National Electricity Market of Singapore

MARKET REPORT 20

CONTENTS

THE NEMS IN 2020 – AT A GLANCE

Total registered capacity of generators fell **4.7%**

13 new facilities were added in the market

2 new electricity retailers joined the market

Forecasted demand declined **2.5%**

Electricity consumption shrank **1.7%**

Number of forced outages fell **18.3%**

Generation supply decreased **4.3%**

Annual value of products traded dropped **29.5%**

Uniform Singapore Energy Price (USEP) plunged **28.8%**

Combined market share of top 3 generation companies fell to **53.0%**

Market share of SP Services fell below that of an electricity retailer to **16.1%**

LETTER FROM THE CHAIRMAN

Dear Industry Members

2020 was an exceptional year for the global energy sector.

Government-imposed lockdowns to curb the spread of Covid-19 significantly reduced economic activity worldwide, leading to a sharp fall in oil prices as the demand for energy products plummeted.

Electricity consumption, closely correlated with economic activity, also took a hit. The International Energy Agency projects that global electricity consumption fell by 2 percent in 2020[1].

In line with these global trends, Singapore's economy contracted 5.4 percent[2] and electricity consumption fell 1.7 percent[3] in 2020. This was the first annual drop in electricity consumption since the start of the National Electricity Market of Singapore (NEMS) in 2003.

Wholesale price movements during the year were mostly consistent with demand and supply changes, as they should be in well-functioning competitive markets. The drop in electricity demand, coupled with a 32 percent plunge in fuel oil price, caused the Uniform Singapore Energy Price (USEP) to fall 28.8 percent to $70.01/MWh which was the second lowest annual level since the market started.

Notwithstanding the challenging environment brought about by the pandemic, I am heartened that we continued to see new investments in the NEMS. Apart from two new market participants, 13 new facilities were added in the market. Building on momentum seen in the last two years, most of these new facilities are intermittent generation source facilities. Although the total registered capacity in the market saw a slight dip of 4.7 percent, this was largely due to the de-registration of an inactive and less efficient 600MW steam turbine unit. Singapore's reserve margin remained strong, when the registered capacity of 11,861MW was measured against the peak demand of 7,000MW.

Competition in the retail market remained robust. For the first time in the market's history, the market share of SP Services (which continues to supply customers buying electricity at the regulated tariff) fell below that of an electricity retailer, demonstrating the success of the Open Electricity Market as more consumers switched from the regulated tariff to the competitive packages offered by the retailers.

Finally, as a prudent market operator, we continued to safeguard the financial integrity of the wholesale market in 2020. Although a record number of 78 default notices[4] were issued, no default levy needed to be recovered from the market as the defaults were either remedied or sufficient credit support was secured.

1 *"Electricity Market Report – December 2020", International Energy Agency.*
2 *"MTI Maintains 2021 GDP Growth Forecast at "4.0 to 6.0 Per Cent"", Ministry of Trade and Industry, Singapore.*
3 *Annual electricity consumption fell 1.7 percent to 50.7 terawatt hours in 2020.*
4 *A default notice is issued when a market participant fails to remit the amount due to the EMC settlement clearing account by the end of the business day following its payment due date. The majority of the 78 default notices arose from the defaults of one market participant.*

ENERGY MARKET COMPANY:

LETTER FROM THE CHAIRMAN

We are committed to further fortify the financial resilience of the market and will continue to review and refine the mechanisms in place.

In a difficult year that was severely disrupted by Covid-19, the safety and morale of our staff, as well as the continuity of the NEMS' operations, were top priorities for Energy Market Company (EMC). I am extremely proud of the strength and adaptability of the EMC team who kept the wholesale market operating seamlessly even when the whole company was working from home. I am equally grateful to our regulator, market participants, governance panels and other partners for their tremendous understanding and support, as the team introduced new work processes and adjusted to the 'new' normal.

With the arrival of the Covid-19 vaccines and Singapore cautiously entering into the final phase of safe re-opening at the end of 2020, I am optimistic that our economy will see a gradual recovery in the new year. For the power sector, two issues will have a significant impact on Singapore's energy future.

The first is the long-term sustainability and reliability of our power system. Demand for electricity is anticipated to grow in the medium- to long-term as our economy recovers. The government has been consulting the industry on the Forward Capacity Market (FCM) to complement the existing spot market. The FCM aims to ensure a reliable supply of electricity to meet our future demand by providing incentives to existing and new resource suppliers, while minimising long-run costs to consumers. When implemented, the FCM will transform the NEMS from an 'energy-only' to an 'energy-plus-capacity' market, and will involve significant changes to the NEMS' systems. EMC is in discussions with the Energy Market Authority and other industry stakeholders on the implementation approach and details.

The second issue is the transition to cleaner generation sources to meet our energy needs, as Singapore tackles the global challenge of climate change. In this respect, the two-year trial to import 100MW of electricity from Peninsular Malaysia could pave the way for Singapore to gain access to 'green' energy resources around the region to supplement local renewable investments. In the longer run, it could also contribute towards greater integration of regional energy markets and the development of the ASEAN Power Grid. The trial aims to assess and refine the technical and regulatory frameworks for importing electricity into Singapore, and will help us understand the impact of electricity imports on Singapore's wholesale market and power system. EMC will play an enabling role to facilitate the import and trading in the wholesale electricity market, by establishing the relevant Market Rules and effecting the necessary system changes.

I am excited about these developments which will create a more vibrant NEMS, as well as a more sustainable and reliable energy future for Singapore.

Agnes Koh
Chairman
Energy Market Company


MARKET
OVERVIEW

MARKET HISTORY

The National Electricity Market of Singapore (NEMS) opened in January 2003 – the culmination of several structural reforms to Singapore's electricity industry.

Singapore's journey to liberalisation traces back to October 1995, when industry assets were first corporatised. In 1998, the Singapore Electricity Pool, a day-ahead market, commenced operation to facilitate competitive bidding among power generation companies. By 2001, the introduction of a new legal and regulatory framework formed the basis for a new electricity market.

The NEMS is an integral part of Singapore's overall energy policy framework, which seeks to balance the three policy objectives of economic competitiveness, energy security, and environmental sustainability. The NEMS places Singapore alongside an international movement to introduce market mechanisms into the electricity industry so as to:

- increase economic efficiency through competition;
- attract private investment;
- send accurate price signals to guide production and consumption decisions;
- encourage innovation; and
- provide consumer choice.

Market Reform Milestones

Corporatisation

1995	Electricity functions of the Public Utilities Board corporatised Singapore Power formed as a holding company
1996	Singapore Electricity Pool (SEP) design process began

Singapore Electricity Pool (SEP)

1998	SEP commenced PowerGrid is SEP Administrator and Power System Operator (PSO)

National Electricity Market of Singapore (NEMS)

2000	Decision for further reform to obtain full benefits of competition New market design process began
2001	Electricity industry legislation enacted Energy Market Authority established as industry regulator and PSO Energy Market Company established as the NEMS wholesale market operator First phase of retail contestability (retail contestability threshold gradually lowered in subsequent years)
2003	NEMS wholesale market trading began
2004	Vesting contract regime introduced Interruptible loads (IL) began to participate in the reserves market
2006	First wholesale market trader joined the market and commenced trading as IL provider First commercial generator since 2003 joined the market and started trading
2008	Sale of Tuas Power to China Huaneng Group in March, Senoko Power to Lion Consortium in September, and PowerSeraya to YTL Power in December Embedded generators (EG) joined the market
2009	New EGs, small generators and incineration plants joined and started trading
2010	Vesting tender introduced to tender out a percentage of non-contestable electricity demand to generation companies for bidding
2012	NEMS completed ten successful years of trading
2013	Singapore's Liquefied Natural Gas (LNG) terminal started commercial operations LNG vesting contract introduced
2015	Electricity futures trading commenced
2016	Demand Response programme introduced
2018	Open Electricity Market (OEM) launched and rolled out in stages
2019	Rollout of OEM across Singapore completed Vesting contract regime rolled back to LNG vesting contract level

Participants and Service Providers in the NEMS

Generators

ExxonMobil Asia Pacific
Keppel Merlimau Cogen
Keppel Seghers Tuas Waste-to-Energy Plant (Tuas DBOO Trust)
National Environment Agency
PacificLight Power
Sembcorp Cogen
Senoko Energy
Senoko Waste-to-Energy
Shell Eastern Petroleum
Singapore Refining Company
TP Utilities
Tuas Power Generation
TuasOne
Tuaspring
YTL PowerSeraya

Wholesale Market Traders

Air Liquide Singapore
Changi Mega Solar*
Enel X Singapore
Green Power Asia
JE Green Solutions
LYS Genco Beta
MSD International GmbH (Singapore Branch)
Public Utilities Board
Red Dot Power*
Sembcorp Solar Singapore
Singapore District Cooling
Singapore LNG Corporation
Sun Electric Energy Assets
Sunseap Leasing
Sunseap Leasing Beta
Terrenus Energy

Retailers

Best Electricity Supply
Bioenergy
Cleantech Solar Singapore Assets
Diamond Energy Merchants
Flo Energy Singapore
GreenCity Energy
Hyflux Energy
I Switch
Just Electric
Keppel Electric
MyElectricity
Ohm Energy
PacificLight Energy
Sembcorp Power
Senoko Energy Supply
Seraya Energy
SilverCloud Energy
Sun Electric Power*
Sunseap Energy
Tuas Power Supply
UGS Energy
Union Power

Market Support Services Licensee

SP Services

Market Operator

Energy Market Company

Power System Operator

Power System Operator

Transmission Licensee

SP PowerAssets

* *Red Dot Power, Changi Mega Solar and Sun Electric Power withdrew from the market in December 2020. However, as Sun Electric Power's last trading day was 31 December 2020, it was included in the total number of retailers at the end of 2020.*

INDUSTRY STRUCTURE

Singapore's electricity industry is structured to facilitate competition in its wholesale and retail markets. Competitiveness is achieved by separating the ownership of the contestable parts of the industry from those with natural monopoly characteristics.

Market Participant Changes in 2020

In 2020, the NEMS welcomed two new retailers – Bioenergy and Flo Energy Singapore. This brought the total number of market participants (MPs) in the NEMS to 51 at the end of 2020, comprising 15 generators, 14 wholesale market traders and 22 retailers.

Generation Licensees

Generation licensees are companies with generating facilities of 10MW or more that are connected to the transmission system and licensed by the EMA to trade in the wholesale electricity market.

Wholesale Market Traders

Wholesale market traders are companies, other than generation licensees or retail licensees, that are licensed by the EMA to trade in the wholesale electricity market. Wholesale market traders include companies with generating facilities of less than 10MW, companies that offer their own loads to be interrupted, as well as companies that provide services to other consumers interested in offering their loads to be interrupted.

Retail Electricity Licensees

Retail electricity licensees are companies that are licensed by the EMA to sell electricity to contestable consumers. Retail electricity licensees that are registered as MPs purchase electricity directly from the wholesale market.

Market Support Services Licensee — SP Services

A Market Support Services Licensee (MSSL) is authorised to provide market support services. Such services include facilitating customer transfers between retailers, meter reading and meter data management. SP Services is the only MSSL. In addition to its market support services function, SP Services also facilitates access to the NEMS for contestable consumers who have not appointed a retailer, and supplies electricity to non-contestable consumers.

Market Operator — EMC

Energy Market Company (EMC) operates and administers the wholesale market. This role includes calculating prices, scheduling generation, clearing and settling market transactions, and procuring ancillary services.
EMC also administers the rule change process and provides resources that support the market surveillance and compliance, and dispute resolution processes.

Transmission Licensee — SP PowerAssets

SP PowerAssets owns and is responsible for maintaining the transmission system.

Power System Operator

The Power System Operator (PSO), a division of the EMA, is responsible for ensuring the security of electricity supply to consumers. The PSO controls the dispatch of generation facilities, co-ordinates scheduled outages, oversees power system emergency planning, and directs the operation of the high-voltage transmission system. The PSO also oversees the real-time operation of the natural gas transmission system.

Regulator — EMA

The Energy Market Authority (EMA) is the regulator of the electricity and gas industries and has the ultimate responsibility for the market framework and for ensuring that the interests of consumers are protected.

Consumers

Consumers are classified as either contestable or non-contestable. Contestable consumers purchase electricity from a retailer or from the wholesale market. Non-contestable consumers purchase electricity from SP Services at the regulated tariff.

MARKET FEATURES

The NEMS has a number of features that drive efficiency and make its design truly world-class. These include:

- **co-optimisation of energy, reserve and regulation products;**
- **security-constrained dispatch and nodal pricing;**
- **near real-time dispatch; and**
- **a Demand Response (DR) programme.**

Co-optimisation of Energy, Reserve and Regulation Products

A sophisticated process involving about 50,000 different mathematical equations is used to determine the price and quantity of the energy, reserve and regulation products traded. Integral to this process is the concept of co-optimisation, wherein the market clearing engine (MCE) considers the overall costs and requirements of all products, and then selects the optimal mix of generation and load registered facilities to supply the market.

Security-Constrained Dispatch and Nodal Pricing

To determine the prices for products traded on the wholesale market, offers made by generators and interruptible loads (ILs) are matched with the system demand forecast and system security requirements. The MCE produces a security-constrained economic dispatch by taking into account the:

- available generation capacity;
- ability of generation capacity to respond (ramping);
- relationship between the provision of energy, reserves and regulation (co-optimisation);
- power flows in the system;
- physical limitations on the flows that can occur in the transmission system;
- losses that are incurred as power is transported; and
- constraints in relation to system security.

This process is run half-hourly to determine the:

- dispatch quantity that each generation unit is to produce and each load facility in the DR programme is to curtail (see details of DR programme on page 9);
- reserve and regulation capacity that each generation unit is required to maintain;
- level of IL that is scheduled; and
- corresponding prices for energy, reserves and regulation in the wholesale market.

Energy, Reserve and Regulation Products

	Description	Purchaser	Seller
Energy	Generated electricity	Retailers	Generators
Reserve	Stand-by generation capacity or interruptible loads (ILs) that can be drawn upon when there is an unforeseen shortage of supply Two classes of reserves are traded: 1) primary reserve (9-second response); and 2) contingency reserve (10-minute response)	Generators	Generators, Retailers and Wholesale Market Traders
Regulation	Generation that is available to fine-tune the match between generation and load	Generators and Retailers	Generators

MARKET FEATURES

Energy prices – referred to as nodal prices – vary at different points on the network. The differences in nodal prices reflect both transmission losses and the physical constraints of the transmission system. This means that the true costs to the market of delivering electricity to each point on the electricity network are revealed.

The MCE models the transmission network and uses linear and mixed integer programming to establish demand and supply conditions at multiple locations (nodes) on the network. Modelling ensures that market transactions are structured in a physically feasible manner, given the capacity and security requirements of the transmission system. For each half-hour trading period, the MCE calculates the prices to be received by generators at the 113 injection nodes, and the prices at up to 873 withdrawal or off-take nodes[5] that are used as the basis for the price to be paid by customers. This method of price determination encourages economically-efficient scheduling of generation facilities in the short term and provides incentives to guide new investment into the power system infrastructure in the long term.

EMC uses metered demand and generation from the MSSL and market prices to settle market transactions on a daily basis. Generators receive the market price for energy that is determined at their point of connection to the transmission network (injection node). Retailers pay the Uniform Singapore Energy Price (USEP) for energy, which is the weighted-average of the nodal prices at all off-take nodes.

Generators pay for reserves according to how much risk they contribute to the system. Regulation is paid for by retailers in proportion to their energy purchases and by dispatched generators up to a ceiling of five megawatt hours for each trading period.

Near Real-Time Dispatch

Market prices and dispatch quantities for energy, reserves and regulation are calculated five minutes before the start of each half-hour trading period. This ensures that the market outcomes reflect prevailing power system conditions, the most recent offers made by generators, as well as the most recent bids made by demand response aggregators and/or retailers. The result of near real-time calculation of dispatched generation quantities ensures as little real-time intervention as possible and hence minimal deviation from a competitive market solution.

To support near real-time dispatch, EMC produces market forecast schedules up to a week ahead of the relevant trading period. These forecast schedules increase in frequency as the trading period approaches to ensure that MPs have the information they need to adjust their trading positions prior to physical dispatch.

Demand Response Programme

In April 2016, a new milestone was reached in the NEMS. A DR programme was introduced to allow consumers to submit bids in the energy market for the purpose of providing load curtailments. Loads located in the same zone can be aggregated and registered as a single load registered facility (LRF) in the market. These LRFs can submit energy bids if they satisfy the necessary requirements, and the MCE will schedule them for load curtailment in a given dispatch period. Scheduled and compliant load curtailments will receive incentive payments, which are calculated based on the estimated falls in the USEP across all non-regulatory loads. These incentive payments will be recovered from contestable consumers through the hourly energy uplift charges.

An ex-post assessment, comparing actual metering data with the expected consumption based on the LRFs' dispatch schedules, will be conducted. LRFs that are scheduled for curtailment have to reduce their consumption accordingly, while LRFs that are not scheduled for curtailment have to consume at their non-curtailed level. Financial penalties will be imposed on LRFs that are deemed to have deviated from their dispatch schedules, and all financial penalties collected will be returned to the market via the monthly energy uplift charges.

5 *Numbers of injection and withdrawal nodes as at 31 December 2020.*


MARKET
GOVERNANCE

Governing Documents and Institutions

The Energy Market Authority (EMA) was established under the Energy Market Authority of Singapore Act 2001. The EMA is the electricity market regulator under the Electricity Act 2001 and is responsible for, among other mandates:

- creating the market framework for electricity and gas supply;
- promoting the development of the electricity and gas industries;
- protecting the interests of consumers and the public;
- issuing licences; and
- advising the Government on energy policies.

Rule Change Process

The day-to-day functioning of the National Electricity Market of Singapore (NEMS) wholesale market is governed by the Singapore Electricity Market Rules.

The rule change process is the responsibility of the Rules Change Panel (RCP). Appointed by the Energy Market Company (EMC) Board, RCP members represent generators, retailers, wholesale market traders, the financial community, the Power System Operator (PSO), the Market Support Services Licensee (MSSL), the transmission licensee, electricity consumers and EMC, ensuring representation by all key sectors of the industry.

The rule change process is designed to maximise transparency and opportunities for public involvement. Rule modifications recommended by the RCP require the support of the EMC Board and the EMA.

When approving changes to the Market Rules, the EMA is required to consider whether the proposed rule modifications (i) unjustly discriminate in favour of or against a market participant (MP) or a class of MPs; or (ii) are inconsistent with the functions and duties of the EMA under subsection 3(3) of the Electricity Act.

The RCP is supported by EMC's Market Administration team, which provides economic analysis of rule modification proposals and makes recommendations to the RCP. Each year, EMC publishes the RCP's work plan on its website to ensure that stakeholders remain informed about the likely evolution of the market.

Market Surveillance and Compliance

The Market Surveillance and Compliance Panel (MSCP) monitors and investigates the conduct of market entities, as well as the structure and performance of, and the activities in, the NEMS. The MSCP is appointed by the EMC Board and comprises professionals independent of the NEMS, whose extensive combined experience spans the areas of financial markets, law, power system operations and economics.

The MSCP is supported by EMC's Market Assessment Unit (MAU). The MAU evaluates activities which indicate breaches of or inefficiencies in the Market Rules, market manuals or System Operation Manual, and potential flaws in the NEMS' overall structure, before submitting a report for the MSCP's determination.

Where the MSCP determines that a market entity is not compliant with the Market Rules, the MSCP may take enforcement actions such as imposing financial penalties and issuing non-compliance letters, directions and orders.

The MAU submits the quarterly MSCP Market Watch, which includes its monitoring, cataloguing and evaluation activities and analyses, to the MSCP. The MSCP provides a summary of investigative and monitoring activities to the EMC in the MSCP Annual Report, which has been published together with the NEMS Market Report since 2007.

Dispute Resolution

The Market Rules set out the dispute resolution process for market entities in the NEMS, which consists of three progressive stages: negotiation, mediation and arbitration. The process is designed to be a fair, efficient and cost-effective way of resolving disputes outside of the courts while maintaining relationships in the NEMS.

