

MARKET REPORT 2019

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ENERGY MARKET COMPANY: Letter from the Chairman

Dear Industry Members

I am pleased to have witnessed another year of robust trading in the National Electricity Market of Singapore (NEMS) in 2019.

A significant development in the year was the retirement of older, less efficient generation sets from the market. A total of five steam turbine units (with close to 1,200MW in registered capacity) were de-registered, leading to an overall 8.2 percent reduction in total registered capacity which was the largest decline in a single year since the market started. The de-registrations stemmed from the rollback of the piped natural gas (PNG) component of vesting contracts to zero.

Despite this, the total registered capacity in the NEMS stood at 12,451MW at the end of the year, which provided a healthy reserve margin against Singapore's peak demand of about 7,200MW. More importantly, efficiency in the NEMS remained high as combined-cycle gas turbine (CCGT) remained the predominant generation type¹.

Another milestone in 2019 was the full rollout of the Open Electricity Market initiative. With all consumers in Singapore now being able to choose their electricity suppliers, competition among the retailers has been vibrant,

as apparent from the shifts in market share and the top three retailers². In line with this, we have seen some consolidation as several electricity retailers exited the market in the course of the year.

With regard to prices, the market performed within expectations, with wholesale prices responding to fundamental changes in demand and supply. The Uniform Singapore Energy Price (USEP) receded below the \$100/MWh level once again in 2019 to \$98.28/MWh, driven primarily by supply-side factors as fuel oil prices dropped 5.9 percent and generation supply rose 2.6 percent.

I am happy to note a significant fall in the number of default notices issued to market participants compared to 2018. To further protect the financial integrity of the market, we undertook a vigorous review of the existing safeguards, to strengthen them and enhance the market's resilience against payment defaults.

I am also pleased that the NEMS has continued to attract new participants and renewable resource investments, which will add vibrancy to our well-functioning, competitive market. Significantly, almost all³ of the new capacity investments in the year were

intermittent generation source (IGS) facilities. With these additions, the total registered capacity of IGS facilities was 138MW, a 146 percent increase over the preceding year. Given Singapore's focus on diversifying its energy sources and the target to deploy at least 2 gigawatt peak of solar energy by 2030, the pace of growth of IGS facilities and their participation in the market is likely to accelerate in the coming years.

To ensure resource adequacy and a reliable supply of electricity at minimum long run cost to consumers, a Forward Capacity Market (FCM) is being planned to provide incentives for generation companies to maintain sufficient and reliable capacity.

Energy Market Company is supporting the development of the FCM at the strategic level through the Market Advisory Panel (MAP) that we set up last year, and operationally through Market Rules and system changes.

The MAP is an important initiative for Singapore's electricity industry. It provides thought leadership on issues affecting the NEMS' long-term sustainability and development which is necessary in a rapidly evolving

energy landscape. I am grateful for the support we have received from the industry's leaders, and I thank them for dedicating their time towards this initiative.

I would also like to convey my appreciation to the Energy Market Authority as well as the experts and professionals on our governance panels. Their support has been integral in evolving the NEMS, and maintaining stability and efficiency in the market.



Agnes Koh
Chairman
Energy Market Company

¹ CCGT units made up 84.4 percent of total registered capacity, and contributed 97.9 percent of total electricity dispatched in 2019.

² The top three electricity retailers (excluding SP Services) by market share were Tuas Power Supply, Seraya Energy and Keppel Electric. Their combined market share in 2019 was 43.9 percent.

³ A total of 26 new facilities were registered in 2019, out of which 25 were IGS facilities which added 38.858MW of capacity.

MARKET **OVERVIEW**



MARKET OVERVIEW: Market History

The opening of the National Electricity Market of Singapore (NEMS) in January 2003 was the culmination of a number of structural reforms to Singapore's electricity industry.

Singapore's journey to liberalisation started in October 1995, when industry assets were corporatised and put on a commercial footing. In 1998, the Singapore Electricity Pool, a day-ahead market, began operations. On 1 April 2001, a new legal and regulatory framework was introduced that formed the basis for a new electricity market.

The NEMS is an integral part of Singapore's overall energy policy framework, which seeks to maintain a balance of 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 as a way 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

●	1995	Electricity functions of the Public Utilities Board corporatised Singapore Power formed as a holding company	Corporatisation
●	1996	Singapore Electricity Pool (SEP) design process began	
●	1998	SEP commenced PowerGrid is SEP Administrator and Power System Operator (PSO)	Singapore Electricity Pool (SEP)
●	2000	Decision for further reform to obtain full benefits of competition New market design process began	National Electricity Market of Singapore (NEMS)
●	2001	Electricity industry legislation enacted Energy Market Authority (EMA) established as industry regulator and PSO Energy Market Company (EMC) 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	

MARKET OVERVIEW: Industry Structure

Participants and Service Providers in the NEMS

Generators			
ExxonMobil Asia Pacific	National Environment Agency	Senoko Waste-To-Energy	Tuas Power Generation
Keppel Merlimau Cogen	PacificLight Power	Shell Eastern Petroleum	TuasOne
Keppel Seghers Tuas Waste-To-Energy Plant (Tuas DBOO Trust)	Sembcorp Cogen	Singapore Refining Company	Tuaspring
	Senoko Energy	TP Utilities	YTL PowerSeraya
Wholesale Market Traders			
Air Liquide Singapore	Green Power Asia	Red Dot Power	Sun Electric Energy Assets
CGNPC Solar-Biofuel Power (Singapore)/JE Green Solutions	LYS Genco Beta	Sembcorp Solar Singapore	Sunseap Leasing
Changi Mega Solar	MSD International GmbH (Singapore Branch)	Singapore District Cooling	Sunseap Leasing Beta
Enel X Singapore	Public Utilities Board	Singapore LNG Corporation	Terrenus Energy
Retailers			
Best Electricity Supply	I Switch	PacificLight Energy	Sun Electric Power
Cleantech Solar Singapore Assets	Just Electric	Sembcorp Power	Sunseap Energy
Diamond Energy Merchants	Keppel Electric	Senoko Energy Supply	Tuas Power Supply
GreenCity Energy	MyElectricity	Seraya Energy	UGS Energy
Hyflux Energy	Ohm Energy	SilverCloud Energy	Union Power
Market Support Services Licensee (MSSL)	Market Operator	Power System Operator (PSO)	Transmission Licensee
SP Services	Energy Market Company	Power System Operator	SP PowerAssets

The following MP changes took place in 2019:

- Enel X Singapore and Terrenus Energy joined the market.
- Charis Electric, Diamond Energy Managers, Environmental Solutions (Asia), Peerer Energy and SingNet withdrew from the market.
- Red Dot Power's retailer licence was terminated. It currently holds a Wholesaler (Demand Side Participation) licence.
- CGNPC Solar-Biofuel Power (Singapore) was renamed JE Green Solutions.

MARKET OVERVIEW: Industry Structure

Singapore's electricity industry is structured to facilitate competitive 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 2019

In 2019, two new market participants (MP) – Enel X Singapore and Terrenus Energy – joined the NEMS. During the year, five MPs exited the market – Charis Electric, Diamond Energy Managers, Environmental Solutions (Asia), Peerer Energy and SingNet.

With the above changes, there were 51 MPs in the NEMS as of end December 2019 comprising 15 generators, 16 wholesale market traders and 20 retailers.

Generation Licensees

Generation licensees are companies with generating facilities that are 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

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 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 OVERVIEW: 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, regulation and reserve 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 7);
- 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 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

Energy, Reserve and Regulation Products

	Description	Purchaser	Seller
Energy	Generated electricity	Retailers	Generators
Reserve	Stand-by generation capacity or IL 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

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 way that is physically feasible 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 114 injection nodes, and the prices at up to 885 withdrawal or off-take nodes⁴ that are used as the basis for the price to be paid by customers. This method of price determination

encourages the 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.

⁴ Numbers of injection and withdrawal nodes are as of 31 December 2019.

MARKET OVERVIEW: Market Features

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 purchase 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.

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, who 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) is responsible for monitoring, investigating and reporting the conduct of MPs and the structural efficiency of the market. The Panel is appointed by the EMC Board and comprises professionals independent of the market, with combined extensive experience covering the areas of power system operation, law and economics.

The Panel is supported by EMC's Market Assessment Unit (MAU). The MAU identifies market rule breaches and assesses market operations for efficiency and fairness, before putting forth recommendations for the Panel's final determination on cases. In circumstances where the MSCP determines that an MP is not compliant with the Market Rules, it may take enforcement action, which may include levying a penalty. The MSCP also recommends remedial actions to mitigate any rule breaches or inefficiencies identified, as part of its objective to promote market efficiency.

The Panel produces the MSCP Market Watch quarterly report, and the MSCP Annual Report which has been published together with the NEMS Market Report since 2007.

Dispute Resolution

The Market Rules contain a process that facilitates the resolution of disputes between MPs and service providers. Specifically, all disputes in the NEMS go through three stages: negotiation, mediation and arbitration. This dispute resolution process is designed to be a cost-effective way of resolving disputes and preserving market relationships by avoiding court proceedings.

The dispute resolution process is managed by the Dispute Resolution Counsellor (DRC) who is appointed by the EMC Board. The DRC also appoints specialised professionals to serve on the mediation and arbitration panels.

The MAU also assists the DRC in facilitating the dispute resolution process in the NEMS.

MARKET GOVERNANCE: Letter from the Chair, Rules Change Panel

Dear Industry Members

The Singapore Electricity Market Rules govern the wholesale market operations of the National Electricity Market of Singapore (NEMS). In today's fast-changing industry landscape, it is even more important for the Market Rules to keep pace with developments and remain relevant. Ideally, the Market Rules should be forward-looking in order to anticipate and accommodate innovations that can benefit the market. Undertaking this responsibility is the Rules Change Panel (RCP), which has the mandate of the EMC Board to evolve the wholesale electricity market. The RCP's role remains as important and challenging as ever, as we cross the 17-year mark of the NEMS.

The main theme of 2019's rule change activities was preserving the financial integrity of the wholesale electricity market. With the introduction of the electricity futures market, we have seen a surge in the number of new retailers. These new participants come with diverse backgrounds that differed greatly from the traditional retailers in the NEMS. This phenomenon prompted the RCP to review the adequacy of prudential requirements for the retail class of participants. While putting in place adequate protection against

defaults in payment, the Panel also studied extensively the various possible options to avoid imposing undue burden on market participants. In addition, the Panel took the precaution of examining the process of handling the resolution of residual risk from a default event.

These were important and timely responses to the exit of four independent retailers in 2018 and early 2019. By ensuring that there can be orderly exits of electricity retailers from the market, I believe consumers' confidence in retailers and the NEMS will be boosted.

An open and competitive electricity market cannot be considered complete without participation from the demand side. On this front, Energy Market Company (EMC) and the Energy Market Authority (EMA) have been working together to refine the market's design in order to create a more conducive environment for the demand side to participate in the wholesale market. This year, the RCP facilitated a rule change allowing an interruptible load provider to seek compensation if its load was required to be curtailed beyond four periods. This addressed

a longstanding issue that bothered interruptible load providers, in which they risked being required to maintain prolonged curtailment of loads without compensation for financial costs. With two new players having signed up to provide demand response and interruptible load services in 2019, I look forward to more active participation from the demand side in the near future.

In 2019, the RCP also reviewed the shortening of gate closure and the Automatic Financial Penalty Scheme. While the Panel decided that no changes were required, the reviews were necessary as they allowed us to revisit the intent of good market design principles, and ensure that our market design continues to reflect these principles as the electricity market evolves.

Finally, the RCP also supported two other rule changes that improved the process efficiencies of outage planning and the registration of new market participants, thereby reducing the administrative burden on market participants and service providers.

