



nems National Electricity
Market of Singapore

MARKET SURVEILLANCE & COMPLIANCE PANEL

20

ANNUAL REPORT

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EXECUTIVE SUMMARY

The Market Surveillance and Compliance Panel (MSCP) Annual Report presents analysis of data and information about Singapore's wholesale electricity market. This edition of the report is based on data and monitoring indices for the period 1 January to 31 December 2020, 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 wholesale electricity market's performance, highlighting key observations on a range of supply, demand and price indices for 2020, and how they compare to 2019.

Supply Indices

- The average supply decreased 4.33% to 7,720MW in 2020 from 8,069MW in 2019, even though the outage level had fallen to 1,206MW per period in 2020 from 1,355MW per period in 2019. This was the largest year-on-year (YOY) decrease in electricity supply since the National Electricity Market of Singapore (NEMS) was established in 2003, as generation companies submitted fewer offers to the system.
- The resultant average supply cushion¹ weakened to 24.06% in 2020 from 25.46% in 2019.
- In line with the above, the capacity ratio² of the Combined Cycle Gas Turbine (CCGT) units decreased 1.32 percentage points to an annual average of 61.99%. On the other hand, the capacity ratio of the Steam Turbine (ST) units increased 0.23 percentage point to an annual average of 0.40% in 2020.

- 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 53.04% in 2020 from 53.31% in 2019.
- CCGT continued to be the predominant generation type in the NEMS, holding an even larger market share in terms of metered energy quantity of 98.33% in 2020 compared to 98.20% in 2019.

Demand Indices

- The actual average demand subsided 2.01% to 5,772MW in 2020 from 5,890MW in 2019. This was the first decline in demand observed in the NEMS, a deviation from the consistent YOY demand growth recorded since the NEMS started. The peak monthly average electricity demand also decreased to 5,984MW as observed in March 2020, compared to 6,098MW in September 2019.
- The demand contraction was mainly caused by the Coronavirus Disease 2019 (Covid-19) pandemic and the consequent measures put in place by the Singapore Government to curb the transmission of the disease. Specifically, demand shrank YOY during the Circuit Breaker³, when many businesses were temporarily closed, as well as during the subsequent gradual reopening of Singapore's economy, when the country was still operating at below business as usual conditions.

- Despite a year of uncertainty brought about by the Covid-19, the accuracy of real-time load forecast in 2020 improved by a greater extent than in 2019. The average forecast error further reduced 0.30 percentage point to 2.16%, the smallest forecast error recorded in the market.

Price Indices

- The Wholesale Electricity Price (WEP) dipped further below \$100/MWh and averaged at \$70.25/MWh in 2020, registering 28.78% lower than \$98.63/MWh in 2019. This was the second lowest WEP observed since the NEMS started, the lowest WEP being \$63.69/MWh in 2016.
- The low WEP in 2020 was primarily driven by a decline of 42.92% in the fuel oil price to US\$249.13/MT in 2020 from US\$436.47/MT in 2019, as Covid-19 took its toll on the global oil demand. A weaker electricity demand as a consequence of the Circuit Breaker implemented by the Singapore Government further depressed the WEP in 2020.
- The total reserve payment fell 33.50% to \$55.93 million in 2020 from \$84.10 million in 2019, reflecting the abated contingency reserve price from \$16.30/MWh to \$9.91/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.
3 The Circuit Breaker, lasting from 7 April to 1 June 2020, was an elevated set of safe distancing measures implemented by the Singapore Government to pre-empt the trend of increasing local transmission of the Covid-19.

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

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

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

Structure and Composition of the MSCP

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

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

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

INTRODUCTION

Mr T P B Menon, Chairman, MSCP



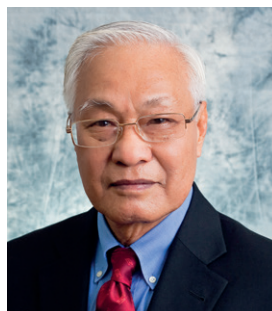
Mr Menon is currently a consultant with Wee Swee Teow LLP. Mr Menon was admitted to the Bar on 26 January 1962. He practised with Oehlers & Choa from 1962 to 1988, becoming a senior partner in 1980. Following the merger of Wee Swee Teow & Co with Oehlers & Choa in 1989, Mr Menon took on the role of senior 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 PBM (Pingat Bakti Masyarakat - Public Service Medal) in 1993.

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 Market Surveillance and Compliance Panel of EMC.

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.

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.

Professor Euston Quah



Professor Euston Quah is Albert Winsemius Chair Professor and head of Economics at the Nanyang Technological University (NTU) 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. Professor Quah is also the president of the

Economic Society of Singapore.

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 National University of Singapore (NUS).

In his continuing career as an economic advisor, Professor Quah has been 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 (now into its third edition in 2020), and the “Cost-Benefit Analysis” book, which is well-known internationally (into its sixth edition in 2020).

Professor Walter Woon, Senior Counsel



Professor Woon, Senior Counsel, is the chairman of RHTLaw Asia. He is currently 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.

He is also a member of the Films Appeal Committee, the Criminal Practice Committee of the Law Society of Singapore and the Chancery Bar Association of England and Wales.

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.

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 EMC's website under [Panel Determinations](#).

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 Market Surveillance and Compliance Panel Annual Report (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 2020 covers the period 1 January to 31 December 2020 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 19th 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 EMC's website under [Panel Reports](#).

MARKET MONITORING



MARKET MONITORING

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

Catalogues of Data and Monitoring Indices

The Singapore Electricity Market Rules (Market Rules) provide for the Market Assessment Unit (MAU), under the supervision and direction of the Market Surveillance and Compliance Panel (MSCP), to develop a catalogue of the data it acquires and a catalogue of the monitoring indices to evaluate market performance.

In 2020, the MAU conducted a public consultation on and modified the Catalogue of Data and the Catalogue of Monitoring Indices to ensure effective monitoring using the provision of information under the catalogue of data and to improve the analysis with the adoption of additional monitoring indices.

On 1 July 2020, the MSCP adopted the updated Catalogue of Data and Catalogue of Monitoring Indices. As a result of the updates, the Market Surveillance and Compliance Panel Annual Report 2020 includes additional analysis of monitoring indicators related to the supply side of the market, specifically, on offer behaviour, and market structure. The addition of these indicators supports broader aspects of market monitoring and helps identify whether the market design facilitates efficient and fair operation of a competitive market.

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, energy and ancillary services indices.

Catalogue of Monitoring Indices

The Catalogue of Monitoring Indices adopted by the MSCP include supply indices, demand indices, and price indices, as listed below:

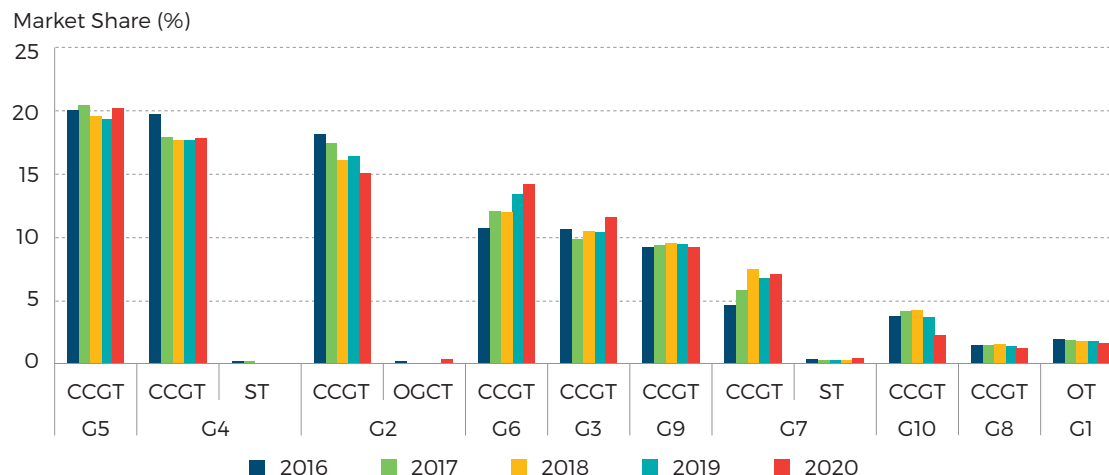
TABLE 1: CATALOGUE OF MONITORING INDICES

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

The [Catalogue of Data](#) and [Catalogue of Monitoring Indices](#) are publicly available on the Energy Market Company (EMC) website.

MARKET CONCENTRATION: MARKET SHARE

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

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 were arranged in descending order according to their market share based on metered energy quantity in 2020.

The market is largely dominated by the Combined Cycle Gas Turbine (CCGT) units, which recorded a market share of 98.33% in 2020, while Other Facilities (OT) units under G1, representing the waste-to-energy incineration plants, accounted for 1.57% of the market share. The market share across the generation mix remained largely similar across the last five years, with strong dependency on the more efficient CCGT units of close to 98% since 2016. The reliance on OT units continued to decline, with the reduction of its market share by metered energy quantity to 1.57% in 2020 from 1.74% in 2019.

The Open Cycle Gas Turbine (OCGT) and Steam Turbine (ST) units under G2, G4 and G7 ran intermittently over the last five years and therefore were not significantly reflected in Chart 1. The ST units classified under G7 were the only facilities that were dispatched annually at an average of 0.07%.

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

Year	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
2016	1.88	18.14	10.57	19.69	19.97	10.68	4.74	1.47	9.14	3.72
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

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

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 2020 are G2, G4 and G5. Their combined market share of 53.04% in 2020 was largely unchanged from the previous year. This was despite some dilution from 2016, when the market share of the three leading generation companies stood at 57.80%.

In the last five years, the largest reduction of market share was observed in G2, with a decline of 3.09 percentage points from 2016 to 15.04% in 2020. Meanwhile, G6 and G7 made more distinctive gains in their market share, with an increase of 3.45 percentage points and 2.43 percentage points to 14.12% and 7.17% respectively over the same period.

MARKET MONITORING

MARKET CONCENTRATION: MARKET SHARE

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

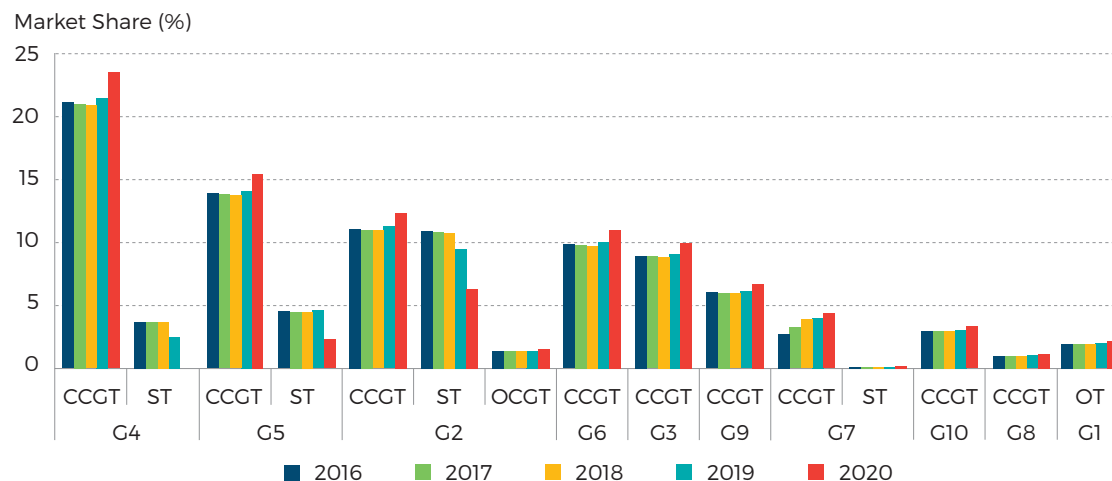


Chart 2 shows the market share based on maximum capacity by generation company. The generation companies were arranged in descending order according to their market share based on maximum capacity in 2020.

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 2020 due to the retirement of six ST generation units in late 2019 and 2020. Of the generation companies with CCGT units, G4 recorded the largest increase in market share to 23.49%.

The total market share of CCGT units, based on the maximum capacity, increased rather significantly over the last year, by 7.62 percentage points to 87.65% in 2020 even though no new CCGT units were added in the NEMS.

The rising market share of CCGT units over the last two years, based on maximum generation capacity across the generation types, was due to the deregistration of two ST units in August 2019, three ST units in September 2019 and one ST unit in June 2020. The fall in market share of ST units meant a corresponding rise in the proportion of generation capacity of the other generation facility types. The market share of ST units fell by 7.94 percentage points to 8.69% by 2020.

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

Year	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
2016	1.93	23.29	8.93	24.80	18.38	9.84	2.84	1.00	6.01	2.97
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

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

Table 3 consolidates the yearly average market share of all generation companies in terms of maximum capacity. 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 by 3.36 percentage points to 61.34% in 2020 when compared to 2019. This was due to the reduction of ST supply market share, which was then proportionately allocated to the rest of the generation types based on their maximum capacity.

MARKET CONCENTRATION: HERFINDAHL-HIRSCHMAN INDEX

TABLE 4: HERFINDAHL-HIRSCHMAN INDEX

Year	Minimum	Maximum	Average	Maximum Share (%)
2016	1,420	1,561	1,470	19.90
2017	1,385	1,457	1,425	20.34
2018	1,342	1,413	1,372	19.47
2019	1,349	1,467	1,400	19.27
2020	1,350	1,534	1,441	20.19

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

Over the last five years, the monthly HHI of the NEMS hovered between the range of 1,300 to 1,600. In 2020, the average of monthly HHI stood at close to 1,400, indicating that the NEMS continues to remain moderately concentrated with no major deviation in the market share of its market participants. There was no new entry of generation units from generation companies which had significantly changed the proportions of metered generation quantity in the market. Similarly, the maximum market share held by the generation company with the highest percentage of metered energy quantity has ranged between 19.00% and 20.50% since 2016.

MARKET MONITORING

MARKET CONCENTRATION: 1-PIVOTAL SUPPLIER TEST

CHART 3: FREQUENCY OF GENERATION COMPANIES AS SINGLE PIVOTAL SUPPLIER

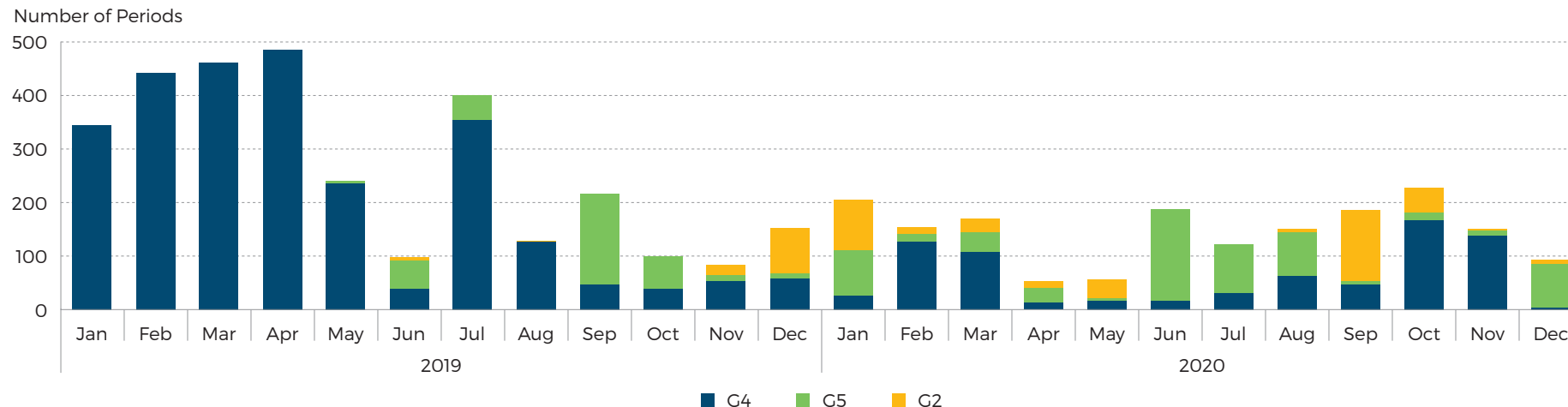


TABLE 5: FREQUENCY OF GENERATION COMPANIES AS SINGLE PIVOTAL SUPPLIER (NUMBER OF PERIODS)

Year	G2	G4	G5	Total
2019	107	2,650	350	3,107
2020	370	746	622	1,738

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 2019 and 2020. The generation companies were arranged in descending order according to their total number of periods as the single pivotal supplier in 2020.

