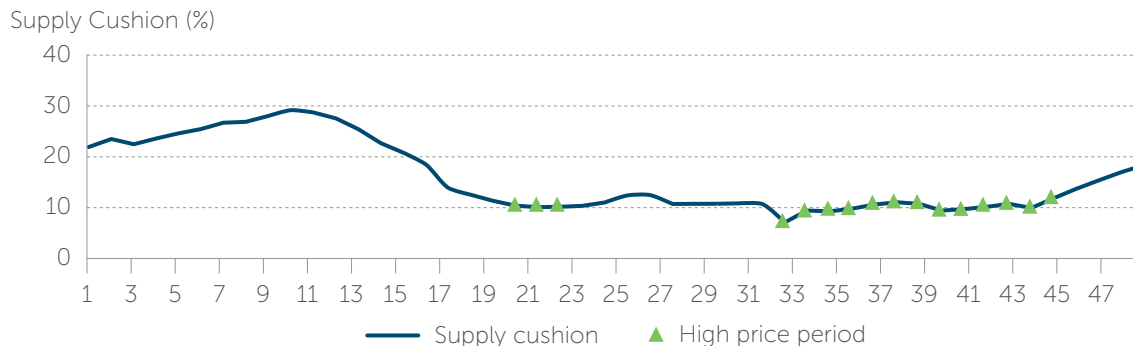
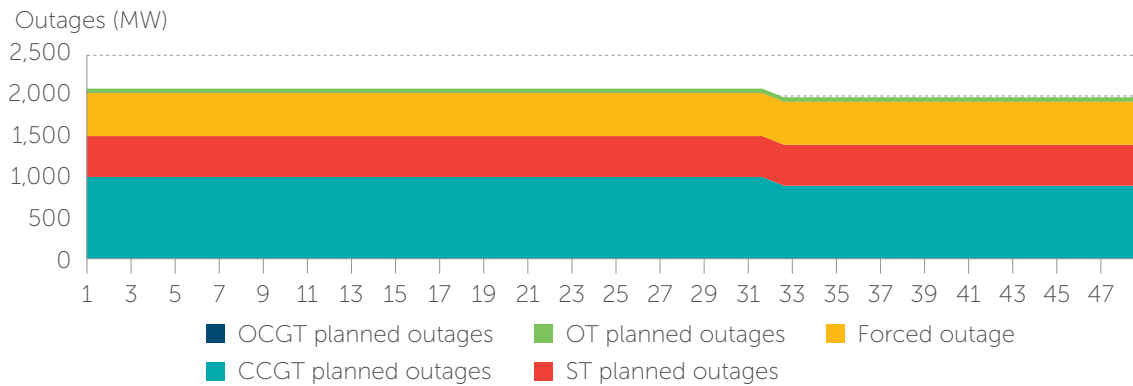
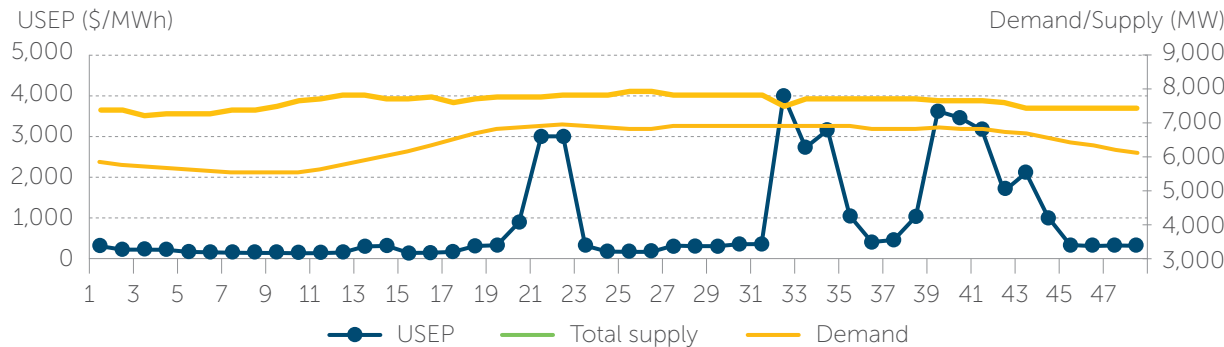
The high prices were largely due to lower supply, as eight CCGT units, two OT units and two ST units, which totalled 2,062 megawatts (MW), were on planned and unplanned maintenance. The high outage volume was largely due to maintenance of upstream gas network, which resulted in additional gas curtailment on top of the ongoing gas curtailment of 1% to 5%. The gas curtailment had indirectly resulted in the forced outage of a CCGT unit, which drove the USEP up from period 28 onwards, as shown in Chart 32.

Contingency reserve shortfall was recorded for a total of six periods (Periods 29, 30, 33 to 35 and 43), regulation shortfall was recorded in periods 43 and 44 and DR curtailment was scheduled for a total of 13 periods (Periods 21 to 24, 27 to 32, 35, 37 and 39). The PSO advised that the power system was in a high-risk operating state in Periods 29 and 43, and in an emergency operating state in Periods 30 to 35 and 44.