The success of the rule change process in 2019 cannot be attributed to the Panel alone. I would like to express my deepest appreciation to the EMA, the Power System Operator, the EMC Board and all market participants for their valuable contributions to the debates and discussions, as well as EMC's Market Administration and Market Operations teams for their analytical support.



Toh Seong Wah
Chair
Rules Change Panel

Rule Changes Supported by the RCP

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

Restoration of Load Registered Facilities Activated to Provide Reserve

The RCP supported the rule change proposal for EMC to stipulate a maximum interruption duration of 120 minutes for interruptible load (IL) activation, beyond which the IL service providers should be allowed to seek compensation.

This addresses IL service providers' concerns relating to operational difficulties and the negative commercial impact of prolonged interruptions. With the maximum interruption duration set at 120 minutes, IL service providers will have more certainty on the operational and financial impact of each interruption.

The RCP also supported EMC's proposal to publish statistics on the frequency and duration of IL activations for existing and potential IL service providers, to help them better estimate the cost of providing IL services.

Gate Closure Exemptions

Previously, offer or bid changes were allowed to be submitted after gate closure only if they served to (i) reflect the changes in the facility's physical capability; or (ii) resolve a situation where the system was under stress.

The RCP reviewed these previous exemptions from the gate closure rule and a proposal to add new exemptions. It supported the proposal to (i) allow a load registered facility (LRF) to revise its reserve offers within gate closure to reflect its unavailability following an activation of reserve; and (ii) allow a generation registered facility (GRF) to revise its offers within gate closure to reflect the GRF's revised capability when it fails to synchronise, and to increase its reserve or regulation supply, if that improves a shortfall situation, when a high-risk operating state is in effect.

The RCP also supported refining the previous gate closure exemptions to allow a GRF to reflect its reduced capability after gate closure for only the first three periods following a forced outage, so as to encourage the tripped GRF to re-offer responsibly.

MARKET GOVERNANCE: Market Evolution

Review of Credit Support Requirements in Alignment with the Lead Time for Transfers During a Retailer of Last Resort Event

The current credit support requirement is set based on an MP's expected average trading exposure over a 30-day period, covering the MP's exposure from the first default day to the day it is suspended from trading. However, this did not take into account the Retailer of Last Resort (RoLR) process, which requires three additional business days for customers to be transferred to the RoLR when a retailer defaults. Considering this, the actual exposure of an MP could span between 34 and 38 days, making the 30-day credit support requirement insufficient.

The RCP supported the proposal to increase the credit support requirement to cover 38 days' exposure for MPs and 33 days' exposure for the MSSL. In addition, the risk exposure threshold to trigger a notification has been lowered from 60% to 45% for MPs and 50% for the MSSL, while the risk exposure threshold to trigger a margin call has been reduced from 70% to 55% for MPs and 60% for the MSSL.

Removal of Requirement for Final Consent for Planned Outages

Previously, a final approval and a final consent from the PSO were required prior to the execution of a planned outage. As a final consent did not provide MPs with any additional assurance operationally and financially, it was proposed that this requirement be removed.

The RCP agreed that the requirement for the PSO's final approval of planned outages was sufficient. It also decided that the requirement for a further final consent was redundant and administratively onerous, and hence should be removed.

Review of Default Levy Arrangements

In the NEMS, credit risk arises from the trading exposures of net debtors. Most of this risk is mitigated by requiring net debtors to provide credit support that covers their estimated payment obligations to the market. However, it is not possible to completely rule out the possibility of a credit support shortfall when an MP defaults in payment. The default levy arrangement allocates this residual credit risk to the market.

The RCP has reviewed the default levy arrangement and corrected errors discovered in default levy calculations. The Market Rules were further improved by elucidating definitions and timelines related to the default levy arrangement.

Bank Readiness Check of Market Participant Registration

The Market Rules require an MP to maintain its bank account at the clearing bank appointed by the EMC. An MP applicant's bank readiness check is thus part of the process to approve its application to register in and participate in the Singapore Wholesale Electricity Market (SWEM).

The current MP registration process requires the applicant to submit a copy of the Third Party Authorisation (TPA) Form as proof that such a bank account is ready. However, an applicant's ability to furnish this document does not necessarily indicate that its bank account is ready. A proposal was thus made to require the applicant to submit the clearing bank's confirmation of the account's readiness instead of a copy of the TPA Form.

The RCP supported this proposal to improve the efficiency of the MP registration process.

Other Rule Changes Considered by the RCP

Review of Automatic Financial Penalty Scheme

The RCP considered a proposal to review the Automatic Financial Penalty Scheme and the treatment of an embedded generator's (EG) must-run quantity.

The RCP agreed that GRFs that are on local control and responding positively to system disturbances should be exempted from the penalty. On the other hand, while the RCP acknowledged that deviations relating to partial forced outages, as well as de-loadings and failures to synchronise due to forced outages, were out of a generation company's control, it decided to defer the decision on whether an exemption should be made for such cases. The Panel took into consideration the fact that such cases are being concurrently reviewed by the EMA under the Intermittent Pricing Mechanism.

The RCP also concluded that no change was required for the treatment of an EG's must-run quantity.

Review of Gate Closure Rules

Gate closure serves to prevent offer or bid changes that are too close to the dispatch period, as such changes can compromise dispatch certainty, unit commitment and system security. The gate closure period in the SWEM is 65 minutes.

The RCP considered a proposal to shorten the gate closure period. It recognised that a shorter gate closure period can enhance efficiency by improving responsiveness to changing market or system/plant conditions. Nevertheless, the RCP was of the view that the current gate closure period of 65 minutes struck a good balance between providing sufficient time for MPs and the PSO to manage unit commitment and system security, and mitigating opportunity for strategic re-offering.

MARKET GOVERNANCE: 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. Ben Giaretta
2. Chelva Rajah, Senior Counsel
3. Giam Chin Toon, Senior Counsel
4. Gregory Thorpe
5. Harry Elias, Senior Counsel
6. Kenneth Tan, Senior Counsel
7. Professor Lawrence Boo
8. N Sreenivasan, Senior Counsel
9. Naresh Mahtani
10. Philip Jeyaretnam, Senior Counsel
11. Phillip Harris
12. Raymond Chan
13. Dr. Robert Gaitskell, Queen's Counsel
14. Tan Chee Meng, Senior Counsel
15. 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 current DMS contacts are:

1. Best Electricity Supply
– Terence Neo
2. Cleantech Solar Singapore Assets
– Andre Nobre
3. Diamond Energy Merchants
– Muhammad Khairul
4. Enel X Singapore – Daniel Garrett
5. Enel X Singapore – Goh Tong Ye
6. Energy Market Company
– Christopher Yeoh
7. ExxonMobil Asia Pacific – Eric Lim
8. ExxonMobil Asia Pacific
– Lim Li Fang
9. ExxonMobil Asia Pacific
– Matthias Franke
10. GreenCity Energy – Chilton Loh
11. Green Power Asia – Daniel Ma
12. Hyflux Energy – Cindy Lim
13. Hyflux Energy – Ooi Chel-Lin
14. I Switch – Senthil Kumar
15. JE Green Solutions – Fan Ke

16. JE Green Solutions
– Xie Jun Chuan
17. Just Electric – Wittman Wah
18. Keppel Electric – Joelyn Wong
19. Keppel Electric – Nicholas Tan
20. Keppel Merlimau Cogen
– Janice Bong
21. Keppel Merlimau Cogen
– Sean Chan
22. LYS Genco Beta – Jonathan Chong
23. MyElectricity – Jeffrey Tan
24. National Environment Agency
– Teresa Tan
25. National Environment Agency
– Yap Hwee Tat
26. Ohm Energy – Nerine Teo
27. PacificLight Energy – Teo Chin Hau
28. PacificLight Power – Teo Chin Hau
29. Power System Operator
– Loh Poh Soon
30. Power System Operator
– Oh Chai Choo
31. Red Dot Power – Vijay Sirse
32. Sembcorp Cogen – Agnes Low
33. Sembcorp Cogen – Andy Lim
34. Sembcorp Power – Serina Wong
35. Sembcorp Power – Winson Kor
36. Sembcorp Solar Singapore
– Fendy Nursalim
37. Senoko Energy – Poo Siok Yin
38. Senoko Energy Supply
– Michelle Lim
39. Senoko Waste-To-Energy
– Lee Song Koi
40. Senoko Waste-To-Energy
– Max Heng
41. Seraya Energy – Elaine Syn
42. Shell Eastern Petroleum
– Grace Chiam
43. Shell Eastern Petroleum
– Koh Sian Kim
44. SilverCloud Energy – Lee Hock Lim
45. Singapore District Cooling
– Dennis Chong
46. Singapore District Cooling
– John Tan
47. Singapore LNG Corporation
– Jasmine Pang
48. Singapore LNG Corporation
– Vincent Lam
49. Singapore Refining Company
– Balasubramaniam Sundararaj
Mohanakkannan
50. Singapore Refining Company
– Ho Weng Foo
51. SP PowerAssets
– Chan Hung Kwan
52. SP Services – Ho Yin Shan
53. SP Services – Rachel Su
54. Sun Electric Energy Assets
– Eugene Lim
55. Sun Electric Energy Assets
– Matthew Peloso
56. Sunseap Energy – Lawrence Kwan
57. Sunseap Leasing – Jonathan Tai
58. Sunseap Leasing – Shawn Tan
59. Sunseap Leasing Beta – Shawn Tan
60. Terrenus Energy – David Chan
61. Terrenus Energy – Kevin Chiu
62. Tuas DB00 Trust – Victor Fong
63. Tuas DB00 Trust – Wilfred Tan
64. Tuas Power Generation
– Priscilla Chua
65. Tuas Power Supply – Jazz Feng
66. Tuas Power Supply – Zhang Ai Jia
67. TuasOne – Jennifer Ong
68. TuasOne – Kang Thian Jian
69. Tuaspring – Terence Ang
70. Tuaspring – Timothy James Reid
71. UGS Energy – Esther Lim
72. UGS Energy – Jessica Ang
73. Union Power – Ellen Teo
74. Union Power – Eric Lim
75. YTL PowerSeraya – Don Tan
76. YTL PowerSeraya
– Jonathan Chew

During the year, eight DMS contacts replaced previous appointees, and an additional seven DMS contacts from new, registered NEMS market participants were nominated.

Dispute Resolution Training

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

On 7 May 2019, I conducted a briefing on the NEMS' dispute resolution process for new DMS contacts. The workshop was organised and supported by EMC's Market Assessment Unit.

Conclusion

I am happy to report that for the past year, 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.