The dispute resolution process is managed by the Dispute Resolution Counsellor (DRC) who is appointed by the EMC Board. In addition, the DRC helps familiarise market entities with the dispute resolution and compensation regime, and appoints law professionals to serve on the mediation and arbitration panels, collectively called the Dispute Resolution and Compensation Panel. The MAU assists the DRC in facilitating dispute resolution in the NEMS.

LETTER FROM THE CHAIR, RULES CHANGE PANEL

Dear Industry Members

Like many organisations and professional bodies, the Rules Change Panel (RCP) had to adapt to a new norm in 2020 as panel meetings went virtual. I am heartened that all Panel members took the change in their stride, and continued to contribute actively to debates and discussions as we tackled a series of financial and technical issues relating to the National Electricity Market of Singapore (NEMS). I would like to thank all Panel members for carrying out their duties with patience, diligence and professionalism.

This year, the RCP's work plan continued to revolve around preserving the financial integrity of the wholesale electricity market. The Panel examined deficiencies and operational gaps in the prudential regime and bilateral contract arrangements. They deliberated and debated extensively on the operational and financial impact of necessary measures to safeguard the financial integrity of the wholesale market. The Panel was able to benefit from different perspectives to ensure that decisions were always balanced and improved overall market efficiency.

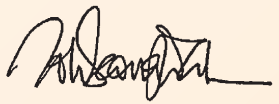
Demand response (DR) is playing an increasingly influential role in the NEMS. 2020 saw the highest number of DR activations since the DR programme was introduced in 2016. This prompted the RCP to examine more closely the value that demand-side resources can bring to the system. Compensation guidelines for load facilities facing prolonged curtailment were developed to provide the right incentives and price certainty to current and potential demand-side participants.

Timely and accurate information disclosures are crucial to improving transparency and fostering competition in electricity markets. This year, the Panel supported the conceptual proposal to provide forecast and (close to) real-time estimates of reserve costs to respective market participants. When implemented, I believe this proposal will help market participants to optimise their operations and translate into efficiency gains for the market.

The RCP continually explores ways to improve the Market Clearing Engine (MCE) by allowing more power system dynamics to be captured in the price discovery and scheduling processes. For instance, the Panel considered the proposal for the MCE to invalidate offers from generators that are on forced outages, so that dispatch schedules are feasible and reflect dynamic market conditions. While the Panel recognised the merits of the proposal, it did not gain majority support in view of the operational challenges arising from the proposal.

The end of 2020 marked the close of the last Panel's term. I would like to take this opportunity to thank all outgoing Panel members – Marcus Tan, Sim Meng Khuan, Matthew Yeo and Senthil Kumar – for their dedicated contributions. At the same time, I would like to extend a warm welcome to Calvin Quek, Terence Ang, Song Jian En, and Cheong Zhen Siong to the new Panel. I look forward to the fresh perspectives that these new members will bring to our discussions as we collectively work towards preparing the NEMS for the future.

I would also like to express my deepest appreciation to the Energy Market Authority, the Power System Operator, the EMC Board and all the NEMS stakeholders whose inputs have contributed to the success of the rule change process.



Toh Seong Wah
Chair
Rules Change Panel

Rule Changes Supported by the RCP

As part of the RCP's continual efforts to guide the evolution of the wholesale electricity market, the following rule changes were discussed and approved.

Compensation Guidelines for Interruptible Load Facilities Interrupted for Prolonged Duration

Load Registered Facilities (LRF) currently provide reserves in the Singapore Wholesale Electricity Market (SWEM) through the Interruptible Load (IL) scheme. Upon activation, an LRF scheduled for reserves is obligated to curtail its load, until the PSO issues a load restoration notice. If the curtailment lasts longer than 120 minutes, the LRF may seek compensation from the PSO. A rule change was proposed to develop compensation guidelines for LRFs that experience prolonged curtailment.

To facilitate this, EMC developed compensation guidelines after studying similar IL products in other jurisdictions. EMC considered that the Uniform Singapore Energy Price (USEP) serves as a fair and transparent indicator of the marginal system avoided cost, and is therefore representative of the value of a prolonged curtailment. It thus proposed that compensation be based on the prevailing USEPs in the curtailment periods beyond 120 minutes.

The proposal was supported by the RCP and approved by the EMA. It will come into effect on 28 April 2021.

Rectification of Default Levy and Estimated Exposure Formulae

In the SWEM, when an MP defaults on its payment and its credit support amount held by EMC is insufficient to cover its invoice amount, a default levy arrangement allocates the residual credit risk to the market. The arrangement is such that one or more default levies may be imposed on the non-defaulting MPs.

A rule change was proposed to correct two formulae pertaining to the default levy and net exposure calculations. In its review, EMC found that the second default levy formula could potentially result in an overstatement of the amount to be recovered from the market. Changes were recommended so that the offsetting effect of any credit support claimed in respect of the MP's default in payment is accurately reflected.

In addition, EMC uncovered deficiencies in the formula to calculate the estimated net exposure of a defaulting MP. Changes were proposed to include a defaulting MP's unpaid invoice amounts so as to correctly reflect that MP's net exposure.

The proposed rule change was supported by the RCP and approved by the EMA. It took effect on 7 January 2021.

Review of the Automatic Financial Penalty Scheme

The Automatic Financial Penalty Scheme (AFPS) was introduced by the EMA to encourage generation registered facilities (GRFs) comply with dispatch schedules, thereby enhancing system reliability and stability. Under this scheme, financial penalties are imposed on GRFs if they deviate from their dispatch schedules.

EMC examined the proposal raised by MPs to broaden the circumstances under which GRFs should be exempted from penalties. It recommended that the generators that are on local control and responding positively to system disturbances should not be penalised under this scheme.

The rule change was supported by the RCP and approved by the EMA. It took effect on 2 September 2020.

Review of Timelines in Relation to Provision of Credit Support

MPs who are net debtors in the SWEM are required to provide and maintain credit support with EMC. If an MP's risk exposure level crosses established thresholds, it is required to provide additional credit support within the timeline stipulated in the Market Rules.

MPs that provide credit support in the form of a Standby Letter of Credit (SBLC) or Banker's Guarantee (BG) are also required to provide replacement credit support prior to the expiry of the existing SBLC or BG, within stipulated timelines.

EMC reviewed the timelines associated with the provision of credit support in the Market Rules and proposed changes to mitigate potential uncovered risk exposure of MPs beyond the credit support pledged to EMC.

The rule change was supported by the RCP and approved by the EMA. It took effect on 21 October 2020.

Other Rule Changes Considered by the RCP

Invalidation of Offers Following Forced Outage

Currently, a GRF experiencing a forced outage is expected to remove its offers in good faith if it is not going to be available. This is so that the market clearing process would account for the GRF's unavailability when determining dispatch and pricing schedules for subsequent periods.

It was observed in several instances that generators failed to remove their offers promptly after their forced outages. This meant that the dispatch schedules for subsequent periods were not reflective of the GRFs' unavailability, and the PSO had to re-dispatch generators in real-time to maintain system stability. EMC proposed that the market clearing engine (MCE) be allowed to automatically invalidate offers from GRFs following forced outages, so that accurate outage information is always incorporated into the MCE in a timely manner.

The RCP considered the proposal at its 113th meeting. There were insufficient votes to proceed with the proposal.

LETTER FROM THE DISPUTE RESOLUTION COUNSELLOR

Dear Industry Members

Dispute Resolution and Compensation Panel

The Dispute Resolution and Compensation Panel (DRCP) was established under the Market Rules to provide dedicated dispute resolution services to the NEMS when required.

The DRCP members are:

Mediation Panel

1. Chow Kok Fong
2. Daniel John
3. Danny McFadden
4. Engelin Teh, Senior Counsel
5. Geoff Sharp
6. Associate Professor Joel Lee
7. Associate Professor Lim Lei Theng
8. Lim Tat
9. Professor Nadja Alexander
10. Dr Peter Adler
11. Robert Yu
12. Shirli Kirschner

Arbitration Panel

1. Chelva Rajah, Senior Counsel
2. Giam Chin Toon, Senior Counsel
3. Gregory Thorpe
4. Kenneth Tan, Senior Counsel
5. Professor Lawrence Boo
6. N Sreenivasan, Senior Counsel
7. Naresh Mahtani
8. Philip Jeyaretnam, Senior Counsel
9. Phillip Harris
10. Raymond Chan
11. Dr Robert Gaitskell, Queen's Counsel
12. Tan Chee Meng, Senior Counsel
13. Professor Tan Cheng Han, Senior Counsel

Dispute Management System Contacts

Pursuant to the Market Rules, each market entity has nominated at least one Dispute Management System (DMS) contact to be the first point of engagement in the event of a dispute.

The DMS contacts[6] are:

1. Air Liquide Singapore – Lim Yong Yi
2. Best Electricity Supply – Terence Neo
3. Bioenergy – David Leong
4. Cleantech Solar Singapore Assets – Andre Nobre
5. Diamond Energy Merchants – Muhammad Khairul
6. Enel X Singapore – Daniel Garrett
7. Enel X Singapore – Goh Tong Ye
8. Energy Market Company – Christopher Yeoh
9. ExxonMobil Asia Pacific – Eric Lim
10. ExxonMobil Asia Pacific – Lim Li Fang
11. ExxonMobil Asia Pacific – Matthias Franke
12. Flo Energy Singapore – Matthijs Guichelaar
13. GreenCity Energy – Chilton Loh

6 The DMS contacts were updated as at 31 December 2020. Please refer to EMC's website for the latest list of DMS contacts.

LETTER FROM THE DISPUTE RESOLUTION COUNSELLOR

14. Green Power Asia – Daniel Ma
15. Hyflux Energy – Cindy Lim
16. Hyflux Energy – Ooi Chel-Lin
17. I Switch – Senthil Kumar
18. JE Green Solutions – Chin Cherk Min
19. JE Green Solutions – Tan Kuen Jong
20. Just Electric – Wittman Wah
21. Keppel Electric – Joelyn Wong
22. Keppel Electric – Tay Hock Hai
23. Keppel Merlimau Cogen – Jeremy Lim
24. Keppel Merlimau Cogen – Sean Chan
25. LYS Genco Beta – Jonathan Chong
26. MyElectricity – Jeffrey Tan
27. National Environment Agency – Teresa Tan
28. National Environment Agency – Yap Hwee Tat
29. Ohm Energy – Nerine Teo
30. PacificLight Energy – Teo Chin Hau
31. PacificLight Power – Teo Chin Hau
32. Power System Operator – Loh Poh Soon
33. Power System Operator – Oh Chai Choo
34. Sembcorp Cogen – Agnes Low
35. Sembcorp Cogen – Andy Lim
36. Sembcorp Power – Serina Wong
37. Sembcorp Power – Winson Kor
38. Sembcorp Solar Singapore – Fendy Nursalim
39. Senoko Energy – Poo Siok Yin
40. Senoko Energy Supply – Michelle Lim
41. Senoko Waste-to-Energy – Lee Song Koi
42. Senoko Waste-to-Energy – Max Heng
43. Seraya Energy – Elaine Syn
44. Shell Eastern Petroleum – Benny Leng
45. Shell Eastern Petroleum – Koh Sian Kim
46. Shell Eastern Petroleum – Teo Woon Kai
47. SilverCloud Energy – Lee Hock Lim
48. Singapore District Cooling – Dennis Chong
49. Singapore District Cooling – John Tan
50. Singapore LNG Corporation – Jasmine Pang
51. Singapore LNG Corporation – Vincent Lam
52. Singapore Refining Company – Balasubramaniam Sundararaj Mohanakkannan
53. Singapore Refining Company – Ho Weng Foo
54. SP PowerAssets – Chan Hung Kwan
55. SP Services – Ho Yin Shan
56. SP Services – Rachel Su
57. Sun Electric Energy Assets – Eugene Lim
58. Sun Electric Energy Assets – Matthew Peloso
59. Sunseap Energy – Laurence Kwan
60. Sunseap Leasing – Jonathan Tai
61. Sunseap Leasing – Shawn Tan
62. Sunseap Leasing Beta – Shawn Tan
63. Terrenus Energy – Charles Wong
64. Terrenus Energy – David Chan
65. Tuas DBOO Trust – Chen Zhixuan
66. Tuas DBOO Trust – Victor Fong
67. Tuas Power Generation – Priscilla Chua
68. Tuas Power Supply – Jazz Feng
69. Tuas Power Supply – Kessler Wong
70. TuasOne – Kang Thian Jian
71. Tuaspring – Ng Zhao Rui
72. UGS Energy – Esther Lim
73. UGS Energy – Jessica Ang
74. Union Power – Ellen Teo
75. Union Power – Eric Lim
76. YTL PowerSeraya – Don Tan
77. YTL PowerSeraya – Jonathan Chew

Dispute Resolution Training

As part of my responsibilities, I provide training in dispute resolution for the DMS contacts.

On 11 December 2020, I conducted a virtual briefing and refresher on the NEMS' dispute resolution process for the DMS contacts. The virtual workshop was organised and supported by EMC's Market Assessment Unit.

Conclusion

I am happy to report that in 2020, no disputes were filed with this office. I thank the DRCP members and DMS contacts for their contributions, and look forward to continuing to support the dispute resolution needs of all NEMS market entities in the coming year.

George Lim
Senior Counsel
Dispute Resolution Counsellor


MARKET
PERFORMANCE

Annual Electricity Consumption 2016–2020

Electricity consumption decreases for the first time since the market started

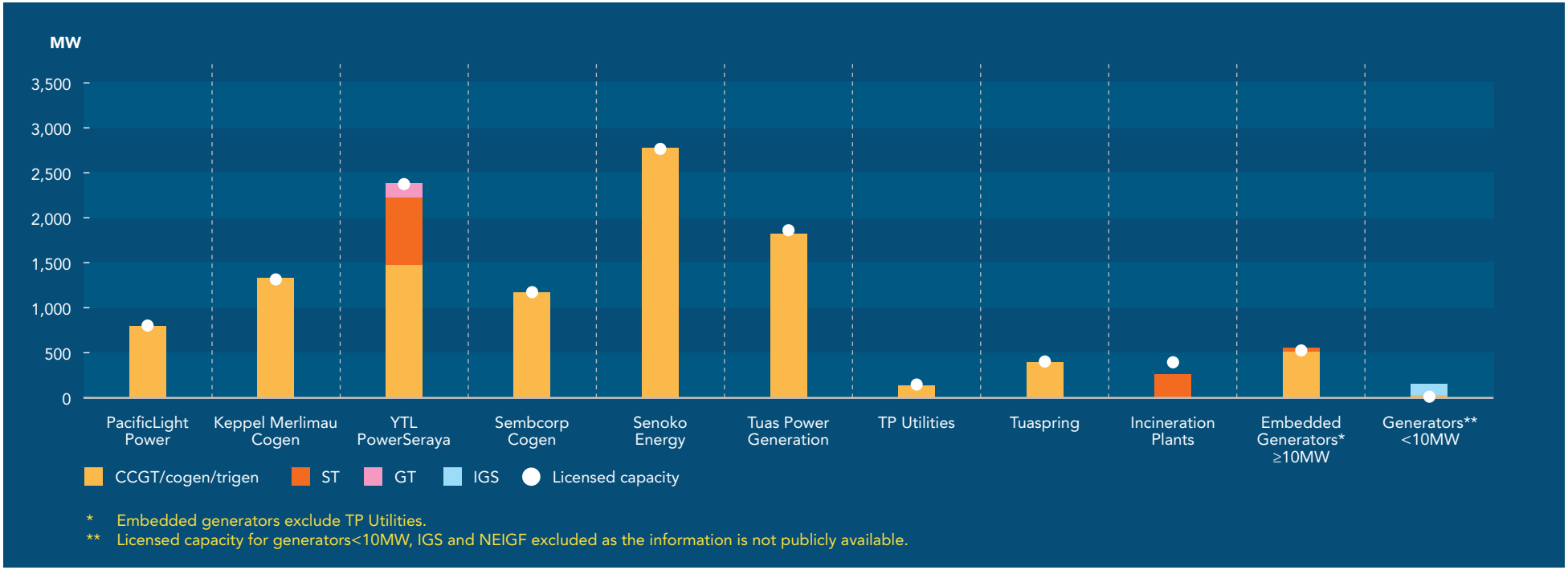
Electricity purchased by market participants (MPs) is settled using electricity consumption data provided by the Market Support Services Licensee (MSSL).

In line with the 5.4 percent[7] contraction in Singapore's economy, electricity consumption in 2020 shrank 1.7 percent year-on-year (YOY). This was the first time that annual electricity consumption had dropped since the market started, reflecting the economic impact of the Circuit Breaker (CB)[8] measures implemented in Singapore to curb the transmission of Covid-19. Total electricity consumption remained slightly above 50.0 terawatt hour (TWh) in 2020, at 50.7TWh.

Compared to the same periods in 2019, electricity consumption was higher in the first and fourth quarters of 2020, but lower in the other two quarters of the year. The largest decline of 5.9 percent was registered in the second quarter when electricity consumption fell to 12.2TWh, the lowest quarterly level since 2016. The gentle recovery in consumption from the third quarter onwards correlated with the end of the CB as Singapore embarked on a phased approach to restart its economy.

7 *"MTI Maintains 2021 GDP Growth Forecast at "4.0 to 6.0 Per Cent"", Ministry of Trade and Industry, Singapore.*
8 *The Singapore government implemented a set of elevated safe distancing measures from 7 April to 1 June 2020 to contain the spread of Covid-19 in Singapore.*

Generation Capacity as at 31 December 2020: Registered Versus Licensed



Licensed capacity and registered capacity decrease in 2020

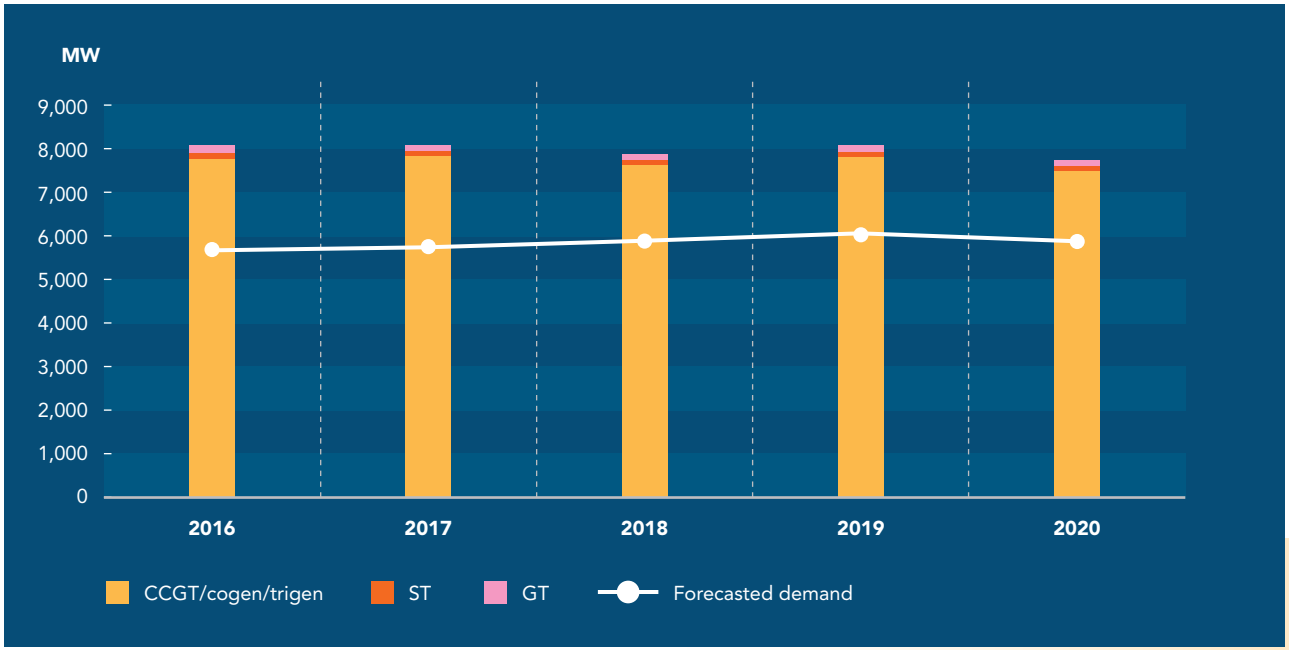
Total licensed capacity in the National Electricity Market of Singapore (NEMS) of generators with capacity larger than or equal to 10 megawatts (MW) fell by 600MW to 11,855MW in 2020. The decline came from the retirement of one ST unit from Tuas Power Generation.