## IDENTIFICATION OF OUTLIER PRICES

CHART 33: DEMAND AND SUPPLY CONDITIONS – 29 NOVEMBER 2021



Date	Monday 29 Nov 2021	All Mondays in Nov 2021
Daily USEP (\$/MWh)	879.75	509.54
Max USEP (\$/MWh)	4,000.24	4,000.24
No. of USEP ≥ \$1,000/MWh	13	33
Demand (MW)	6,464	6,401
Supply Cushion (%)	16.34	18.96
Offers ≤ \$100/MWh (%)	72.84	74.32

### Summary

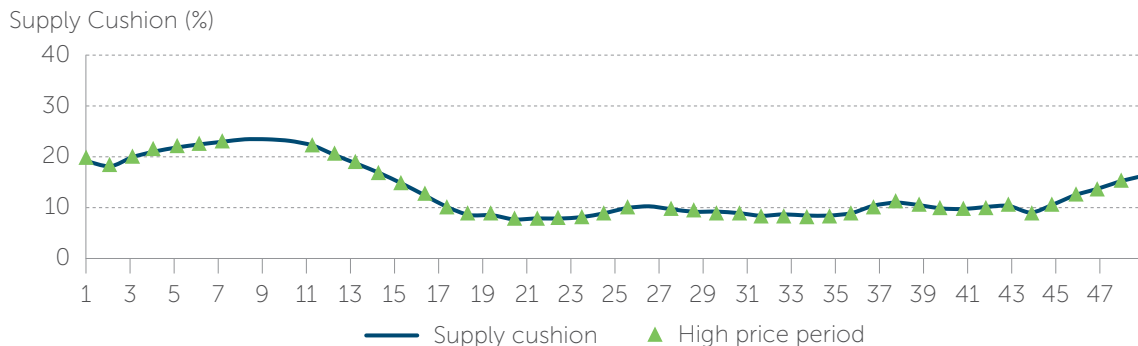
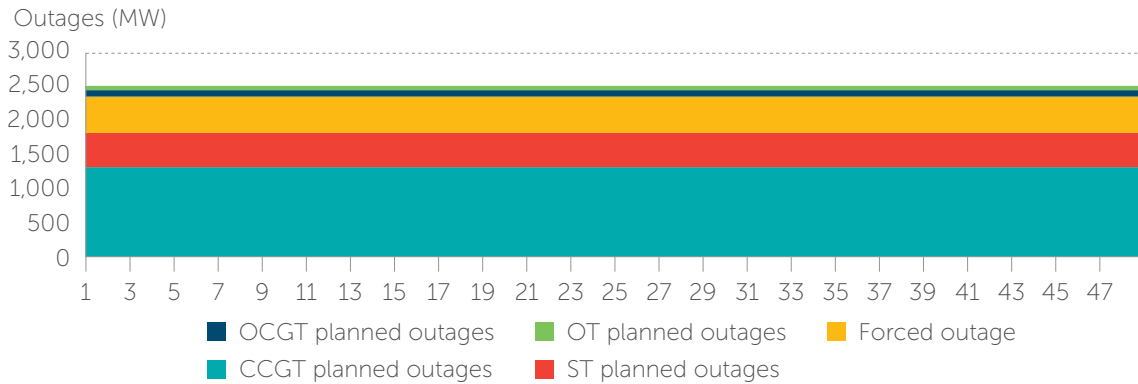
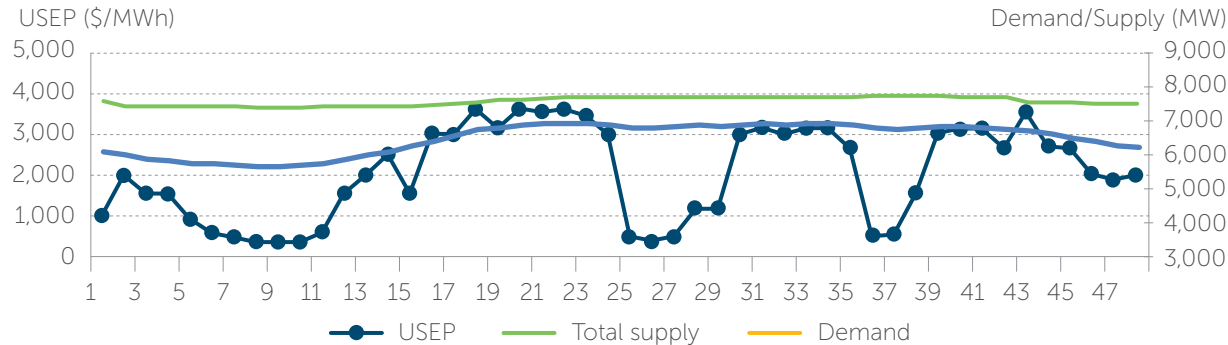
On Monday, 29 November 2021, the USEP rose above \$400/MWh for 16 periods, of which 13 periods saw the price rising above \$1,000/MWh. This was the 13<sup>th</sup>-highest daily average USEP since the market started.

The high prices were largely due to lower supply, as six CCGT units, two OT units and two ST units, which totalled 2,047MW, were on planned maintenance. The high outage volume was largely due to maintenance of upstream gas network, which resulted in additional gas curtailment on top of the ongoing gas curtailment of 1% to 5%. This could have resulted in offers shifting to higher price tranches as the proportion of offers below \$100/MWh on 29 November 2021 was lower than the average for Mondays in November 2021. This was because generation companies would need to activate more costly alternatives to make up for the supply shortage caused by the gas curtailment.

Contingency reserve shortfall was recorded in Period 32 and DR curtailment was scheduled for a total of five periods (Periods 31, 33, 38, 42 and 44). The PSO advised that the power system was in a high-risk operating state in Period 32.