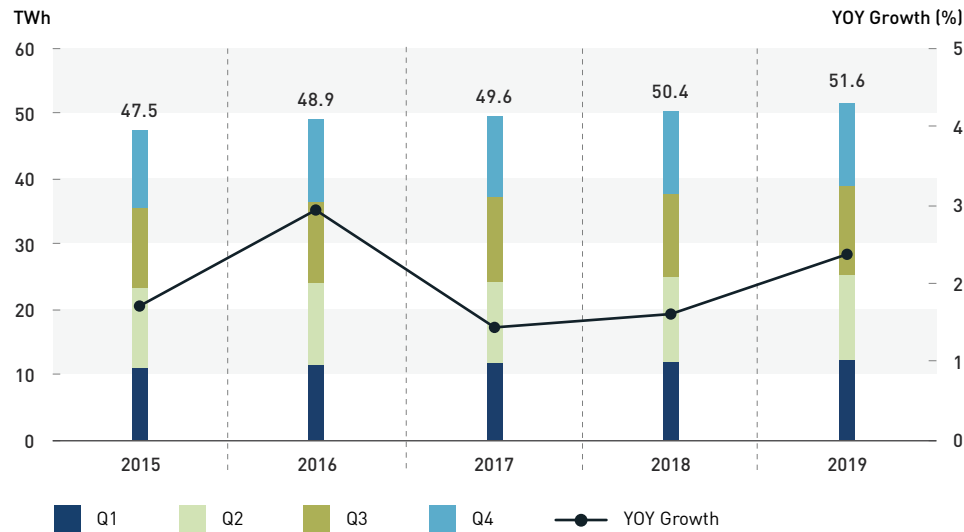
George Lim

Senior Counsel
Dispute Resolution Counsellor

MARKET PERFORMANCE



Annual Electricity Consumption 2015 – 2019



Electricity consumption continues to grow in 2019

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

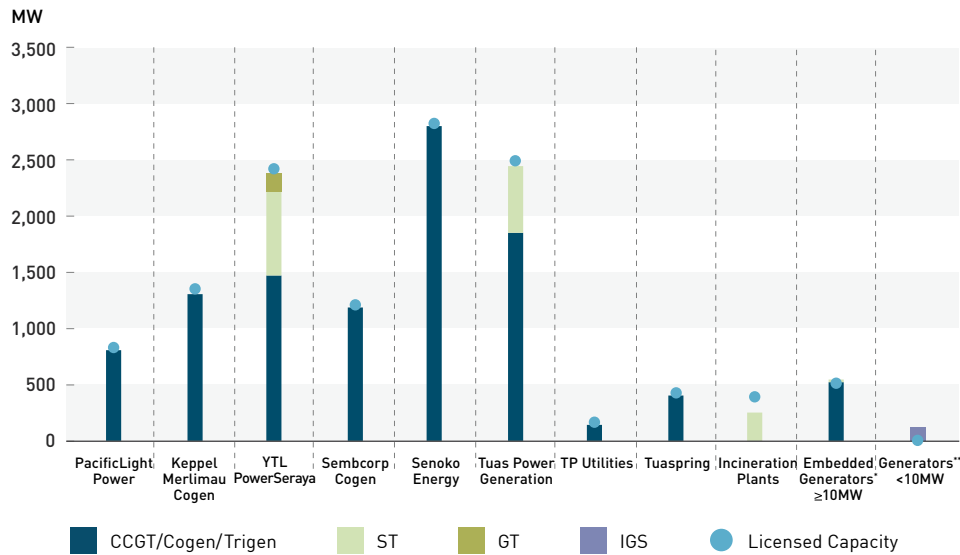
While Singapore's economy grew 0.7 percent in 2019⁵, the year-on-year (YOY) growth in electricity consumption was 2.4 percent. Total electricity consumption remained above the 50.0 terawatt hour (TWh) level for the second successive year and registered 51.6TWh in 2019.

Compared to the same periods in 2018, electricity consumption was higher for all four quarters of 2019. The largest increase was in the third quarter when electricity consumption rose 3.7 percent. The smallest increase of 0.9 percent was registered in the fourth quarter. In addition, the second and third quarters registered the highest quarterly electricity consumption levels since the market started, at 13.0TWh and 13.4TWh respectively.

⁵ Based on the Singapore Ministry of Trade and Industry press release on 17 February 2020: "MTI Downgrades 2020 GDP Growth Forecast to "-0.5 to 1.5 Per Cent"".

MARKET PERFORMANCE: Overview of the Year

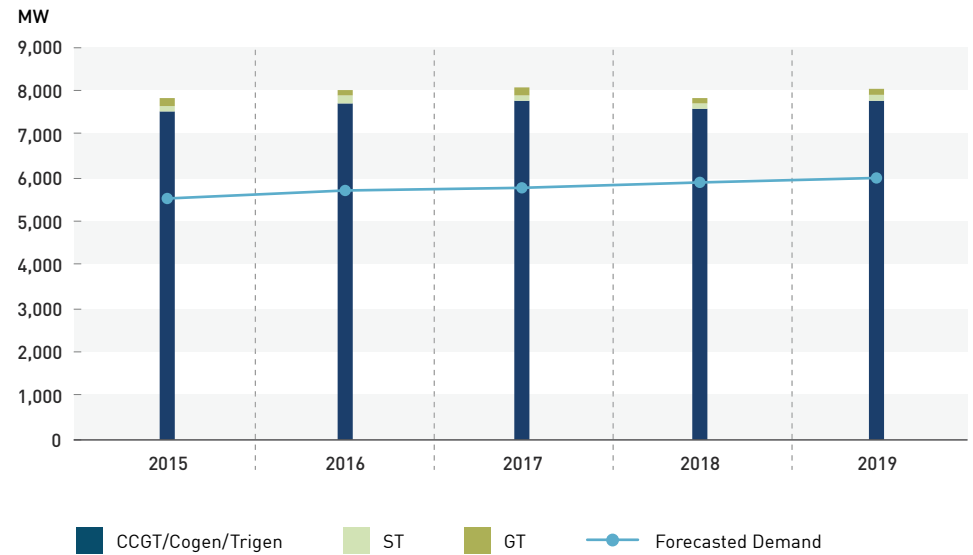
Generation Capacity as of 31 December 2019: Registered Versus Licensed



* Embedded generators exclude TP Utilities.

** Licensed capacity for generators < 10 MW excluded as the information is no longer publicly available.

Annual Generation Supply by Plant Type 2015 – 2019



Both licensed capacity and registered capacity decrease in 2019

Total licensed capacity in the National Electricity Market of Singapore (NEMS) of generators with capacity larger than or equal to 10 megawatts (MW) decreased 1,191MW to 12,455MW in 2019. The decline came primarily from the retirement of three ST units from YTL PowerSeraya, and two ST units from Senoko Energy.

Total registered capacity dropped 8.2 percent to 12,451MW in 2019. This was attributed to the

de-registration of the above-mentioned ST generation facilities, and the registration of 26 new facilities in the NEMS (see details on page 22).

The proportion of CCGT/cogen/trigen registered capacity to total registered capacity increased by 6.9 percentage points to 84.5 percent.

CCGT/cogen/trigen = Combined-cycle gas turbine/cogeneration/trigeneration (combined category)
 ST = Steam turbine
 GT = Gas turbine
 IGS = Intermittent generation sources
 Embedded generators (EG) = Generation units that generate electricity to their onsite load principally for self-consumption

Annual generation supply increases in 2019

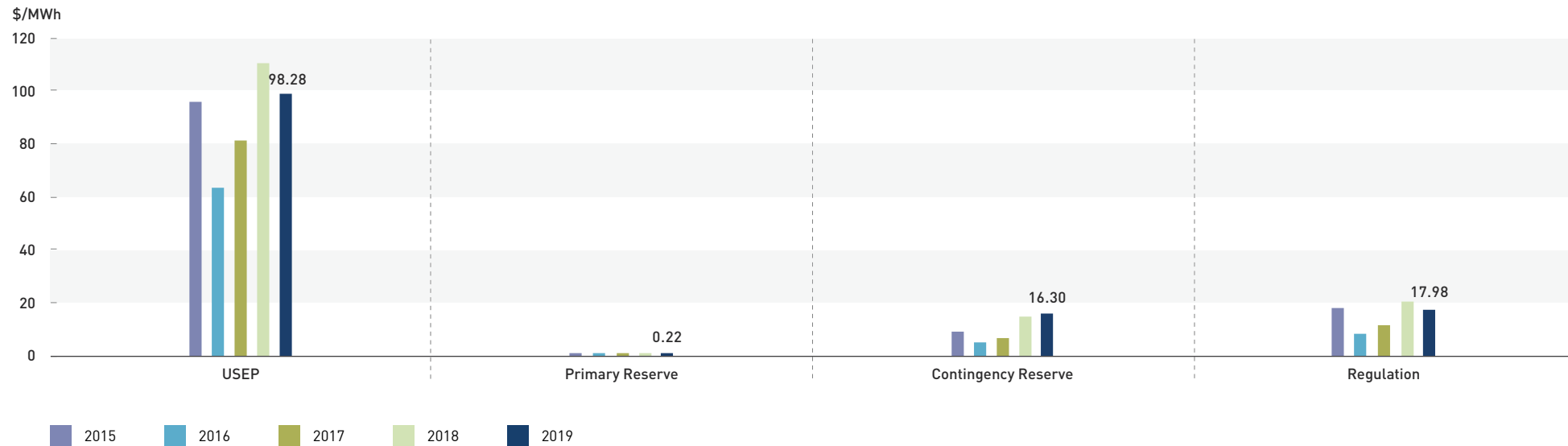
The annual generation supply in 2019 increased 2.6 percent to 8,069MW, after a decline to below 8,000MW in 2018.

CCGT/cogen/trigen supply increased to 7,794MW in line with higher generation supply, particularly from April to September with the lifting of the security constraint that was applied to Jurong Island and Tembusu. Similar to 2018, supply remained above forecasted demand by a margin of 29.5 percent.

Both ST and GT supplies expanded in 2019. ST and GT supplies were 0.7 percent and 12.0 percent higher respectively compared to 2018.

MARKET PERFORMANCE: Overview of the Year

Annual USEP and Ancillary Prices 2015 – 2019



Prices of most products drop in 2019

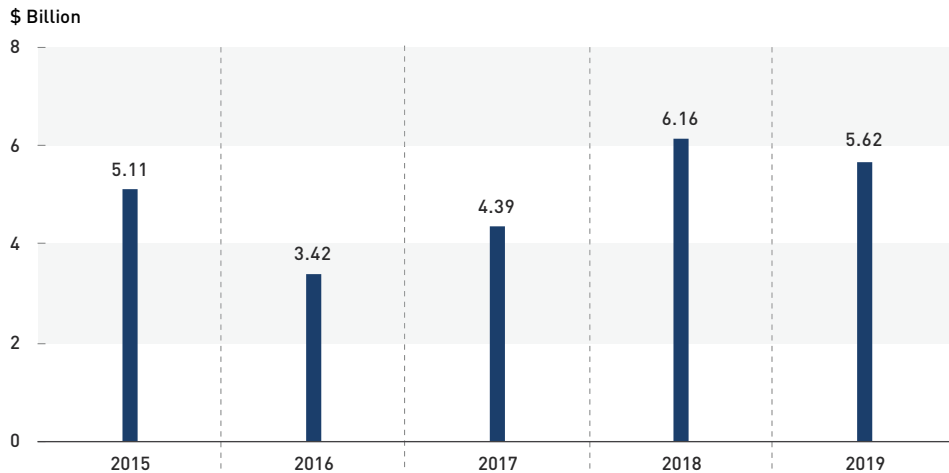
The annual average Uniform Singapore Energy Price (USEP) declined 11.0 percent compared to 2018, to \$98.28 per megawatt hour (MWh) in 2019. With a supply expansion, the USEP was less volatile in 2019 – the daily USEP registered above \$100.00/MWh on 118 days, compared to 229 days in 2018.

Primary reserve price decreased 42.9 percent to \$0.22/MWh as there were less price spikes due to fewer periods with intertie disconnection. Contingency reserve price increased 11.7 percent to \$16.30/MWh as a result of tighter market conditions, particularly in the month of February.

The regulation requirement was revised upwards from 120MW to 125MW from 1 February 2019. Nevertheless, regulation price declined 13.4 percent to \$17.98/MWh in 2019 as an expansion of relatively cheaper offers from April onwards exerted downward pressure on prices.