There were three generation companies identified as the single pivotal supplier in 2019 and 2020. In the monthly overview of single pivotal supplier over the two years, there was an average of 340 periods per month with a single pivotal supplier in January to June 2019, predominantly under G4. However, the market structure reflected a change from the second half of (H2) 2019 onwards, with the role of single pivotal supplier rotating between G2, G4 and G5. The shift was attributed to the retirement of ST units in August and September 2019 and in June 2020. This had reduced the capacity surplus provision by the generation companies and therefore a reduction in the average number of periods with a single pivotal supplier in H2 2019. The average monthly number

of periods with a pivotal supplier fell to 178 periods in the H2 of 2019, and subsequently to an average of 145 periods in 2020.

Looking at the individual generation companies, the shift in the frequency of a single generation company being the single pivotal supplier was apparent between 2019 and 2020. There were 2,650 periods when G4 was the single pivotal supplier in 2019, but this fell 71.85% to 746 periods in 2020. On the other hand, the number of periods for which G2 was the single pivotal supplier more than tripled to 370, while the ones for G5 almost doubled to 622 periods in 2020. This came with a lower proportion of supply capacity by generation companies after the retirement of ST units.

CHART 4: COMPARISON OF CAPACITY RATIO OF CCGT UNITS

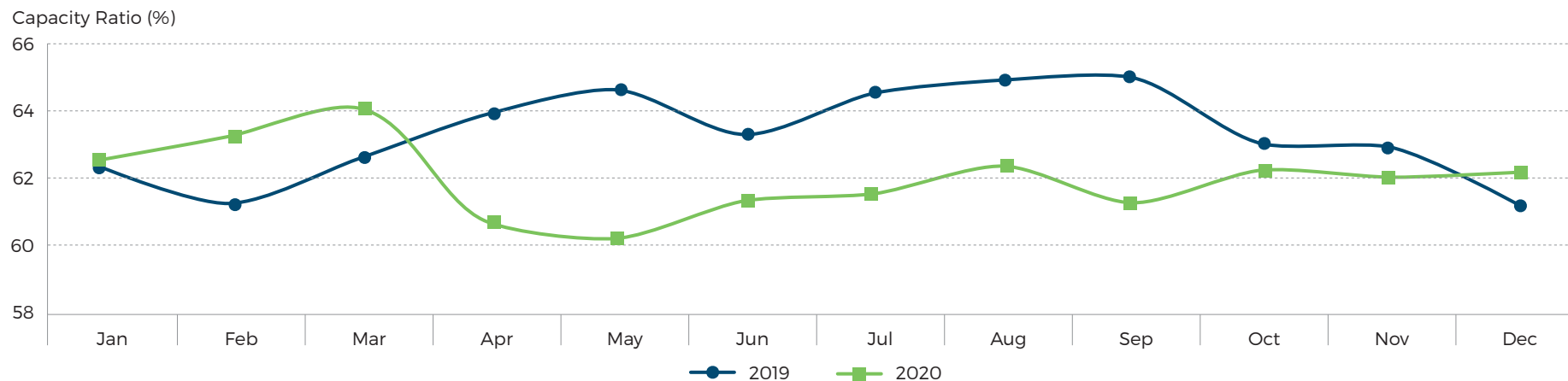


TABLE 6: CAPACITY RATIO BY GENERATION TYPE (%)

Year	CCGT	ST	OT	OCGT
2019	63.31	0.16	47.79	0.27
2020	61.99	0.40	43.69	0.04
YOY Change	-1.32	0.23	-4.10	-0.23

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 2019 and 2020.

In 2020, the capacity ratio was lower for the CCGT, OCGT as well as OT generation types when compared to 2019. The reduction in the utilisation rate of these facilities was a consequence of the impact of the Coronavirus Disease 2019 (Covid-19) pandemic, which caused a decline in the system demand, lowering the scheduled capacity. The OT units registered the largest decline of 4.10 percentage points to 43.69%. The larger decline in the utilisation level of OT units could be attributed to the more competitive offers by CCGT amid the weak demand conditions observed in 2020.

The CCGT units' capacity ratio fell 1.32 percentage points to 61.99%. Despite the reduction observed, the CCGT units continued to hold the largest capacity ratio by generation type, as the most efficient generation type in the NEMS. Overall, the NEMS continued to rely on the CCGT units to meet the system demand. The utilisation rates of ST and OCGT units remained low as they are the less efficient and more expensive generation capacity types in the market.

A monthly comparison of the capacity ratio of CCGT units in 2019 and 2020 is shown in Chart 4. There is a correlation between the monthly CCGT capacity ratio and the movements in demand, as shown in Chart 12 (page 21).

Overall, the capacity ratio for CCGT units fell 1.32 percentage points to 61.99% in 2020, reflecting a reduction in the utilisation of the CCGT generation type compared to 2019. This was similar to the movements in demand, as the monthly capacity ratio of CCGT units was higher for the months of January, February, March and December in 2020 than in 2019. The dip in the capacity ratio utilisation in April correlated with the period when the country-wide Circuit Breaker measures were implemented by the Singapore Government due to the Covid-19 pandemic.

In 2020, the highest capacity ratio of 64.10% was observed in March when there was still expansion in demand before the implementation of Circuit Breaker measures led to an economic slowdown.

MARKET MONITORING

SUPPLY INDICES: OUTAGES

TABLE 7: AVERAGE OUTAGES BY GENERATION TYPE (MW)

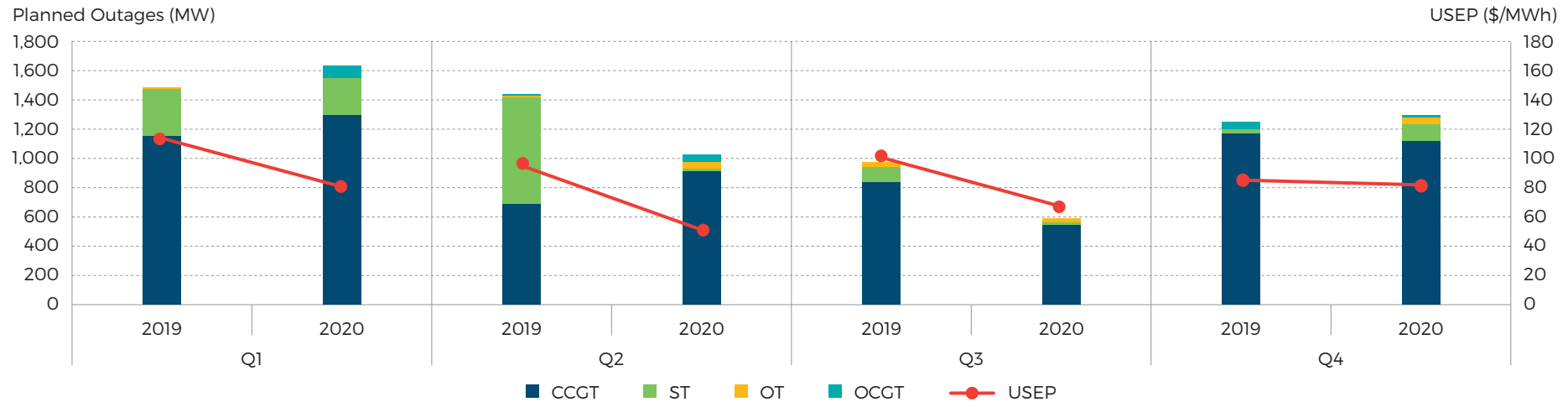
Year	Planned Outages						Forced Outages						Total Outages	YOY Change (%)
	CC GT	ST	OT	OCGT	Sum	%	CCGT	ST	OT	OCGT	Sum	%		
2016	863.92	168.90	38.21	2.77	1,073.79	96.81	35.14	0.06	0.15	0.00	35.34	3.19	1,109.13	17.51
2017	743.74	322.02	21.72	32.62	1,120.10	98.76	13.79	0.04	0.20	0.00	14.02	1.24	1,134.12	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

Table 7 provides an overview of the periodic outage volume by generation type for the last five years. From 2016 to 2019, the total outages rose year-on-year (YOY). 2020 was the first year with an annual decline - total outages per period fell 11.01% to 1,206MW.

The planned outages in 2020 constituted 92.57% of the average outages volume, a reduction of 2.00 percentage points from 94.57% in 2019. The lower outage volume was due to the reduction in ST units' planned outages for 2020. ST units recorded the largest decline from 299MW to 92MW while the CCGT, OT and OCGT units recorded a slight increase in the volume of planned outages.

In 2020, the volume of annual average forced outages per period of 90MW was the highest recorded over the past five years. It accounted for 7.43% of the total outage volume per period. The forced outage volume doubled over the last five years, with an increase in the contribution by CCGT units.

CHART 5: PLANNED OUTAGES VS USEP



A higher level of planned outages usually coincides with a higher USEP due to the contraction in supply. In 2020, the impact of Covid-19 reduced the effect of outage volume on the USEP, against the backdrop of overcapacity in the NEMS. The weak demand conditions may have further reduced the influence of outages volume on the USEP movement. Chart 5 above compares the quarterly average planned outages against the quarterly average USEP in 2019 and 2020.

In 2020, the shift of quarterly planned outages did not show significant correlation to movements in the USEP. Q1 and Q4 2020 registered higher overall outage levels compared to 2019, whereas Q2 and Q3 2020 registered lower overall outage levels compared to 2019. Despite these shifts in quarterly outage volumes, the USEP remained depressed across all quarters in 2020 in comparison to 2019.

The USEP registered a steep decline between Q1 and Q3 in 2020, compared to the same quarters in 2019. This is in line with the view that the USEP has a higher correlation with the short run marginal cost, for which fuel oil price is a proxy. The fuel oil price⁴ for Q1, Q2 and Q3 in 2020 declined 36.89%, 58.89% and 45.59% respectively from 2019's levels.

In Q4 2020, the USEP saw a slight decline but remained largely similar to the price observed in Q4 2019. This correlated with a decline of 27.68% in fuel oil price to US\$274.15/MT in Q4 2020 from US\$379.08/MT in Q4 2019.

4 All fuel oil prices mentioned in the MSCP Annual Report 2020 are based on the SGX Platts Singapore Fuel Oil 180cst Index Futures to ensure consistency throughout the report.

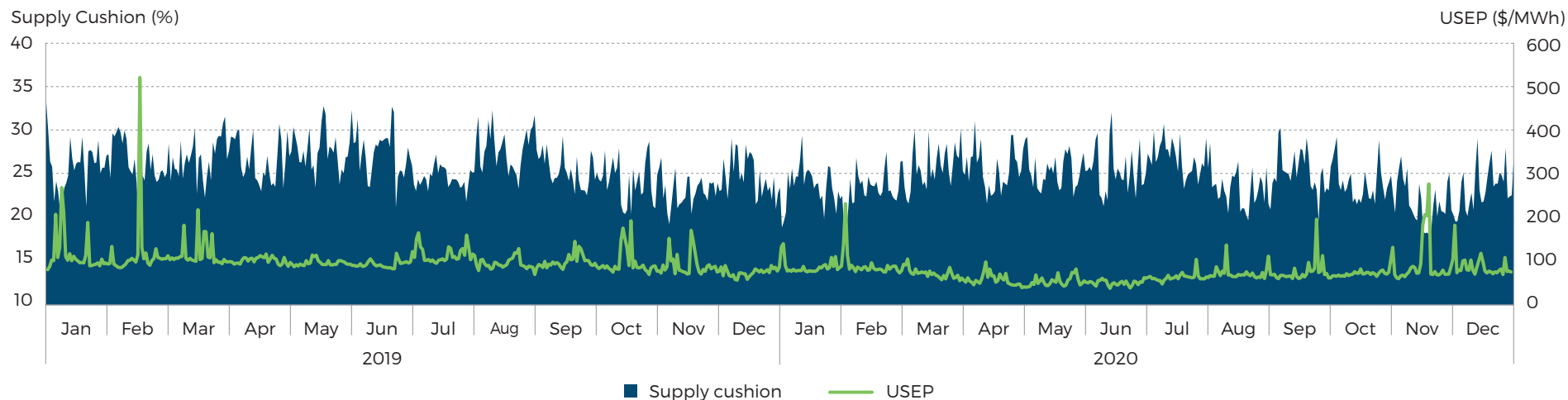
The fuel oil price mentioned in the past issues of the MSCP Annual Report (up to MSCP Annual Report 2019) was based on the Intermediate Fuel Oil (IFO) 180 price, a component used in the calculation of vesting contract prices.

Due to the unavailability of the IFO 180 price after 19 February 2020, the fuel oil price recorded from 2020 was changed from the IFO 180 price (expressed in US\$/barrel) to the SGX Platts Singapore Fuel Oil 180cst Index Futures (expressed in US\$/MT), which is published by the Singapore Exchange Limited. The SGX Platts Singapore Fuel Oil 180cst Index Futures was chosen as a suitable proxy to allow for continuous monitoring of IFO 180 price movements.

MARKET MONITORING

SUPPLY INDICES: SUPPLY CUSHION

CHART 6: RELATIONSHIP BETWEEN SUPPLY CUSHION AND USEP



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. In 2020, the annual average USEP traded at \$70.01/MWh and the yearly average supply cushion recorded was 24.06%. The USEP declined by 28.77% from 2019 to \$70.01/MWh in 2020 – the second lowest annual USEP since the market started.