Total registered capacity of generators dropped 4.7 percent to 11,861MW in 2020. This was attributed to the de-registration of two generation facilities including the abovementioned ST unit, and the registration of 11 new generation facilities in the NEMS (see details on pages 24 and 25).

CCGT/cogen/trigen registered capacity made up a larger proportion – 88.6 percent – of total registered capacity in 2020, an increase of 4.1 percentage points from 2019.

CCGT/cogen/trigen = Combined-cycle gas turbine/cogeneration/trigeneration (combined category)
ST = Steam turbine
GT = Gas turbine
IGS = Intermittent generation sources
NEIGF = Non-exporting embedded intermittent generation facilities
EG = Embedded generators. These are generation units that generate electricity to their onsite load principally for self-consumption

Annual Generation Supply by Plant Type 2016–2020



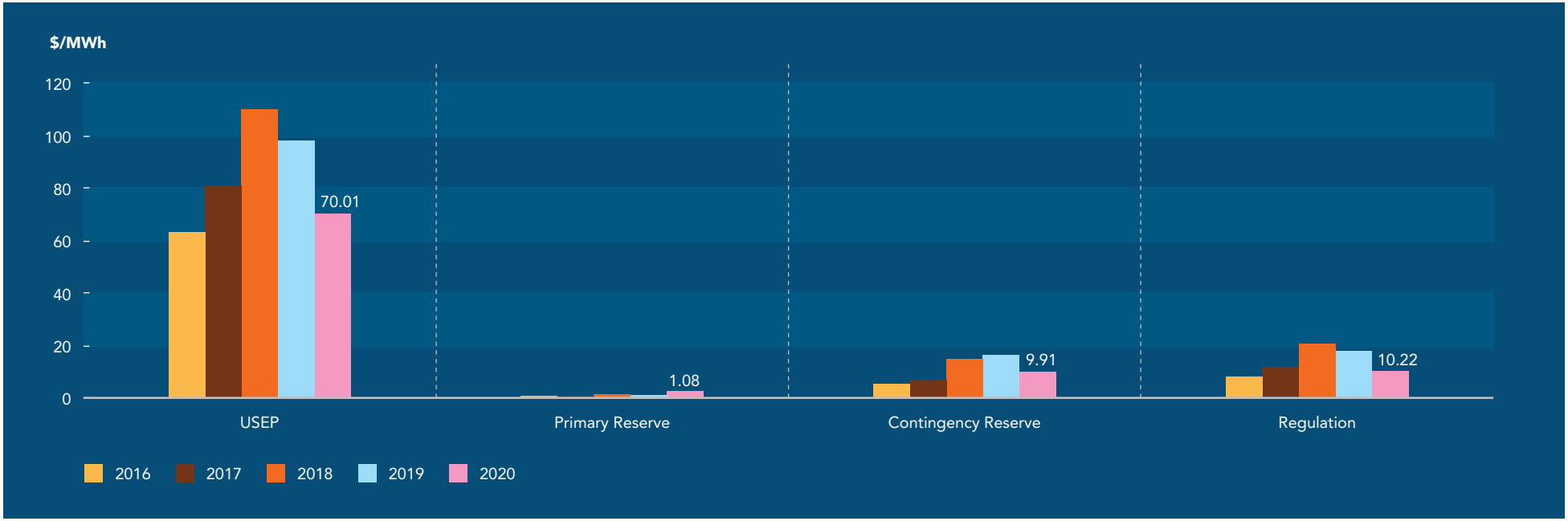
Annual generation supply decreases in 2020

The annual generation supply decreased 4.3 percent in 2020 to 7,720MW, its lowest level since 2014.

CCGT/cogen/trigen supply fell to 7,470MW, in line with the lower overall generation supply. The supply remained 27.4 percent above forecasted demand, which was the narrowest margin in the past six years as the decline in supply was sharper than the 2.5 percent fall in forecasted demand.

Both ST and GT supplies contracted in 2020. ST and GT supplies were 8.0 percent and 10.1 percent lower, respectively, compared to 2019.

Annual USEP and Ancillary Prices 2016–2020



Prices of most products fall in 2020

The annual average Uniform Singapore Energy Price (USEP) plummeted 28.8 percent from $98.28 per megawatt hour (MWh) in 2019 to $70.01/MWh in 2020, which is the second lowest level since the market started. This was the result of the plunge in fuel oil prices arising from the Covid-19 global economic shutdown, and weaker forecasted demand due to the CB measures.

The primary reserve price surged from $0.22/MWh in 2019 to $1.08/MWh in 2020 due to higher primary reserve requirements and fewer offers. Primary reserve requirement was relatively high in March when there were 213 periods with intertie disconnection (which resulted in price spikes), and again in June and July when the Risk Adjustment Factor (RAF)[9] was doubled between 25 June and 31 July 2020[10].

The contingency reserve price decreased 39.2 percent to $9.91/MWh due to lower requirements and more offers in the cheaper tranches.

The regulation price decreased 43.2 percent to $10.22/MWh. This was attributed to an expansion of relatively cheaper offers from July onwards, and the regulation requirement being revised down from 125MW to 123MW from 1 February 2020.

9 There is an RAF for each class of reserve in the NEMS. The RAF is multiplied by the raw reserve requirement to arrive at the final reserve requirement that is cleared by the market clearing engine (MCE). The PSO may amend the RAF for any reserve class temporarily if it foresees power system conditions that may warrant a higher reserve requirement than usual.

10 The RAF was increased from 1.0 to 2.0 when repair works were carried out on a cable tunnel. This was to ensure the secure operation of the power system.

OVERVIEW OF THE YEAR

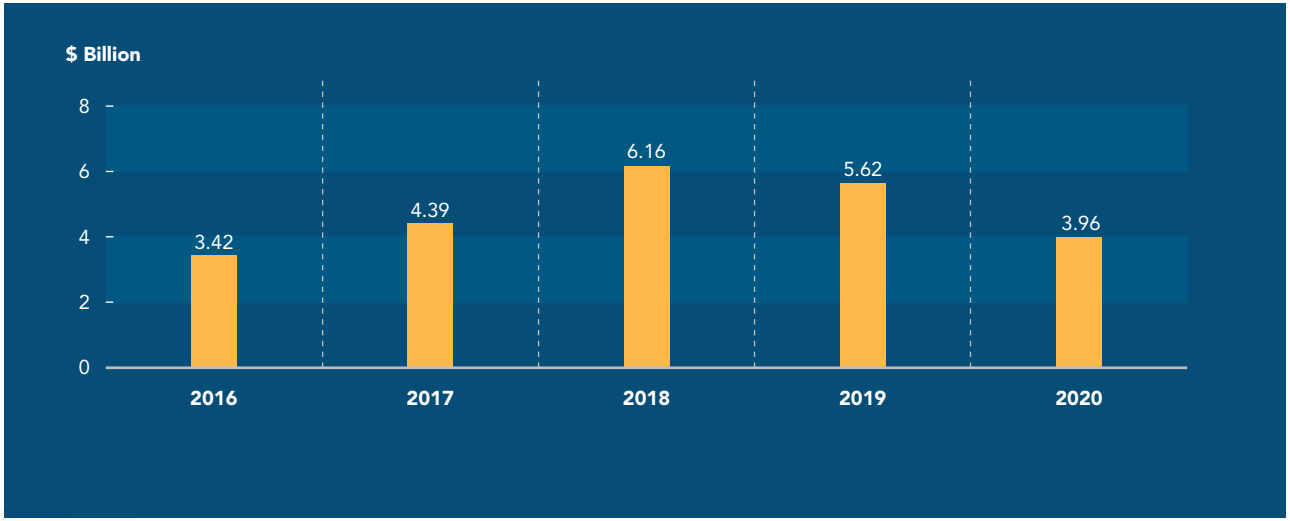
Annual value of products traded continues to decline

The value of products traded captures the transacted value of all products traded in the NEMS: energy, reserves, and regulation. Energy Market Company (EMC) uses the metered demand and generation data from the MSSL as well as market prices in the NEMS to settle market transactions on a daily basis.

The annual value of products traded fell 29.5 percent year-on-year to $3.96 billion in 2020, a second consecutive year of decline that was primarily due to the weaker USEP.

In 2020, the energy market accounted for 98.2 percent of all products traded, while the reserve and regulation markets accounted for 1.5 percent and 0.3 percent respectively.

Annual Value of Products Traded 2016–2020

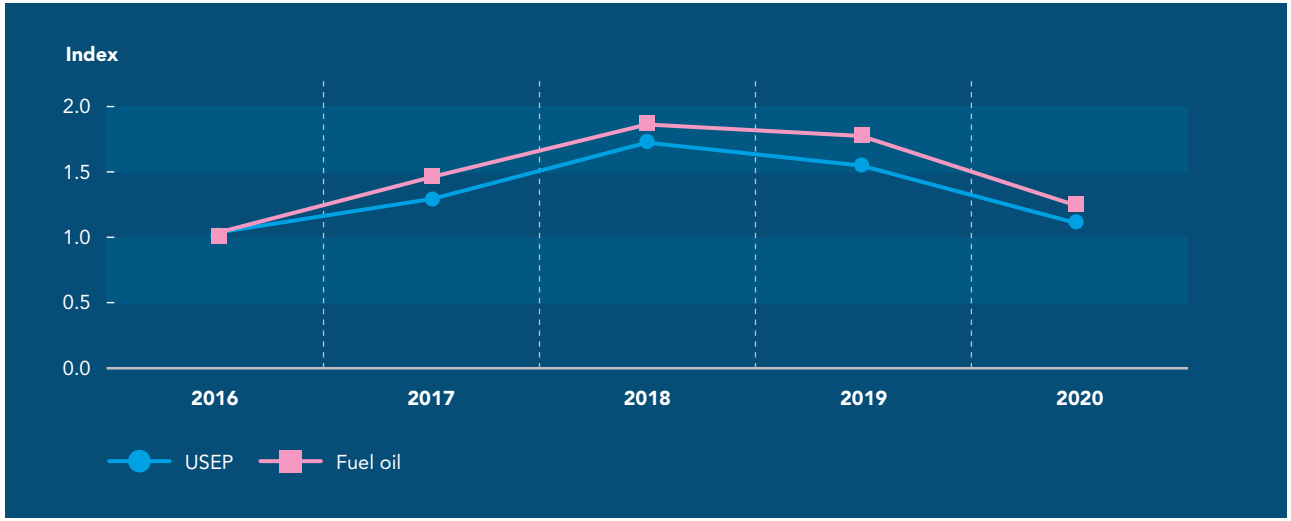


USEP continues to fall in parallel with fuel oil price[11]

The USEP index[12] decreased to 1.11 while the fuel oil price index dropped to 1.22 in 2020. Both indices moved in close tandem with each other and the USEP index led the decline.

This is the second year running that both indices have fallen after two consecutive years of increase in 2017 and 2018. The decline in the fuel oil price index outpaced that of the USEP index in 2020, narrowing the gap between the two indices slightly.

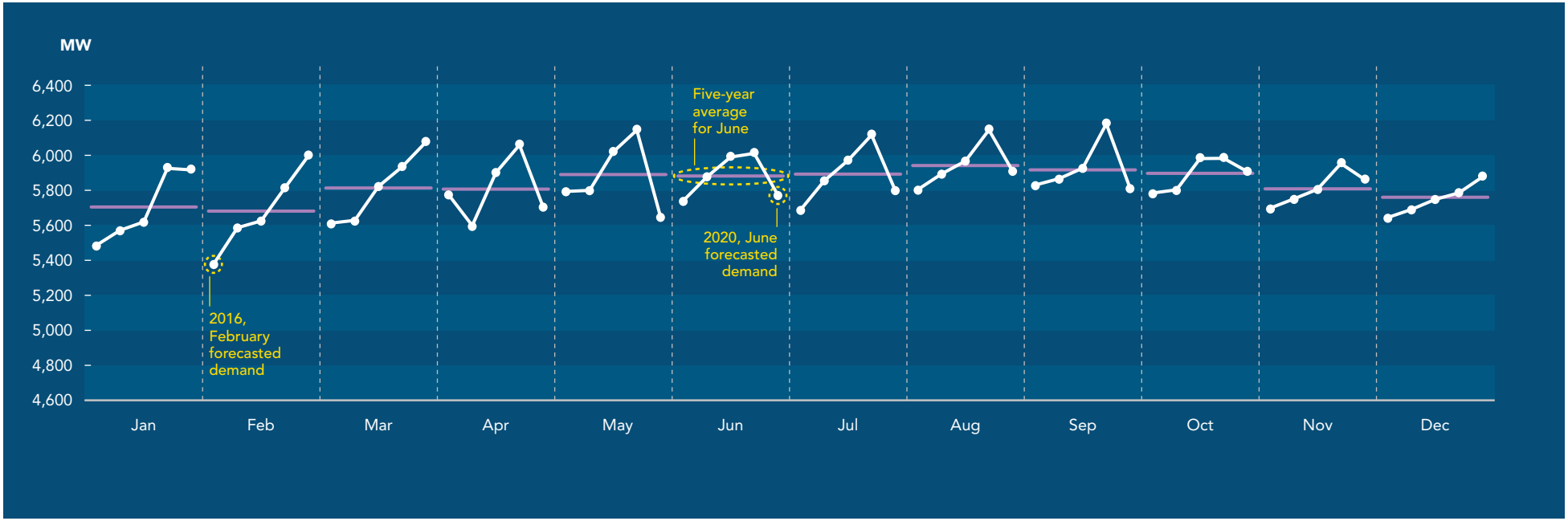
Annual USEP and Fuel Oil Price Movements 2016–2020



11 Based on a proxy for fuel oil price.

12 The USEP index is computed using 2016 as the index base. Therefore, the USEP index in 2016 is 1, while the USEP index in 2020 is 1.11 (computed using the 2020 USEP of $70.01/MWh divided by the 2016 USEP of $63.29/MWh).

Monthly Forecasted Demand 2016–2020



Forecasted demand decreases in most months

Forecasted demand refers to the projected electricity consumption in Singapore. The forecast is provided in real time by the Power System Operator (PSO) and is a key component in determining the USEP.

The annual forecasted demand fell 2.5 percent in 2020 to 5,866MW. The trend on a monthly basis varied, with monthly demand reaching new highs in February, March and December, and plunging to five-year lows in May and September.

Compared to 2019, demand was lower in all months of 2020 except February, March and December. In 2020, monthly average demand was highest in March, which registered the second largest YOY jump of 2.4 percent to 6,089MW. Monthly average demand was lowest in May, which registered the sharpest YOY decline of 8.3 percent to 5,650MW. These trends correspond to the implementation of CB measures from April to May, and the gradual resumption of economic activities thereafter.

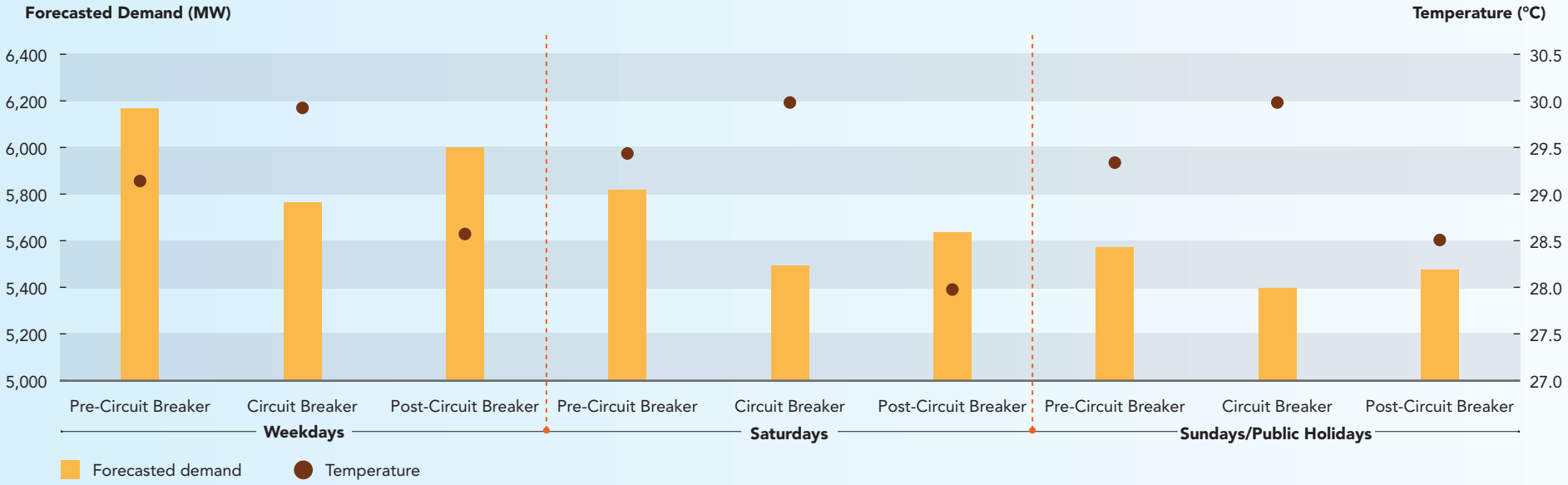
Another contributing factor was the lower temperature observed in most months of 2020 compared to 2019. 2020's September, in particular, was the coolest September in the last decade[13].

The peak half-hourly demand of 7,034MW was recorded in Period 22 on 11 Aug 2020. This was lower than 2019's peak of 7,195MW seen in Period 29 on 27 May 2019.

13 "Another Fortnight of Wet Weather Following a Wet and Cool September", Meteorological Service Singapore.

ENERGY DEMAND

Impact of Covid-19 on Forecasted Demand in 2020



Forecasted demand decreases for all day types

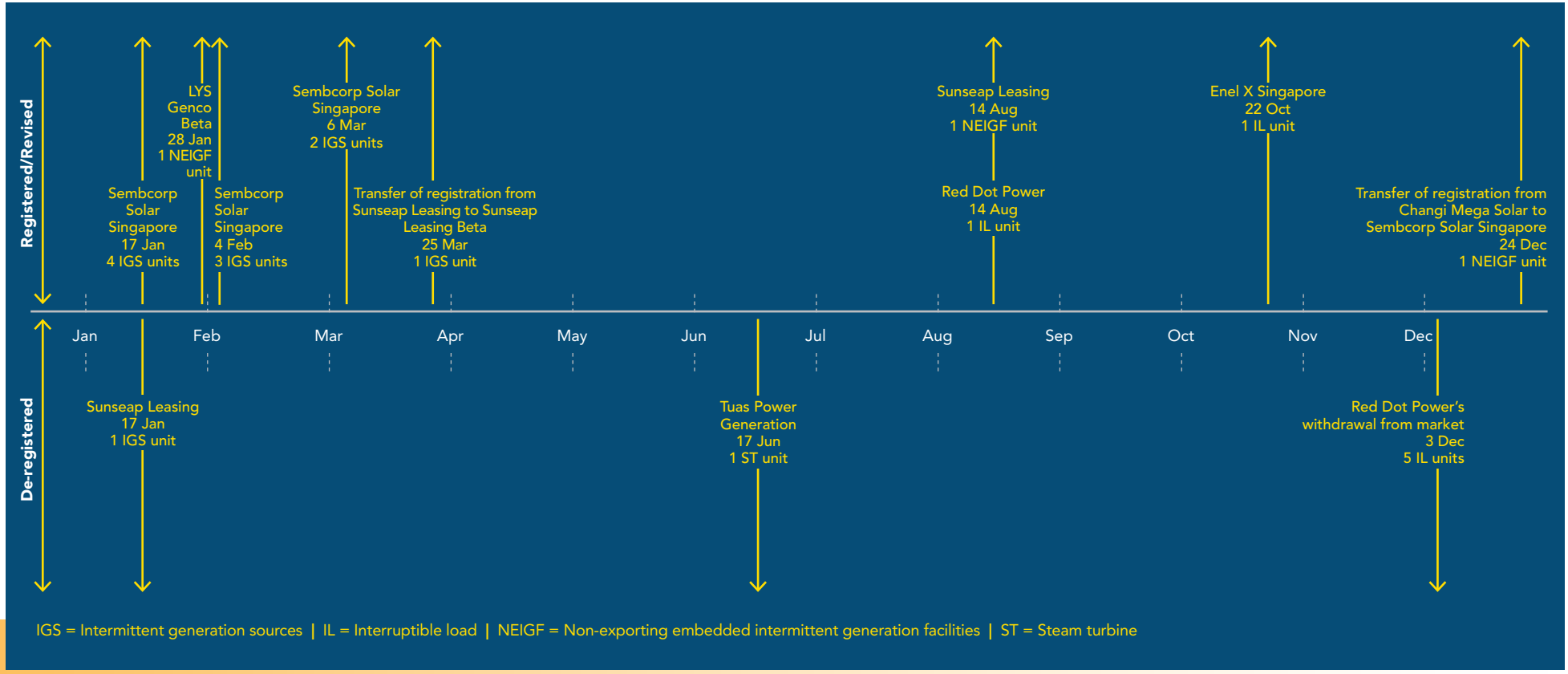
In 2020, the average demand was lowest across all day types when CB kicked in, compared to pre-CB and post-CB phases.