## IDENTIFICATION OF OUTLIER PRICES

CHART 34: DEMAND AND SUPPLY CONDITIONS – 1 DECEMBER 2021



Date	Wednesday 1 Dec 2021	All Wednesdays in Dec 2021
Daily USEP (\$/MWh)	2,058.85	883.76
Max USEP (\$/MWh)	3,640.33	3,998.71
No. of USEP ≥ \$1,000/MWh	36	57
Demand (MW)	6,586	6,457
Supply Cushion (%)	14.18	16.53
Offers ≤ \$100/MWh (%)	77.76	76.35

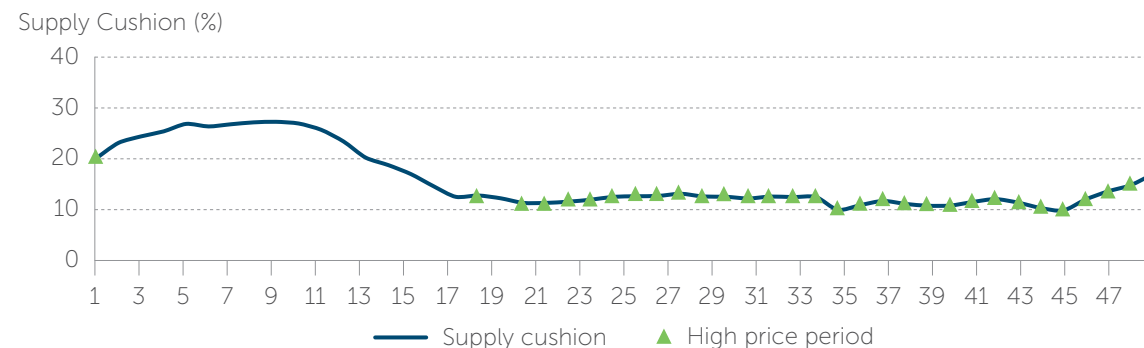
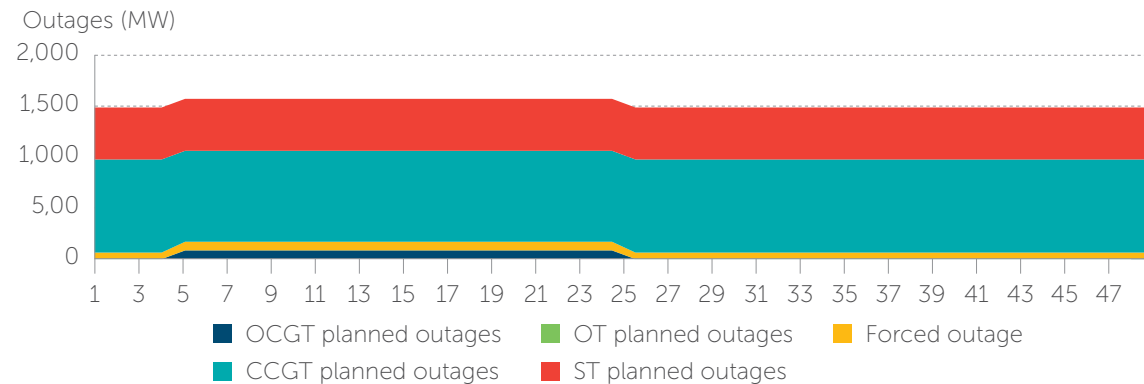
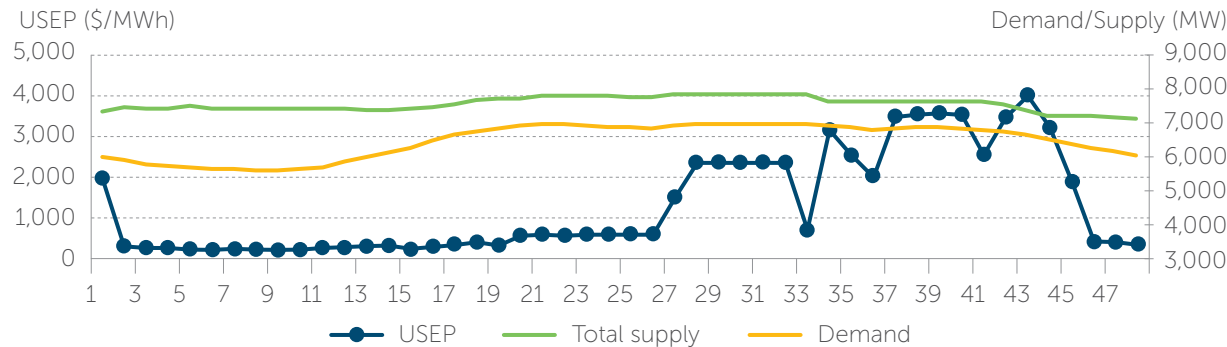
### Summary

On Wednesday, 1 December 2021, the USEP rose above \$400/MWh for 44 periods, of which 36 periods saw the price rising above \$1,000/MWh. This was the highest daily average USEP since the market started, the second-highest daily average USEP was recorded on 2 December 2021.

The high prices were largely due to higher demand and lower supply, as five CCGT units, two OT units, two ST units and one Open Cycle Gas Turbine (OCGT) unit, which totalled 2,503MW, were on planned maintenance. Similarly, the high outage volume was largely due to maintenance of upstream gas network, which resulted in additional gas curtailment on top of the ongoing gas curtailment of 1% to 5%. In addition, the average daily demand was 6,586MW, which was 2% higher than the average daily demand on Wednesdays in December 2021. This was the fifth-highest daily average daily demand since the market started. DR activations were scheduled from Periods 17 to 30 and 32 to 38.

## IDENTIFICATION OF OUTLIER PRICES

CHART 35: DEMAND AND SUPPLY CONDITIONS – 8 DECEMBER 2021



Date	Wednesday 8 Dec 2021	All Wednesdays in Dec 2021
Daily USEP (\$/MWh)	1,314.10	883.76
Max USEP (\$/MWh)	3,998.71	3,998.71
No. of USEP ≥ \$1,000/MWh	19	57
Demand (MW)	6,456	6,457
Supply Cushion (%)	15.86	16.56
Offers ≤ \$100/MWh (%)	75.91	76.35

### Summary

On Wednesday, 8 December 2021, the USEP rose above \$400/MWh for 30 periods, of which 19 periods saw the price rising above \$1,000/MWh. This was the seventh-highest daily average USEP since the market started.