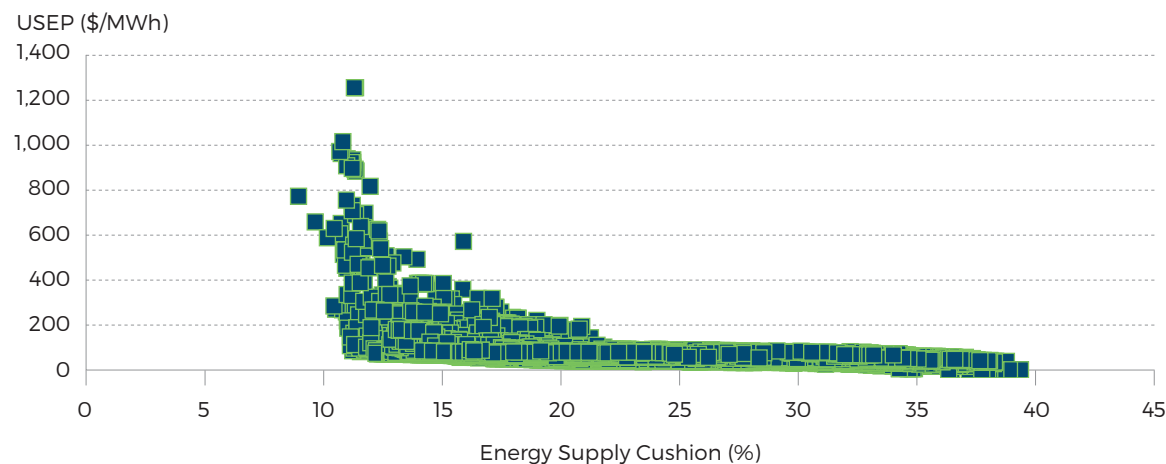
Chart 6 illustrates the relationship between the daily average USEP and the daily average supply cushion for 2019 and 2020. It was observed that the days with high USEP were as a result of the low supply cushion. For instance, the daily average price spikes observed in February, March, August, September, November and December 2020 ranged between \$102.21/MWh and \$275.33/MWh⁵. On days with a high USEP, the daily average supply cushion fluctuated within a low range of 17.77% to 22.47% in the same period.

Compared to 2019, the supply cushion in 2020 tightened by 1.40 percentage points to 24.06%. Concurrently, the USEP traded lower and with less volatility, reflecting the lower influence of supply cushion in 2020 compared to 2019.

The low and less volatile USEP was mainly attributed to the loss in demand as a result of the impact of Covid-19 pandemic as well as the low cost of supply due to the depressed oil price in 2020.

⁵ The daily average price spikes identified were a result of periodic USEP being above \$500/MWh for the mentioned months.

CHART 7 : RELATIONSHIP BETWEEN SUPPLY CUSHION AND USEP IN 2020



The relationship between the USEP and the supply cushion in 2020 was further analysed across all dispatch periods, as shown in Chart 7. The USEP exceeded \$400/MWh on 60 instances in 2020, down from 80 in 2019.

Historically, it has been observed that price spikes occur when the supply cushion falls below the 15% level. In 2020, there were 59 occurrences of high prices observed when the supply cushion was below 15%, the same number of occurrences recorded in 2019. For these 59 occurrences, the periodic supply cushion ranged between 9.05% and 14.10% while the USEP ranged between \$446.03/MWh and \$1,254.04/MWh.

Only on one occasion did the daily USEP exceed \$400/MWh when the supply cushion was above 15%. The price spike to \$570.72/MWh occurred when the supply cushion was at 16.08%.

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
2016	13	329.55	1,252.59	17,555	63.08	1,053.62
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

Table 8 summarises the yearly average USEP movements with a supply cushion of more or less than 15% over the past five years.

The number of periods for which the supply cushion was below 15% rose exponentially from 2016 to 2020.

In the earlier years of 2016 and 2017, few such periods were registered, but hundreds of such periods were registered from 2018 onwards. 2020 registered a sharp spike in the number of periods with a supply cushion of under 15%, to a total of 848. Notably, the average USEP during such periods also sank to a five-year low

of \$167.28/MWh. This indicated that despite the tight supply conditions, there were sufficient offers in the lower price tranches to meet demand needs during these periods.

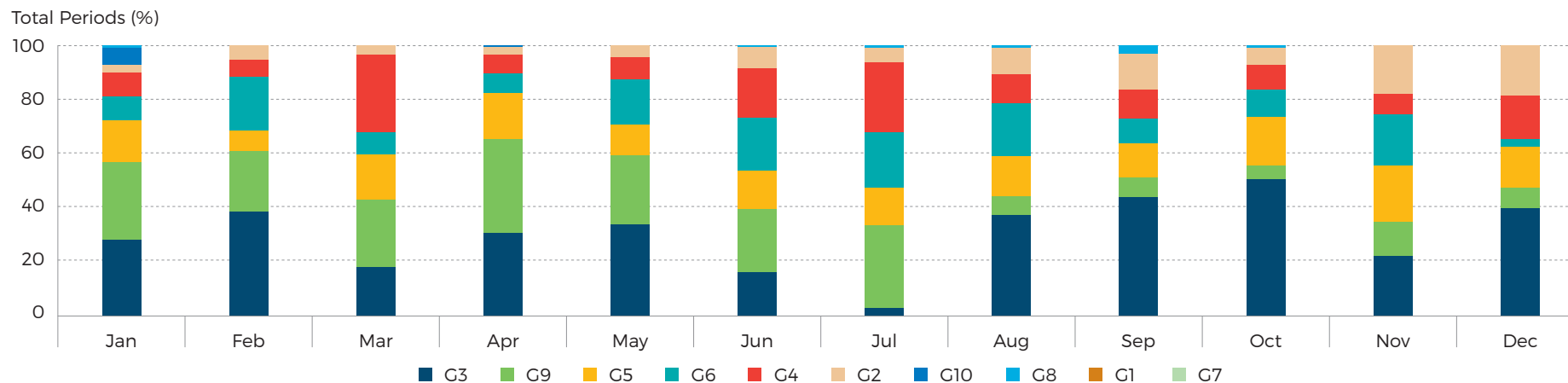
The maximum USEP for periods when supply cushion was under 15% remained similar to that in previous years – ranging above \$1,000/MWh. On the other hand, periods when the supply cushion was above 15% in 2020, also saw one of the lowest average and maximum USEP levels over the last five years, at \$65.07/MWh and \$570.72/MWh respectively. The lower USEP in 2020 was largely attributed to depressed fuel oil prices, which imply lower generation costs for generation companies.

The data in Table 8 also implies that in 2020, there was a shift in the occurrences of price spikes of periodic USEP when the supply cushion was under 15%. The price spikes are mostly congregated in the lower supply cushion environment and there was less volatility when the supply cushion was above 15%.

MARKET MONITORING

SUPPLY INDICES: PRICE SETTER

CHART 8: TREND OF PRICE SETTING GENERATION COMPANIES



Price setter refers to the block price quantity pair provided by a generation company which 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. All in all, three main generation companies contributed to 65.43% of the time when there is a price setter.

The three main generation companies identified to be price setters in 2020 were G3, G5 and G9, with averages of 30.36%, 14.62% and 20.45% respectively, for all the periods with a price setter. On a monthly level, it was observed that G9 was one of the key price setters for an average of 27.14% of the time from January to July. However, the frequency decreased sharply to an average of 7.93% for the latter half of the year. This could have corresponded to a reduction in capacity due to planned or unplanned maintenance which restricts the ability of generation companies to offer competitively in the market. On the other hand, G3 and G5 were the price setters for consistent percentages of periods each month.

SUPPLY INDICES: OFFER/BID VARIATIONS

CHART 9: OFFER VARIATIONS MADE AFTER GATE CLOSURE

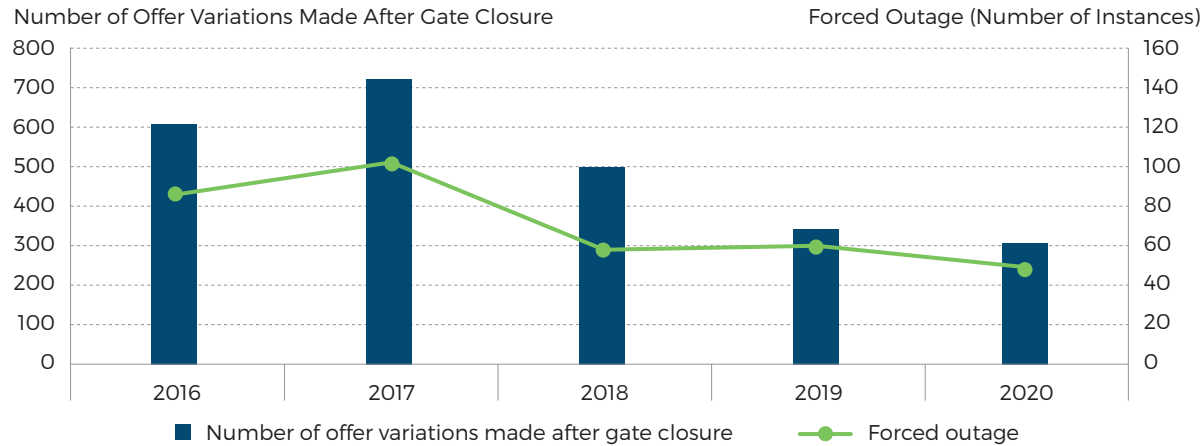
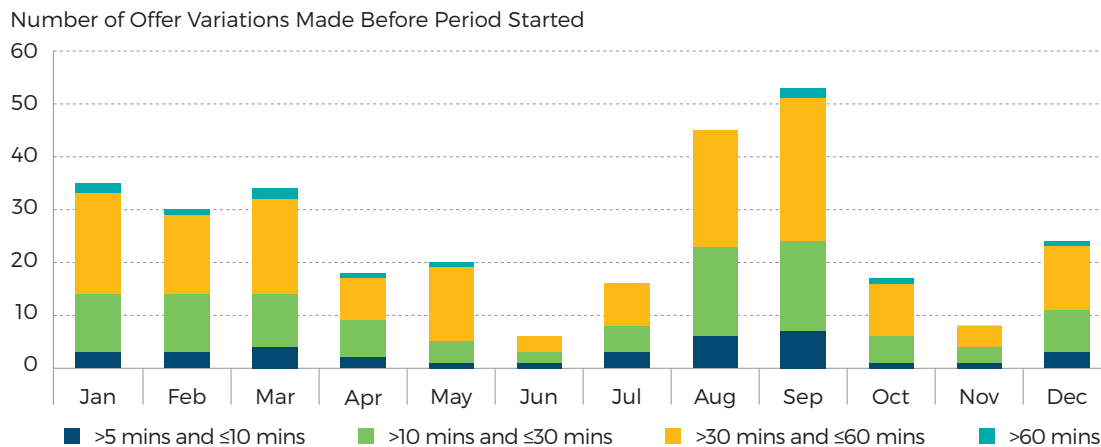


Chart 9 compares the number of gate closure variations made from 2016 to 2020 in relation to the number of forced outages. The trend of forced outage occurrences largely correlates with the number of cases where offer variations were made after gate closure.

Other than in 2017, when both factors in Chart 9 rose, the number of offer variations made after gate closure as well as the number of forced outages have generally trended downwards. The number of periods with forced outages and the offer variations made after gate closure close to halved from 2016 to 2020. There were 49 forced outages in 2020, compared to 86 in 2016. Correspondingly, the 306 instances of offer variations made after gate closure in 2020 represented a significant fall from the 606 instances observed in 2016.

This indicates increased stability in the supply system over the years, possibly due to regular planned maintenance reducing the instances of forced outage. Consequentially, the need for submission of offers after gate closure by generation companies was also lower, resulting in higher efficiency and market stability.

CHART 10: SUBMISSION TIME 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 are regularly reported to the MSCP for investigation.

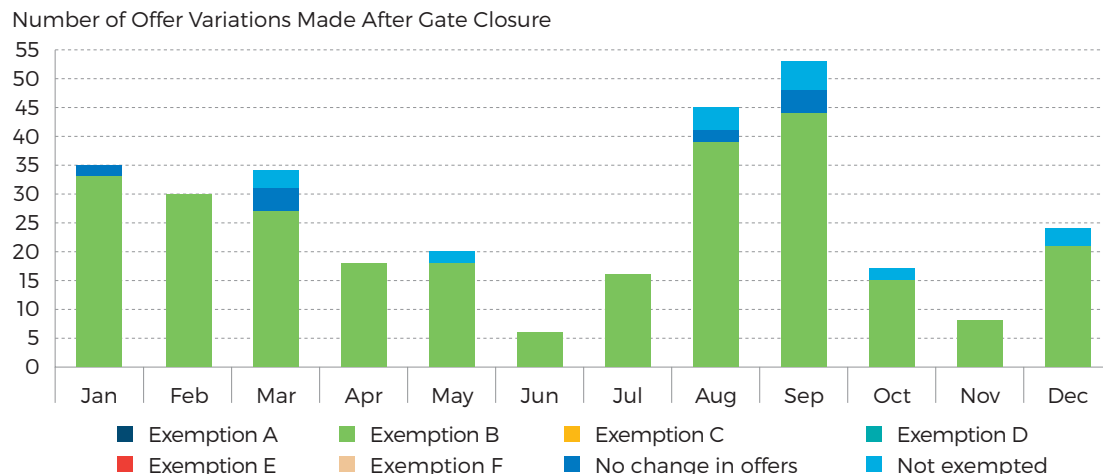
Chart 10 reflects monthly offer variations in 2020 submitted during the gate closure window, categorised by ranges of proximity of submission time to the actual trading period. This is a study of changes in generation capacity offers which may impact system security.

Submission of offers during the gate closure window happens between 10 minutes to 60 minutes before the actual trading periods for close to 85% of the occurrences. This reflects that generation companies are sufficiently able to respond within the gate closure window on the actual physical capability of the generating units.

MARKET MONITORING

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 306 cases received by the MSCP in 2020, 275 cases were determined not to be in breach of the Market Rules as they were exempted under Exemption B, and 12 cases were determined not to be in breach due to offer submissions with no changes in offer.

The remaining 19 cases, which were not exempted, took place in six of the 12 months of 2020.

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 the 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 the 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 the 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, the 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.

TABLE 9: DEMAND RESPONSE ACTIVATIONS IN 2020

Date	Period	USEP (\$/MWh)	CUSEP ⁶ (\$/MWh)
3 Jan	28	188.17	217.79
4 Feb	22	221.37	221.91
27 Jul	28	250.03	253.85
27 Jul	29	247.77	254.36
14 Sep	20	233.53	237.54
14 Sep	22	232.24	245.50
21 Sep	22	163.69	254.30
25 Sep	29	228.69	252.84
28 Sep	18	332.54	455.47
28 Sep	19	303.35	454.51
28 Sep	20	467.21	718.13
28 Sep	22	451.19	508.27
28 Sep	23	248.96	350.96
16 Nov	28	187.21	202.32
16 Nov	29	187.21	202.32
18 Nov	29	577.31	757.75
19 Nov	28	937.91	1,008.66
19 Nov	29	933.14	1,008.68
19 Nov	30	636.95	913.17
20 Nov	22	1,254.04	1,008.06
20 Nov	23	730.87	1,008.07
20 Nov	24	187.40	630.34
20 Nov	31	582.93	927.39

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 who only partially comply with their scheduled curtailment will not be entitled to any incentive payments. Penalties will be imposed on licensed load providers who are compliant with less than 95% of their scheduled curtailment.

Table 9 displays the number of DR activations in 2020. There has been an increase in the frequency of participation of DR. Since the introduction of DR in the market, there were only two successful activations in 2018 and none in 2019. However, in 2020, DR was activated in a total of 23 periods. This brought about market system-wide benefit and cost savings with reduced wholesale energy prices, as can be seen by comparing the USEP to the counterfactual USEP (CUSEP).

6 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 with the assumption that there is no dispatchable energy bid.