MARKET PERFORMANCE: Overview of the Year

Annual Value of Products Traded 2015 – 2019



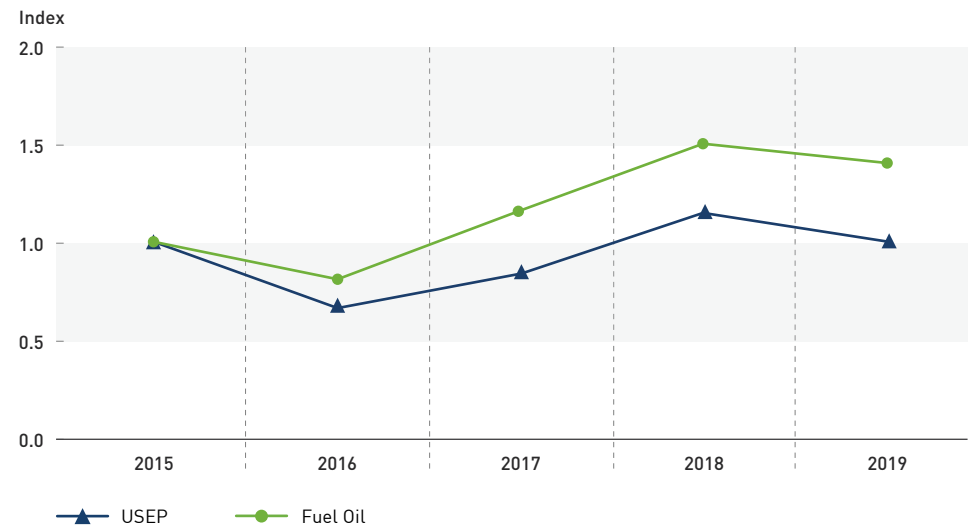
Annual value of products traded declines after two consecutive years of increase

The value of products traded shows the transacted value for all products traded in the NEMS: energy, reserves, and regulation. 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 in 2019 decreased 8.8 percent from 2018, to \$5.6 billion. This was the first year of decline after two consecutive years of increase, largely due to the weaker USEP.

In 2019, the energy market accounted for 98.0 percent of all products traded, while the reserve and regulation markets accounted for 1.6 percent and 0.4 percent respectively.

Annual USEP and Fuel Oil Price Movements 2015 – 2019



USEP falls in parallel with fuel oil price⁶

The USEP index⁷ decreased in 2019 to 1.02, while the fuel oil price index dropped to 1.44. The two indices moved in close tandem, with the USEP index leading the decline.

This was the first time that both indices had fallen after two consecutive years of increase in 2017 and 2018.

The gap between the USEP and fuel oil price indices widened in 2019. The decline in the USEP index outpaced that of the fuel oil price index, suggesting spark spread⁸ may have worsened during the year.

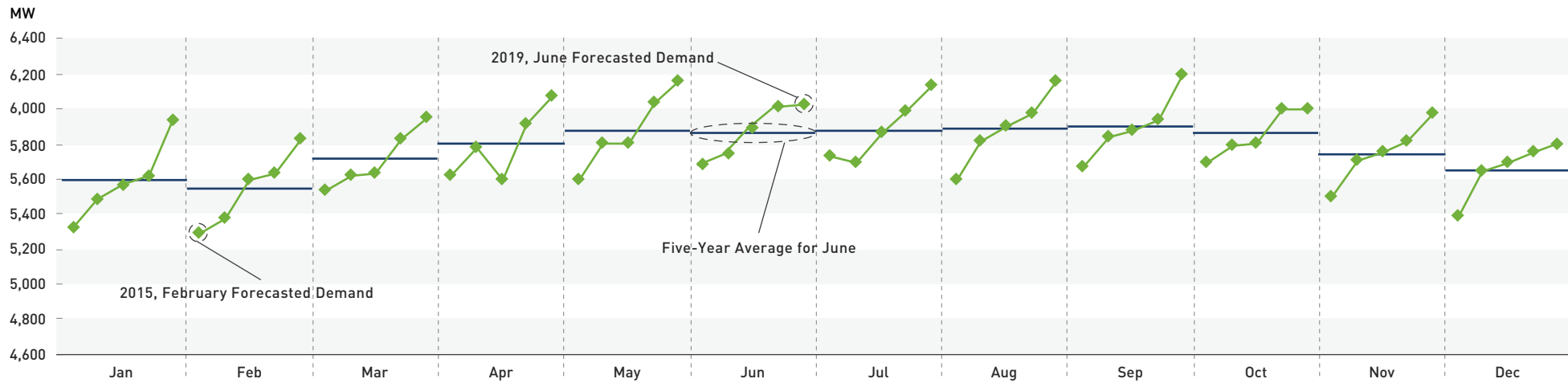
⁶ Based on a proxy for fuel oil price.

⁷ The USEP index is computed using 2015 as the index base. Therefore, the USEP index in 2015 is 1, while the USEP index in 2019 is 1.02 (computed using the 2019 USEP of \$98.28/MWh divided by the 2015 USEP of \$96.00/MWh).

⁸ Spark spread is the difference between the wholesale electricity price and the cost of production using natural gas.

MARKET PERFORMANCE: Energy Demand

Monthly Forecasted Demand 2015 – 2019



Forecasted demand rises across all 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.

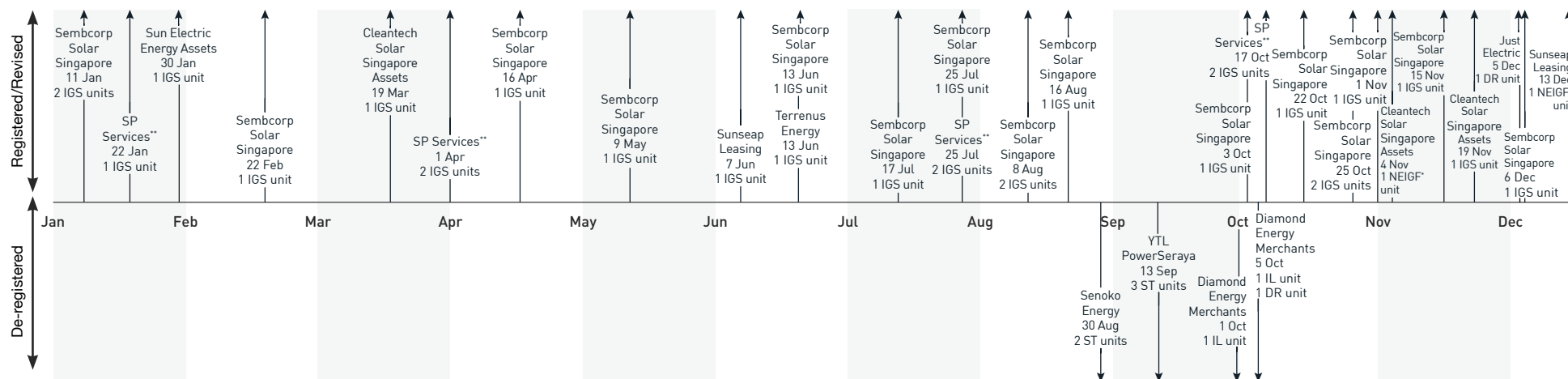
The annual forecasted demand rose 2.5 percent in 2019 to 6,018MW. The forecasted demand reached new monthly highs for all months in 2019 compared to 2018.

Compared to 2018, demand was higher in all 12 months of the year. The highest forecasted demand growth YOY was 5.6 percent in January, which corresponded to the largest monthly temperature increase of 2.4 degrees Celsius compared to January 2018. The highest monthly average forecasted demand in 2019 was 6,196MW in September, which also registered the second highest YOY growth of 4.4 percent.

A record peak half-hourly forecasted demand of 7,195MW was recorded in Period 29 on 27 May 2019. This was higher than 2018's peak of 7,071MW seen in Period 22 on 11 May 2018.

MARKET PERFORMANCE: Energy Supply

Generation and Load Facilities Registered, De-registered and Revised in 2019



* NEIGF refers to non-exporting embedded intermittent generation facilities.
 ** SP Services includes aggregated facilities and capacity revisions.

26 new facilities registered in 2019

At the end of 2019, the total registered capacity of generation facilities in the NEMS stood at 12,451MW. Out of this, 84.4 percent or 10,512MW belonged to the CCGT/cogen/trigen category. As of 31 December 2019, there were 111 generation facilities and one load facility registered in the NEMS.

During the year, 26 new facilities were added from six MPs which collectively contributed 25 intermittent generation source (IGS)⁹ facilities and one demand response (DR) facility to the market. A breakdown of the new facilities registered can be seen from the table on the right (top).

The 25 new IGS facilities, together with the capacity revisions made to two aggregated IGS facilities (table on the right, bottom), added an additional 82.124MW of IGS capacity in the NEMS.

With regard to de-registrations, five generation facilities were de-registered in 2019 – three ST units from YTL PowerSeraya at 233MW, 233MW and 232MW, and two ST units from Senoko Energy at 243MW and 250MW. Additionally, two load facilities were de-registered by Diamond Energy Merchants – one interruptible load (IL) facility of 2.2MW for contingency reserve provision, and another facility providing 7.2MW for energy, 7.0MW for primary reserve and 13.2MW for contingency reserve.

New Facilities Registered

Market Participant	Generation Type	Registered Capacity
Cleantech Solar Singapore Assets	2 IGS units & 1 NEIGF unit	0.150MW, 0.500MW, 1.400MW [#]
Just Electric	1 DR unit	35.000MW
Sembcorp Solar Singapore	18 IGS units	0.960MW, 0.660MW, 2.220MW, 1.260MW, 3.852MW, 0.953MW, 0.600MW, 0.840MW, 5.280MW, 0.660MW, 0.720MW, 0.216MW, 0.156MW, 0.720MW, 1.020MW, 1.320MW, 5.280MW, 0.120MW
Sun Electric Energy Assets	1 IGS unit	0.242MW
Sunseap Leasing	1 IGS unit & 1 NEIGF unit	1.219MW, 3.860MW [#]
Terrenus Energy	1 IGS unit	4.650MW

Capacity Revisions

Market Participant	Generation Type	Revised Capacity ^{##}
SP Services	2 IGS units	62.076MW, 1.447MW

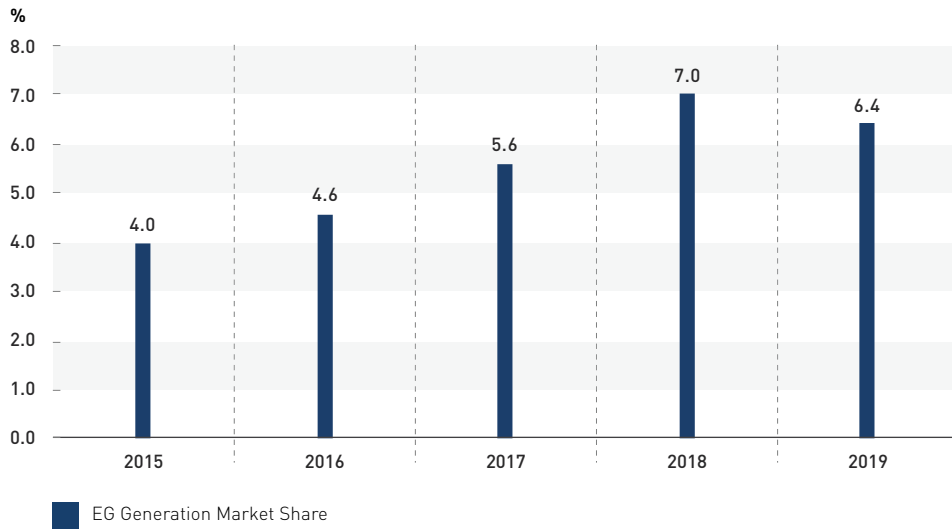
[#] Capacity for NEIGF unit.

^{##} Capacities of the two aggregated units revised upwards from 20.257MW in 2018, to 63.523MW in 2019.

⁹ Includes NEIGFs registered in 2019.