The high prices were largely due to higher demand and lower supply, as four CCGT units, two ST units, one OT unit and one OCGT unit, which totalled 1,508MW, were on planned maintenance. There was an ongoing gas curtailment of 1% to 5%. The fall in supply was largely due to low upstream gas pressure, which resulted in additional gas curtailment on top of the ongoing gas curtailment of 1% to 5%. This could have resulted in offers shifting to higher price tranches as the proportion of offers below \$100/MWh on 8 December 2021 was lower than the average for Mondays in November 2021. This was because generation companies would need to activate more costly alternatives to make up for the fall in supply caused by the gas curtailment.

A person in a dark suit is holding a magnifying glass over a clipboard. The clipboard contains several documents with charts and graphs. The magnifying glass is positioned over one of the documents, which shows a bar chart and a line graph. The person's hand is visible, holding a pen. The background is blurred, showing other people in a meeting or office setting. The word "INVESTIGATIONS" is overlaid in white, bold, uppercase letters on the right side of the image. Below the text is a horizontal line with a small dot in the center. There are also decorative blue dots scattered across the image.

# INVESTIGATIONS

## SUMMARY OF INVESTIGATION ACTIVITIES

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

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

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

Table 17 reflects the position regarding investigation and enforcement activities from the start of the market on 1 January 2003 to 31 December 2021, 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 2021

- The MSCP made rule breach determinations on 33 cases of offer variations after gate closure. The remaining 275 cases of offer variations after gate closure were assessed by the MSCP to be not in breach. The MSCP also determined to take no further action on six cases of offer variations after gate closure.
- With regard to other cases, the MSCP completed three investigations. The remaining six cases were attributed to referrals from EMC related to events of default.
- In 2021, the MSCP issued 17 rule breach determinations. A total of \$76,500 in financial penalties<sup>14</sup> was imposed across ten rule breach determinations, with \$15,000 being the highest financial penalty imposed on a party in breach. A non-compliance letter from the MSCP was issued for the remaining seven cases.
- The total costs imposed on the parties in breach was \$37,500.
- The MSCP issued three suspension orders in 2021. Of the three suspended MPs, two were subsequently terminated from participation in the National Electricity Market of Singapore. The MSCP also issued one other order in the year.
- One case was referred to the MSCP in relation to market efficiency and fairness. The case was subsequently submitted by the MSCP to the Energy Market Authority in accordance with the Market Rules.

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

TABLE 17: INVESTIGATION AND ENFORCEMENT STATISTICS

Rule Breaches	1 Jan 2003 to 31 Dec 2021	1 Jan to 31 Dec 2021
<b>(A) Total number of offer variations after gate closure received</b>	<b>38,223</b>	<b>799</b>
<b>Total number of cases closed</b>	<b>37,686</b>	<b>314</b>
• cases in which the MSCP determined a breach	199	33
• cases in which the MSCP determined no breach	17,797	275
• cases in which the MSCP took no further action	19,690	6
<b>(B) Origin of cases (excluding offer variations after gate closure)</b>	<b>211</b>	<b>9</b>
• self-reports	174	3
• referrals or complaints	30	6
• initiated by the MSCP	7	0
<b>Total number of cases closed</b>	<b>210</b>	<b>9</b>
• cases in which the MSCP determined a breach	140	3
• cases in which the MSCP determined no breach	14	0
• cases in which the MSCP took no further action	45	1
• cases in which the MSCP made a determination on an event of default	11	5
• suspension orders	6	3
• other orders	2	1
• termination orders	2	2
<b>(C) Total number of MSCP hearings</b>	<b>17</b>	<b>5</b>
• suspension hearings	10	4
• termination hearings	1	1
• investigation hearings	6	0
<b>(D) Enforcement action</b>		
• highest financial penalty imposed on a party in breach	\$842,861	\$15,000
• total financial penalties imposed on parties in breach	\$1,335,861	\$76,500
<b>(E) Costs</b>		
• highest award of costs imposed on a party in breach	\$43,750	\$3,500
• total costs imposed on parties in breach	\$328,525	\$37,500
<b>Market Efficiency and Fairness</b>	<b>1 Jan 2003 to 31 Dec 2021</b>	<b>1 Jan to 31 Dec 2021</b>
<b>Total number of cases</b>	<b>8</b>	<b>1</b>
• referrals or complaints	3	1
• initiated by the MSCP	5	0
<b>Total number of cases closed</b>	<b>8</b>	<b>1</b>

# SECTIONS 50 & 51 OF THE ELECTRICITY ACT

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## 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.

On 30 September 2021, the Market Surveillance and Compliance Panel (MSCP) received one case relating to the alleged breach of sections 50 and 51 of the Electricity Act associated with the high price events occurring from 26 to 29 July and on 3 August 2021. On 5 October 2021, the MSCP referred the case to the EMA in accordance with sections 4.4.3 and 4.4.4 of Chapter 3 of the Market Rules. Background information was also provided by the MSCP to support the EMA in undertaking this investigation by way of the MSCP's report on its observations on the Uniform Singapore Energy Price (USEP) spikes during those periods.

## Information Requirements to Assist the EMA

The Singapore Electricity Market Rules<sup>15</sup> (Market Rules) provide for the Market Assessment Unit (MAU), under the supervision and direction of the 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, and 22 August 2016, with the latest modification made and published on 12 August 2020.

<sup>15</sup> Section 4.3.10 of Chapter 3 of the Singapore Electricity Market Rules.