MARKET MONITORING

DEMAND INDICES: METERED ENERGY QUANTITY

CHART 12: COMPARISON OF ACTUAL DEMAND

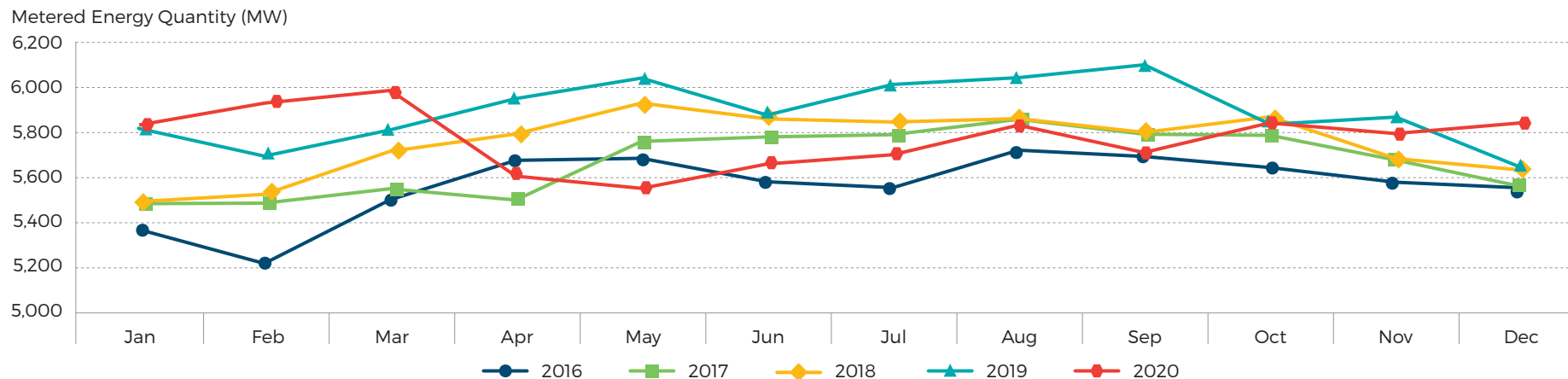


Chart 12 compares the actual demand (computed from metered energy quantity) between 2016 and 2020. Based on the yearly average, the demand shrank 2.01% to 5,772MW in 2020, from 5,890MW in 2019. This was the first decrease in the yearly average demand since the NEMS started in 2003.

With a steady increase in the yearly average demand before 2020, the monthly average demand typically increases YOY as well. However, the monthly average demand in 2020 was lower than that in 2019 for most of the months - from April to September and November. In particular, the demand of 5,550MW in May 2020 was the lowest monthly average since 5,523MW in February 2018.

The slump in demand from April to September 2020 was largely because of the Covid-19 pandemic. In April 2020, the Singapore Government announced the start of the Circuit Breaker and implemented tighter preventive measures to curb the spread of the disease and many businesses were temporarily closed. In May 2020, further preventive measures were put in place and more workplaces were closed. Although Singapore transitioned from the Circuit Breaker to a gradual reopening of the economy in June 2020, namely Safe Re-opening from 2 June 2020 (Phase 1) and Safe Transition from 19 June 2020 (Phase 2), Singapore was still operating at below business as usual conditions. As a result of this, the electricity demand averaged at 5,604MW between April and June 2020, with the demand of 5,550MW in May 2020 being the lowest during the year, 8.10% lower than May 2019 when the monthly average demand was 6,039MW.

From July to September 2020, the monthly average demand rose to 5,746MW as the Safe Transition continued, more businesses reopened, and some people were allowed to return to workplaces. This demand was still below the pre-Covid-19 level of 6,050MW from July to September 2019, indicating that the NEMS was still recovering from the impact of the pandemic.

The demand in November 2020 was 5,793MW, 1.26% lower than the 5,866MW observed in November 2019. As demand tends to move in tandem with temperature, the lower demand in November 2020 was likely due to the lower temperature of 28.4°C, compared to 29.3°C in November 2019.

In 2020, the highest YOY demand growth of 4.14% was recorded in February, as there were 20 weekdays in February 2020, more than the 18 weekdays in February 2019⁷. The highest YOY decrease of 8.10% occurred in May, due to the Circuit Breaker.

⁷ There were two public holidays in February 2019 - the first two days of Chinese New Year fell on 5 and 6 February 2019.

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
2016	55.62	38.12	15.55	10.68
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

In the NEMS, 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). 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. 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.

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 schedule⁸. As the STS is generated more frequently and closer to the real-time dispatch period than the PDS, the load variation between the STS and the real-time dispatch schedule tends to be smaller than that between the PDS and the real-time dispatch schedule.

The mean load variation between the PDS and the real-time dispatch schedule in 2020 was 53.98MW, 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 2020 was 40.13MW, which was 3.64 times as large as that between the STS and the real-time dispatch schedule. With a larger average and a wider spread in variation, the PDS was less reflective of the real-time market conditions than the STS.

In 2020, the mean load variation between the PDS and real-time dispatch schedule was 3.24% lower than that in 2019, indicating a higher accuracy in the PDS. The mean load variation between the STS and real-time dispatch schedule also went down 4.13% in 2020, indicating an improved accuracy in the STS as well.

The mean of the load variations in the forecast schedules was the lowest in the last five years. This implies that the forecast schedules provided more accurate load forecasts, which were closer to the real-time dispatch schedule compared to previous years.

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

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

Year	Variation between Real-Time Load Forecast & Actual Demand	YOY Change
2016	2.70	-0.04
2017	2.26	-0.44
2018	2.58	0.32
2019	2.46	-0.12
2020	2.16	-0.30

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 the 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 0.30 percentage point to 2.16% in 2020, from 2.46% in 2019. This was the smallest variation observed since the NEMS started, suggesting that the real-time load forecast in 2020 was the most accurate thus far.

MARKET MONITORING

PRICE INDICES: LNG VESTING PRICE AND WHOLESALE ELECTRICITY PRICE

CHART 13: LVP VS MONTHLY VOLUME-WEIGHTED AVERAGE WEP

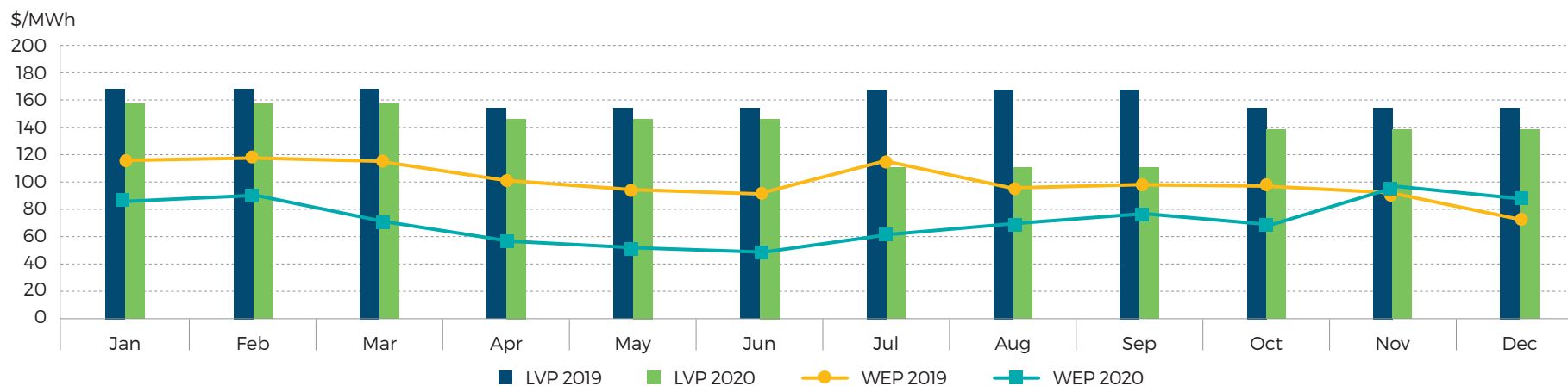


Chart 13 shows the LNG Vesting Price (LVP)⁹ and the volume-weighted average Wholesale Electricity Price (WEP) on a monthly basis for 2019 and 2020. As the LVP reflects the long run marginal cost of a generation facility, the WEP should follow the LVP closely in an efficient market.

The monthly volume-weighted average WEP in 2020 was lower than that in 2019 for a significant part of the year – from January to October. This was mainly driven by reduced demand for electricity and lower fuel oil prices as businesses halted and global oil demand sank due to the Covid-19 pandemic.

The largest YOY drop in the WEP was in June, when the WEP decreased 46.87% to \$48.26/MWh, from \$90.84/MWh in June 2019. The last time the WEP was at a similar level was in April 2016, when an oversupply of generation capacity applied a downward pressure on the energy prices in the NEMS. At that time, the WEP was \$44.69/MWh.

As for the remaining months, the monthly volume-weighted average WEP showed a YOY rise of 5.08% and 19.99% in November and December respectively. This was likely caused by the multiple periods of high energy prices in November and December 2020, when the market experienced tight supply conditions.

Given the prolonged duration of lower WEP in 2020, the yearly volume-weighted average WEP fell 28.16% to \$71.89/MWh in 2020 from \$100.08/MWh in 2019. The yearly volume-weighted average WEP was 48.07% lower than the yearly average LVP in 2020.

The LVP declined 14.13% to \$138.44/MWh in 2020 from \$161.21/MWh in 2019. Despite a decrease in the LVP in 2020, the volume-weighted average WEP remained noticeably below the LVP as the WEP decreased by a greater magnitude. The observation of the WEP staying consistently below the LVP aligns with the Energy Market Authority (EMA)'s decision to phase out the vesting contract regime¹⁰ from 1 July 2023.

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 solely depended on the LVP.

¹⁰ To encourage the acceptance of regasified LNG, the EMA also implemented the LNG Vesting Scheme upon the completion of the LNG terminal in May 2013, which would be in force until 2023. There will be no LNG vesting quantity when the LNG vesting contracts expire on 30 June 2023. From 1 July 2023, all vesting contracts will cease, and the vesting contract regime will be completely phased out.

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

CHART 14 : INDEX OF LVP, WEP, FUEL OIL PRICE AND ELECTRICITY TARIFF

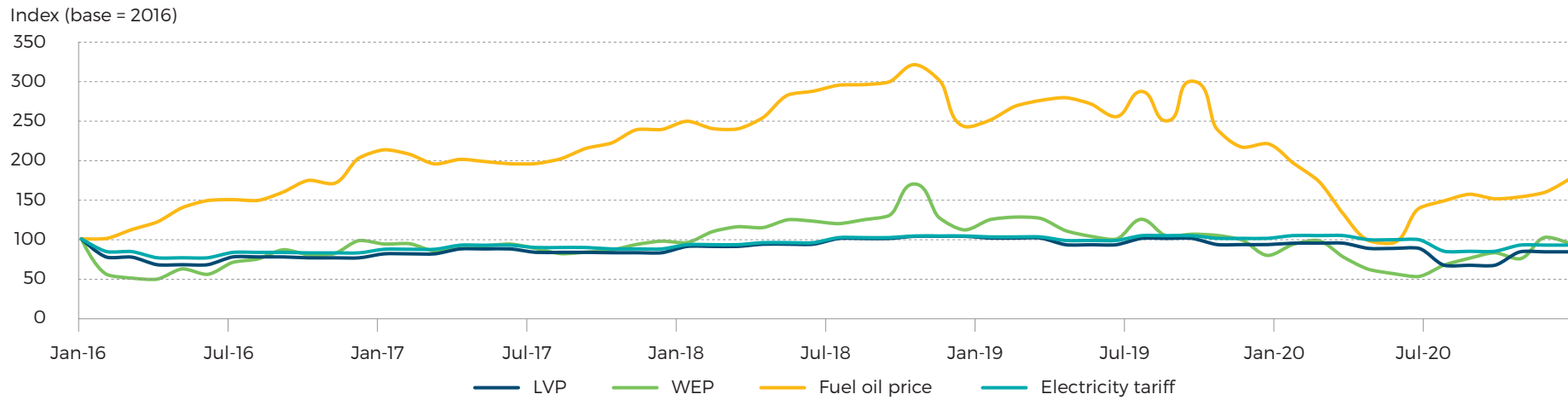


Chart 14 shows the relative changes in the LVP, the WEP, the fuel oil price and the electricity tariff for the past five years, expressed as indices against the prices in the base year 2016.

The WEP moved in tandem with the fuel oil price throughout the review period from 2016 to 2020, implying that the fuel oil price was a factor which could account for the changes in the WEP. Comparing the recent two years, the fuel oil price fell 42.92% to US\$249.13/MT in 2020, from US\$436.47/MT in 2019 and the WEP fell 28.78% to \$70.25/MWh in 2020, from \$98.63/MWh in 2019.

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 2016 to 2020. Like the LVP, the electricity tariff also slipped 6.37% to \$0.24/kWh in 2020 from \$0.25/kWh in 2019.

MARKET MONITORING

PRICE INDICES: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY

TABLE 12: CORRELATION COEFFICIENT OF WEP AND METERED ENERGY QUANTITY

Month	2019			2020		
	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	0.72	0.52	25	0.85	0.72	25
Feb	0.64	0.41	23	0.66	0.44	23
Mar	0.65	0.42	21	0.79	0.62	27
Apr	0.67	0.45	22	0.61	0.37	21
May	0.58	0.34	23	0.64	0.40	22
Jun	0.60	0.36	24	0.91	0.83	29
Jul	0.73	0.54	26	0.84	0.70	29
Aug	0.80	0.64	29	0.72	0.52	30
Sep	0.83	0.69	29	0.77	0.59	27
Oct	0.71	0.50	27	0.82	0.68	31
Nov	0.70	0.49	24	0.57	0.33	23
Dec	0.83	0.68	29	0.71	0.50	27
Average/Sum	0.70	0.50	302	0.74	0.56	314

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.

Continuing the trend in 2019, the relationship between the WEP and demand became even more pronounced in 2020, as the yearly average r value rose to 0.74 in 2020 from 0.70 in 2019 and the number of days when r was greater than 0.5 went up to 314 days in 2020 from 302 days in 2019.

The r^2 value increased to 0.56 in 2020 from 0.50 in 2019. This meant that about 56% of the variance in the WEP in 2020 could be attributed to variations in the demand, compared to about 50% in 2019.

PRICE INDICES: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY

CHART 15: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY IN 2020

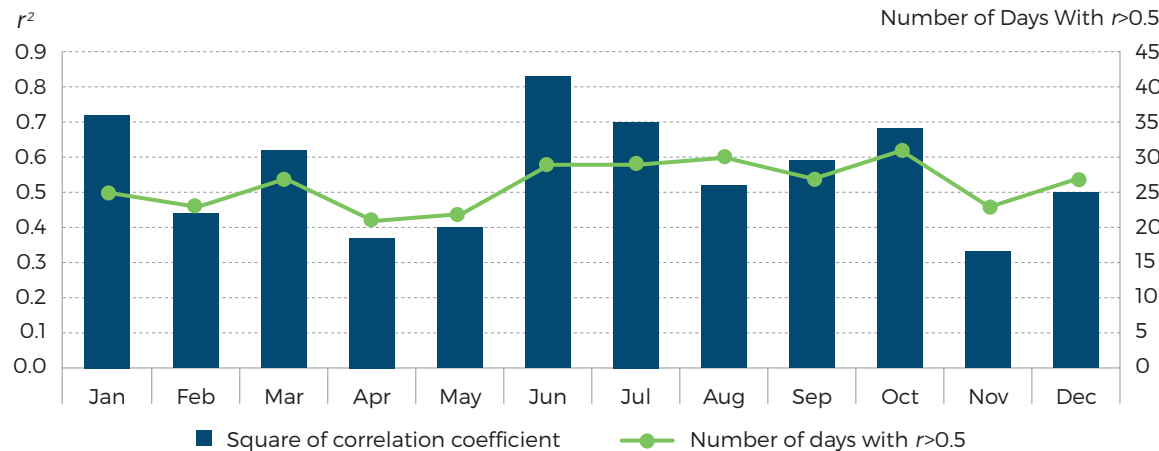


Chart 15 shows the correlation between the WEP and the metered energy quantity in 2020. Generally, the r^2 value positively correlates to the number of days when the r value is greater than 0.5.