Before the implementation of CB measures, the average demand on weekdays, Saturdays, and Sundays/public holidays was 6,161MW, 5,813MW and 5,569MW respectively. The periodic demand ranged between 4,734MW and 7,032MW.

When CB kicked in, the average temperature was higher across all day types. The average temperature on weekdays and Sundays/public holidays was 0.7 degree Celsius higher, while that on Saturdays was 0.6 degree Celsius higher. Despite warmer weather, average demand fell across the board. The largest decline of 6.5 percent was recorded on weekdays, followed by 5.5 percent on Saturdays and 3.1 percent on Sundays/public holidays. The range of periodic demand narrowed to between 4,732MW and 6,422MW.

As Singapore eased out of its CB, demand gradually recovered despite temperatures averaging lower than pre-CB levels. Compared to the CB phase, the average temperature on weekdays, Saturdays, and Sundays/public holidays fell by 1.3 degrees Celsius, 2.0 degrees Celsius and 1.5 degrees Celsius respectively. The average demand, however, rose across all day types, in line with the resumption of economic activities. The highest average demand growth of 4.1 percent was recorded on weekdays, followed by 2.6 percent on Saturdays and 1.4 percent on Sundays/public holidays. Despite the increase, the average demand on weekdays, Saturdays, and Sundays/public holidays was 2.7 percent, 3.1 percent and 1.8 percent lower than pre-CB levels, respectively. The range of periodic demand widened to between 4,615MW and 7,034MW.

Generation and Load Facilities Registered, De-registered and Revised in 2020



IGS = Intermittent generation sources | IL = Interruptible load | NEIGF = Non-exporting embedded intermittent generation facilities | ST = Steam turbine

11 new generation facilities and two new load facilities registered in 2020

At the end of 2020, the total registered capacity of generation facilities in the NEMS stood at 11,861MW. Out of this, 88.6 percent or 10,512MW belonged to the CCGT/cogen/trigen category. As at 31 December 2020, there were 120 generation facilities and three load facilities[14] registered in the NEMS.

During the year, 13 new facilities were added from five MPs which collectively contributed 11 intermittent generation source (IGS)[15] facilities and two load facilities to the market. A breakdown of the new facilities registered can be found in the table below.

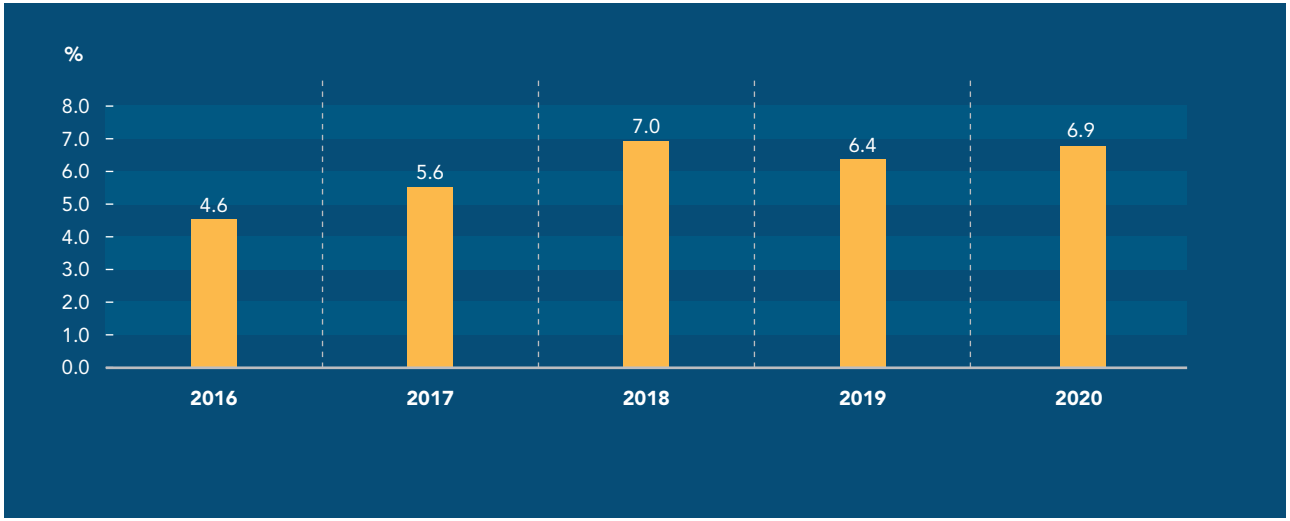
With regard to de-registrations, two generation facilities were de-registered in 2020 — one ST unit from Tuas Power Generation at 600MW, and one IGS unit from Sunseap Leasing at 1.02MW. Red Dot Power withdrew from the market, resulting in the de-registration of its five load facilities amounting to 8.1MW of contingency reserve provision. Prior to Changi Mega Solar's withdrawal from the market, the registration of its 2.84MW non-exporting embedded intermittent generation facility (NEIGF) unit was transferred to Sembcorp Solar Singapore.

New Facilities Registered

Market Participant	Generation Type	Registered Capacity
Enel X Singapore	1 IL unit	1.900MW
LYS Genco Beta	1 NEIGF unit	1.320MW
Red Dot Power[16]	1 IL unit	2.000MW
Sembcorp Solar Singapore	9 IGS units	0.300MW, 1.440MW, 0.816MW, 0.120MW, 0.516MW, 4.812MW, 0.576MW, 0.240MW, 0.660MW
Sunseap Leasing	1 NEIGF unit	1.170MW

14 As at 31 December 2019, there were 111 generation facilities and six load facilities registered in the NEMS.
15 Included NEIGFs registered in 2020.
16 The IL unit was registered by Red Dot Power on 14 August 2020. Subsequently, Red Dot Power withdrew from the market on 3 December 2020.

Embedded Generator Generation Market Share 2016–2020



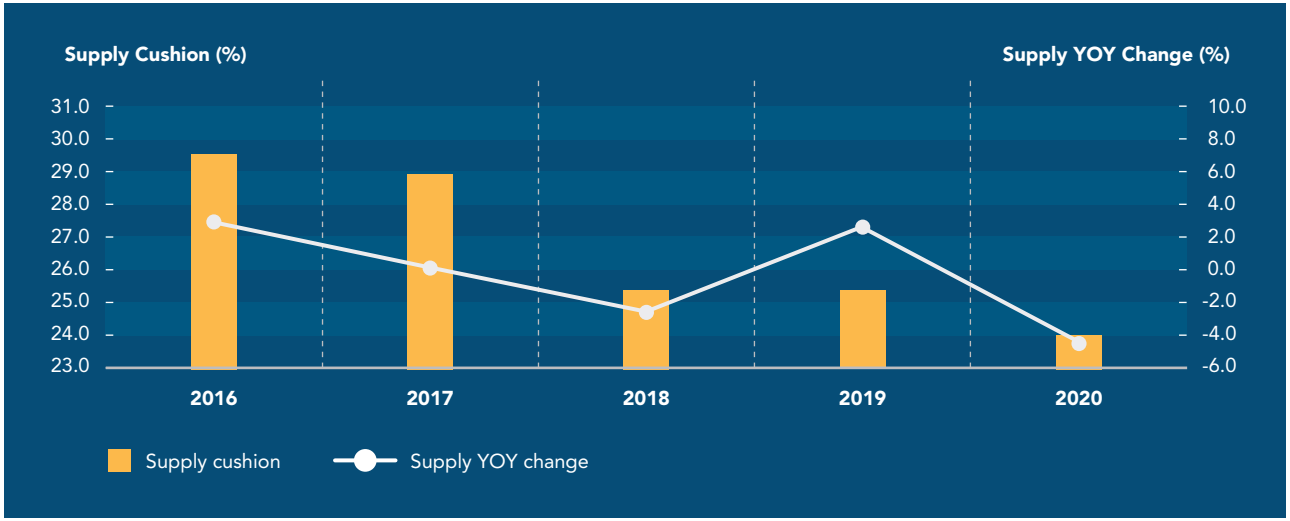
Generation market share of embedded generators rebounds

The market share of embedded generators (EGs) in the NEMS reversed its decline in 2019 and rose to 6.9 percent in 2020. This was due to lower maintenance of EG facilities.

The highest monthly EG market share was registered in May at 7.7 percent, while the lowest was in October at 5.1 percent. The standard deviation was 0.69 percent, down from 2019's standard deviation of 0.77 percent.

There were similar movements in the monthly EG market share in the last four years. Between March and May each year, the monthly market share of EGs was largely below the annual average level.

Annual Supply Cushion 2016–2020

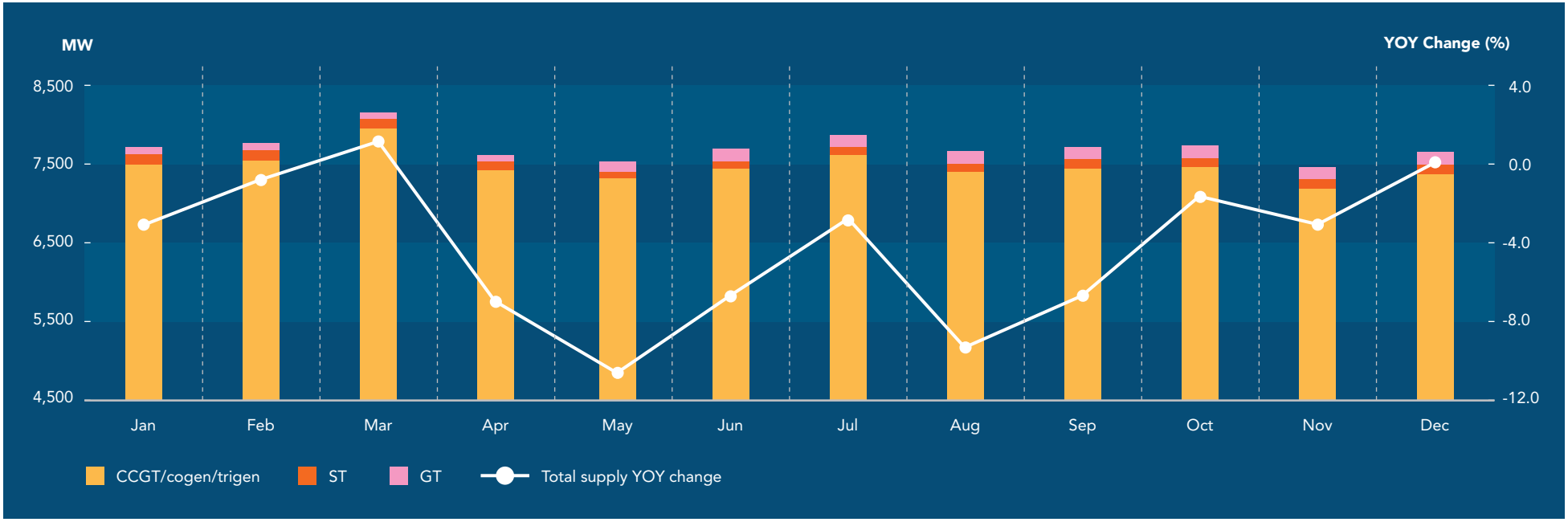


Supply cushion contracts in 2020

The supply cushion is the percentage of total generation supply that is available after matching off forecasted demand. It is calculated by subtracting forecasted demand from total supply, over total supply.

In 2020, total supply dropped more than forecasted demand. This resulted in a dip of 1.3 percentage points in the supply cushion to 24.1 percent, which is the lowest annual supply cushion level since 2012.

Monthly Supply by Plant Type 2020



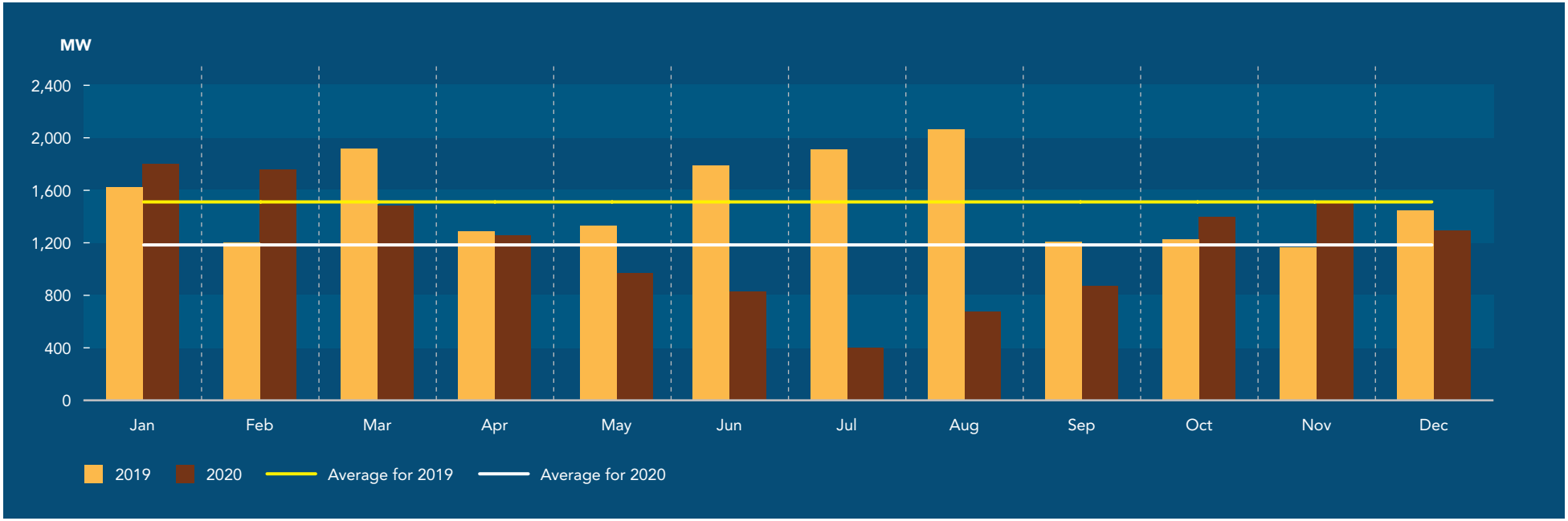
Total supply shrinks with most months registering YOY decline

For ten out of the 12 months in 2020, total supply registered YOY declines of between 1.1 percent and 10.8 percent. These declines outweighed the YOY growth of 1.3 percent in March and 0.2 percent in December, resulting in lower total supply for the year overall compared to 2019. The total supply from April to November was generally lower than that for the same months in each of the past four years, in line with the implementation of CB restrictions from April to May, and the gradual post-CB recovery in economic activities.

The most efficient generation type — CCGT/cogen/trigen — continued to lead in market share, making up 96.8 percent of total supply. This was a 0.2 percentage point increase over 2019's level and a new high for the category. The market share of both ST and GT shrank 0.1 percentage point each, to 1.5 percent and 1.7 percent respectively. The market share of CCGT/cogen/trigen from March to July was larger than it had been for the same months in each of the past four years, and the market share of both ST and GT was correspondingly lower.

In 2020, the monthly supply exceeded the 8,000MW level only once, in March. This was the lowest number of such months in any one year since 2014. The monthly supply was at its lowest level of 7,463MW in November when the overall maintenance level was relatively high. The second lowest monthly supply level of 7,536MW was seen in May, when the CB measures were in place.

Monthly Generation Maintenance 2019 Versus 2020



Generation maintenance decreases

The annual average generation maintenance level[17] decreased 21.8 percent in 2020 to 1,182MW. For eight months during the year, the monthly generation maintenance levels fell YOY, averaging 967MW. In the remaining four months, the monthly generation maintenance levels rose YOY and averaged 1,613MW.

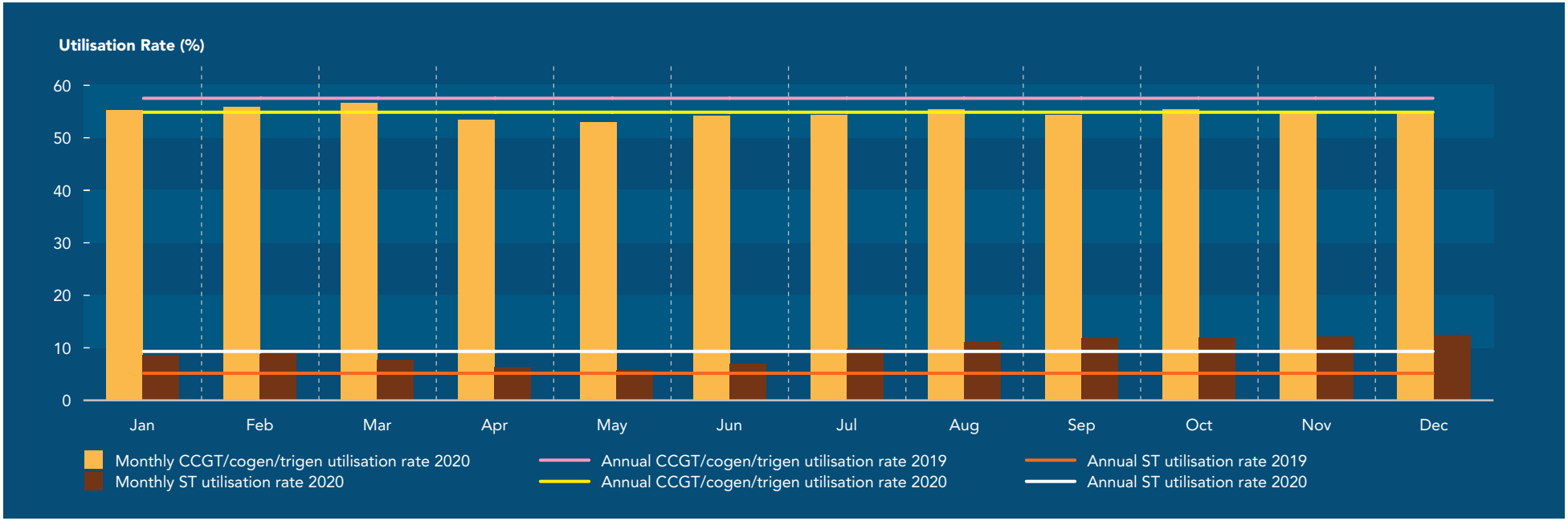
The highest monthly average generation maintenance level of 1,800MW was in January, while the lowest level of 392MW was in July.

The standard deviation of monthly generation maintenance continued to increase from 331MW in 2019 to 440MW in 2020, as the monthly generation maintenance range widened to between 392MW and 1,800MW.

The ratio of generation maintenance to registered capacity fell from 12.1 percent in 2019 to 10.0 percent in 2020, marking its first decline since 2015.

17 Generation maintenance refers to the overhaul and retrofitting of generation facilities. Generation maintenance levels are calculated based on the Annual Generator Outage Programme (AGOP) provided by the PSO.