# SECTIONS 50 AND 51 OF THE ELECTRICITY ACT

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

**TABLE 18: 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
2	Maximum combined generation capacity and reserve capacity of each registered facility	Once and upon change	Electronic mail
3	Maximum ramp-up and/or ramp-down rate of each registered facility	Once and upon change	Electronic mail
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

\* SFTP is a direct link established between EMC and EMA's databases to allow information to be transmitted directly from EMC to 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 any abnormal trends identified in the Uniform Singapore Energy Price (USEP), including a comprehensive analysis of the market drivers and other factors that may have contributed to the movements.

In the course of monitoring and investigative activities carried out from January to December 2021, the MSCP and MAU submitted four reports to the EMA regarding the MSCP's observations on the USEP spikes from: (i) 25 to 30 July and 2 August 2021; (ii) 22 to 24 September 2021; (iii) 6 to 12 October 2021; and (iv) 13 to 31 October 2021. The MSCP did not determine any breach of the Market Rules leading to the price spikes.



# ASSESSMENT OF THE WHOLESALE ELECTRICITY MARKET

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## STATE OF COMPETITION AND EFFICIENCY OF THE WHOLESALE ELECTRICITY MARKET

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 2021 is as follows:

### Market Structure and Competition

#### Entry of New Market Participants

Four new market participants (MPs) were registered in the National Electricity Market of Singapore (NEMS) in 2021:

TABLE 19: NEW MARKET PARTICIPANTS REGISTERED IN 2021

Date	Market Participant	Market Participant Class
6 Apr	Sunseap Energy Ventures	Wholesale market trader
20 Apr	Sunseap VPower	Wholesale market trader
13 May	Sembcorp Floating Solar Singapore	Generation licensee
25 Aug	Terrenus Energy SL2	Wholesale market trader

#### New Facilities in the Market

In 2021, 11 new facilities<sup>16</sup> joined the market. Of the 11 facilities, five were intermittent generation sources (IGS) with a total registered capacity of 73.58 megawatts (MW).

One battery facility from Sunseap Energy Ventures was registered on 29 July 2021. This was NEMS' first battery facility with a maximum generation capacity of 4.9MW<sup>17</sup>.

Two Other Turbine (OT) facilities belonging to TuasOne were registered in the NEMS on 21 December 2021. Each of the OT facilities registered a maximum generation capacity of 68.1MW.

Additionally, one facility from the Public Utilities Board joined the market with a generation capacity of 3.904MW.

There were also two interruptible load (IL) facilities from Keppel Electric, registered on 19 October 2021, bringing the total number of IL facilities in the market to five. The IL facilities from Keppel Electric each registered a maximum contingency reserve capacity of 1MW.

#### Withdrawal of Market Participants

In 2021, two MPs withdrew their participation in the NEMS.

- Sun Electric Power on 1 January 2021; and
- ISwitch on 22 December 2021.

The MSCP also issued two termination orders to Sun Electric Energy Assets and SilverCloud Energy on 17 March 2021 and 21 December 2021 respectively.

#### De-Registration of Facilities in the Market

In view of the suspension order issued by the MSCP to Sun Electric Energy Assets on 5 February 2021 and the subsequent termination order issued on 17 March 2021, 12 IGS units belonging to Sun Electric Energy Assets were deregistered from the market. On 30 July 2021, Sunseap Leasing also deregistered one 0.428MW IGS unit.

### Market Price Behaviour

#### USEP surged in 2021

The Uniform Singapore Energy Price (USEP) rose in 2021 after two consecutive annual declines. The USEP increased 180.45% to an annual average of \$196.33 per megawatt hour (MWh) in 2021 from \$70.01/MWh in 2020, while the Wholesale Electricity Price rose 178.47% to an annual average of \$195.62/MWh in 2021, from \$70.25/MWh in 2020.

After falling 2.54% in 2020 due to the impact of the Covid-19 pandemic, forecasted electricity demand rose 5.36% in 2021, primarily driven by the global economic recovery. The Singapore economy continued its reopening efforts to gradually relax the safe management measures established due to the Covid-19 pandemic. As a result, the stronger electricity demand in 2021 contributed to higher electricity prices.

The higher energy prices also coincided with higher fuel oil prices. On a year-on-year basis, fuel oil prices rose to an annual average of US\$406.81/MT in 2021, from US\$249.13/MT in 2020.

### 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.

2021 recorded a 1.14 percentage points drop in market share based on maximum capacity for the top three market players to 60.20%, from 61.34% in 2020. In terms of metered energy quantity, the market share held by the three largest players in the NEMS also slipped 2.49 percentage points to 50.55% in 2021, from 53.04% in 2020.

<sup>16</sup> Excluding non-exporting intermittent generation facility (NEIGF). There were two NEIGF units from the Public Utilities Board which registered in the market in 2021. Please refer to: <https://www.emcsg.com/aboutthemarket/generationfacilityregistration>.

<sup>17</sup> The actual generation capacity is 2.4MW, with a modelled capacity of 4.9MW.

## STATE OF COMPETITION AND EFFICIENCY OF THE WHOLESALE ELECTRICITY MARKET

### Productive Efficiency

The year saw mixed movements in productive efficiency. We observed an increase in the market share of the most efficient generation technology, the Combined Cycle Gas Turbine (CCGT) units, in terms of maximum capacity, but a decrease in the market share of CCGT units in terms of energy quantity generated.

The market share of CCGT units based on metered energy quantity dropped 0.23 percentage point to 98.10% in 2021, from 98.33% in 2020. The decrease in market share of CCGT units was picked up by the other generation types, namely Other Turbine (OT) units, Gas Turbine (GT) units and Steam Turbine (ST) units, which rose 0.14, 0.07 and 0.03 percentage point respectively in 2021. Notably, the market share of GT units rose from 0% to 0.07% in 2021, consistent with our observation that more GT units were run up more frequently in light of the USEP spikes.