The highest r^2 value recorded in 2020 was 0.83 in June, when there were 29 days with r value greater than 0.5, only one day shy of a complete month. This showed that the changes in the WEP observed in June 2020 were chiefly due to changes in demand.

The lowest r^2 value in 2020 occurred in November at 0.33, with 23 days when the r value was greater than 0.5. As the WEP is also dependent on factors such as fuel oil price, outage level, supply cushion and generators' offers, the impact of demand on the WEP could have been dampened by these variables, resulting in a weaker correlation in November 2020.

CHART 16: CORRELATION BETWEEN WEP AND METERED ENERGY QUANTITY FOR 2016-2020

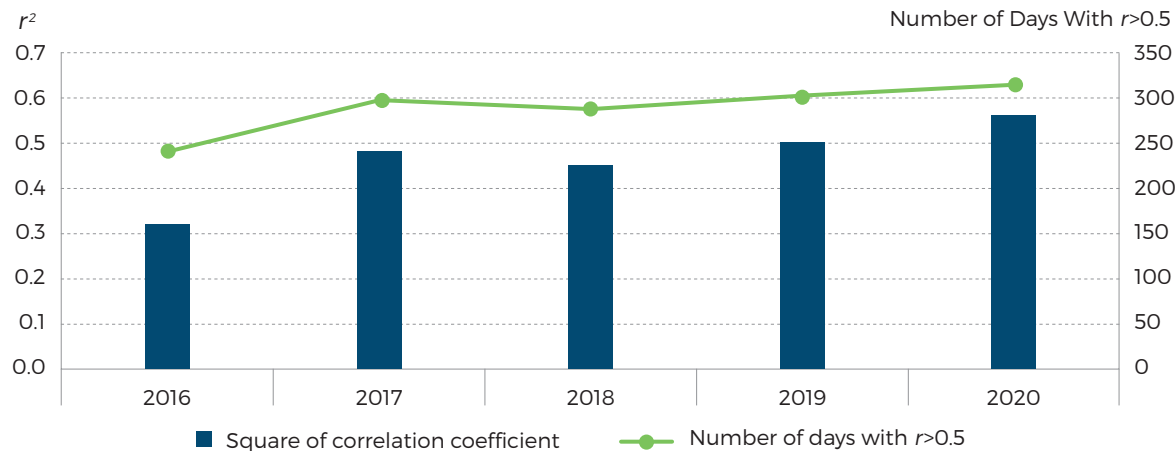


Chart 16 shows the correlation between the WEP and the metered energy quantity for the past five years.

From 2016 to 2020, both the r^2 value and the number of days with r value greater than 0.5 were generally on the rise, indicating the growing influence of demand on energy prices.

Given an r^2 value of 0.32 in 2016, changes in demand could account for about 32% of the WEP movements in 2016. The r^2 value went up to 0.56 in 2020, which meant that changes in demand could explain as much as 56% of the WEP movements in 2020.

The number of days with r value greater than 0.5 increased to almost 300 in 2017 and 2018, before exceeding 300 in 2019 and 2020. In fact, the r^2 value and the number of days with r value greater than 0.5 were the highest since 2004, after 0.58 and 317 days in 2003.

MARKET MONITORING

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

CHART 17: PERCENTAGE OF HOURS WHEN THE WEP FALLS INTO A PARTICULAR PRICE RANGE

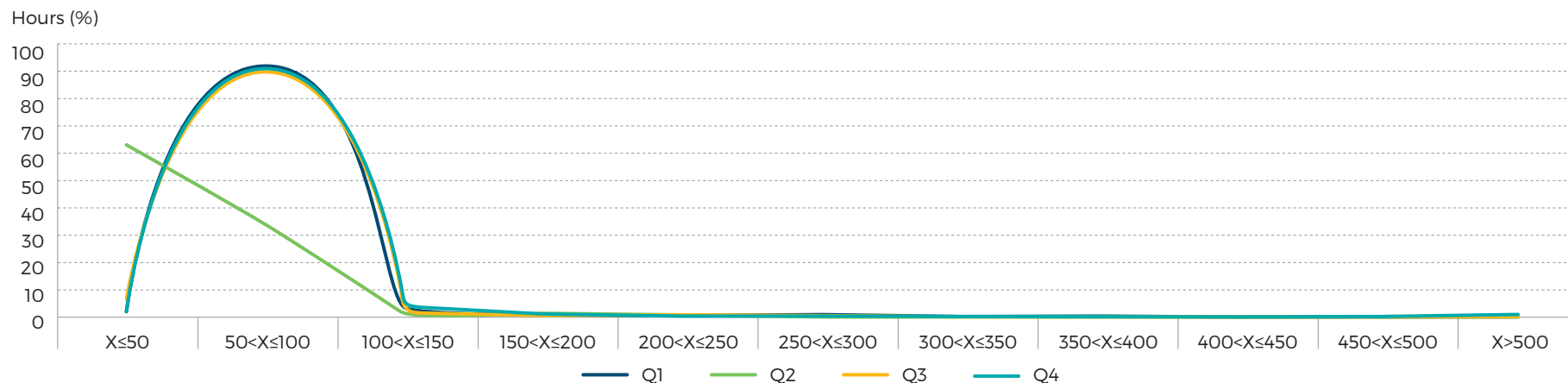


Chart 17 shows the frequency of the WEP in various price ranges, measured as a percentage of the total number of hours in each quarter of 2020. The price distribution shifted leftward from Q1 to Q2 2020 before moving rightward in Q3 and Q4 2020, reflecting the impact of the Covid-19 pandemic on energy prices in the NEMS as the economy slowed down in Q2 2020 and gradually recovered in Q3 and Q4 2020.

The WEP in Q1 2020 settled in the \$50/MWh to \$100/MWh tranche for 91.96% of the time, averaging at \$80.83/MWh. The WEP exceeded \$500/MWh for three periods which occurred on 2 February, 3 February and 5 March 2020.

In Q2 2020, the distribution of the WEP shifted leftward. The WEP fell to or below \$50/MWh for 63.07% of the time and remained between \$50/MWh and \$100/MWh for 33.86% of the time. The WEP stayed below \$250/MWh throughout the quarter and averaged at \$51.05/MWh. This reflected the low WEP in Q2 2020, when the WEP was within the lower price tranches for the majority of the hours. The monthly average WEP ranged from \$47.26/MWh to \$55.46/MWh in Q2 2020, registering the three lowest monthly average WEPs observed in 2020.

The distribution of the WEP moved rightward in the Q3 2020, leading to a higher quarterly average WEP of \$67.74/MWh, albeit lower than that in Q1. This was because the WEP was at or below \$50/MWh for only 6.45% of the time; the WEP mostly settled between \$50/MWh and \$100/MWh, for 89.81% of the time. The WEP exceeded \$500/MWh for a total of five periods on 11 August, 25 September and 28 September 2020.

In Q4 2020, the peak of the distribution of the WEP rose as the frequency of the WEP from \$50/MWh to \$100/MWh increased to 91.00% of the time. There were 40 periods where the WEP went beyond \$500/MWh, the highest frequency among the quarters in 2020. The peak periodic WEP of \$1,241.07/MWh was recorded on 20 November 2020. Therefore, the WEP averaged at \$81.64/MWh, the highest quarterly WEP in 2020.

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

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

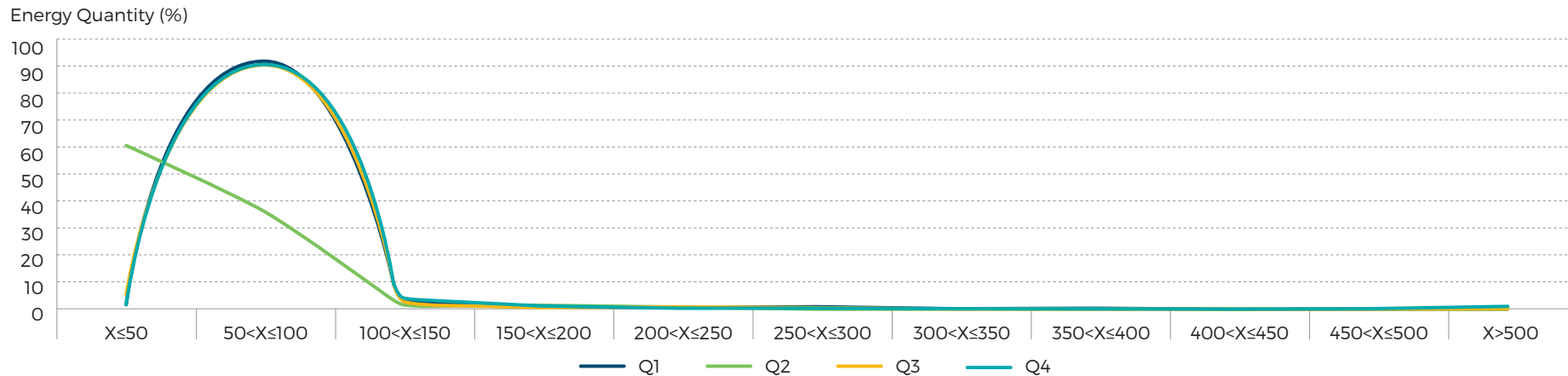


Chart 18 shows the frequency of the WEP in various price ranges, measured as a percentage of the total metered energy quantity in each quarter of 2020. The behaviour of the price distribution was very much like the one described in Chart 17 - the price distribution shifted leftward from Q1 to Q2 2020 before moving rightward in Q3 and Q4 2020, reflecting the impact of the Covid-19 pandemic on energy prices in the NEMS.

With the exclusion of Q2 2020, 90.85% of the total energy quantity in 2020 was priced between \$50/MWh and \$100/MWh. In Q2 2020, 60.55% of the total energy quantity was priced at or below \$50/MWh instead; the percentage of total energy quantity priced between \$50/MWh and \$100/MWh shrank to 36.14%. Consequently, the WEP of \$51.05/MWh in Q2 2020 was the lowest quarterly average WEP observed in 2020, at least 24.65% lower than the other three quarters.

MARKET MONITORING

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

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

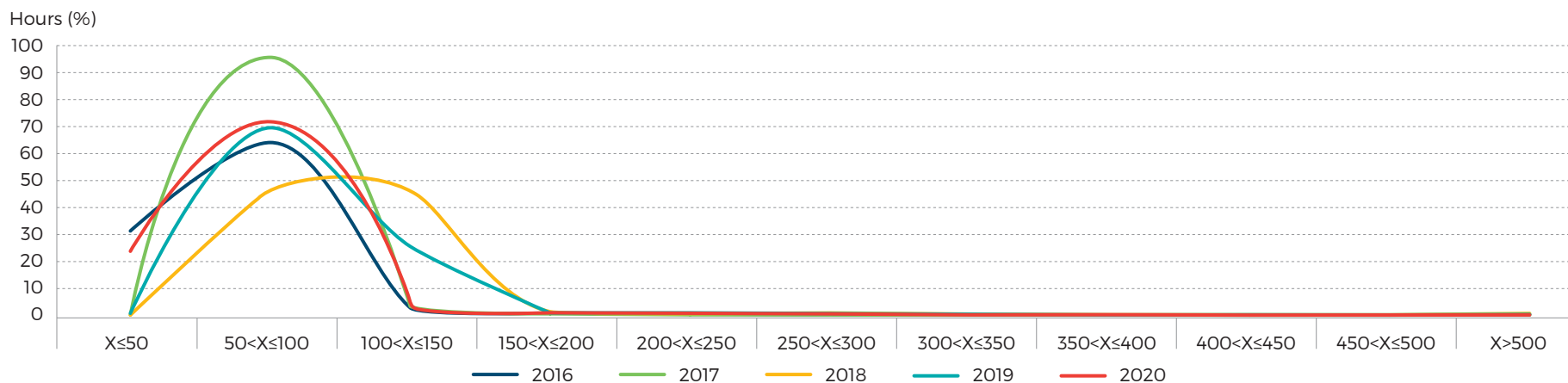


Chart 19 shows the historical price distribution for the past five years expressed as a percentage of the total number of hours in each year, to examine longer term trends.

In 2016, the WEP cleared at or below \$50/MWh 31.30% of the time and cleared between \$50/MWh and \$100/MWh 64.21% of the time. The yearly average WEP of \$63.69/MWh in 2016 was the lowest since the NEMS was established.

In 2017 and 2018, the distribution of the WEP shifted rightward as the WEP increased. The yearly average WEP rose to \$81.19/MWh in 2017 as 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. The yearly average WEP 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, the distribution of the WEP shifted leftward as the frequency with which the WEP ranged between \$50/MWh and \$100/MWh grew to 69.72% of the time and the frequency with which the WEP ranged between \$100/MWh and \$150/MWh fell to 25.55% of the time. The yearly average WEP thus dropped to \$98.63/MWh.

In 2020, the distribution of the WEP shifted leftward again, akin to the one in 2016. As it did in 2016, the 2020 WEP mostly cleared at or below \$50/MWh, or within the \$50/MWh to \$100/MWh tranche, for 18.34% and 76.70% of the time respectively.

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

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

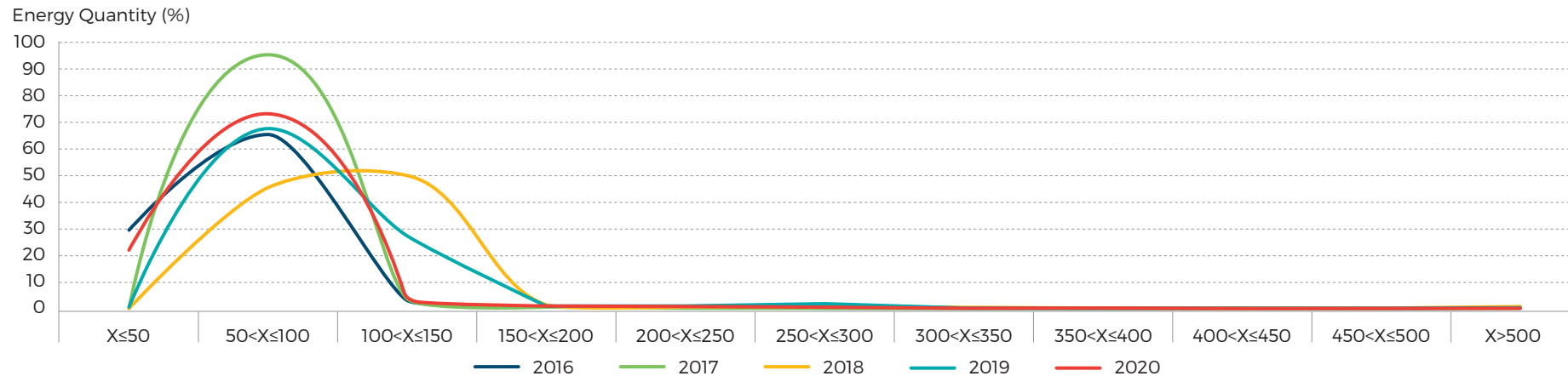


Chart 20 shows the historical price distribution for the past five years, expressed as a percentage of the total metered energy quantity in each year. As with Chart 19, Chart 20 is meant for the observation of longer-term trends.