Monthly Utilisation Rate by Plant Type 2020



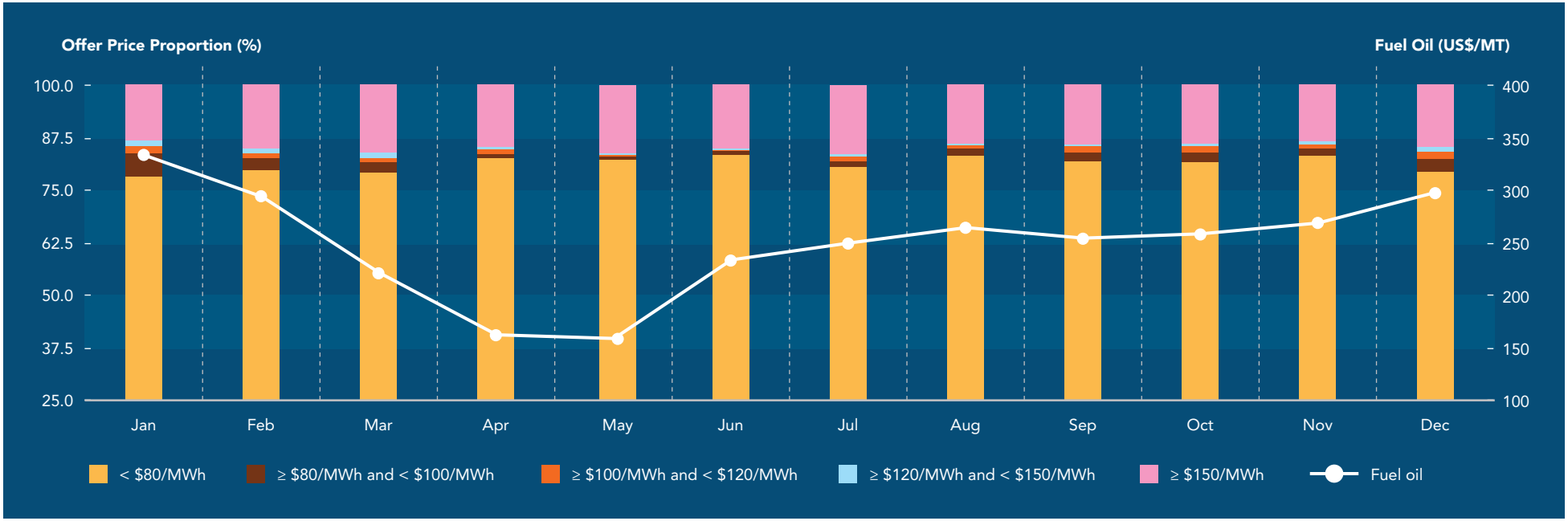
Utilisation rate for CCGT/cogen/trigen drops while that for ST improves

In 2020, the monthly CCGT/cogen/trigen utilisation rate ranged between 53.2 percent in May and 57.0 percent in March. Apart from February and December, the utilisation rate was lower in all months compared to 2019, with the largest decline of 6.1 percentage points seen in May. Similar to the movement in total supply, the CCGT/cogen/trigen utilisation rate from April to November was lower than that for the same months in each of the past four years.

Overall, the CCGT/cogen/trigen utilisation rate in 2020 dipped 2.6 percentage points to 55.0 percent as less energy was scheduled compared to 2019.

The monthly ST utilisation rate in 2020 ranged between 5.5 percent in May and 12.5 percent in December. The lowest monthly ST utilisation rate coincided with the lowest monthly CCGT/cogen/trigen utilisation rate in May, underlining the low overall utilisation rate of generation facilities when the CB measures were in place. The ST utilisation rate was higher in all months compared to 2019 due to the de-registration of one ST unit, resulting in a higher annual ST utilisation rate of 9.4 percent. In fact, in the last four years, the monthly ST utilisation rate has been higher YOY largely due to the declining total ST capacity.

Monthly Energy Offer Price Proportion and Fuel Oil Price 2020



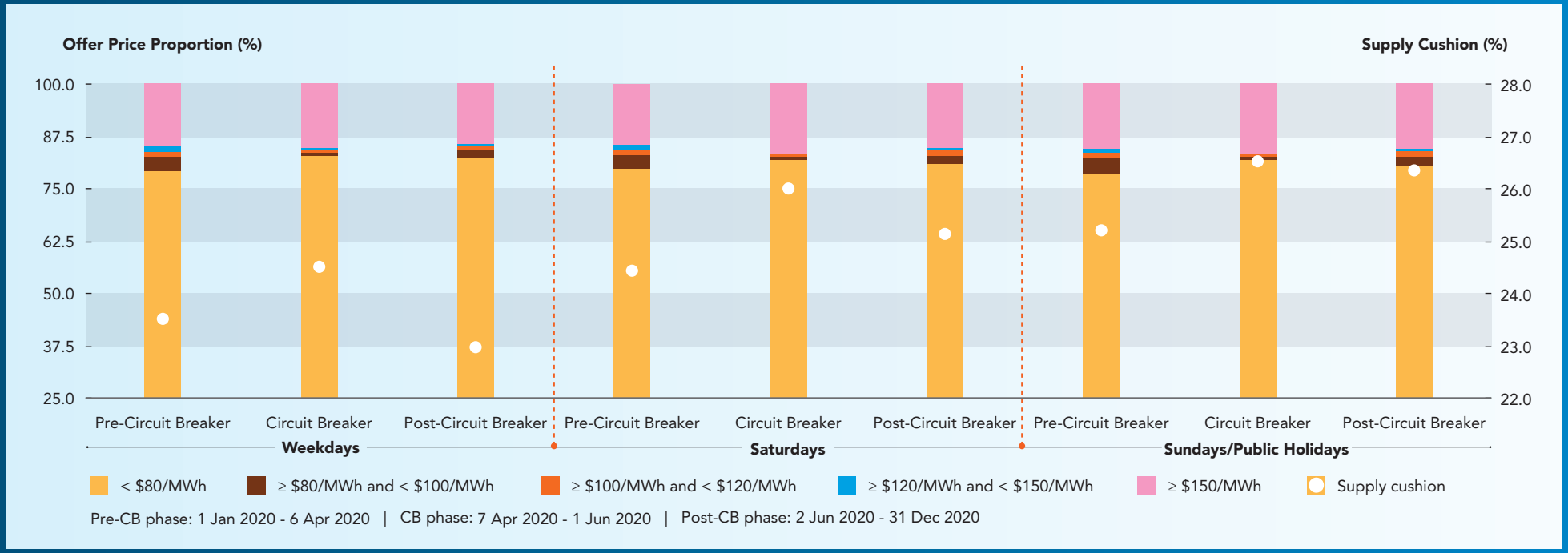
Energy offer prices and fuel oil prices move in tandem

In 2020, the daily fuel oil price ranged between US$132.22 per metric tonne (MT) and US$345.48/MT. The highest monthly level was registered in January, while the lowest monthly level was recorded in May.

Fuel oil prices plunged from US$331.00/MT in January to US$159.67/MT in May, underlining the impact of an unprecedented loss of global demand due to the Covid-19 pandemic. Thereafter, fuel oil prices began to recover, albeit at a slower pace in the face of global economic uncertainty and faltering recovery in fuel oil demand.

Throughout 2020, the proportion of energy offers moved largely in tandem with fuel oil prices. The proportion of energy offers below $80.00/MWh rose above 80.0 percent from April to November, reaching a high of 83.3 percent in June. This receded to below 80.0 percent in December, when fuel oil price recovered to the year's second highest monthly level.

Impact of Covid-19 on Energy Supply in 2020



More volatile supply conditions

In 2020, supply conditions were more volatile across all day types once CB measures were implemented.

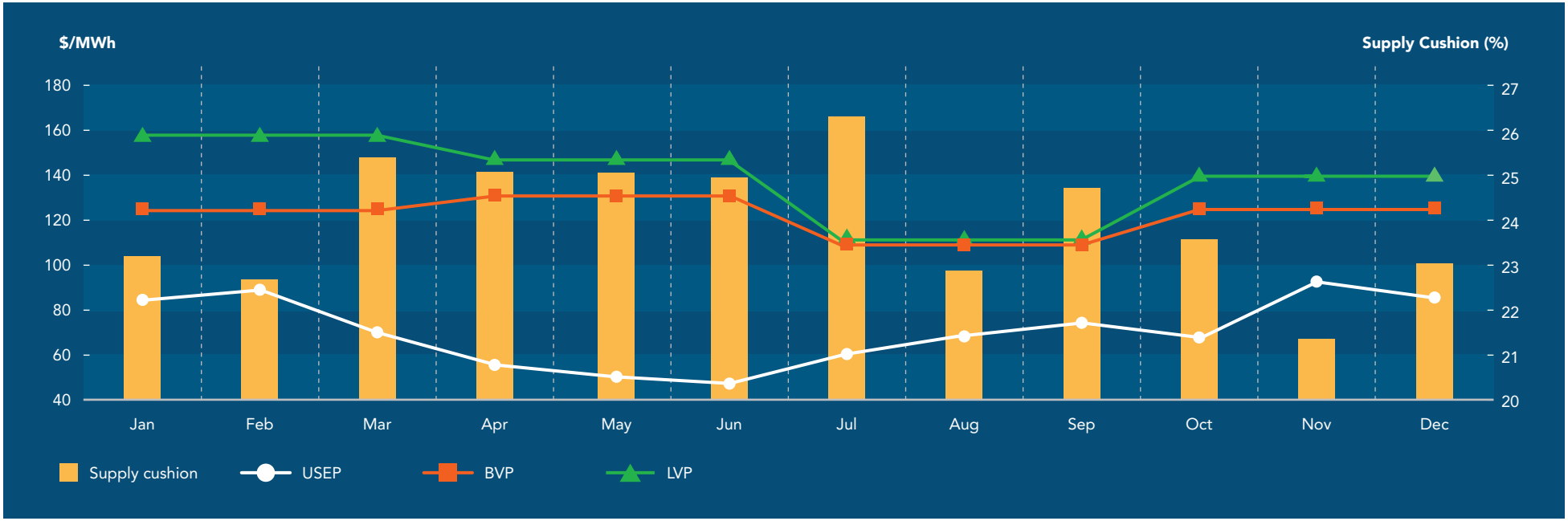
Before the CB kicked in, the average supply cushion on weekdays, Saturdays, and Sundays/public holidays was 23.5 percent, 24.4 percent, and 25.3 percent respectively. The proportion of energy offers below $80.00/MWh averaged slightly below 80.0 percent for all day types. The periodic supply cushion ranged between 10.6 percent and 39.2 percent.

During the CB, the average supply cushion grew across all day types. The average supply cushion on Saturdays grew the most to 26.0 percent, coinciding with a 2.2 percentage point increase in the proportion of energy offers below $80.00/MWh. Although the average supply cushion on weekdays grew the least to 24.3 percent, it coincided with the highest growth in the proportion of energy offers below $80.00/MWh of 3.7 percentage points. For Sundays/public holidays, the average supply cushion rose to 26.5 percent, while the proportion of energy offers below $80.00/MWh increased 3.4 percentage points. The range of periodic supply cushion narrowed to between 16.2 percent and 39.8 percent.

When the CB measures were progressively lifted, the supply cushion and the proportion of energy offers below $80.00/MWh declined across the board. Compared to the CB phase, the average supply cushion on weekdays fell the most to 23.0 percent, corresponding to the smallest drop of 0.5 percentage point in the proportion of energy offers below $80.00/MWh. The average supply cushion on Saturdays and Sundays/public holidays decreased to 25.2 percent and 26.3 percent respectively. This coincided with a 1.1 percentage point and 1.4 percentage point decrease in the proportion of energy offers below $80.00/MWh on Saturdays and Sundays/public holidays respectively.

Comparing the post-CB to the pre-CB phase, the average supply cushion was 0.5 percentage point lower on weekdays, but 0.9 percentage point and 1.0 percentage point higher on Saturdays and Sundays/public holidays respectively. The proportion of energy offers below $80.00/MWh was higher across the board, by 3.2 percentage points, 1.2 percentage points and 1.9 percentage points on weekdays, Saturdays, and Sundays/public holidays respectively. The range of periodic supply cushion expanded to between 9.1 percent and 38.8 percent.

Monthly USEP, BVP, LVP and Supply Cushion 2020



USEP stays below BVP[18] and LVP benchmarks throughout the year

In 2020, the USEP registered below the Balance Vesting Price (BVP) and LNG Vesting Price (LVP) in all months. The spread between the monthly minimum USEP of $46.91/MWh and the monthly maximum USEP of $92.27/MWh was wider compared to 2019, at $45.36/MWh.

The annual average BVP of $121.77/MWh was $51.76/MWh or 73.9 percent higher than the annual average USEP of $70.01/MWh. This was lower than the $54.75/MWh spread observed in 2019.

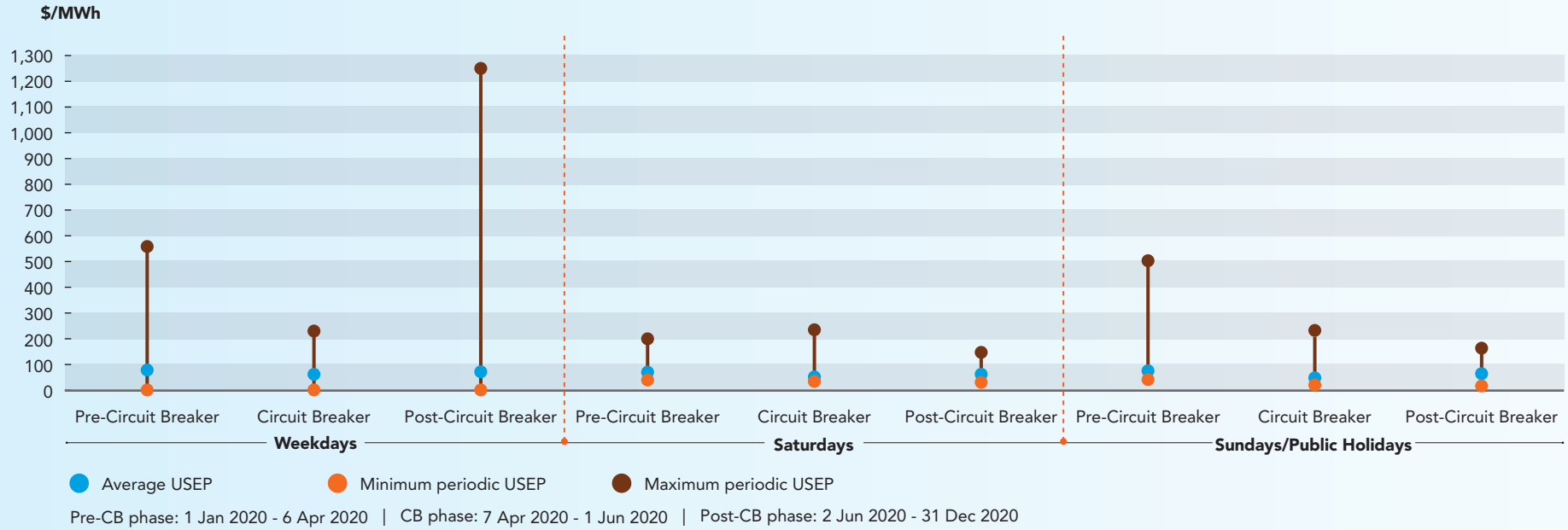
At the monthly level, the widest spread between the BVP and the USEP was observed in June, when the BVP was $83.55/MWh above the USEP. The smallest spread was observed in November, when the BVP was $32.11/MWh above the USEP.

The spread between the annual average LVP and the annual average USEP increased 8.1 percent, from $63.20/MWh in 2019 to $68.35/MWh in 2020. The largest spread between the monthly USEP and the monthly LVP was in June, when the LVP was $99.52/MWh above the USEP. The smallest spread was observed in September when the LVP was $36.76/MWh above the USEP.

The monthly supply cushion was below 25.0 percent for all months except March, April, May and July. 2020's annual supply cushion of 24.1 percent was also 1.3 percentage points lower than 2019's.

18 The BVP is used as a benchmark for USEP because it is used to set the lower price bound for restricted energy bids.

Impact of Covid-19 on Energy Prices in 2020



USEP averages lower with more volatility

In 2020, the average USEP was the lowest across all day types during the CB. Volatility in the USEP at the periodic level was dampened during the CB, but rose above pre-CB levels thereafter.

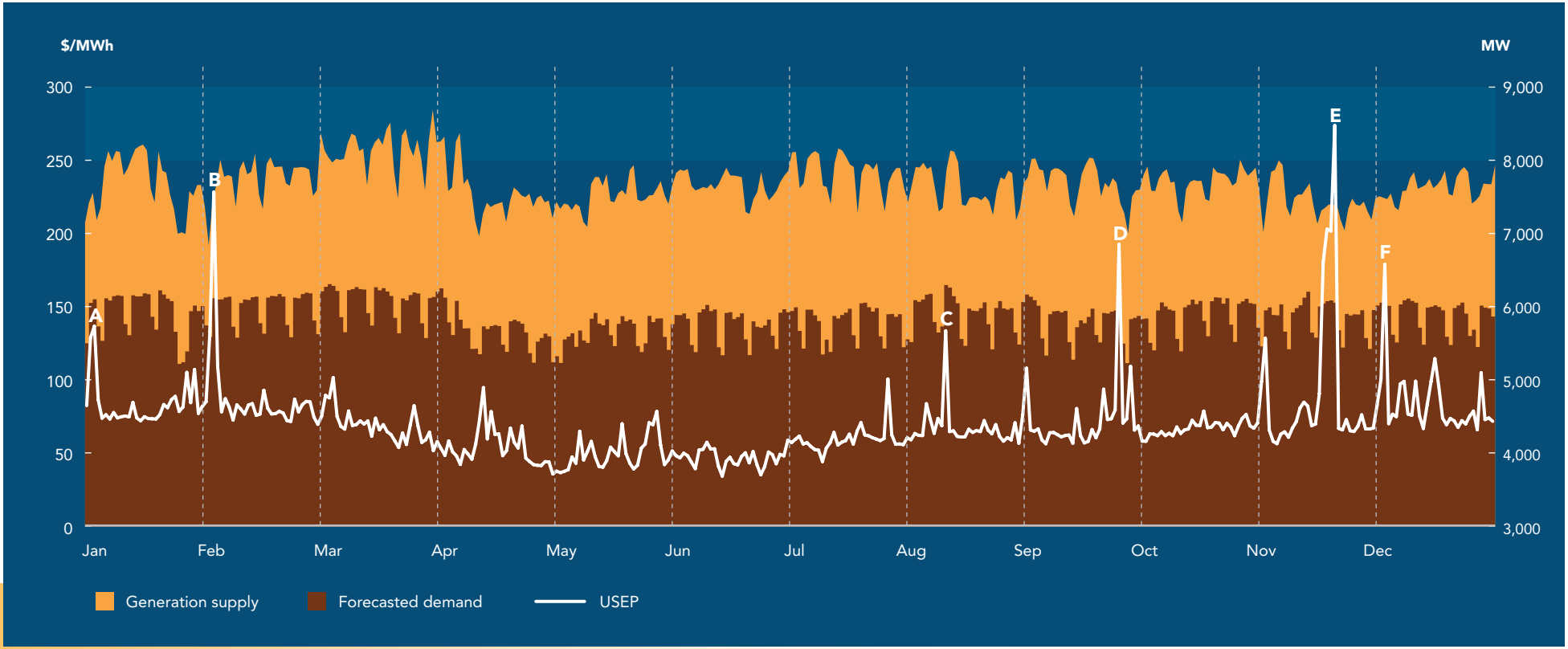
Before the CB measures were put in place, the average USEP on weekdays, Saturdays, and Sundays/public holidays was $80.64/MWh, $72.04/MWh and $77.64/MWh respectively. The periodic USEP ranged between $0.00/MWh and $570.72/MWh. There were three periods when the USEP was above $500.00/MWh, while there was only one period when the USEP was below $1.00/MWh.

During the CB, the average USEP on Sundays/public holidays fell the most, by 36.7 percent. Weekdays saw the smallest decline of 31.9 percent, while Saturdays registered a 35.4 percent decline. The average USEP on Saturdays was the lowest at $46.55/MWh, while the average USEP on weekdays and Sundays/public holidays registered $54.91/MWh and $49.13/MWh respectively. The range of periodic USEP narrowed to between $0.00/MWh and $230.42/MWh, and the number of periods registering USEP levels of below $1.00/MWh increased to four.

After the CB, the average USEP recovered across the board. Compared to the CB phase, the highest average USEP growth of 36.8 percent was recorded on Saturdays when the USEP averaged $63.66/MWh. This was followed by a 34.3 percent increase in the USEP on weekdays when it averaged $73.74/MWh. The smallest average USEP growth of 27.4 percent was observed on Sundays/public holidays when the average USEP was the lowest, at $62.61/MWh.