MARKET PERFORMANCE: Energy Supply

Embedded Generator Generation Market Share 2015 – 2019

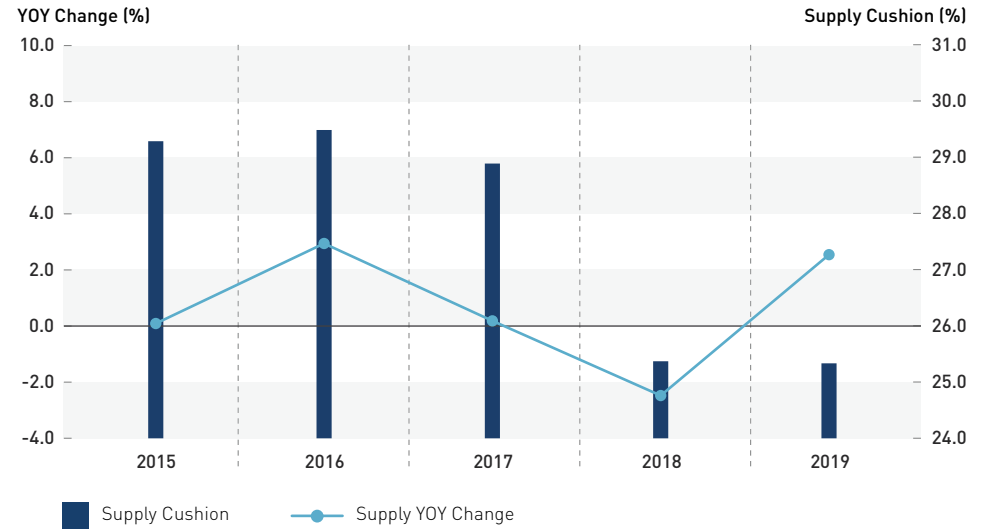


Embedded generator generation market share drops after three consecutive years of increase

After three consecutive years of increase, the EG generation market share in the NEMS dropped from 7.0 percent in 2018 to 6.4 percent in 2019. This was due to higher maintenance of EG facilities.

The highest monthly EG generation market share was registered in August at 7.3 percent, and the lowest was in May at 4.7 percent. The standard deviation was 0.77 percent, down from 2018's standard deviation of 0.82 percent.

Annual Supply Cushion 2015 – 2019



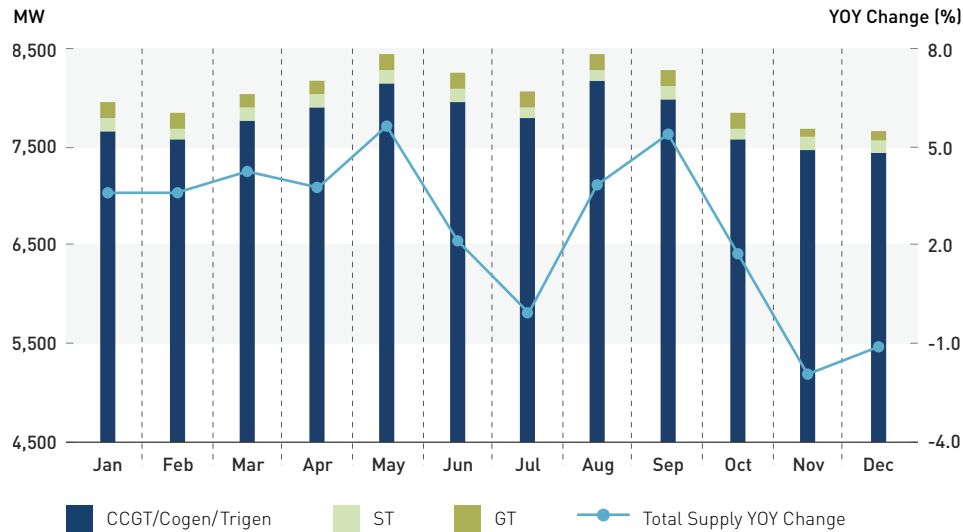
Supply cushion remains the same as 2018's level

Supply cushion measures 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.

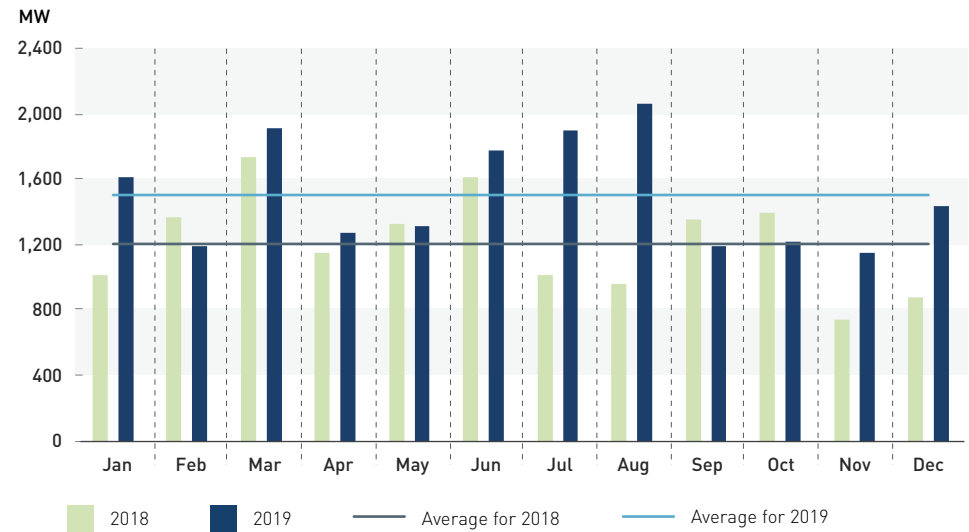
In 2019, both forecasted demand and total supply increased. This resulted in a supply cushion of 25.4 percent, which was similar to 2018's level and the lowest annual supply cushion level in the past five years.

MARKET PERFORMANCE: Energy Supply

Monthly Supply by Plant Type 2019



Monthly Generation Maintenance 2018 Versus 2019



Total supply increases despite negative YOY growth for three months

In 2019, total supply registered YOY growth of between 1.9 percent and 5.6 percent in nine out of 12 months. This outweighed the negative growth in July, November and December, and resulted in an overall higher total supply for the year compared to 2018.

The most efficient generation type – CCGT/cogen/trigen – continued to lead in market share at 96.6 percent of the total supply. This was slightly lower than 2018’s level. The market share of ST stayed at 1.6 percent while GT increased to 1.8 percent.

In 2019, supply surpassed the 8,000MW level for seven months, compared to three months in 2018. The monthly supply was the lowest in December at 7,649MW.

Generation maintenance increases in 2019

The annual average generation maintenance level¹⁰ increased 24.2 percent in 2019 to 1,511MW. The monthly generation maintenance levels were higher YOY in eight months during the year, averaging 1,647MW. In the remaining four months, the monthly generation maintenance levels were lower compared to 2018 and averaged 1,239MW. The highest monthly average generation maintenance level was in August, followed by March and July.

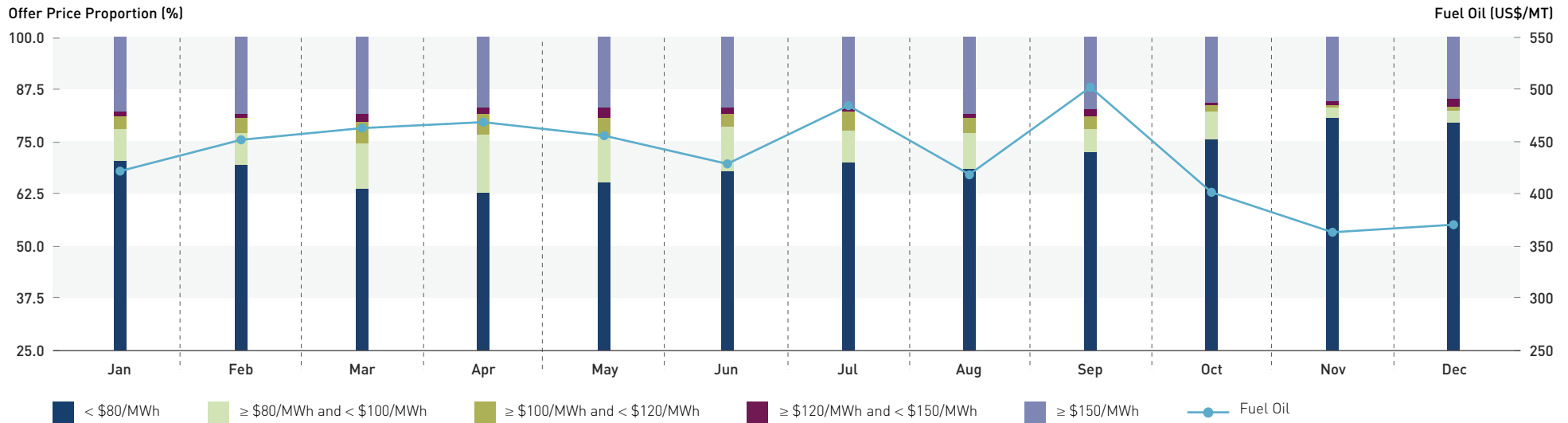
The standard deviation of monthly generation maintenance increased from 303MW in 2018 to 331MW in 2019, as the monthly generation maintenance range widened to between 1,158MW and 2,063MW.

The ratio of generation maintenance to registered capacity rose from 9.0 percent in 2018 to 12.1 percent in 2019.

¹⁰ 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.

MARKET PERFORMANCE: Energy Supply

Monthly Energy Offer Price Proportion and Fuel Oil Price 2019



Energy offer prices shift in tandem with falling fuel oil prices

In 2019, the daily fuel oil price ranged between USD325.50 per metric tonne (MT) and USD617.50/MT. The highest monthly level was registered in September when the fuel oil price rose above USD500.00/MT, while the lowest monthly levels were registered in November and December when it fell below USD400.00/MT.

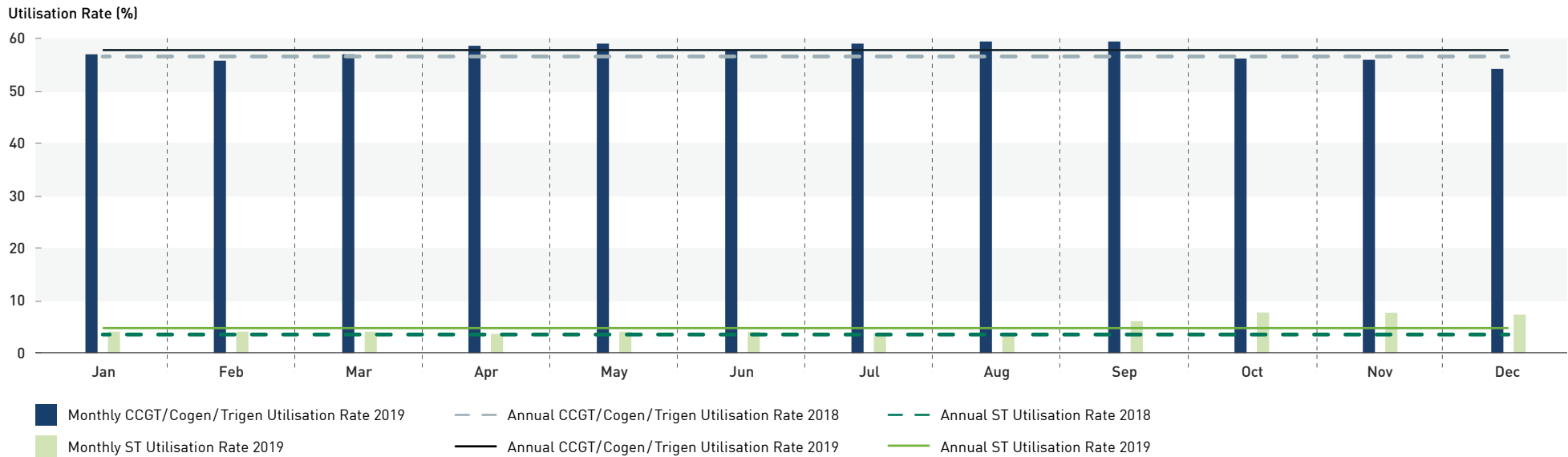
Fuel oil prices fluctuated in the first nine months and peaked in September at USD504.05/MT. Thereafter, fuel oil prices began to fall until the end of the year, with the largest monthly decline of 20.2 percent being registered in October. In line with this, the share of energy offers below \$80.00/MWh began to rise in October – it reached 75.6 percent in October, and stayed

above 80.0 percent in November and December. The proportion of energy offers in this price band was the highest in November at 80.9 percent.