In terms of maximum capacity, the market share of CCGT units and OT units grew 1.73 percentage points and 0.42 percentage point respectively in 2021. The market share of ST units shrank 2.18 percentage points to 6.52% in 2021 from 8.69% in 2020, due to the deregistration of one 600 MW generation capacity ST unit from Tuas Power Generation on 17 June 2020. The market share of OCGT units remained fairly consistent at 1.54%.

### Pricing Efficiency

Prices in the NEMS generally reflected the supply and demand conditions in 2021. From October to December 2021, there was greater price volatility in the NEMS, which saw the USEP and the Wholesale Electricity Price (WEP) surging to an average of \$437.03/MWh and \$434.64/MWh respectively in those three months. The elevated electricity prices corresponded to a period of instability in the overall supply system, exacerbated by the upstream gas network issues, as well as a global fuel shortage.

### Looking Ahead

#### Market Rule Changes to Enable Electricity Imports Trial

On 2 December 2021, the Energy Market Authority (EMA) issued an Information Paper to announce updates to the Market Rules to accommodate electricity imports trials and multiple importers using the interconnector.

The EMA has appointed one competent entity (Importer) to trial the import and sale of up to 100MW of electricity in Singapore via the existing interconnector between Singapore and Peninsular Malaysia. The Importer will be licensed by the EMA. The EMA also intends to facilitate up to another 100MW of cross-border power trade under the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project, which could start in 2022. In addition, the EMA is embarking on a pilot to import 100MW equivalent of nonintermittent electricity from a solar farm in Pulau Bulan, Indonesia, via a new interconnector to Singapore. The pilot is expected to be commissioned by around 2024.

The additions to the existing Market Rules include matters relating to registration, schedule and dispatch and settlement and took effect from 26 January 2022. The Market Assessment Unit (MAU)/MSCP had coordinated with EMC to develop the necessary information required to fulfil its monitoring obligations under the newly effected Market Rules.

## STATE OF COMPLIANCE WITHIN THE WHOLESALE ELECTRICITY MARKET

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

The assessment as to the state of compliance within the wholesale electricity market is set out below.

### Offer Variations After Gate Closure

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

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

Chart 36 compares the number of offer variations after gate closure submitted by MPs in 2021 with those of previous years.

Following a record low number of offer variations after gate closure cases seen in 2020, this number rose 161.11% in 2021 to 799 cases. The surge in offer variations after gate closure cases was observed in the latter months of 2021, which coincided with the occurrences of unplanned piped natural gas curtailment and the volatile electricity spot price situation.

The MSCP has completed and issued determinations on 262 of the 799 offer variations made after gate closure cases in 2021. Of the 262 cases, 231 cases were assessed to not have been in breach of the Market Rules. The MSCP decided to take no further action on six cases and issued rule breach determinations on 25 cases. The remaining 537 cases are scheduled to be discussed for the MSCP's determination in 2022.

CHART 36: OFFER VARIATIONS MADE AFTER GATE CLOSURE

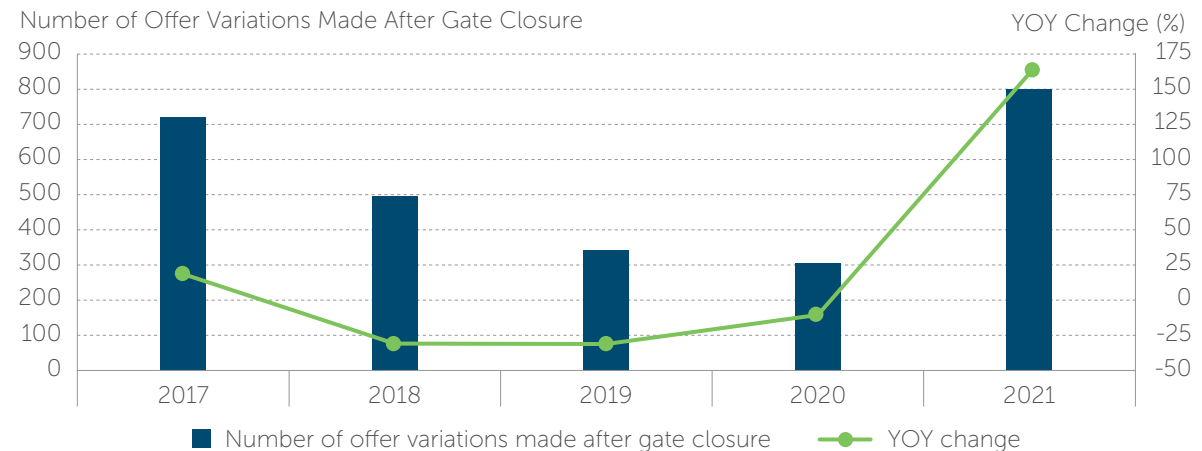


TABLE 20: OFFER VARIATIONS MADE AFTER GATE CLOSURE

Year	Number of Offer Variations Made After Gate Closure	YOY Change (%)
2017	719	18.65
2018	497	-30.88
2019	342	-31.19
2020	306	-10.53
2021	799	161.11

## STATE OF COMPLIANCE WITHIN THE WHOLESALE ELECTRICITY MARKET

### Rule Breach Determinations Issued

For the period 1 January to 31 December 2021, the MSCP issued 17 determinations regarding rule breaches, three suspension orders and two termination orders.