Notwithstanding the recovery, the average USEP after the CB was still lower than pre-CB levels. Compared to the pre-CB phase , the post-CB average USEP of $73.74/MWh on weekdays was 8.6 percent lower, the post-CB average USEP of $63.66/MWh on Saturdays was 11.6 percent lower, and the post-CB average USEP of $62.61/MWh on Sundays/public holidays was 19.4 percent lower. The range of periodic USEP widened to between $0.00/MWh and $1,254.04/MWh. The number of periods registering USEP levels of above $500.00/MWh surged to 45 and happened mostly in November, while the number of periods registering USEP levels of below $1.00/MWh rose to nine and occurred primarily in June.

Daily USEP, Forecasted Demand and Generation Supply 2020



ENERGY PRICES

The key observations on the USEP fluctuations in 2020 are as follows:

Point A: On 3 January (Friday), two CCGT units and one EG unit were on planned maintenance, while another three CCGT units were on unplanned maintenance. The daily average USEP was $137.51/MWh while the peak periodic USEP was $269.35/MWh in Period 32. The supply cushion was below 20.0 percent from Periods 16 to 44. During these periods, contingency reserve shortfall was recorded in Periods 27 and 29, and from Periods 31 to 34, and demand response (DR) curtailment was scheduled in Period 28. The PSO advised that the power system was at a high-risk operating state in Periods 27, 29 and 31, and in an emergency operating state in Period 32.

Point B: On 3 February (Monday), the daily average USEP was $229.64/MWh, while the periodic USEP for the day peaked at $570.72/MWh in Period 1. There were four CCGT units on planned maintenance. The average demand of 6,135MW was 13.5 percent higher than demand on the preceding Monday, which was a public holiday, and 2.4 percent higher than the average weekday demand in the previous week.

The supply cushion averaged 17.8 percent, which was the second lowest daily average level for the year. The supply cushion fell below 20.0 percent for 36 periods – Periods 1 and 2, and Periods 15 to 48. Primary reserve and regulation shortfalls were recorded in Period 1, while a contingency reserve shortfall was recorded in Periods 20 and 36, and from Periods 39 to 43. The PSO advised that the power system was at a high-risk operating state in Periods 20, 36 and 39, and in an emergency operating state in Periods 1 and 40. One GT unit was scheduled in Period 1, between Periods 21 and 23, and between Periods 27 and 35.

Point C: On 11 August (Tuesday), the daily average USEP was $134.37/MWh. An EG unit was on planned maintenance. The average demand was 6,315MW, which was the highest daily average level since the introduction of the Covid-19 CB measures on 7 April, and the second highest daily average level for the year.

The supply cushion stayed above 20.0 percent from Period 1 to Period 15. Thereafter, it started to fall below 20.0 percent until Period 37. Between Periods 16 and 37, the USEP averaged $216.85/MWh. The supply cushion went back to 20.0 percent in Period 38 before falling below that level again from Periods 39 to 44. The peak periodic USEP of $551.24/MWh, observed in Period 22, coincided with the highest demand level of the day of 7,034MW and the lowest supply cushion level of 11.7 percent. Contingency reserve shortfall was recorded in Periods 19, 20, 22, 23, 24 and 28, during which the power system was at a high-risk operating state in Periods 19, 22 and 28, and in an emergency operating state in Periods 20 and 23.

Point D: On 25 September (Friday), the daily USEP averaged $193.79/MWh with three periods registering USEP levels of above $500.00/MWh. During these periods of higher USEP levels, the supply cushion averaged 9.9 percent and reached a low of 9.1 percent in Period 33. This was also the lowest periodic supply cushion level for the year. In the same period, the USEP peaked at $771.41/MWh for the day. One CCGT unit and one EG unit were on planned maintenance, and another two CCGT units were on unplanned maintenance. In addition, one other CCGT unit tripped in Period 1 while another CCGT unit tripped in Period 31.

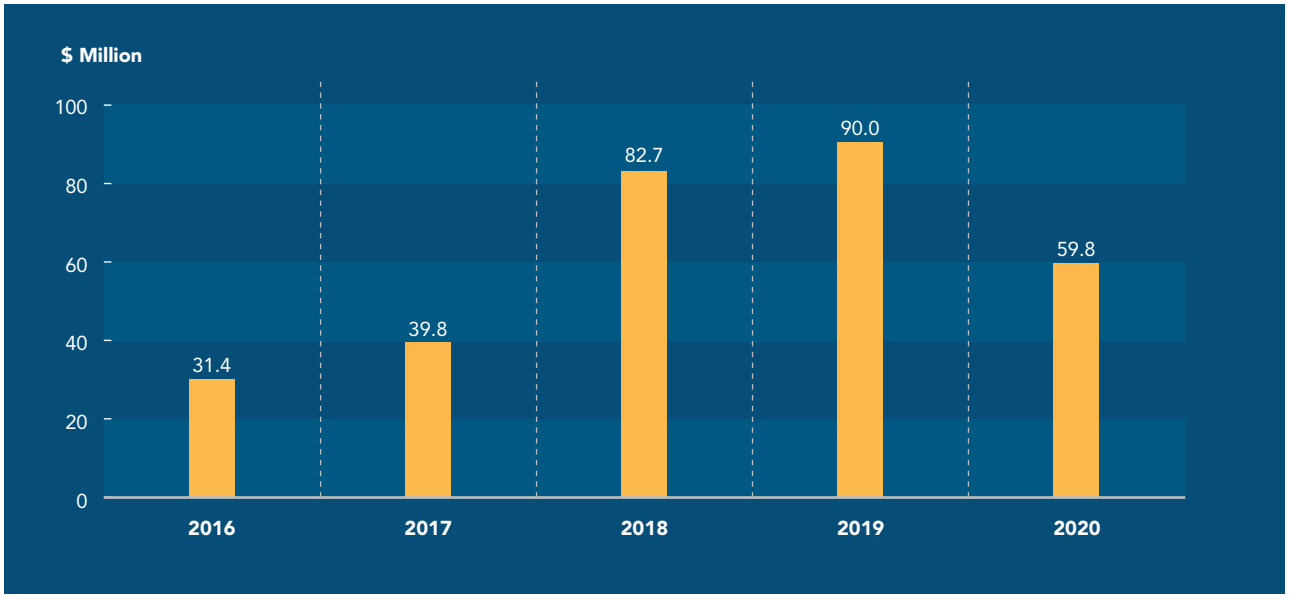
Contingency reserve shortfall was recorded for a total of 14 periods (Periods 19 to 20, Periods 22 to 23, Period 28, Period 30, and Periods 33 to 40), while regulation shortfall was recorded in Period 33. During these periods, DR curtailment was scheduled in Period 29 while one GT unit was scheduled to run from Periods 33 to 34. IL was activated in Period 31 and restored in the following period. The PSO advised that the power system was at a high-risk operating state in Periods 19, 22, 28, 30 and 33, and in an emergency operating state in Periods 20, 23 and 34.

Point E: On 20 November (Friday), the daily average USEP registered the highest daily average level for the year at $275.33/MWh. Two CCGT units and one EG unit were on planned maintenance, one CCGT unit was on partial planned maintenance, and one CCGT unit was on unplanned maintenance. Over the course of the day, the supply cushion was below 20.0 percent for 31 periods (Periods 16 to 46). There were 11 periods when the USEP rose above $500.00/MWh, out of which three periods registered USEP levels of more than $1,000.00/MWh. The USEP in Period 22 reached a high of $1,254.04/MWh. This was also the highest periodic USEP for the year. During these periods of higher USEP levels, one GT unit was scheduled in Period 23 while DR curtailment was scheduled in Periods 22, 23, 24 and 31.

Point F: On 3 December (Thursday), three CCGT units and one EG unit were on planned maintenance, while another two CCGT units were on partial unplanned maintenance. The daily USEP averaged $180.01/MWh with five periods registering USEP levels of above $500.00/MWh. The supply cushion stayed above 20.0 percent from Period 1 to Period 15. Thereafter, it fell below 20.0 percent until Period 44. Between Periods 16 and 44, the supply cushion averaged 14.5 percent. The peak periodic USEP of $815.47/MWh observed in Period 32 coincided with the lowest supply cushion of the day at 12.1 percent. The supply cushion went back above 20.0 percent from Period 45 onwards. During these three blocks of periods, the USEP averaged $72.75/MWh, $250.21/MWh and $73.24/MWh respectively.

ANCILLARY MARKETS

Annual Reserve Payment 2016–2020

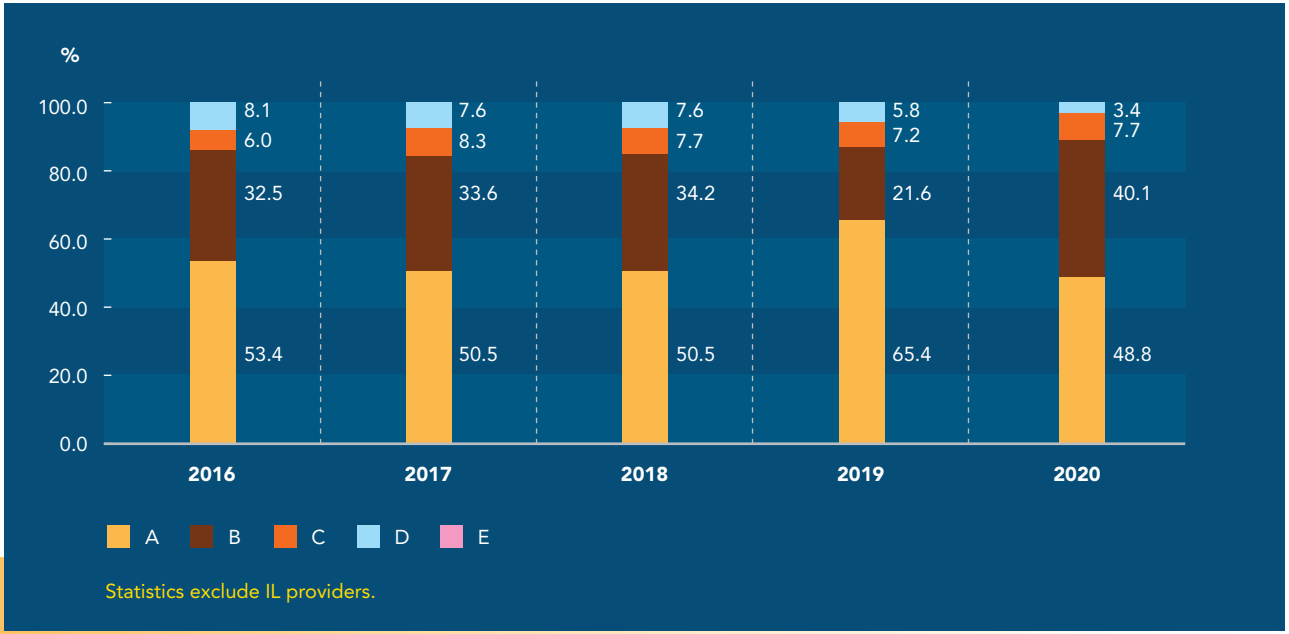


Reserve payment decreases for the first time since 2017

Reserves serve as a backup in the electricity market for unexpected outages caused by generators tripping. The amount of reserves required is determined by the amount needed should the largest on-line generator trip. In the NEMS, two reserve products are traded: primary and contingency reserves. Each reserve has its own price and response time, the latter being nine seconds for primary reserve and ten minutes for contingency reserve. The generators bear the cost of procuring the reserves.

Compared to 2019, reserve costs decreased 33.6 percent to $59.8 million. This was driven by a decline in the contingency reserve price, which outweighed an increase in the primary reserve price. The contingency reserve price fell by $6.39/MWh to $9.91/MWh while the primary reserve price rose by $0.86/MWh to $1.08/MWh.

Reserve Provider Group Effectiveness for Primary Reserve Class (Aggregate) 2016–2020



Responsiveness of reserve providers improves marginally

Reserve providers in the NEMS are classified into five groups, with Group A reflecting reserve providers with the highest level of responsiveness and Group E reflecting those with the lowest level of responsiveness. A higher level of responsiveness attracts a higher proportion of reserve price.

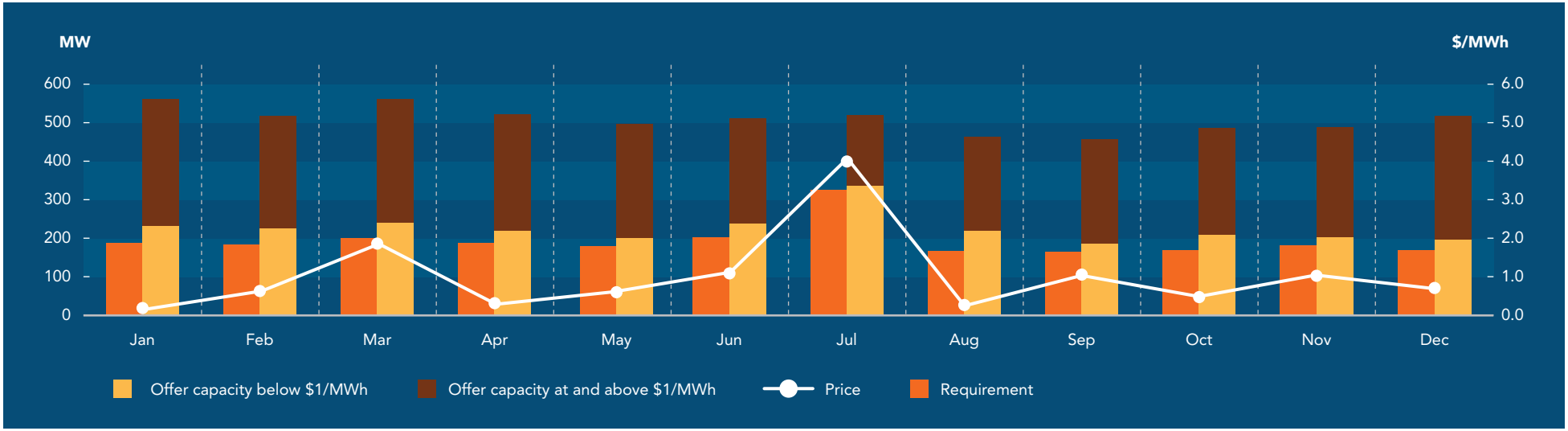
In 2020, some of the reserve providers in Groups A and D moved into Groups B and C. The percentage of reserve providers in Groups A and D decreased 16.6 percentage points and 2.5 percentage points respectively. In contrast, the percentage of reserve providers in Groups B and C increased 18.6 percentage points and 0.5 percentage point respectively. As a result, the proportion of reserve providers in Group A fell to a new low since 2011 — 48.8 percent. Groups B and D recorded the highest and lowest proportions since the market started, of 40.1 percent and 3.4 percent respectively.

Overall, the responsiveness of reserve providers improved slightly in 2020. 88.9 percent of the reserve providers fell into the more responsive Groups A and B, up from 87.0 in 2019, while the proportion of reserve providers in the less responsive Groups C and D fell from 2019's 13.0 percent to 11.1 percent.

As with 2019, there were no reserve providers in the Group E category.

All contingency reserve providers were classified in Group A.

Monthly Primary Reserve Price, Requirement and Supply 2020



More frequent spikes in primary reserve prices

The annual average primary reserve price surged to $1.08/MWh in 2020, which was nearly five times compared to 2019's $0.22/MWh. The highest monthly primary reserve price was $4.01/MWh in July, followed by $1.88/MWh in March. The lowest monthly average of $0.24/MWh was observed in January.

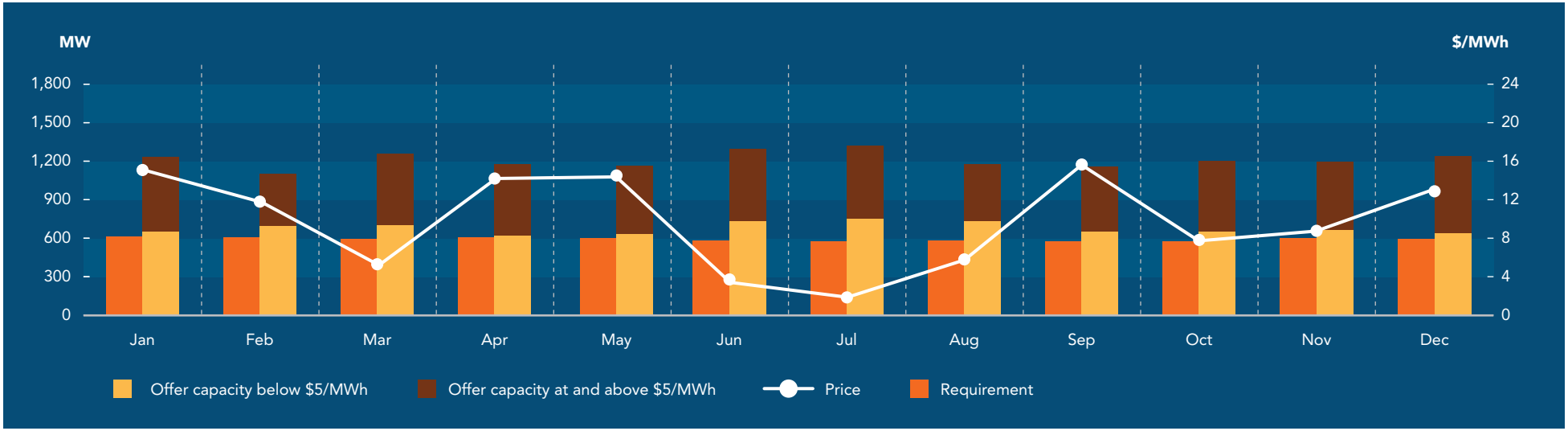
The annual average primary reserve requirement rose 13.5 percent to 193MW in 2020. In contrast, the annual primary reserve offers fell 3.6 percent to 509MW.

At the monthly level, the primary reserve requirement ranged between 164MW and 325MW, with the lowest level seen in September and the highest in July. The monthly primary reserve offers were largely above 500MW from January to July, and fell below 500MW thereafter until November. The monthly primary reserve offers were lowest in September at 458MW and highest in January at 562MW. The proportion of primary reserve offers below $1.00/MWh ranged between 38.2 percent and 47.3 percent in all months except July. In July, 64.4 percent of offers were below $1.00/MWh, up from 46.3 percent in June.

Following a planned outage of the intertie connection between Singapore and Malaysia that was scheduled between 2 and 6 March, Singapore's power system was in isolated mode. This resulted in 213 periods of intertie disconnections in 2020, 131 more than the 82 periods seen in 2019. In addition, the RAF for primary reserve was revised from 1.0 to 2.0 from Period 35 on 25 June to Period 48 on 31 July. As a result, primary reserve requirements were driven up, resulting in higher average prices in March and July. The highest daily average price for the year was registered on 27 July at $33.06/MWh. The highest periodic price for the year of $310.00/MWh was registered in Period 1 on 3 February and Period 32 on 5 March, during which primary reserve shortfalls were recorded. There were two periods of primary reserve shortfalls in 2020, compared to none in 2019.

With the exception of the RAF adjustment for the abovementioned periods, the RAF was set at 1.0 for the remaining periods in the year.

Monthly Contingency Reserve Price, Requirement and Supply 2020



Contingency reserve price drops on lower requirement and lower offer prices

The annual average contingency reserve price fell 39.2 percent to $9.91/MWh in 2020. The highest monthly contingency reserve price of $15.73/MWh was observed in September, while the lowest monthly contingency reserve price of $2.24/MWh was registered in July.

The annual average contingency reserve requirement dipped 0.2 percent to 596MW in 2020. The annual average contingency reserve offers fell 0.7 percent to 1,222MW. The proportion of contingency reserve offers below $5.00/MWh was 57.5 percent, up from the 54.5 percent registered in 2019.