The behaviour of the price distribution based on energy quantity would be similar to the one described in Chart 19 – the price distribution shifted rightward in 2017 and 2018 before moving leftward in 2019 and 2020.

In 2016, 29.51% of the total energy quantity was priced at or below \$50/MWh and 65.49% of the total energy quantity was priced from \$50/MWh to \$100/MWh. In 2017, this distribution of the WEP changed to 95.53% for the \$50/MWh to \$100/MWh tranche and 3.61% for the \$100/MWh to \$150/MWh tranche. Correspondingly, the WEP in 2017 was 27.48% higher than that in 2016 since a higher volume of electricity was cleared within higher price ranges.

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%. As a result, the WEP in 2018 was 36.09% higher than that in 2017.

The yearly average WEP in 2019 then decreased 10.74% from that in 2018. This was due to more energy quantity being cleared within the \$50/MWh to \$100/MWh tranche – 67.72% of the total energy quantity in 2019. In addition, less energy quantity – 27.31% – was cleared between \$100/MWh and \$150/MWh in 2019.

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.

MARKET MONITORING

PRICE INDICES: ACCURACY OF SHORT-TERM PRICE FORECAST

TABLE 13: VARIATION IN REAL-TIME USEP IN 2020 (\$/MWH)

Month	Variation between STS & Real-Time
Jan	-0.24
Feb	0.43
Mar	-0.06
Apr	-0.43
May	0.70
Jun	-0.20
Jul	-0.18
Aug	1.30
Sep	-1.06
Oct	0.24
Nov	0.91
Dec	2.82

Table 13 shows the difference in the USEP produced in the STS and the real-time dispatch schedule as a monthly average variation in 2020. 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 March 2020 were very close to the real-time USEP - only \$0.06/MWh above the real-time USEP on average. The largest monthly average variation in the USEP was observed in December 2020, when the real-time USEP was \$2.82/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 2020 was \$0.35/MWh, which meant that the forecast USEP in the STS is highly indicative of the real-time USEP, with a difference of less than a dollar per MWh on average during the year.

ANCILLARY SERVICE INDICES: RESERVE PRICES

CHART 21: PRIMARY RESERVE PRICE

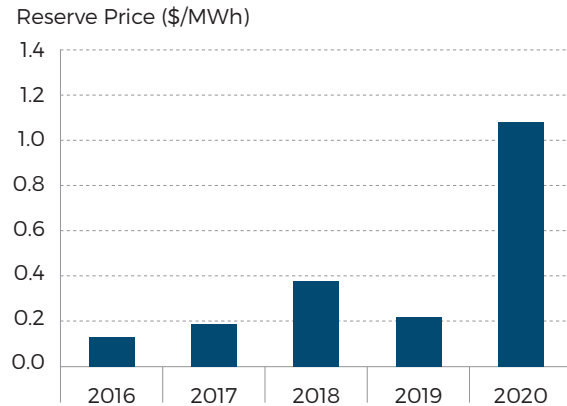


Chart 21 shows the average primary reserve¹¹ price in the NEMS for the past five years.

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 2016 to 2019, the yearly average primary reserve price remained below \$1/MWh, corresponding to the declining primary reserve requirement. During this period, the primary reserve price was at its lowest levels of \$0.13/MWh in 2016 and \$0.19/MWh in 2017.

The primary reserve price cleared at \$1.08/MWh in 2020, crossing \$1/MWh for the first time since \$1.67/MWh in 2014. The fivefold increase in the primary reserve price from \$0.22/MWh in 2019 to \$1.08/MWh in 2020 was led by a 13.56% rise in the primary reserve requirement in 2020. The higher primary reserve requirement was the result of a higher risk adjustment factor for primary reserve requirement from 1.00 to 2.00 between 25 June and 31 July 2020, to ensure secure operation and cater for a higher potential generation loss. The previous change in the risk adjustment factor for primary reserve requirement was on 15 January 2013, to 1.20.

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

CHART 22: CONTINGENCY RESERVE PRICE

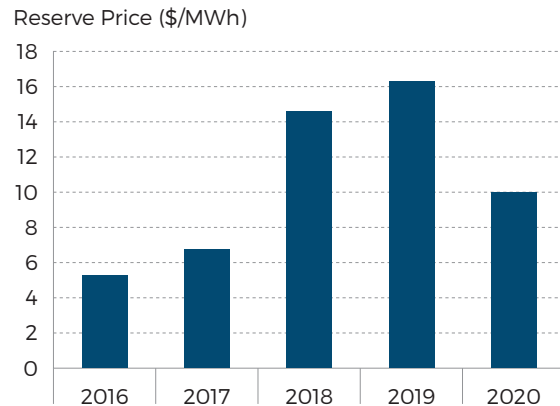


Chart 22 shows the average contingency reserve price in the NEMS for the past five years.

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 2016 to 2019, the yearly average contingency reserve price went up from \$5.27/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 lower contingency reserve price was in line with a reduction in the number of contingency reserve shortfall episodes in the NEMS from 368 instances in 2019 to 69 instances in 2020. The highest contingency reserve price was also lower in 2020 than in 2019 – the contingency reserve price peaked at \$300.00/MWh in 2020, while it reached \$1,037.97/MWh in 2019.

MARKET MONITORING

ANCILLARY SERVICE INDICES: RESERVE PRICES

CHART 23: RESERVE PAYMENT AND REQUIREMENT

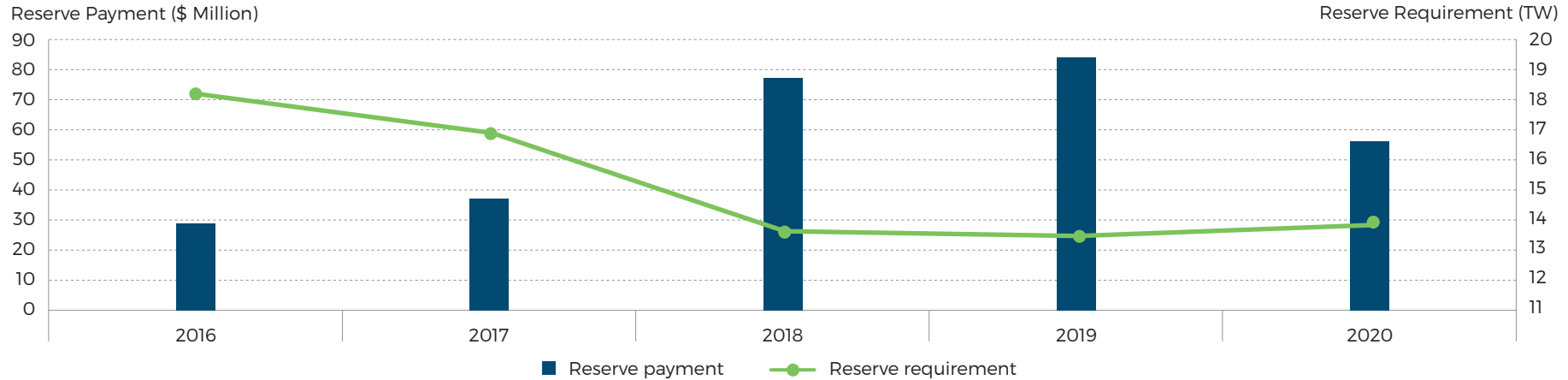


Chart 23 shows the total payment and requirement for primary and contingency reserves in the NEMS for the past five years.

The reserve payment had been increasing every year since 2016, before falling 33.50% from \$84.10 million in 2019 to \$55.93 million in 2020. Although the primary reserve price increased in 2020, the contingency reserve price dropped by a larger magnitude, resulting in a lower reserve payment for the year.

In contrast, the reserve requirement had been on a downward trend since 2016, including a drastic drop of 19.24% in 2018 that was mainly due to the removal of the secondary reserve class. Thereafter, the reserve requirement rose 2.75% from 13.45TW in 2019 to 13.82TW in 2020. As the contingency reserve requirement fell a marginal 0.32% in 2020, the higher reserve requirement was due to the increase in primary reserve requirement.

ANCILLARY SERVICE INDICES: RESERVE PRICES

CHART 24: RESERVE PAYMENT AND CONTINGENCY RESERVE PRICE

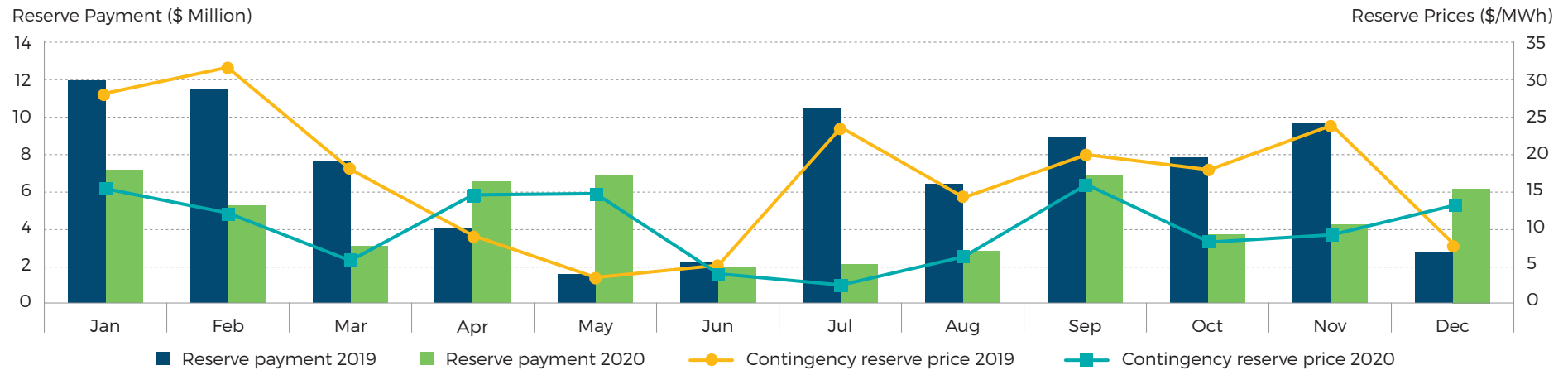


Chart 24 compares the reserve payment against the contingency reserve price between 2019 and 2020 on a monthly average basis.

Given that the contingency reserve price is typically of a larger value, ranging from \$5/MWh to \$20/MWh, than the primary reserve price which has not gone above \$2/MWh in the past decade, the contingency reserve payment tends to be the main contributor to the total reserve payment. Hence, changes in the monthly reserve payment are influenced by movements in the contingency reserve price.

Comparing 2019 and 2020, the contingency reserve price was higher in April, May and December 2020. Correspondingly, a higher total reserve payment was reported for each of these three months in 2020. The reserve payment collected in May 2020 was 4.50 times of the amount collected in May 2019, due to a similar rise in the contingency reserve price from \$3.26/MWh to \$14.51/MWh.

By the same token, the remaining nine months in 2020 recorded lower reserve payments due to lower contingency reserve prices relative to 2019. The largest YOY decrease of 80.33% in the reserve payment was from July 2019 to July 2020, coinciding with the largest drop of 90.44% in the contingency reserve price to \$2.24/MWh from \$23.39/MWh. The lower contingency reserve price implies more stability in the NEMS as the market experienced less instances of contingency reserve shortfall – there were 143 advisory notices reporting contingency reserve shortfall in 2019, compared to 39 notices in 2020.

MARKET MONITORING

ANCILLARY SERVICE INDICES: INTERRUPTIBLE LOAD

TABLE 14: IL ACTIVATIONS FOR CONTINGENCY RESERVE MARKET

Month	2019		2020	
	Instances of IL Activation	Number of Periods of IL Activation	Instances of IL Activation	Number of Periods of IL Activation
Jan	4	19	0	0
Feb	0	0	0	0
Mar	1	3	1	3
Apr	0	0	0	0
May	1	1	0	0
Jun	1	1	0	0
Jul	1	2	0	0
Aug	0	0	1	2
Sep	1	1	1	2
Oct	0	0	0	0
Nov	1	2	0	0
Dec	1	2	0	0
Sum	11	31	3	7

Table 14 compares the Interruptible Load (IL)¹² activations to provide contingency reserve between 2019 and 2020.

The IL activations were noticeably less frequent in 2020 compared to 2019, with three activations across a total duration of seven periods – three periods on 25 March and two periods each on 19 August and 25 September. The IL activations were likely to have occurred to make up for the compromised supply in the system when CCGT units encountered forced outages.

¹² 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 25: PERCENTAGE CONTRIBUTION FROM IL FOR THE TWO CLASSES OF SCHEDULED RESERVE

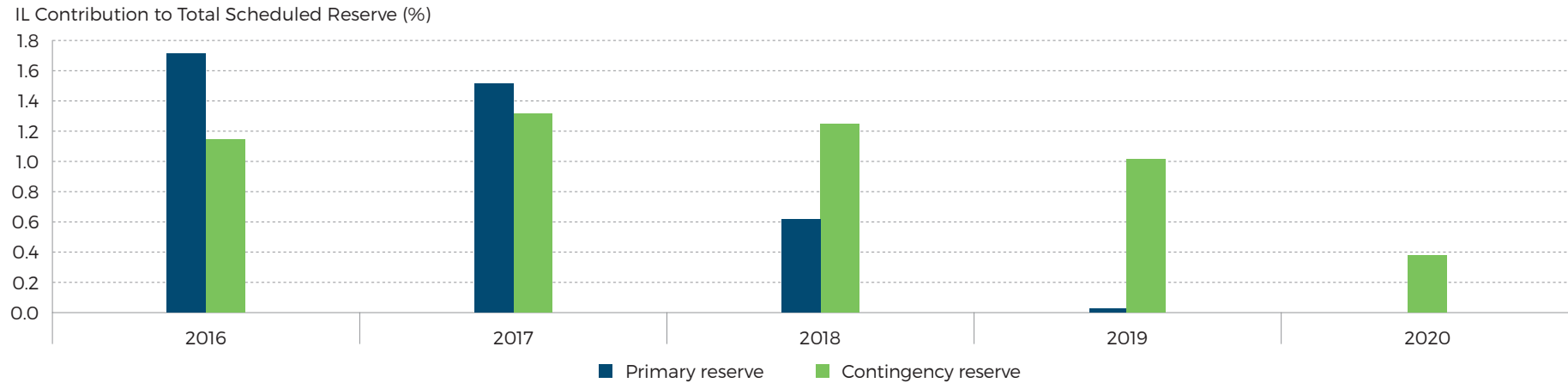


Chart 25 shows the contribution of IL to primary and contingency reserves in the past five years.

In 2016, the contribution of IL to primary reserve was 1.72%. It then contracted to 1.52% in 2017, 0.62% in 2018, 0.01% in 2019 and eventually 0.00% in 2020.

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. In 2019, the remaining IL facility did not submit offers into the market for most of the year and eventually de-registered from the NEMS on 5 October 2019. There was no IL facility providing primary reserve in 2020.

From 2016 to 2017, the contribution of IL to contingency reserve grew 0.16 percentage point to 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 and down to 0.37% in 2020. The lower contribution of IL to contingency reserve was because there were fewer IL activations in 2020.