The determinations issued by the MSCP are a 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

14 MSCP rule breach determinations were issued in 2021 across ten market participants in relation to 33 offer variations after gate closure events:

- [Tuas Power Generation's](#) offer variations after gate closure on 30 September 2020;
- [ExxonMobil Asia Pacific's](#) offer variations after gate closure on 2 October 2020;
- [National Environment Agency's](#) offer variations after gate closure on 13 December 2020;
- [Keppel Seghers Tuas Waste-to-Energy Plant \(in its capacity as Trustee of Tuas DBOO Trust\)'s](#) offer variations after gate closure on 15 January 2021;
- [Senoko Energy's](#) offer variations after gate closure on 19 January 2021;
- [Tuaspring's](#) offer variations after gate closure on 6 April 2021;
- [YTL PowerSeraya's](#) offer variations after gate closure on 20 April 2021;
- [Tuas Power Generation's](#) offer variations after gate closure on 27 April 2021;
- [Shell Eastern Petroleum's](#) offer variations after gate closure on 4 May 2021;

- [Sembcorp Cogen's](#) offer variations after gate closure on 19 May 2021;
- [Tuas Power Generation's](#) offer variations after gate closure on 21 May 2021;
- [Sembcorp Cogen's](#) offer variations after gate closure on 2 June 2021;
- [YTL PowerSeraya's](#) offer variations after gate closure on 15 June 2021; and
- [Singapore Refining Company's](#) offer variations after gate closure on 19 August 2021.

#### Failure to Comply with the Market Operation Responsibilities under the Market Rules

EMC was served a rule breach determination from the MSCP in 2021.

- [Energy Market Company's](#) failure to release short-term schedule on 16 November 2020.

#### Other Rule Breaches

There were two rule breach determinations issued to MSD International GmbH (Singapore Branch) and Enel X Singapore in 2021.

- [MSD International GmbH \(Singapore Branch\)'s](#) late payment of annual market participant fees 2021; and
- [Enel X Singapore's](#) failure to maintain its reserve scheduled on 20 April 2021.

#### Determinations Relating to Events of Defaults

In 2021, the MSCP issued three suspension orders to Sun Electric Energy Assets, SilverCloud Energy and UGS Energy. Sun Electric Energy Assets and SilverCloud Energy were subsequently terminated from participation in the market.

#### Suspension order

- Suspension order against [Sun Electric Energy Assets](#) on 5 February 2021;
- Suspension order against [SilverCloud Energy](#) on 20 October 2021; and
- Suspension order against [UGS Energy](#) on 22 October 2021.

#### Termination order

- Termination order against [Sun Electric Energy Assets](#) on 17 March 2021; and
- Termination order against [SilverCloud Energy](#) on 21 December 2021.

The number of rule breach determinations issued in 2021 rose to 14 from nine in 2020. There were also three suspension orders and two termination orders issued in 2021, as compared to none in 2020.

The majority of the rule breach determinations issued in 2021 related to failure to comply with gate closure rules. Since 26 August 2019, the Market Rules in relation to gate closure exemptions have been amended to allow generation registered facilities to submit offer variations after gate closure to reflect its revised capability only for the three consecutive dispatch periods immediately following a forced outage or its failure to synchronise. The stricter requirement in the new Market Rules allowing for revised offers only for the next three dispatch periods is likely to have resulted in more breaches of those Market Rules in 2021.

## STATE OF COMPLIANCE WITHIN THE WHOLESALE ELECTRICITY MARKET

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

The MSCP receives information from EMC when a notice of default<sup>18</sup> 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 when a market participant has been unable to remit to the EMC settlement clearing account by the end of the business day following its payment due date.

Under the circumstances<sup>19</sup> when a default notice has been issued, the MAU and the MSCP remain vigilant for further information and confirmation by EMC about the default event's remedy. If a default is not remedied, EMC takes the steps required by the Market Rules, which include issuing a request for suspension hearing to the MSCP. 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 financial risk exposure and ultimately to safeguard the financial integrity of the NEMS.

In 2021, EMC issued a total of 19 default notices to market participants, in comparison to 78 notices of default issued in 2020. During 2021, three suspension orders were issued to three market participants, two of which were subsequently terminated from participation in the market. 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 market.

**Automatic Financial Penalty Scheme**

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

In 2021, 11 generation companies were issued automatic financial penalties amounting to a total sum of \$442,302.65. The market also saw a total of \$115,884.12 imposed on two load registered facilities under the AFPS.

There was a 93.55% year-on-year increase in the amount of financial penalties imposed under the AFPS from \$288,401.00 in 2020 to \$558,186.77 in 2021. This was due to the high periodic USEPs recorded in the latter part of 2021, which raised the financial penalty quantum in accordance with the calculation of the AFPS under the formula.

TABLE 21: 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

18 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.

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

# CONCLUSION



A line chart is displayed on the laptop screen, showing data trends for seven regions across four quarters. The regions are America, Japan, China, Africa, Newzealand, Australia, and France. The Y-axis ranges from 0 to 100. The X-axis shows Quarter 1, Quarter 2, Quarter 3, and Quarter 4.

Region	Quarter 1	Quarter 2	Quarter 3	Quarter 4
America	50	60	78	69
Japan	45	65	50	58
China	81	55	58	72
Africa	62	57	68	74
Newzealand	70	60	80	74
Australia	50	41	47	28
France	25	26	92	28

A table is displayed on the laptop screen, showing data for seven regions across four quarters. The regions are America, Japan, China, Africa, Newzealand, Australia, and France. The Y-axis ranges from 0 to 100. The X-axis shows Quarter 1, Quarter 2, Quarter 3, and Quarter 4.

Region	Quarter 1	Quarter 2	Quarter 3	Quarter 4
America	50	60	78	69
Japan	45	65	50	58
China	81	55	58	72
Africa	62	57	68	74
Newzealand	70	60	80	74
Australia	50	41	47	28
France	25	26	92	28

The Market Surveillance and Compliance Panel (MSCP) is generally satisfied with the state of compliance in the National Electricity Market of Singapore (NEMS) in 2021. The MSCP issued 17 rule breach determinations over the year. The number of offer changes made after gate closure increased to 799 in 2021 from 306 in 2020, and 262 determinations were issued by the MSCP. The sharp increase in the total number of gate closure cases recorded in 2021 was observed amid high volatility in the wholesale price, in particular during the second half of the year.