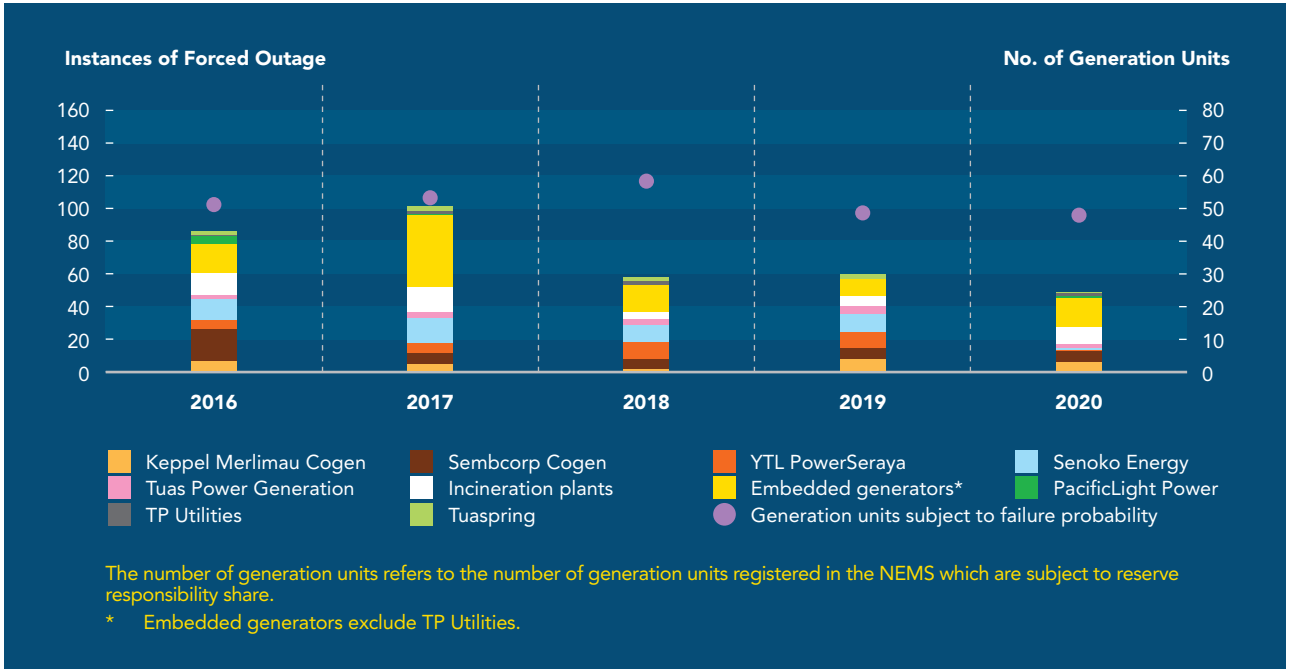
At the monthly level, the contingency reserve requirement was largely above 600MW from January to May. It started to fall below 600MW thereafter, with a brief rise to slightly above 600MW in November. The lowest monthly contingency reserve requirement of 579MW was observed in July, while the highest monthly contingency reserve requirement of 617MW, was seen in January. The monthly contingency reserve offers were highest in July at 1,336MW and lowest in February at 1,114MW. The proportion of contingency reserve offers below $5.00/MWh ranged between 51.3 percent and 56.5 percent in all months except February and August, when it rose to 62.5 percent and 62.2 percent respectively.

Compared to other months, September recorded more periods with contingency reserve shortfalls, resulting in the highest monthly contingency reserve price in 2020. The highest daily average contingency reserve price of $104.48/MWh was registered on 3 February, when there were seven periods of contingency reserve shortfalls.

Overall, there were 68 periods of contingency reserve shortfalls in 2020, down from 368 periods in 2019.

The RAF for contingency reserve was unchanged at 1.5 in 2020.

Annual Forced Outages by Generation Companies 2016–2020



The number of generation units refers to the number of generation units registered in the NEMS which are subject to reserve responsibility share.

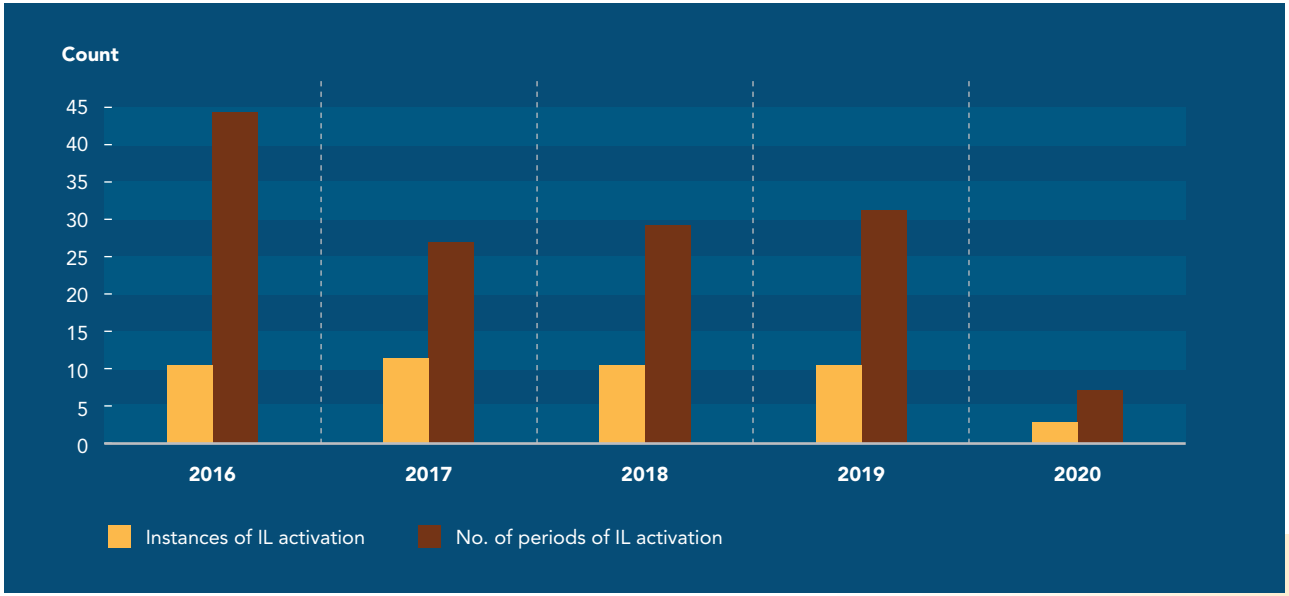
* Embedded generators exclude TP Utilities.

Total number of forced outages decreases

There was a total of 49 forced outages in 2020, down from 60 in 2019. This is the lowest level since the market started, and it can be attributed to a decrease in the number of forced outages experienced by most generation companies.

The number of generation units subject to failure probability fell with the retirement of one generation facility in 2020.

Annual Interruptible Load (IL) Activations for Contingency Reserve Market 2016–2020



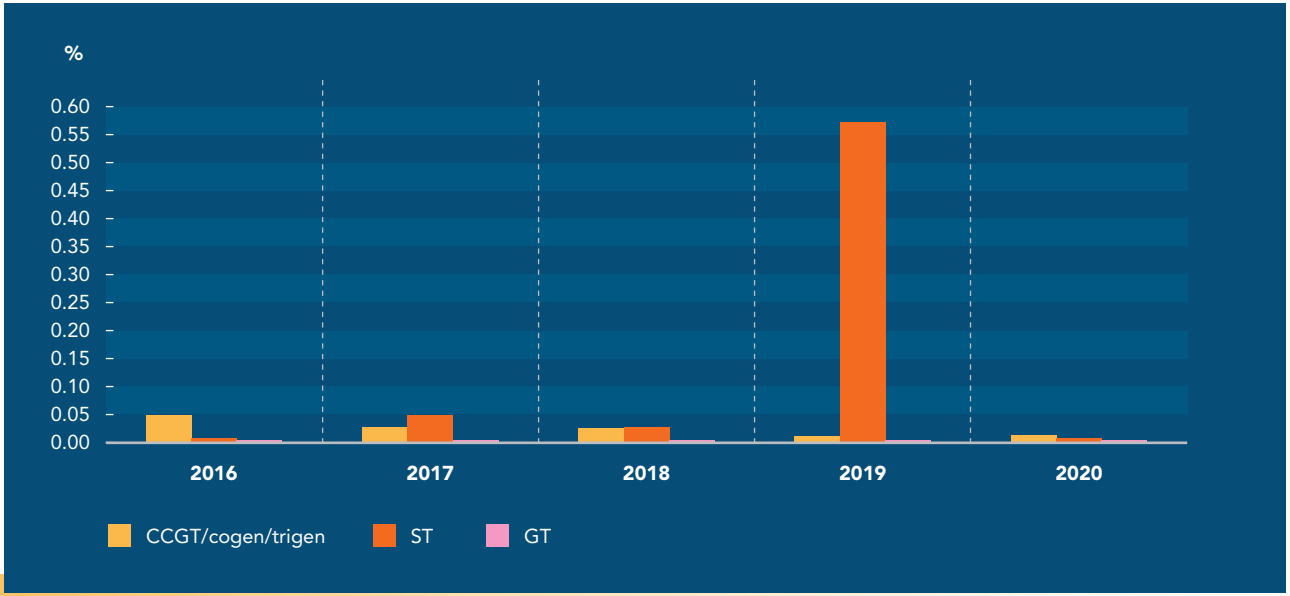
Instances and number of periods of IL activation decline

As at 31 December 2020, there was no registered capacity for IL for primary reserve. For contingency reserve, the total registered capacity fell from 12.1MW to 7.9MW.

In 2020, the number of IL activations for contingency reserve fell from 11 to three, and the total number of periods when IL was activated for contingency reserve fell from 31 to seven. These trends were consistent with the lower number of forced outages of larger generation units.

The longest continuous stretch of IL activation lasted three periods on 25 March. There were also two periods each of IL activation on 19 August and 25 September. This was an improvement from 2019, when the longest continuous stretch of IL activation lasted 14 periods.

Average Failure Probability by Year 2016–2020



Mixed outcomes in reliability of generation facilities

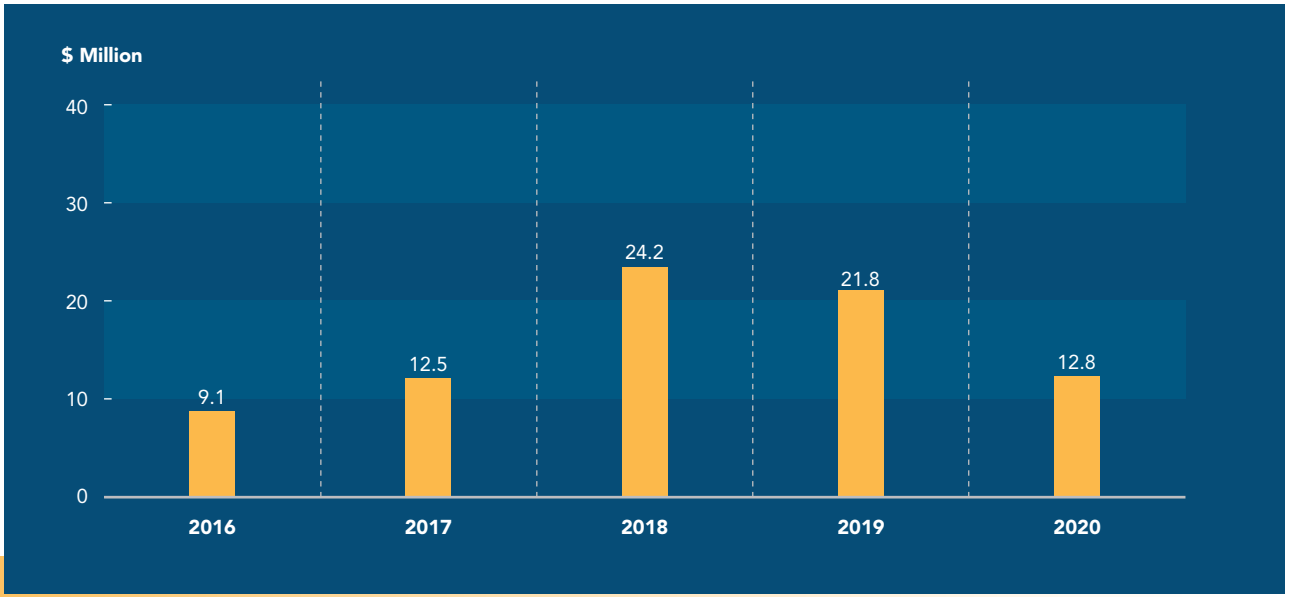
The average failure probability for a Generation Registered Facility (GRF) is the probability that after being dispatched by the PSO for a settlement interval, the GRF will cease operating, disconnect from the transmission system, or both, during that settlement interval, even if no other GRF fails. A generation facility with a lower failure probability will be allocated less reserve cost compared to one with a higher failure probability.

In short, failure probability is a measure of how reliable a generation facility is. The lower its failure probability, the higher its reliability.

In 2020, the average failure probabilities of CCGT/cogen/trigen, ST, and GT facilities were 0.011 percent, 0.005 percent, and 0.001 percent respectively. Compared to 2019, the failure probability of CCGT/cogen/trigen facilities rose in 2020, while that of ST facilities declined. The increase in the failure probability of CCGT/cogen/trigen facilities was due to more occurrences of forced outages arising from eight CCGT/cogen/trigen facilities, of which four were EG facilities. The failure probability of ST facilities fell to its lowest level since 2017, thanks to fewer occurrences of forced outages at one ST facility. The failure probability of GT facilities remained the same.

Despite the huge drop in the failure probability of ST facilities, this category represented just 2.0 percent of the overall market share of generation facilities. The overall performance of generation facilities was mixed as reflected in the failure probability levels, which aligned with the facilities' respective occurrences of forced outages.

Annual Regulation Payment 2016–2020

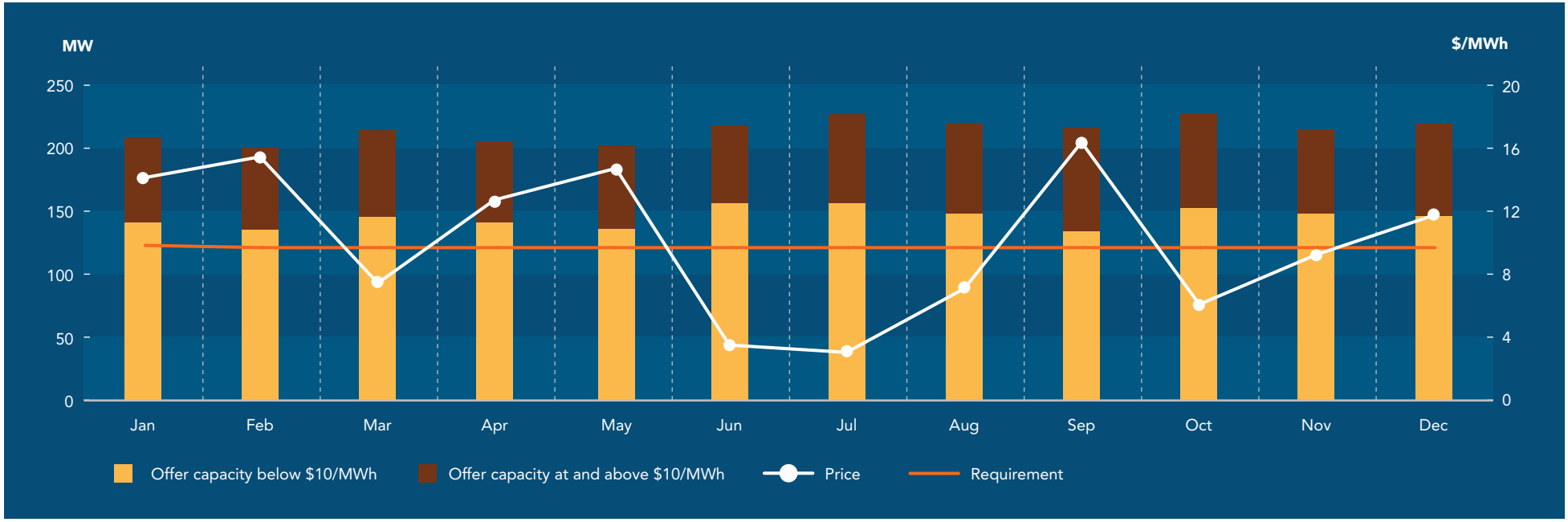


Regulation payment declines for the second consecutive year

Regulation payment declined 41.3 percent to $12.8 million in 2020. This was in line with the decrease in regulation requirement from 125MW to 123MW with effect from 1 February 2020, as well as the 43.2 percent decline in regulation price to $10.22/MWh.

Compared to 2019, monthly regulation payment decreased between $0.4 million and $2.1 million for eight months in the year. The largest decline was in July which registered the lowest monthly regulation payment of $0.3 million. The highest monthly regulation payment was $1.7 million in September.

Monthly Regulation Price, Requirement and Supply 2020



Less volatility in regulation prices

In 2020, the annual average regulation price declined 43.2 percent to $10.22/MWh, the lowest level since 2017.

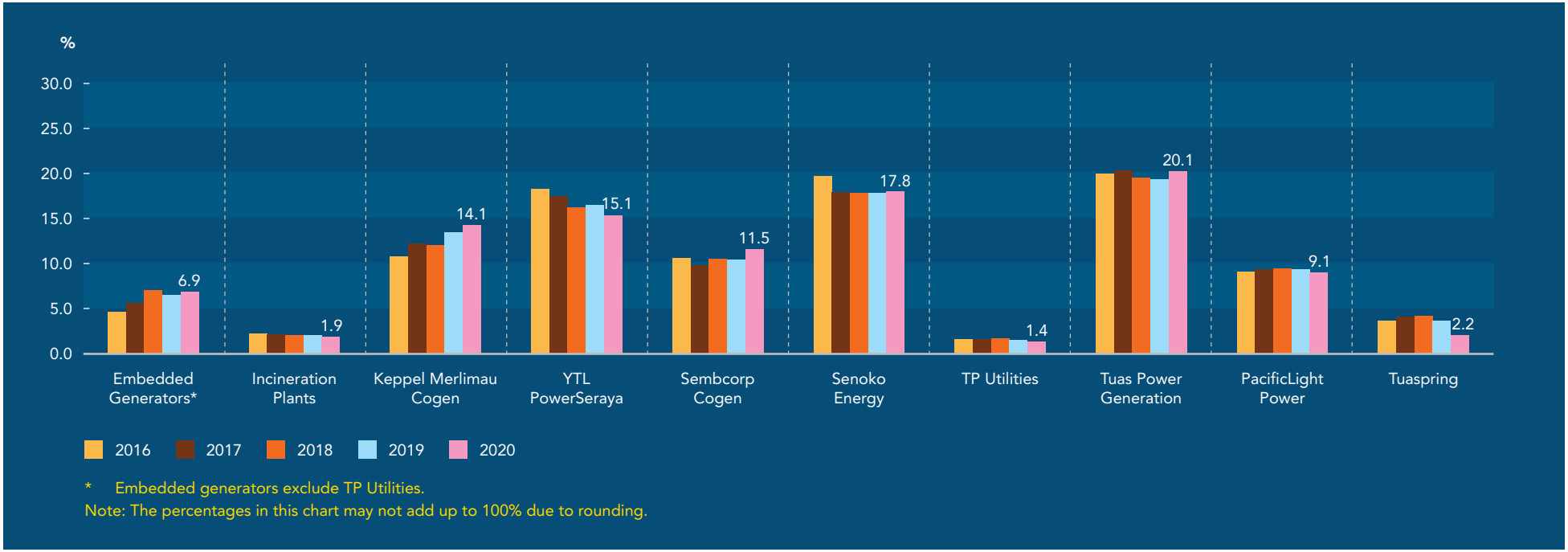
Regulation prices were less volatile in 2020. In 2019, the lowest monthly regulation price was $6.17/MWh in May while the highest was $32.62/MWh in February — a spread of $26.45/MWh. In 2020, this spread narrowed to $13.61/MWh. The lowest monthly regulation price was July's $3.01/MWh while the highest was September's $16.62/MWh. The standard deviation decreased from $8.97/MWh in 2019 to $4.77/MWh in 2020.

Compared to 2019, the monthly regulation offers were higher YOY in all months except February, April and May. In addition, the proportion of regulation offers below $10.00/MWh was largely lower YOY from July onwards. Coupled with a lower regulation requirement that took effect from 1 February 2020, the monthly regulation price was lower YOY in all months except April, May, September and December.

There were four periods of regulation shortfalls in 2020, down from 44 periods in 2019.