MARKET MONITORING

ANCILLARY SERVICE INDICES: REGULATION PRICES

CHART 26: REGULATION AVAILABILITY VS REGULATION PRICE

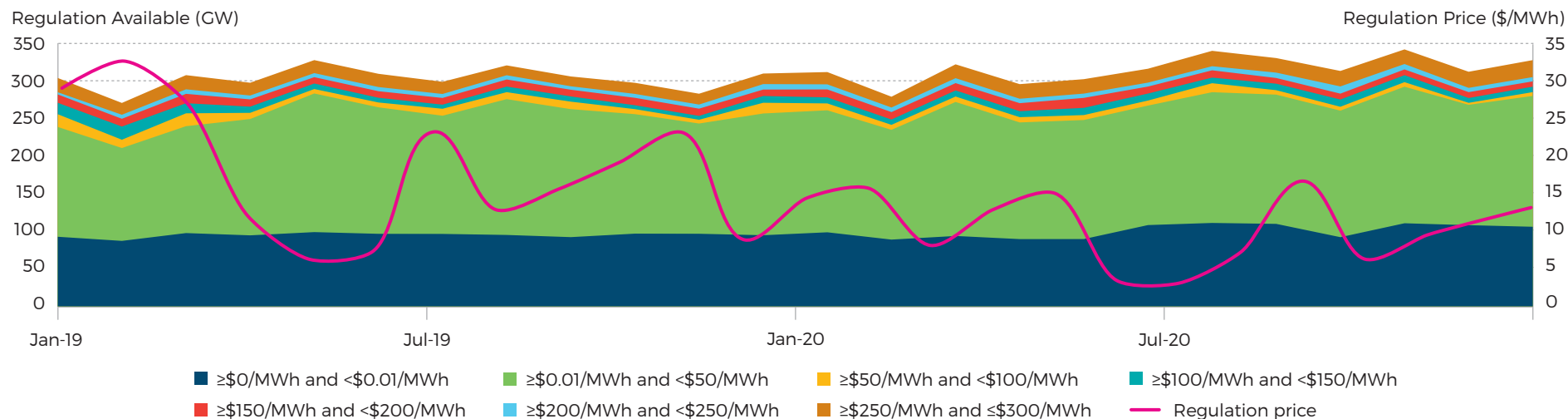


Chart 26 shows the aggregated regulation quantity offered at various price ranges and the regulation price throughout 2019 and 2020, expressed as monthly averages. Notwithstanding the fluctuations, the regulation price generally declined over the two years. The regulation price ranged from \$6.17/MWh to \$32.62/MWh in 2019; this range shifted down and narrowed to become \$3.01/MWh to \$16.62/MWh in 2020.

In 2020, the regulation availability grew 4.40% while the regulation requirement shrank 1.17%. Combining the effects of stronger supply and weaker demand for regulation, the yearly average regulation price slid 43.13% to \$10.22/MWh in 2020 from \$17.98/MWh in 2019.

There were some adjustments to the breakdown of the regulation offers in 2020: the regulation offers from the middle price tranches (between \$50/MWh and \$200/MWh) were redistributed to the lower price tranches (below \$50/MWh) and higher price tranches (between \$200/MWh and \$300/MWh). The regulation offers above \$300/MWh remained unchanged at zero. The regulation offers in the lower price tranches occupied 84.25% of the total regulation availability in 2020, up from 83.52% in 2019 while offers in the higher price tranches formed 8.10% of the total regulation availability in 2020, up from 7.03% in 2019.

It was also observed that the regulation price typically moved in the opposite direction from regulation availability, which is an expected behaviour. In 2020, when regulation availability peaked in October, the regulation price went down to \$6.21/MWh, one of the lowest levels for the year. In the same way, when regulation availability receded in February, the regulation price reached \$15.67/MWh, among the highest during the year.

ECONOMETRIC MODEL AND OUTLIER PRICES



ECONOMETRIC MODEL AND OUTLIER PRICES

Since 2007, the Market Surveillance and Compliance Panel (MSCP) Annual Report has incorporated an econometric model¹³ to identify and analyse outlier prices. The model provides a means of estimating the dependent variable Uniform Singapore Energy Price (USEP) through the use of independent variables, including the Combined Cycle Gas Turbine (CCGT) supply, Steam Turbine supply, energy supply cushion, offers below \$100/MWh, energy demand, reserve cushion and lagged fuel oil prices. The model is also adjusted to distinguish planned outages between generation types, and forced outages by month, day-of-week, and year via the use of dummy variables.

A review of the econometric model¹⁴ was conducted in 2020 to include enhancements to ensure that the model remains relevant in the evolving electricity market. The enhancements involved adding variables to create a dynamic model, control for macroeconomic impact on the USEP, address seasonality and refine the overall equation of the model. The revised model yielded better results than the previous model in terms of explanatory power, prediction accuracy and data fitness.

Table 15 shows the estimation results for the three most explanatory variables detected by the revised econometric model, as well as the model diagnostics represented by R^2 .

TABLE 15: ESTIMATION RESULTS – JANUARY 2003 TO DECEMBER 2020

Variable	Coefficient
Constant	8.89
LOG (Supply Cushion)	-1.54
LOG (Demand)	0.74
LOG (Offers Below \$100/MWh)	-0.56
Model Diagnostics	
R^2	0.87
Number of Observations	6,329

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 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:

- a 1% increase in demand raises the USEP by 0.74%;
- a 1% increase in supply cushion lowers the USEP by 1.54%; and
- a 1% increase in offers below \$100/MWh lowers the USEP by 0.56%.

The econometric model studied 6,329 observations and yielded an R^2 value of 0.87 in 2020, which meant that 87% of the changes in the USEP could be explained by the changes in the supply cushion, demand and offers below \$100/MWh. The R^2 value climbed 8.33 percentage points from 2019, which implied that the econometric model had an improved explanatory power in 2020. Apart from improvements to the econometric model, the additional 150 observations from 2020 contributed to the stronger R^2 value as well.

Another point to note would be the level of statistical significance of the variables, measured as the P-value. 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.

¹³ Further details on the previous econometric model are available in [How Market Fundamental Factors Affect Energy Prices in the NEMS – An Econometric Model](#).

¹⁴ Further details on the revised econometric model are available in [Econometric Model Design, Approach and Methodology Report – A Review of the Current Methodology](#).

ECONOMETRIC MODEL AND OUTLIER PRICES

IDENTIFICATION OF OUTLIER PRICES

CHART 27: ACTUAL VS PREDICTED LOG USEP WITHIN THREE STANDARD DEVIATIONS

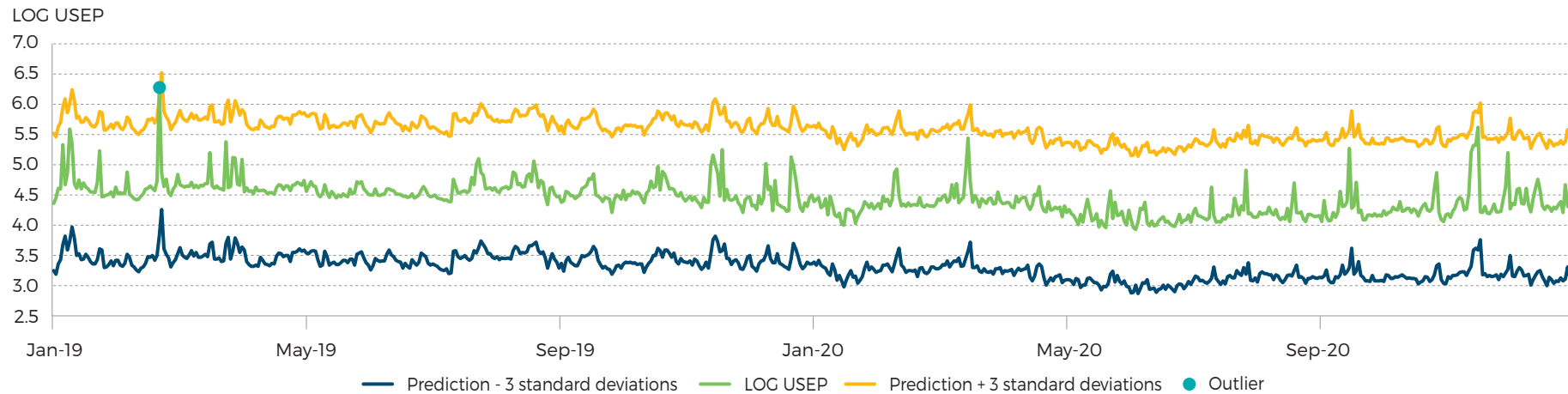


Chart 27 shows the actual daily average USEP, the upper and lower bands of the predicted daily average USEP, and the outliers identified by the revised econometric model from January 2019 to December 2020, expressed on a logarithmic scale.

In 2019, the revised model identified the USEP of \$520.58/MWh on 16 February 2019 as an outlier, exceeding the upper band of the predicted USEP of \$444.77/MWh. The market conditions that day did not support the high USEP – forecast demand was 5,664MW, which was lower than the monthly average demand of 5,821MW in February 2019; 77.55% of the offers from generation companies were priced below \$100/MWh, which was even more than the monthly average of 76.85% in February 2019. In addition, the fuel oil price and the lagged fuel oil price associated with 16 February 2019 were US\$414.47/MT and US\$369.37/MT respectively. Both prices were lower than the monthly averages of US\$451.58/MT and US\$421.72/MT.

In 2020, there was no outlier price detected by the model. This indicated that the USEP movements throughout 2020 were intuitive and largely influenced by supply- and demand-side factors, with no anomaly observed. Furthermore, it could be inferred that the NEMS became more efficient over time, as the market established a USEP which was representative of the prevailing market conditions, resulting in no outliers identified by the model.

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, the Energy Market Company 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 16 reflects the position regarding investigation and enforcement activities from the start of the market on 1 January 2003 to 31 December 2020, 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 2020

- In 2020, 12 cases of offer variations after gate closure were determined to be in breach of the Market Rules. The remaining 300 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 four cases of offer variations after gate closure.
- With regard to other cases, the MSCP completed four investigations. Three of those four cases were determined to be a breach of the Market Rules. Additionally, the MSCP made one determination on an event of default, bringing the total number of other cases closed in 2020 to five.
- The MSCP issued nine rule breach determinations. A total of \$69,500.00 in financial penalties¹⁵ was imposed across eight rule breach determinations, with \$10,000.00 being the highest financial penalty imposed on a party in breach. A non-compliance letter from the MSCP was issued for the remaining case.
- The total costs imposed on the parties in breach was \$20,300.00.
- There were no cases referred to, or initiated by, the MSCP in relation to market efficiency and fairness.

¹⁵ Financial penalties imposed by the MSCP are returned to the market as a component of the monthly energy uplift charge.

TABLE 16: INVESTIGATION AND ENFORCEMENT STATISTICS

Rule Breaches	1 Jan 2003 to 31 Dec 2020	1 Jan to 31 Dec 2020
(A) Total number of offer variations after gate closure received	37,424	306
Total number of cases closed	37,372	316
• cases in which the MSCP determined a breach	166	12
• cases in which the MSCP determined no breach	17,522	300
• cases in which the MSCP took no further action	19,684	4
(B) Origin of cases (excluding offer variations after gate closure)	202	3
• self-reports	171	2
• referrals or complaints	24	1
• initiated by the MSCP	7	0
Total number of cases closed	201	5
• cases in which the MSCP determined a breach	137	3
• cases in which the MSCP determined no breach	14	1
• cases in which the MSCP took no further action	44	0
• cases in which the MSCP made a determination on an event of default	6	1
• suspension orders	3	0
• other orders	1	0
(C) Total number of MSCP hearings	12	1
• suspension hearings	6	1
• investigation hearings	6	0
(D) Enforcement action		
• highest financial penalty imposed on a party in breach	\$842,861	\$10,000
• total financial penalties imposed on parties in breach	\$1,259,361	\$69,500
(E) Costs		
• highest award of costs imposed on a party in breach	\$43,750	\$4,800
• total costs imposed on parties in breach	\$291,025	\$20,300
Market Efficiency and Fairness		
Total number of cases	7	0
• referrals or complaints	2	0
• initiated by the MSCP	5	0
Total number of cases closed	7	0

SECTIONS 50 & 51 OF THE ELECTRICITY ACT



SECTIONS 50 AND 51 OF THE ELECTRICITY ACT

Competition-Related Provisions in the Electricity Act

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

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

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

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

Conduct constitutes an abuse if it consists of:

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

Information Requirements to Assist the EMA

The Singapore Electricity Market Rules¹⁶ (Market Rules) provide for the Market Assessment Unit (MAU), under the supervision and direction of the Market Surveillance and Compliance Panel (MSCP), to develop a set of information requirements to assist the EMA in fulfilling its obligations with respect to prohibiting anti-competitive agreements and abuse of a dominant position, under sections 50 and 51 of the Electricity Act.

The first set of information requirements was finalised in consultation with the EMA and published on 27 March 2003. As the market evolved, modifications to the information requirements were published on 18 August 2003, 28 January 2004, 3 April 2012 and 22 August 2016, with the latest modification made and published on 12 August 2020.

16 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 17: 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 that may have been received or any information that may have been uncovered that may indicate the possibility of anti-

competitive agreements, or the abuse of a dominant position, contrary to sections 50 or 51 of the Electricity Act.

The MAU, on behalf of the MSCP, also develops ad-hoc reports on any abnormal trends identified in the Uniform Singapore Energy Price, including a comprehensive analysis of the market drivers and other factors that may have contributed to the movements.

In the course of monitoring and investigative activities carried out from January to December 2020, the MAU and the MSCP did not identify any possibility of anti-competitive agreements or the abuse of a dominant position and, therefore, did not submit any report to the EMA.



ASSESSMENT OF THE WHOLESALE ELECTRICITY MARKET

ASSESSMENT OF THE WHOLESALE ELECTRICITY MARKET

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 2020 is as follows:

Market Structure and Competition

Entry of New Market Participants

Three new market participants (MPs) were registered in the National Electricity Market of Singapore (NEMS) in 2020:

TABLE 18: NEW MARKET PARTICIPANTS REGISTERED IN 2020

Date	Market Participant	Market Participant Class
7 Oct	Bioenergy Pte. Ltd.	Retailer
22 Oct	Enel X Singapore Pte. Ltd. (Enel X Singapore)	Interruptible Load (IL) provider
3 Dec	Flo Energy Singapore Pte. Ltd.	Retailer

New Facilities in the Market

In 2020, nine new intermittent generation sources (IGS) from Sembcorp Solar Singapore Pte. Ltd. were registered in the NEMS. The total registered capacity of the said facilities is 9.48MW.

Two load facilities were registered in the NEMS in 2020. On 14 August 2020, Red Dot Power Pte. Ltd. (Red Dot Power) registered its fifth IL facility providing a maximum contingency reserve of 2MW in the NEMS. Enel X Singapore also registered its first IL facility in the NEMS on 22 October 2020. The facility has a maximum contingency reserve capacity of 1.9MW.

Withdrawal of Market Participants

In 2020, two MPs withdrew their participation in the NEMS.

- Red Dot Power on 2 December 2020; and
- Changi Mega Solar Pte. Ltd. on 24 December 2020.

De-Registration of Facilities in the Market

On 17 January 2020, Sunseap Leasing Pte. Ltd. deregistered one 1.02MW IGS facility.

One generation facility belonging to Tuas Power Generation Pte. Ltd. was also de-registered from the market on 17 June 2020. This was a steam turbine unit of 600MW generation capacity.

Following the withdrawal of Red Dot Power's participation in the NEMS, its five interruptible load facilities, with a total capacity of 8.1MW, also deregistered from the market with effect from 3 December 2020.