Throughout 2019, the proportion of energy offers moved largely in tandem with fuel oil prices, as offers shifted from lower price bands to higher price bands on rising fuel oil prices.

MARKET PERFORMANCE: Energy Supply

Monthly Utilisation Rate by Plant Type 2019



Utilisation rates for CCGT/cogen/trigen and ST improve

In 2019, the monthly CCGT/cogen/trigen utilisation rate ranged between 54.2 percent in December and 59.7 percent in September. Other than October and December, the utilisation rates were higher in all months compared to 2018, with the biggest improvement of 3.2 percentage points seen in January.

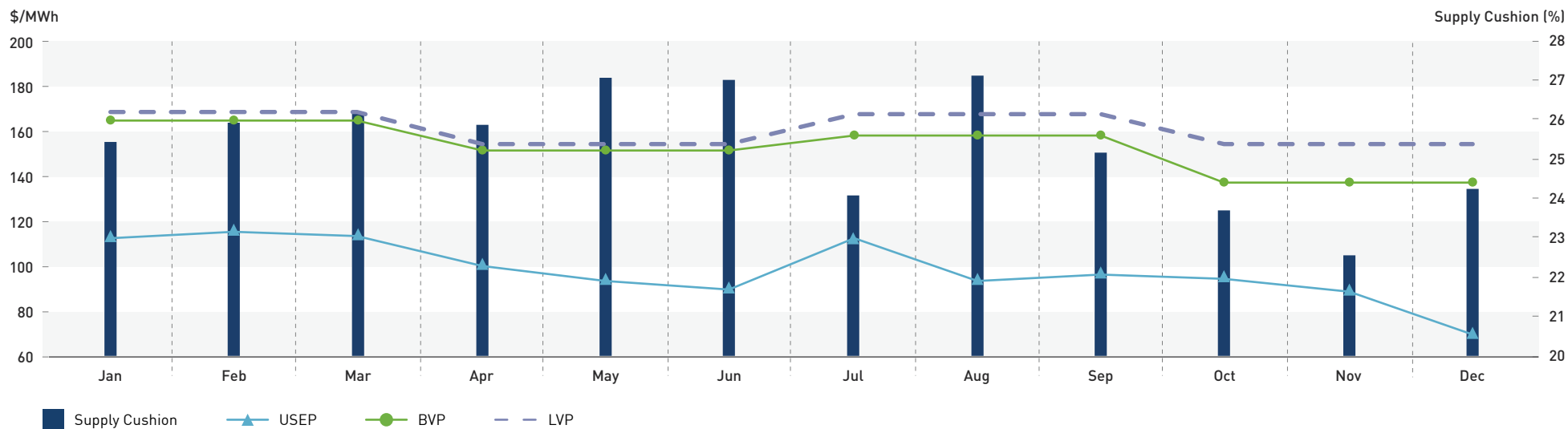
Overall, the utilisation rate for CCGT/cogen/trigen in 2019 improved 1.0 percentage point to 57.6 percent, as more energy was scheduled compared to 2018.

The monthly ST utilisation rate in 2019 ranged between 3.5 percent and 8.1 percent. It was higher in seven out of 12 months compared to 2018 – with the largest increase of 3.9 percentage

points seen in December – and this led to a greater annual ST utilisation rate of 5.1 percent. The improvement in the ST utilisation rate was due to the de-registration of five ST units.

MARKET PERFORMANCE: Energy Prices

Monthly USEP, BVP, LVP and Supply Cushion 2019



USEP stays below BVP and LVP benchmarks throughout the year

In 2019, the USEP registered below the Balance Vesting Price (BVP) and LNG Vesting Price (LVP) in all 12 months. The spread between the monthly minimum USEP of \$71.24/MWh and the monthly maximum USEP of \$115.17/MWh was smaller compared to 2018, at \$43.93/MWh.

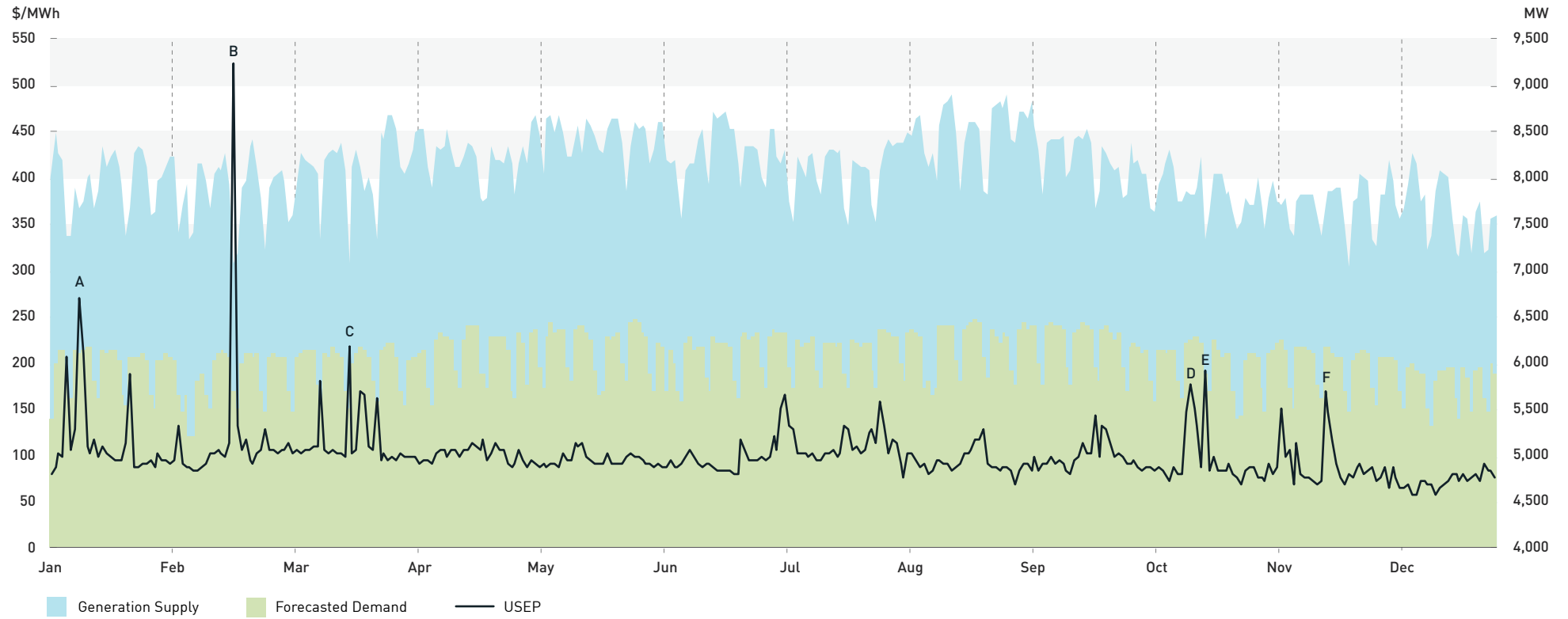
The annual average BVP of \$153.03/MWh in 2019 was \$54.75/MWh or 55.7 percent higher than the annual average USEP of \$98.28/MWh. This was an increase from the \$44.10/MWh gap observed in 2018. At the monthly level, the largest spread between the BVP and the USEP was observed in December, when the BVP was \$66.31/MWh above the USEP. The smallest gap was observed in October, when the BVP was \$43.16/MWh above the USEP.

The spread between the annual average LVP and the annual average USEP increased 17.2 percent, from \$53.91/MWh in 2018 to \$63.20/MWh in 2019. The largest gap between the monthly USEP and the monthly LVP was in December, when the LVP was \$83.29/MWh above the USEP. The smallest gap was observed in February when the LVP was \$53.78/MWh above the USEP.

The monthly supply cushion was below 25.0 percent in July, October, November and December, at 24.1 percent, 23.7 percent, 22.6 percent and 24.3 percent respectively. The supply cushion averaged 25.4 percent in 2019, which was the same as 2018's average.

MARKET PERFORMANCE: Energy Prices

Daily USEP, Forecasted Demand and Generation Supply 2019



MARKET OVERVIEW

MARKET GOVERNANCE

MARKET PERFORMANCE

ADDITIONAL INFORMATION

MARKET PERFORMANCE: Energy Prices

The key observations on the USEP fluctuations in 2019 are as follows:

Point A: On 8 January, three CCGT units, of which one was an EG unit, were on unplanned maintenance. The demand was slightly below 6,100MW, the daily average USEP was \$266.91/MWh while the peak periodic USEP was \$592.70/MWh in Period 23. The PSO advised that the power system was at a high-risk operating state in Period 16 due to contingency reserve shortfall. The supply cushion fell to 18.5 percent and an emergency operating state was declared in the subsequent period. From Period 16 to Period 36, the USEP averaged \$473.58/MWh when the supply cushion fell to between 13.5 and 18.5 percent. The power system returned to normal operating state from Period 37 onwards.

Point B: On 16 February, the daily USEP averaged \$520.58/MWh with 14 periods registering USEP levels of above \$1,000.00/MWh. Three CCGT units, of which one was an EG unit, were on planned maintenance, one CCGT unit was on unplanned outage while another CCGT unit tripped in Period 14. During these periods of higher USEP levels, the supply cushion averaged 13.0 percent and reached a low of 11.2 percent in Period 22. The PSO advised that

the power system was at a high-risk operating state in Period 17, and an emergency operating state between Periods 18 and 46. GT was scheduled to run from Period 18 to Period 44 that day. The power system was back to normal operating state from Period 47.

Point C: On 17 March, the daily average USEP was \$215.89/MWh. Three CCGT units were on planned maintenance and three CCGT units on unplanned maintenance. On that Sunday, the total supply was 3.7 percent lower than the previous Sunday. While the average supply cushion over the day remained over 22.0 percent, the periodic USEPs were higher due to the significant number of units on unplanned maintenance. The periodic USEP during the day peaked at \$1,187.31/MWh in Period 43, when demand was at the second highest periodic level of 5,952MW. The supply cushion for the day ranged between 15.6 percent and 30.2 percent.

Point D: On 15 October, four CCGT units, of which one was an EG unit, were on planned maintenance. The daily average demand was 6,243MW and peak periodic demand was 6,918MW. The daily average USEP was \$173.29/MWh while the peak periodic USEP was \$606.10/MWh. The PSO advised that

the power system was at a high-risk operating state in Period 21 due to contingency reserve shortfall. The supply cushion fell to 16.0 percent and an emergency operating state was declared in the subsequent period. The power system returned to normal operating state in Period 24. The USEP averaged \$275.88/MWh from Periods 21 to 24. The PSO advised again in Period 29 that the power system was at a high-risk operating state and an emergency operating state was declared in the subsequent period. The power system returned to normal operating state from Period 39. From Period 29 to Period 39, the USEP averaged \$305.69/MWh. It peaked at \$606.10/MWh in Period 36, when the periodic supply cushion was at the lowest level of 14.4 percent.