Rule breaches and gate closure violations were found not to have had a significant impact on the NEMS as the Market Assessment Unit (MAU) worked in coordination with the Power System Operator to analyse relevant information about breaches to the Market Rules potentially leading to any effect on the system security and reliability of supply, as well as leading to any price distortion that could have had an impact on the market conditions or the financial integrity of the market.

2021 was a year of surge in electricity demand as the Singapore economy began to recover following the easing of the Covid-19 restrictions combined with high oil prices and gas production outages around the world. The shocks were observed in particular in the natural gas market, with a direct impact on the countries that source their electricity generation from this fuel. Singapore was no exception, due to its reliance on imported natural gas for most of its electricity production, experiencing shortages in gas supply.

From the second half of 2021, issues at the upstream gas production facility in Indonesia<sup>20</sup>, as well as gas pressure issues in the supply from South Sumatra, resulted in Singapore's Wholesale Electricity Price recording its third-highest level observed since the NEMS started. These market conditions led to five electricity retailers defaulting on their payments and exiting the market. 19 notices of default were referred to the MSCP. The MSCP issued three market suspension orders and two termination orders, including additional orders necessary to safeguard the financial integrity of the market in accordance with the Singapore Electricity Market Rules (Market Rules).

The MSCP considers it relevant to highlight that, along with the MAU, prompt enforcement actions were taken, following the provisions established under the Market Rules, to make sure that our reinforcement efforts served to deter recurrence, ensure that market participants are compliant with the Market Rules, and safeguard the financial integrity of the wholesale electricity market in Singapore.

Regarding productive efficiency, the market share of the Combined Cycle Gas Turbine units, the most efficient generation technology in Singapore in terms of both energy quantity generated and maximum capacity, remained the most dominant in 2021. However, the generation became less concentrated as the combined market share of the three largest generation companies has gradually reduced in the last five years in terms of maximum capacity, and in the last two years based on metered energy quantity, reflecting an improvement in market competition. This was observed in the context of a moderately concentrated market.

As for the market's composition, four new market participants joined the NEMS in 2021. The NEMS' total registered capacity also increased with 11 new facilities entering the market, bringing the total registered facilities in the NEMS to 114 units with a collective maximum generation capacity of 12,149.35 megawatts (MW) and maximum load curtailment capacity of 40MW. This includes the first battery facility registered in the NEMS. The total number of IGS facilities in 2021 now stands at 52 units, with a collective maximum generation capacity of 292.006MW, an increase from 135.807MW a year ago.

During 2021, the MSCP provided its views to proposed rule modifications that were introduced to review the existing processes established under the Market Rules, such as the review of allowable remedies for events of default and the deterrence of late payment by market participants. All in all, these improvements will bring about a more competitive and dynamic electricity industry for the years to come.

Moreover, the MAU, guided by the MSCP, worked closely with the Energy Market Authority (EMA) and Energy

Market Company to develop a monitoring framework to fulfil its obligations under the newly effected Market Rules for the trial to import electricity from Peninsular Malaysia to Singapore. This is part of Singapore's efforts to decarbonise the power system and enhance energy security by diversifying its energy supply sources. Additionally, the MSCP has discussed and acknowledged EMA's requirements in terms of Market Rules enforcement under EMA's mechanism to allocate gas from the standby fuel facilities to gencos willing to draw required fuel for their electricity production as part of EMA's measures to secure Singapore's fuel and electricity supply<sup>21</sup>.

The MSCP looks forward to the continuous evolution of the industry to greater heights and will continue to play a critical role to enforce compliance with the Market Rules and enhance our market monitoring and surveillance scope as the wholesale electricity market of Singapore evolves. The MSCP is fully satisfied with the knowledge and technical expertise of the MAU in its support of the NEMS monitoring and surveillance activities, the investigation of alleged breaches of the Market Rules, and advisory functions to the MSCP on enforcement actions to make sure that the market consolidates its path towards a more efficient and effective operation.

I would like to acknowledge the support and guidance I have received from the members of the MSCP and the MAU over the years. I would also like to wish Professor Walter Woon, the incoming Chairman of the MSCP, all the best during his term of office.



**Mr T P B Menon**

Chairman  
Market Surveillance and Compliance Panel

<sup>20</sup> Ministry of Trade and Industry parliamentary reply, 1 November 2021, "[Oral reply to PQs on Energy-related matters](#)".

<sup>21</sup> Energy Market Authority media release, 19 October 2021, "[Pre-emptive Measures to Enhance Singapore's Energy Security and Resilience](#)".





# USER GUIDE

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## 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.
- LNG Vesting Prices are provided by SP Services as the Market Support Services Licensee (MSSL) on the [Open Electricity Market](#) website every quarter, based on a list of long run marginal cost parameters of a combined cycle gas turbine (CCGT) unit from the Energy Market Authority, including capital cost, non-fuel operating cost, carbon price and fuel oil price.
- Data for forecast demand and outages is compiled from reports prepared by the Power System Operator (PSO), including advisory notices.
- Throughout this report, demand figures are based on the forecast demand supplied by the PSO, except where metered energy quantities are indicated.
- Metered energy quantities are supplied by SP Services. All metered data used in this report is final data, derived after any settlement re-runs.
- CCGT units refer to all generating units clustered under the CCGT/cogen/trigen umbrella.

TABLE 22: DEFINITION OF PEAK, SHOULDER AND OFF-PEAK PERIODS\*

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

\* Source: MSSL

## 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 figures in the MSCP Annual Report and the NEMS Market Report due to differing methodologies.

## 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

From its 2021 edition onwards, 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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