Market Price Behaviour

Continued Drop in USEP in 2020

The Uniform Singapore Energy Price (USEP) continued to decline in 2020. The USEP dropped 28.77% to an annual average of \$70.01/MWh in 2020 from \$98.28/MWh in 2019, while the Wholesale Electricity Price decreased 28.78% to an annual average of \$70.25/MWh in 2020, from \$98.63/MWh in 2019.

The decline in electricity price was attributed to the weaker electricity demand market in 2020. The reduction in energy consumption was a result of the Government's nationwide precautionary measures in response to the Coronavirus Disease 2019 (Covid-19) pandemic, particularly the restrictions of activities during the circuit breaker period. Coupled with an economic contraction in Singapore's gross domestic product, forecasted electricity demand dropped 2.54% to 5,866MW in 2020, from 6,018MW in 2019.

The lower energy prices coincided with lower fuel oil prices. On a year-on-year basis, fuel oil prices dropped to an annual average of US\$249.13/MT in 2020, from US\$436.47/MT in 2019.

Efficiency of the Electricity Markets

Market Concentration

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

The concentration level in the generator sector has remained fairly stable in the recent years. However, there was a notable decrease in market concentration in 2020 due to the deregistration of generation facilities.

2020 recorded a 3.36 percentage points drop in market share based on maximum capacity for the top three market players to 61.34%, from 64.70% in 2019. In terms of metered energy quantity, the market share held by the three largest players in the NEMS also slipped 0.27 percentage point to 53.04% in 2020, from 53.31% in 2019.

Productive Efficiency

The year saw further improvements in productive efficiency with the increase in the market share of the most efficient generation technology, the Combined Cycle Gas Turbine (CCGT) units, in terms of both energy quantity generated and maximum capacity.

The market share of CCGT units based on metered energy quantity rose 0.13 percentage point to 98.33% in 2020, from 98.20% in 2019. There was also a minimal 0.03 percentage point increase in the market share of Steam Turbine (ST) units to 0.09% in 2020. On the other hand, the market share of Other Turbine (OT) units fell 0.16 percentage point to 1.57% in 2020 while the market share of Gas Turbine (GT) units remained the same.

ASSESSMENT OF THE WHOLESALE ELECTRICITY MARKET

STATE OF COMPETITION AND EFFICIENCY OF THE WHOLESALE ELECTRICITY MARKET

In terms of maximum capacity, the market share of CCGT units rose 7.62 percentage points to 87.65% in 2020. The market share of ST units decreased 7.94 percentage points to 8.69% in 2020 from 16.63% in 2019. The market share of the OT and OCGT units was 2.15% and 1.51% respectively.

Pricing Efficiency

Prices in the NEMS generally reflected the supply and demand conditions in 2020.

Looking Ahead

Rectification of Second Default Levy and Estimated Net Exposure Formulae

If a market participant defaults on its payment and the amount of credit support held by the EMC in respect of the market participant is insufficient to cover the market participant's net invoice amount, the current Market Rules require all non-defaulting market participants to bear default levies in proportion to their respective absolute net invoice amounts. The existing default levy arrangements provide for a first default levy, a second default levy, and multiple default levies to be applied to the market.

The review identified that the current second default levy formula did not account for the credit support claimed or drawn by the EMC in respect of a payment default and a rectification was proposed to correct it. A rectification to the estimated net exposure formula was also made to include a defaulting market participant's unpaid invoice amount.

These changes took effect from 7 January 2020.

Compensation Guidelines for Interruptible Load Facilities Interrupted for Prolonged Duration

EMC conducted a review of the compensation guidelines for load registered facilities providing interruptible load services that are interrupted beyond 120 minutes during a contingency event.

The Rules Change Panel endorsed the proposal to set a maximum interruption duration of 120 minutes of interruptible load activation, beyond which interruptible load service providers are allowed to seek compensation.

EMC also developed appropriate guidelines to calculate compensable amounts for interruptible loads interrupted beyond 120 minutes. The prevailing USEP would be used as the reference price to compute compensation amounts for load registered facilities across affected periods.

The new rules will take effect from 28 April 2021.

EMA to Trial Electricity Imports

The Energy Market Authority (EMA) announced that it would be embarking on a two-year trial for electricity imports from Peninsular Malaysia to Singapore. The trial aims to assess and refine the technical and regulatory frameworks for importing electricity into Singapore to facilitate larger-scale imports from the region in future.

A Request for Proposal (RFP) is expected to be issued by March 2021 for 100MW (i.e., about 1.5% of Singapore's peak electricity demand) of electricity imports. One importer will be selected through an open and competitive selection process. Under this RFP, electricity imports could commence as early as end-2021 via the existing electricity interconnector between Singapore and Malaysia.

Developing a Forward Capacity Market to Enhance the SWEM

Since June 2019, the EMA has consulted the industry on developing a Forward Capacity Market to enhance the Singapore wholesale electricity market (SWEM).

The SWEM is currently an energy-only market where generators are remunerated primarily based on spot energy prices. The forward capacity market was deemed suitable by EMA as a solution to achieve desired reliability in a timely manner. This was based on the experiences of other jurisdictions that have faced or are facing similar challenges regarding resource adequacy. The EMA will publish its final determination paper in due course.

ASSESSMENT OF THE WHOLESALE ELECTRICITY MARKET

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 28 compares the number of offer variations after gate closure submitted by MPs in 2020 with the previous years.

Following a record low number of offer variations after gate closure cases seen in 2019, this number continued to fall 10.53% in 2020 to a new record low of 306. The further reduction in the number of offer variations after gate closure was the result of fewer forced outages in 2020 and demonstrates the efficient provision of reliable energy supplies to the market.

The MSCP has completed and issued determinations on 257 of the 306 offer variations made after gate closure cases in 2020. Of the 257 cases, 246 cases were assessed to not have been in breach of the Market Rules. The MSCP decided to take no further action on four cases and issued rule breach determinations on seven cases. The remaining 49 cases are scheduled to be discussed for the MSCP's determination in 2021.

CHART 28: OFFER VARIATIONS MADE AFTER GATE CLOSURE

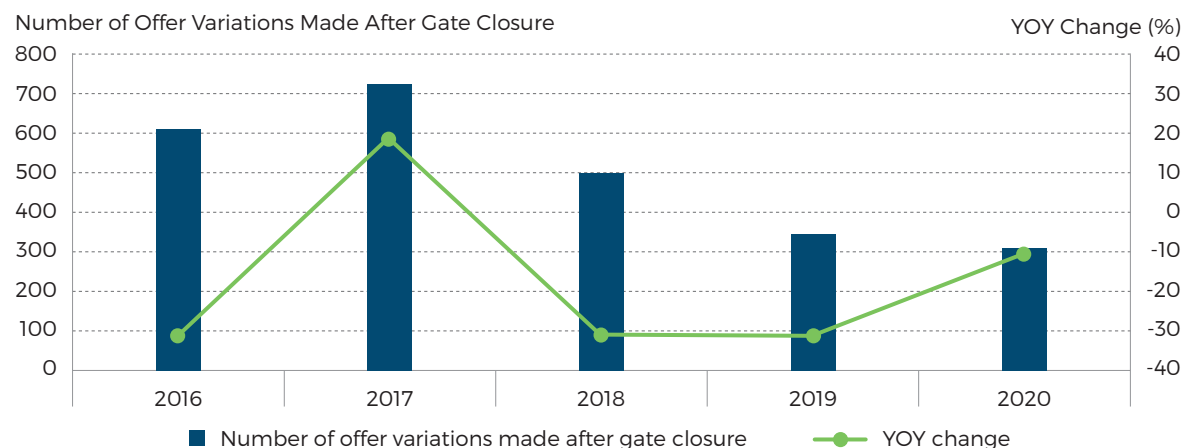


TABLE 19: OFFER VARIATIONS MADE AFTER GATE CLOSURE

Year	Number of Offer Variations Made After Gate Closure	YOY Change (%)
2016	606	-31.45
2017	719	18.65
2018	497	-30.88
2019	342	-31.19
2020	306	-10.53

Rule Breach Determinations Issued

For the period 1 January to 31 December 2020, the MSCP issued nine determinations regarding rule breaches.

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

Six MSCP rule breach determinations were issued in 2020 in relation to 12 offer variations after gate closure events:

- [Sembcorp Cogen Pte Ltd's](#) offer variations after gate closure on 24 and 25 November 2019.
- [Sembcorp Cogen Pte Ltd's](#) offer variation after gate closure and failure to submit offer variation to reflect generating capability on 30 November 2019.

ASSESSMENT OF THE WHOLESALE ELECTRICITY MARKET

STATE OF COMPLIANCE WITHIN THE WHOLESALE ELECTRICITY MARKET

- [Senoko Energy Pte. Ltd.'s](#) offer variation after gate closure on 3 December 2019.
- [ExxonMobil Asia Pacific Pte. Ltd.'s](#) offer variations after gate closure for 26 March 2020.
- [ExxonMobil Asia Pacific Pte. Ltd.'s](#) offer variations after gate closure on 24 May 2020.
- [ExxonMobil Asia Pacific Pte. Ltd.'s](#) offer variations after gate closure on 13 August 2020.

Failure to Comply with the Declared Quantities

The MSCP also issued one determination against TP Utilities Pte. Ltd. with regard to the non-compliance of their declared quantity (i.e., the energy offer quantity in the first price-quantity pair) with the Market Rules.

- [TP Utilities Pte. Ltd.'s](#) declared quantity on 5 November 2019.

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

EMC was served two rule breach determinations from the MSCP, one for its breach occurring in October 2019 and another in June 2020.

- [Energy Market Company Pte Ltd's](#) incorrect final settlement documents for 24 and 25 October 2019.
- [Energy Market Company Pte Ltd's](#) failure to determine, release and publish real-time dispatch schedule and short-term schedule on 28 June 2020.

The number of rule breach determinations issued in 2020 remained at nine, same as the previous year.

However, there was an increase in the number of rule breach determinations made in relation to offer variations after gate closure, from two in 2019 to six in 2020. 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 the said Market Rules in 2020.

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

The MSCP receives information from the EMC when a notice of default¹⁷ 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 circumstances¹⁸ 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 the 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 2020, EMC issued a total of 78 default notices to market participants, in comparison to six notices of default issued in 2019. The MSCP also received one request from

EMC to issue a suspension order to a defaulting market participant. A suspension hearing was conducted and concluded as per the Market Rules. During 2020, no suspension orders to market participants were issued by the MSCP. The MSCP and MAU continue to be vigilant and committed in their monitoring and actions in accordance to 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 2020, ten generation companies were issued with automatic financial penalties amounting to a total sum of \$205,731.00.

Since the inception of the scheme, there has been a decrease in the penalties collected under the AFPS. This reflects an improvement in the generators' compliance with dispatch schedules.

In 2020, the market also saw a financial penalty imposed on a load registered facility under the AFPS, for a sum of \$82,670.00.

TABLE 20: 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

17 A default notice is a notice issued by the 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.

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

CONCLUSION

The image features a person's hands in the foreground, with one hand holding a pen and pointing towards a laptop screen. The background is a blurred office setting. Overlaid on the image are several digital graphics: a line graph with data points on the left, a bar chart in the lower-left, a network of nodes and lines on the right, and various circular and rectangular patterns in the bottom corners. The overall color palette is dominated by blues and oranges, with a soft, glowing light effect.

The Market Surveillance and Compliance Panel (MSCP) is generally satisfied with the state of compliance in the National Electricity Market of Singapore (NEMS) in 2020. The MSCP issued nine rule breach determinations over the year. The number of offer changes made after gate closure declined from 342 to 306 and six determinations were issued by the MSCP. The improved total gate closure cases recorded in 2020 reflect the MSCP's reinforcement efforts in ensuring that market participants are compliant with the Singapore Electricity Market Rules (Market Rules) and the effectiveness of the implementation of the remedial actions by the relevant market participants to minimise recurrence.

Rule breaches and gate closure violations were found not to have had 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.

During 2020, the Wholesale Electricity Price recorded a 28.78% drop in its annual average price from 2019, mainly driven by the impact of the Coronavirus Disease 2019 (Covid-19) pandemic on the market. This was evidenced by lower fuel oil prices as global demand for oil went down, and a decline in electricity demand, as businesses' operations and industrial sectors were halted. This was coupled with a contraction of the Singapore economy - impacted by the restrictions of the Circuit Breaker and the international economic situation.

Under these circumstances, the number of default notices issued by Energy Market Company to market participants rose significantly to a record number of 78 in 2020, compared to only six in 2019. Nevertheless, no suspension orders were issued by the MSCP to any market participant in 2020, as had been the case in 2019. The MSCP considers it relevant to highlight that, along with the MAU, we continued to take prompt

actions in accordance with the Market Rules in order to ensure that the MSCP's determinations and orders are made to safeguard the financial integrity of the wholesale market.

In the MSCP and the MAU's efforts to continue improving the market surveillance and monitoring processes, a review of the econometric model that serves as a helpful tool to identify price outliers has been successfully conducted and applied to the 2020 outlier price analysis. The MSCP is pleased to count with an enhanced model that has not only improved in its explanatory power, prediction accuracy, and data fitness, but will also continue to be relevant to the NEMS framework over time. During 2020, the improved econometric model identified zero instances of outlier prices, in comparison to two high price events identified by the previous model in 2019.

Further improvements in productive efficiency were seen in 2020, with the increase in the market share of the most efficient generation technology, the Combined Cycle Gas Turbine units, in terms of both energy quantity generated and maximum capacity. Additionally, the share of the top three market players reduced from 2019 to 2020, both in terms of maximum capacity and metered energy quantity, reflecting an improvement in market competition. Moreover, the market share was further distributed based on maximum capacity by a reduction in supply by steam turbine units that retired from the market. This was observed in the context of a moderately concentrated market.

As for the market's composition, three new market participants joined the NEMS in 2020 - two under the retailer market participant class and one under the interruptible load provider market participant class. The NEMS' total registered capacity also increased with nine additional intermittent generation facilities entering the market, bringing the total to 60 units with a collective capacity of 135.807MW. On top of this, two load facilities registered in the NEMS provide additional contingency reserve.

Notwithstanding the challenging circumstances due to the Covid-19 pandemic, 2020 saw new initiatives such as the Energy Market Authority (EMA) announcement of a trial to import electricity from Peninsular Malaysia to Singapore. The trial aims to assess and refine the technical and regulatory frameworks for importing electricity into Singapore to facilitate larger-scale imports from the region in the future. The EMA has also consulted the industry to develop a Forward Capacity Market, a market mechanism to achieve reliability objectives in a timely manner.

In line with the above-mentioned initiatives, new rule modifications were also introduced to review and improve the existing processes established in the NEMS, such as the rectification of second default levy and estimated net exposure formulae, and the compensation guidelines for interruptible load facilities interrupted for a prolonged duration. All in all, these developments will bring about a more competitive and dynamic electricity industry for the years to come.

The MSCP looks forward to the continuous evolution of the industry to greater heights and will persist with its commitment to enforce compliance with the Market Rules, supported by the MAU's monitoring and surveillance activities, investigations of alleged rule breaches, and advisory functions to the Panel on enforcement actions to make sure that the market consolidates its path towards a more efficient and effective operation.



Mr T P B Menon
Chairman
Market Surveillance and Compliance Panel

USER GUIDE



Data

- Due to rounding, numbers presented throughout this report may not add up precisely to the totals indicated, and percentages may not precisely reflect the absolute figures for the same reason.
- All real-time and forecast prices and settlement data are provided by Energy Market Company.
- LNG Vesting Prices are provided by SP Services Limited (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 21: 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:
 - 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
 - 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 outages 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.

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