Point E: On 19 October, three CCGT units, of which one was an EG unit, were on planned maintenance. The daily USEP averaged \$190.26/MWh. There were 28 periods when the USEP rose above \$200.00/MWh, out of which two periods registered USEP levels of more than \$500.00/MWh. The PSO advised that the power system was at a high-risk operating state in Period 19, and in emergency operating state from Period 20 to Period 24. The system returned to normal operating state in

Period 25. The supply cushion on that Saturday averaged 20.1 percent and during periods of emergency operating state, it fell below 15.0 percent.

Point F: On 18 November, two CCGT units, of which one was an EG unit, were on planned maintenance. In addition, one CCCT unit (an EG unit) was on unplanned maintenance. The average demand was 6,159MW while the peak periodic demand was 6,863MW. The PSO advised that the power system was at a high-risk operating state in Period 20. In the following period, it returned to a normal operating state. The power system went into high-risk operating state again in Period 22 before returning to normal operating state in Period 23. A CCGT unit that tripped in Period 30 brought the power system back to a high-risk operating state in Period 31, and an emergency operating state from Period 32 to Period 37. The power system returned to normal operating state in Period 38. The daily average USEP was \$168.35/MWh. There were 21 periods when the USEP rose above \$200.00/MWh, out of which three periods registered USEP levels of above \$500.00/MWh. The average supply cushion between Period 20 and Period 37 was 14.1 percent, and this dropped to 11.7 percent in the three periods when the USEP was above \$500.00/MWh.

MARKET PERFORMANCE: Energy Prices

Summary of Security Constraints in 2019

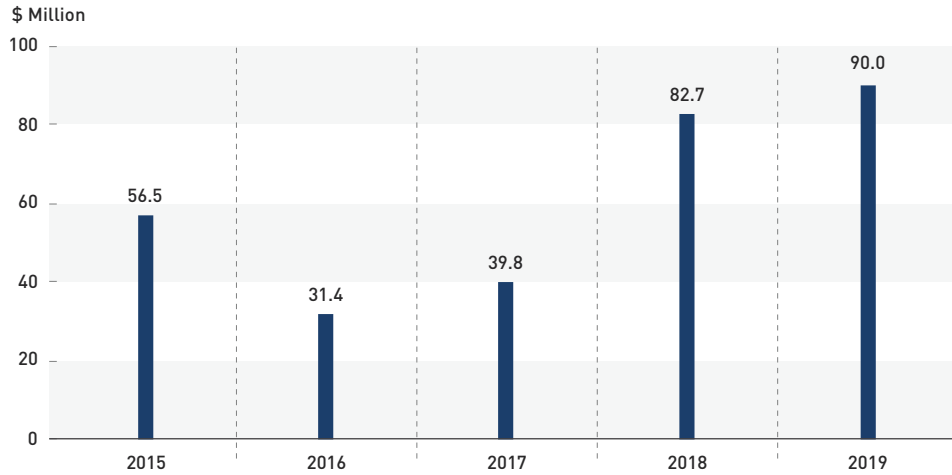
Security Constraint	Affected Region	Limit	Start Date	Expiry Date
1	Three lines between Jurong Island and Tembusu 	1,150MW	1 January 2019	31 March 2019

Application of security constraints in 2019

The PSO implemented only one security constraint in the year, with a 1,150MW limit for the three lines connecting Jurong Island and Tembusu. The security constraint was applied for the first three months of 2019, and was in place until 31 March 2019. It was lifted after a new 400kV substation on Jurong Island started operations.

This security constraint was first applied from Period 26 on 24 April 2014, until Period 48 on 31 December 2014. This security constraint was applied again from Period 1 on 1 January 2015 until Period 48 on 31 December 2018, and from Period 1 on 1 January 2019 to Period 48 on 31 March 2019 thereafter.

Annual Reserve Payment 2015 – 2019



Reserve payment increases for third consecutive year

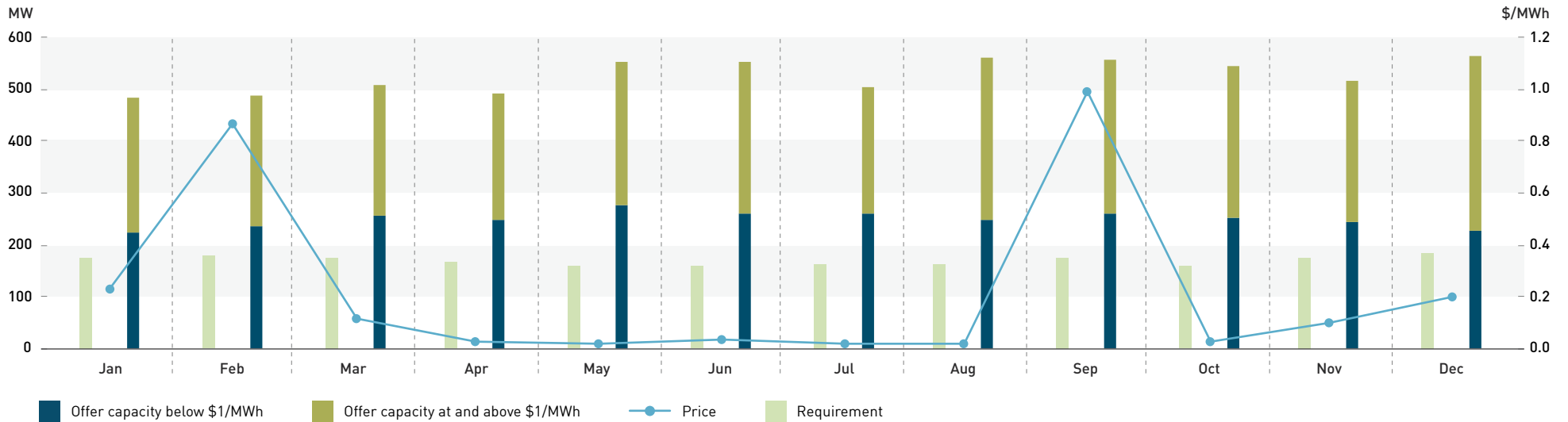
Reserves serve as a backup in the electricity market for unexpected outages caused by generators tripping. The amount of reserves required is determined by the amount needed should the largest on-line generator trip. In the NEMS, two reserve products are traded: primary and contingency reserves. Each 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 2018, reserve costs increased 8.8 percent to \$90.0 million. This was the result of a higher contingency reserve price. Contingency reserve price increased 11.7 percent to \$16.30/MWh while primary reserve price fell 42.9 percent to \$0.22/MWh.

MARKET PERFORMANCE: Ancillary Markets

Monthly Primary Reserve Price, Requirement and Supply 2019



Lower primary reserve prices as fewer intertie disconnection periods

The annual average primary reserve price was 42.9 percent lower at \$0.22/MWh in 2019. The highest monthly primary reserve price was seen in September at \$0.98/MWh, while the lowest monthly average was observed in May, July and August at \$0.02/MWh.

The annual average primary reserve requirement was at 170MW in 2019, 5.0 percent lower than in 2018. The annual primary reserve offers were 10.1 percent higher at 528MW.

There were 82 periods of intertie disconnections in 2019, 50 fewer than the 132 periods seen in 2018. This, coupled with the lower annual average primary reserve requirement, resulted in a lower annual average primary reserve price compared to 2018's level of \$0.38/MWh. In 2019, there were no primary reserve shortfalls.

On a monthly basis, the primary reserve requirement ranged between 159MW and 185MW in 2019, with the lowest level seen in June and October, and the highest in February. The monthly primary reserve offers were lowest in January and highest in August.

The month of September saw the highest primary reserve price. Following a planned outage of the intertie connection between Singapore and Malaysia that was carried out between 19 and 20 September, Singapore's power system was in isolated mode. That drove up primary reserve requirements and resulted in higher primary reserve prices. The primary reserve price on 19 September averaged \$8.68/MWh and the highest periodic price was registered in Period 42 at \$33.33/MWh. On 20 September, the primary reserve price averaged \$18.91/MWh and the

highest periodic price was registered in Period 20 at \$56.38/MWh.

There were no changes to the Risk Adjustment Factor (RAF)¹¹ in 2019. It was set at 1.0 for primary reserve.

¹¹ 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.

MARKET PERFORMANCE: Ancillary Markets

Monthly Contingency Reserve Price, Requirement and Supply 2019



Contingency reserve price rises on lower contingency reserve supply

The annual average contingency reserve price rose 11.7 percent to \$16.30/MWh in 2019. The highest monthly contingency reserve price was observed in February at \$31.45/MWh while the lowest was registered in May at \$3.26/MWh.

The annual average contingency reserve requirement remained at 597MW in 2019. The annual average contingency reserve offers in 2019 fell 2.2 percent to 1,230MW.

At the monthly level, the lowest contingency reserve requirement was observed in October at 584MW and the peak contingency reserve requirement was seen in November at 612MW. The monthly contingency reserve offers were highest in May at 1,333MW and lowest in November at 1,163MW.

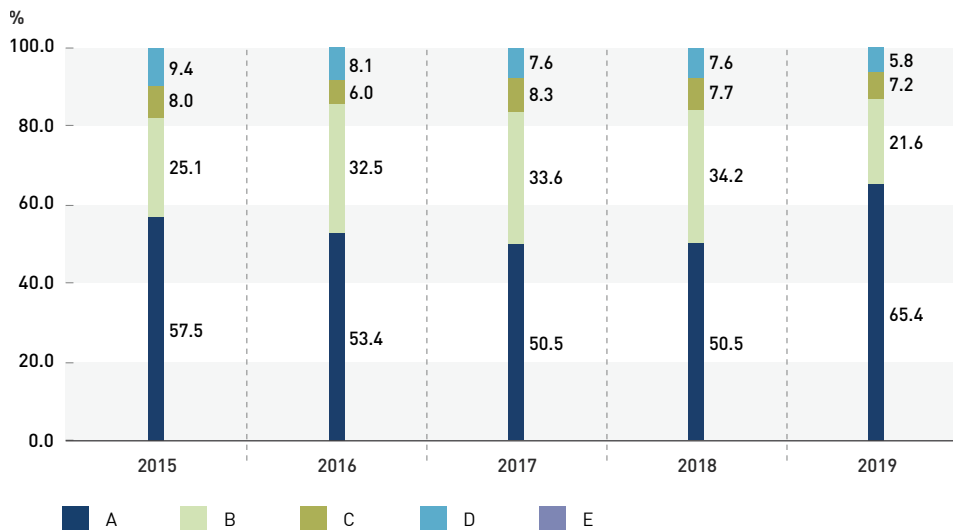
July recorded more days with contingency reserve shortfalls due to constraint violation penalties compared to the other months in 2019. However, contingency reserve prices were higher during periods of contingency reserve shortfalls in February.

The highest daily average contingency reserve price was registered on 16 February at \$396.46/MWh. That day, there were 30 periods of contingency reserve violations when the Stepwise Constraint Violation Penalty kicked in, resulting in contingency reserve shortfalls. The contingency reserve price rose above \$1,000.00/MWh for a total of 12 periods.

There were no changes to the RAF in 2019 which was set at 1.5 for contingency reserve.

MARKET PERFORMANCE: Ancillary Markets

Reserve Provider Group Effectiveness for Primary Reserve Class (Aggregate) 2015 – 2019



Statistics exclude IL providers.

Reserve provider group effectiveness improves significantly

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 2019, the percentage of reserve providers in Groups B, C and D decreased 12.6 percentage points, 0.5 percentage point and 1.8 percentage points respectively. The proportion of reserve providers in Group B decreased for the first time since 2014 to 21.6 percent.

The percentage of reserve providers in Group A rose 14.9 percentage points to 65.4 percent in 2019, the highest level since the market started.