COMPETITION IN THE GENERATION AND RETAIL MARKETS

Annual Market Share by Generation Company 2016–2020 (Based on Scheduled Generation)



Competition continues to be keen in generation market

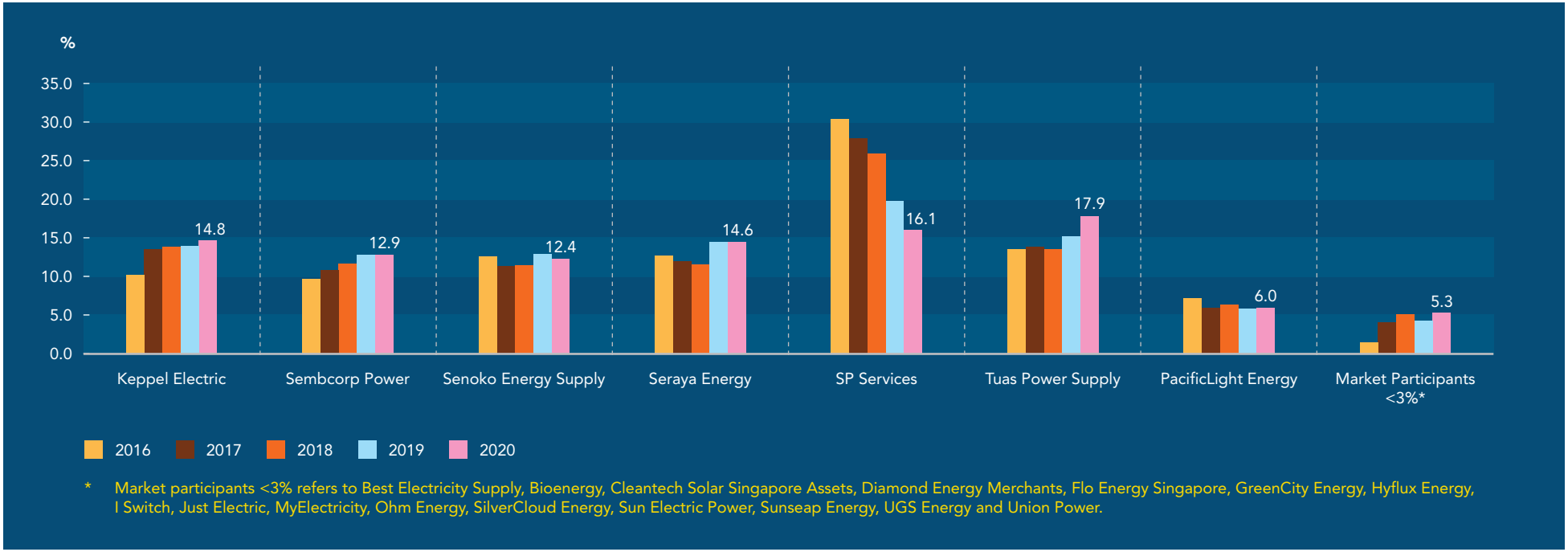
The combined market share of the three leading generation companies (YTL PowerSeraya, Senoko Energy and Tuas Power Generation) shrank 0.3 percentage point to 53.0 percent in 2020. Tuas Power Generation's market share grew 0.9 percentage point to 20.1 percent, while Senoko Energy's market share grew 0.1 percentage point to 17.8 percent. YTL PowerSeraya's market share shrank 1.3 percentage points to 15.1 percent, the smallest it has been since the market started.

Among the smaller generation companies, Keppel Merlimau Cogen's market share rose 0.7 percentage point to 14.1 percent, the largest it has clinched since the market started. Tuaspring's market share shrank the most, by 1.4 percentage points, followed by PacificLight Power whose market share contracted by 0.3 percentage point.

The market share of Sembcorp Cogen and the EGs expanded 1.2 percentage points and 0.5 percentage point respectively, while that of TP Utilities contracted 0.1 percentage point. The incineration plants saw a 0.1 percentage point dip in their market share to the smallest share they have held since the market started.

COMPETITION IN THE GENERATION AND RETAIL MARKETS

Annual Market Share of Market Support Services Licensee and Retailers 2016–2020 (Based on Withdrawal Energy Quantity)



Market share of SP Services overtaken for the first time

In the Open Electricity Market (OEM), the consumption of residential consumers who have switched from SP Services to retailers and selected the Load Profiling (LP) metering option (LP consumers) is included as part of the system residual load which will be wholly settled by SP Services in the NEMS. SP Services will bilaterally settle the consumption of each retailer's aggregated LP consumers outside the NEMS.

To better reflect the market share of the retailers, the consumption of these LP consumers needs to be allocated back to their respective retailers. As it was in 2019, this allocation was done and reflected in the retailers' market share figures for 2020.

Competition continued to be robust in the retail market in 2020 with two new retailers, Bioenergy and Flo Energy Singapore, joining the NEMS. Tuas Power Supply's market share surpassed that of SP Services for the first time, while Keppel Electric and Seraya Energy remained in the top three positions[19].

The market share of SP Services shrank 3.8 percentage points to 16.1 percent, as more consumers switched to their retailers of choice. Tuas Power Supply's market share grew the most, by 2.6 percentage points to 17.9 percent. The market share of Keppel Electric grew 0.7 percentage point to 14.8 percent, while that of Seraya Energy and PacificLight Energy grew 0.1 percentage point each, to 14.6 percent and 6.0 percent respectively. The market share of Senoko Energy Supply shrank 0.6 percentage point to 12.4 percent, while that of Sembcorp Power remained the same at 12.9 percent.

The market share of the 'Market participants <3%' category grew 1.0 percentage point to 5.3 percent. This category comprises retailers with a market share of less than 3.0 percent each.

19 Excluding SP Services which continues to supply customers buying electricity at the regulated tariff.

SETTLEMENT, PRUDENTIAL MANAGEMENT, AUTOMATIC FINANCIAL PENALTY SCHEME AND MINIMUM STABLE LOAD COMPENSATION SCHEME

EMC is the financial clearing house for the wholesale market and settles the following transactions:

- **energy;**
- **ancillary market products — two classes of reserve (primary and contingency) and regulation;**
- **bilateral and vesting contracts;**
- **uplift charges;**
- **financial adjustments;**
- **fee recovery of EMC and the PSO administration costs; and**
- **contracted ancillary services not provided through the ancillary market (black-start services).**

The market is well secured. To cover the exposure of a debtor and the time required to manage a default, all retailers must provide on-going collateral to EMC. This credit support protects EMC and other MPs from payment defaults. EMC reviews the risk exposure of MPs on a daily basis.

Margin Calls and Notices of Default — 1 January to 31 December 2020

A margin call is issued when a retailer's estimated net exposure reaches a value that is equivalent to or greater than 55.0 percent of its level of credit support (for MPs), or 60.0 percent of its level of credit support (for the MSSL)[20]. In 2020, EMC issued a total of eight margin calls.

A notice of default is issued when an MP is unable to remit to the EMC settlement clearing account by the end of the business day following its payment due date. In 2020, EMC issued a record number of 78 default notices. Of these, 73 led to the issuance of a First Default Levy Notice and the settlement amounts were made good by drawing from the defaulting MPs' credit support. The settlement amounts for the remaining five default notices were remedied on the following business day.

Automatic Financial Penalty Scheme (AFPS) and Minimum Stable Load (MSL) Compensation Scheme — 1 January to 31 December 2020

The AFPS is a penalty scheme that was introduced in November 2015 and applied to all GRFs that deviate from their dispatch schedules by more than 10MW. The intent was to incentivise the GRFs to comply with dispatch instructions. The AFPS was subsequently extended to include all load registered facilities (LRFs) under the DR programme introduced in April 2016, and now applies to all LRFs with restricted energy bids that deviate from their dispatch schedules.

In 2020, there were 39 periods when the AFPS kicked in, including two periods for a deviating LRF for the first time. The total penalty collected was $288,401.00. The penalty collected was returned to the market via the monthly energy uplift charges.

The MSL compensation scheme compensates participating GRFs when they are constrained for energy at their MSLs and their offer prices are higher than the marginal clearing price. It was implemented in November 2015 to enhance system security and create financial certainty for these facilities over the recovery of costs. In 2020, $3,071.17 was paid out for a total of four periods under the MSL compensation scheme. The amount paid out was funded by the market via the monthly energy uplift charges.

20 With effect from 8 January 2020, the risk exposure threshold to trigger a margin call has been reduced from 70 percent across the board to 55 percent for MPs and 60 percent for the MSSL.

CONTRACTED ANCILLARY SERVICES

In addition to the co-optimised energy, reserve and regulation markets, EMC negotiates and enters into ancillary services contracts on behalf of the PSO, to ensure the reliable operation of Singapore's power system. If these services cannot be procured competitively due to a limited number of available suppliers, for example, their prices are regulated.

From 1 April 2020 to 31 March 2021, the only contracted ancillary service required was black-start capability. Black-start services ensure that there is initial generation to supply electric power for system restoration following a complete blackout.

Based on the PSO's operational requirements, EMC procured 88.848MW of black-start services at a cost of $9.80 million for the period from 1 April 2020 to 31 March 2021. The capability was sourced from YTL PowerSeraya, Senoko Energy, Tuas Power Generation, and Keppel Merlimau Cogen.

Contracted Ancillary Services — 1 April 2020 to 31 March 2021

Contract Period	Cost of Ancillary Services	Total MW Contracted
1 April 2020 to 31 March 2021	$9,797,431.03	88.848

MARKET FEES

The costs associated with the wholesale functions of the NEMS are recovered directly from the wholesale market through fixed fees as well as variable fees that are proportionate to the quantity of energy that the MPs trade.

EMC Fees — 1 July 2020 to 30 June 2021

Market Participant (MP) Fee	$10,000 per MP (annual)
MP Registration Fee	$5,000 per registration (one-off)
RSA Hardware Token Fee	$350 per token (once every three years from 6th token onwards per MP) $110 per token (replacement fee for lost or damaged token)
EMC Fee per MWh ($/MWh)	0.3357

PSO Fixed Fees — 1 July 2020 to 30 June 2021

MP Fee	$3,500 per MP (annual)
MP Registration Fee	$1,650 per legal entity registration (one-off)

PSO Net Fees — 1 April 2020 to 31 March 2021

PSO Net Fees ($'000)	26,252

ADDITIONAL INFORMATION

LETTER FROM THE CHAIR, MARKET ADVISORY PANEL

Dear Industry Members

The Covid-19 pandemic has created a challenging operating environment for many organisations, including the market participants of the National Electricity Market of Singapore (NEMS). For the first time since 1975, Singapore's annual electricity generation fell year-on-year in 2020, due to the severe slowdown in domestic economic activities.

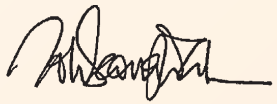
Notwithstanding the pandemic, electricity demand over the medium- to long-term is expected to grow. The Singapore government is committed to developing the energy market to drive the right behaviour over the long term. The Forward Capacity Market (FCM) has been identified as a suitable market framework that could ensure the long-term sustainability and reliability of Singapore's power system.

One of the Market Advisory Panel's (MAP) objectives is to develop strategies and long-term solutions to address current and upcoming market challenges and opportunities. In line with that, the MAP established the Industry Working Group 1 (IWG 1) to study the proposed FCM design. The IWG 1 was tasked to make recommendations to the Energy Market Authority (EMA) to enhance the FCM's design, with the intent of contributing to a sustainable energy future for Singapore.

I am pleased to report that the IWG 1 completed its study in October 2020 and produced a report with four broad recommendations to enhance the FCM's design. The report has been forwarded to the EMA for its consideration.

I would like to thank all MAP members for their time and invaluable perspectives, as well as the industry working group members for their dedication and hard work.

We will continue to partner the industry to co-create and develop sustainable solutions that will benefit the NEMS in the long run.



Toh Seong Wah
Chair
Market Advisory Panel

SUMMARY OF RECOMMENDATIONS TO THE ENERGY MARKET AUTHORITY ON RESOURCE ADEQUACY

Background

As part of the MAP's effort to study broad and strategic issues affecting the development of the NEMS, the Industry Working Group 1 (IWG 1) was formed to study and analyse issues regarding resource adequacy as well as the EMA's proposed design for the FCM.

Four Main Recommendations by Industry Working Group 1

The IWG 1 prepared a report covering four principle-based recommendations to the EMA. They are as follows:

- Provide a level-playing field for all technologies (technology-neutrality) and participants;
- Provide more clarity on the interactions between the FCM and the real-time markets;
- Review the FCM on a regular basis; and
- Develop a participation model for distributed energy resources for the future.

Provide a level-playing field for all technologies and participants

This recommendation aims to level the playing field for all technologies and participants in the different aspects of the FCM design. It hopes to instill confidence in the market for both existing and potential participants. Specifically, the IWG 1 recommends the following:

- To remove, due to its discriminatory nature, the Multi-Year Commitment scheme for new combined-cycle plants that meet the EMA's heat rate standards;
- To explore alternative non-discriminatory mechanisms to attract new plantings in Singapore;
- To allow all types of frequency-responsive resources that meet the Power System Operator's (PSO) technical specifications to be included in the floor of 9GW Frequency Responsive Resources; and
- To review the caps for demand response and energy storage systems on a regular basis. As a start, to review the caps on an annual basis until such technologies mature in Singapore.

Provide more clarity on interactions between the FCM and real-time markets

This recommendation hopes to assist all stakeholders in Singapore's energy market ecosystem to better understand and appreciate the impact of the FCM. It will enhance transparency in the NEMS and help attract new entrants in the long run. Specifically, the IWG 1 recommends the following:

- For the EMA to provide more details on the impact on/interactions between the various energy policies; and
- For the EMA to provide detailed procedural papers on the determination of components of the demand curve such as price cap, reserve margin and the slope of the demand curve.

ADDITIONAL INFORMATION:

SUMMARY OF RECOMMENDATIONS TO THE ENERGY MARKET AUTHORITY ON RESOURCE ADEQUACY

Review the FCM on a regular basis

This recommendation seeks to ensure that the FCM remains relevant in future as Singapore's power system dynamics may change with higher penetration of renewable resources. Specifically, the IWG 1 recommends the following:

- To conduct an independent review of resource qualification at a higher frequency. As a start, a review every two years is recommended until the technologies have matured; and
- To conduct a cost-benefit analysis after the initial phrase of the FCM, akin to a similar study for the wholesale electricity market that was conducted in 2005/2006.

Develop a participation model for distributed energy resources

This recommendation aims to ensure that more distributed energy resources can participate in the FCM, adding positive competitive pressure on capacity prices and minimising long run costs for consumers. Specifically, the IWG 1 recommends the following:

- To ensure that the participation model is workable both in the FCM and the spot market; and
- To remove the resource caps as Singapore gains more operational experience dealing with demand resources and energy storage systems.

Submission of Recommendations to Energy Market Authority

The MAP-endorsed IWG 1 report covering the above four recommendations was submitted to the EMA on 26 October 2020.

For more information, please refer to the link below:
https://www.emcsg.com/aboutthemarket/marketadvisorypanel

GLOSSARY

ancillary services
The additional services needed to ensure the security and reliability of the power system. The ancillary services traded competitively on the wholesale market are regulation and the two classes of reserves (primary and contingency). The black-start ancillary service is contracted by Energy Market Company (EMC) on behalf of the Power System Operator (PSO) on an annual basis.

balance vesting price (BVP)
This refers to the price for the balance vesting quantity allocated.

balance vesting quantity
With the start of the Liquefied Natural Gas (LNG) Vesting Scheme in the third quarter of 2013, a certain percentage of the total allocated vesting quantity is pegged to LNG. The remaining percentage pegged to piped natural gas is known as the balance vesting quantity.

black-start ancillary service
A service to ensure that there is initial generation of power, without using power from the grid, so as to restore systems following a complete blackout.

co-optimisation
The process used by the market clearing engine (MCE) to ensure that the most inexpensive mix of energy, reserves, and regulation is purchased from the market to meet electricity demand in each dispatch period.

demand response (DR)
This enables contestable consumers to voluntarily reduce their electricity demand in response to market conditions, particularly during periods of high wholesale market prices or when system reliability is adversely affected.

dispatch schedule
A schedule produced by the MCE every half-hour. It is the basis for the supply and consumption of energy, and the supply of reserve and regulation in the market.

distributed energy resources (DER)
Electricity-producing resources or controllable loads that are connected to a local distribution system or a host facility within the local distribution systems. In Singapore's context, examples of DER include solar panels, electricity storage and controllable loads. These resources are typically smaller in scale than the traditional generation facilities that serve most of Singapore's electricity demand.

embedded generators (EG)
Generation units that generate electricity to their on-site load principally for self-consumption.

energy
The flow of electricity.

forward capacity market (FCM)
An annual competitive auction that is held a few years ahead of a specified period to procure the most cost-efficient capacity to meet Singapore's electricity supply reliability standard.

gigawatt (GW)
A measure of electrical power equivalent to one thousand megawatts. Gigawatt hour (GWh) represents the number of gigawatts produced or consumed in an hour.

intermittent generation sources (IGS)
Sources of energy whose output depends on environmental factors and weather conditions, such as solar and wind energy. While there are IGS facilities connected to the grid in Singapore, IGS are not scheduled for dispatch by the PSO in the wholesale market because the power output cannot be controlled or varied at will.

interruptible load (IL)
The amount of electricity that a consumer makes available for interruption in the event of a system disturbance in exchange for reserve payment. The PSO controls the activation of interruptible loads.

licensed capacity
Capacity of a facility licensed by the Energy Market Authority (EMA).

LNG vesting price (LVP)
The price for the LNG vesting quantity allocated.

LNG vesting quantity
With the start of the LNG Vesting Scheme in the third quarter of 2013, a certain percentage of the total allocated vesting quantity is pegged to LNG. This is known as the LNG vesting quantity.

load
The consumption of electricity.

market clearing engine (MCE)
The linear programme computer application used to calculate spot market quantities and prices.

market participant (MP)
A person who has an electricity licence issued by the EMA and has been registered with EMC as a market participant to trade in the wholesale electricity market.

megawatt (MW)
A measure of electrical power equivalent to one million watts. Megawatt hour (MWh) represents the number of megawatts produced or consumed in an hour.

GLOSSARY

metered demand
The electricity consumption that is proxied by the withdrawal energy quantity (WEQ).

nodal pricing
A market structure in which prices are calculated at specific locations, or nodes, in the power system to reflect the demand and supply characteristics of each location, taking into consideration transmission losses and congestion. Nodal pricing is also commonly referred to as locational marginal pricing. In the settlement reports, this is termed as the market energy price (MEP).

open electricity market (OEM)
An initiative by the EMA to enable all business consumers and households to buy electricity from a retailer of their choice at a price plan that best meets their needs, or remain on the regulated tariff rate.

registered capacity
This denotes the capacity of a facility registered with the National Electricity Market of Singapore (NEMS). Registered capacity may differ from licensed capacity.

regulation
Generation that is on standby to fine-tune or correct frequency variations or imbalances between demand and supply in the power system.

reserve
Stand-by generation capacity or interruptible load that can be drawn upon when there is an unforeseen disruption of supply.

retail market
The transactions made between retail companies and end consumers.

retailer of last resort (RoLR)
The one or more retailers who will take responsibility for the customers of a retailer that is no longer able to, or has lost the right to, retail electricity to its customers.

supply cushion
This measures the percentage of total supply available after matching off demand.

terawatt (TW)
A measure of electrical power equivalent to one million megawatts. Terawatt hour (TWh) represents the number of terawatts produced or consumed in an hour.

uniform Singapore energy price (USEP)
The weighted-average of the nodal prices at all off-take nodes.

vesting contract
A regulatory instrument imposed on some generators by the EMA, with the objective of mitigating the potential exercise of market power when the supply side of the industry is concentrated among a small number of generators. A vesting contract requires these generators to sell a specified quantity of electricity (vesting contract level) at a specified price (vesting contract hedge price).

vesting contract hedge price (VCHP)
This is calculated by the Market Support Services Licensee (MSSL), SP Services, every three months. It is determined using the long-run marginal cost of the most efficient generation technology in the Singapore power system, i.e., the combined-cycle gas turbine (CCGT). EMC's settlement system uses the VCHP to settle the vesting quantity between the MSSL and the generation companies. With the introduction of LNG into the generation mix, the VCHP has been replaced by 'LNG vesting price' and 'balance vesting price' since July 2013.

withdrawal energy quantity (WEQ)
This is measured in MWh and refers to the amount of electricity withdrawn by load facilities. It is provided by the MSSL, SP Services.

wholesale market
The transactions made between generation companies and retail companies.

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