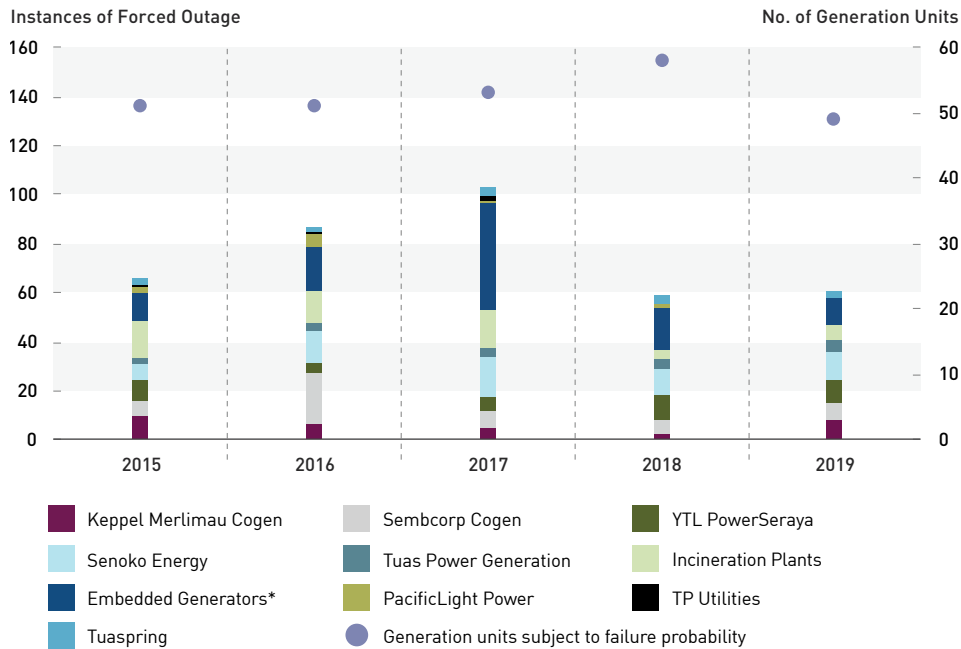
Overall, the reserve provider group effectiveness improved significantly in 2019. The total percentage of reserve providers in Groups A and B increased to 87.0 percent, while the total percentage of reserve providers in Groups C and D decreased to 13.0 percent.

Similar to 2018, there were no reserve providers in the Group E category.

All contingency reserve providers were classified in Group A.

MARKET PERFORMANCE: Ancillary Markets

Annual Forced Outages by Generation Companies 2015 – 2019



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.

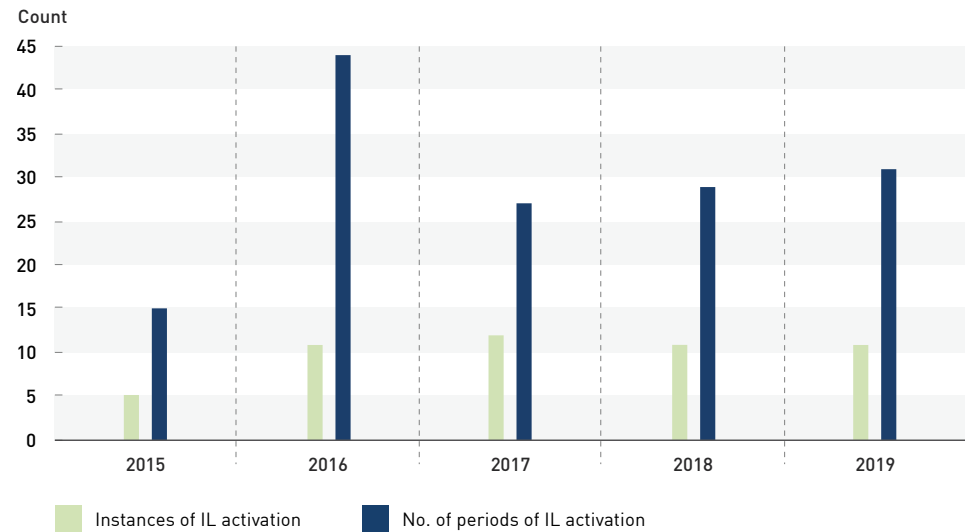
Total number of forced outages increases

There were a total of 60 forced outages in 2019, up from 58 in 2018. This was the second lowest level seen since the market started.

With the exception of three generation companies, the rest either experienced the same number or an increase in the number of forced outages.

The number of generation units subject to failure probability decreased with the retirement of five generation facilities in 2019.

Annual Interruptible Load (IL) Activations for Contingency Reserve Market 2015 – 2019



Slight increase in number of periods of IL activation

As of 31 December 2019, there was no registered capacity for IL for primary reserve, compared to 7.0MW in 2018. For contingency reserve, the total registered capacity dropped from 15.4MW to 12.1MW.

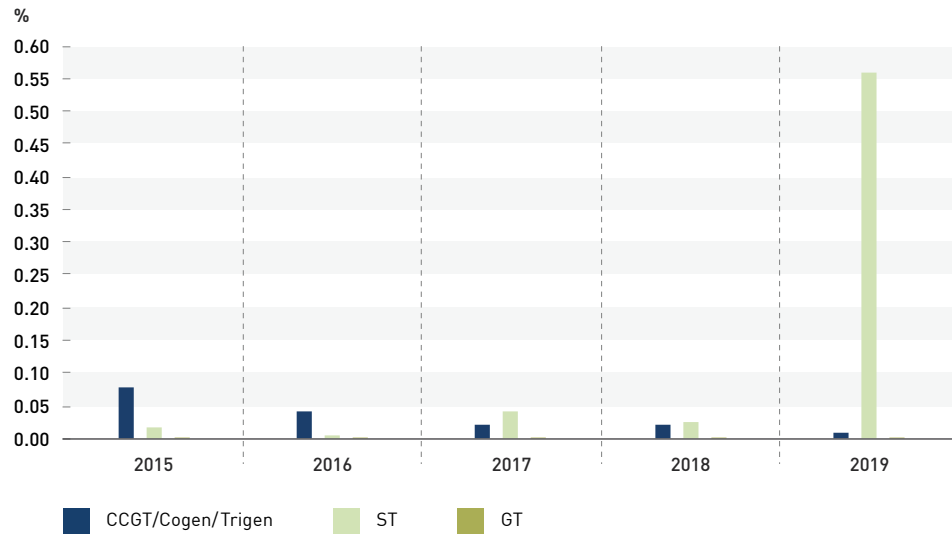
In 2019, the number of IL activations for contingency reserve was unchanged at 11, but the total

number of periods when IL was activated for contingency reserve increased by two to 31.

The longest continuous stretch of IL activation lasted 14 periods on 5 January. There were three periods of IL activation on 20 March, and two periods each on 14 January, 25 January, 7 July, 7 November and 27 December. The remaining four activations lasted one period each.

MARKET PERFORMANCE: Ancillary Markets

Average Failure Probability by Year 2015 – 2019



Mixed outcomes in reliability of generating 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.

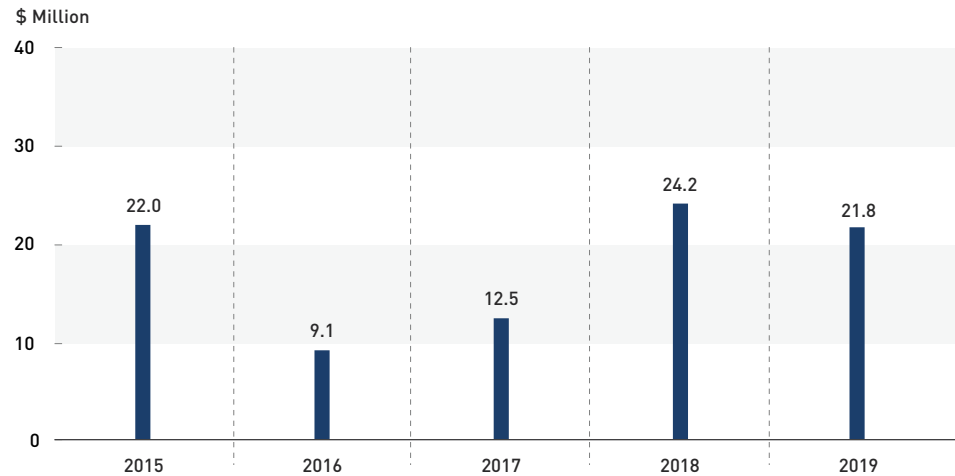
In short, failure probability is a measure of the reliability of the generation facility. The lower the failure probability, the higher the reliability of the generation facility.

In 2019, the average failure probabilities for CCGT/cogen/trigen, ST and GT facilities were 0.009 percent, 0.560 percent, and 0.001 percent respectively. Compared to 2018, the failure probability of CCGT/cogen/trigen facilities fell while that of GT facilities remained the same. The large increase in the failure probability of ST facilities was due to multiple outages of one ST facility.

The overall performance of generation facilities was mixed as reflected in the failure probability levels, which aligned with respective occurrences of forced outages.

MARKET PERFORMANCE: Ancillary Markets

Annual Regulation Payment 2015 – 2019

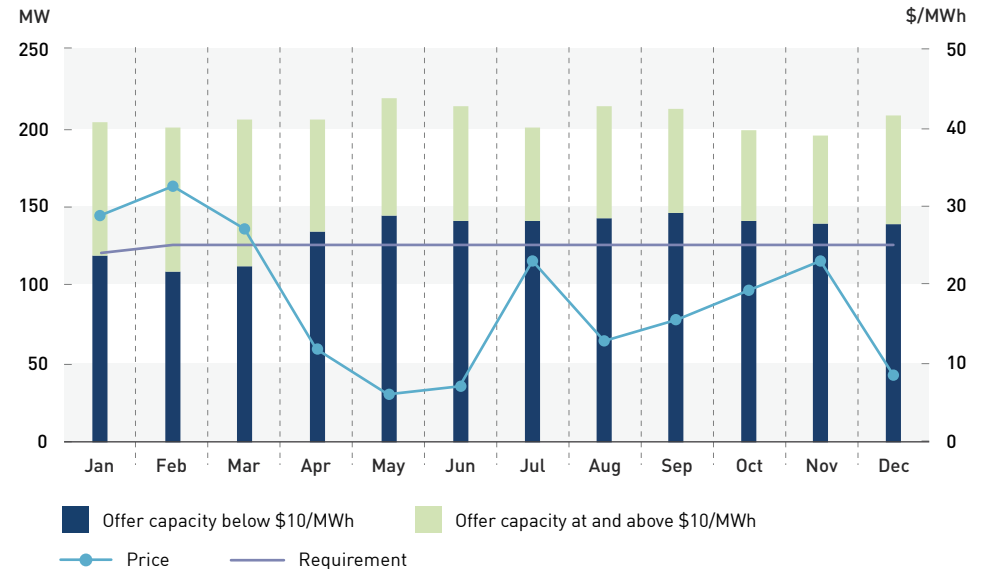


Regulation payment declines after two consecutive years of increase

Despite an increase in the regulation requirement from 119MW to 124MW as of 1 February 2019, regulation payment declined 9.9 percent to \$21.8 million due to a 13.4 percent fall in regulation price to \$17.98/MWh in 2019.

The regulation payment increased five months in the year, with monthly growth of between \$0.2 million and \$1.8 million. The largest increase was in January which recorded the highest monthly regulation payment of \$2.9 million. The lowest monthly regulation payment was \$0.7 million in May.

Monthly Regulation Price, Requirement and Supply 2019



More volatility in regulation prices

In 2019, the annual average regulation price declined 13.4 percent to \$17.98/MWh compared to 2018's \$20.76/MWh.

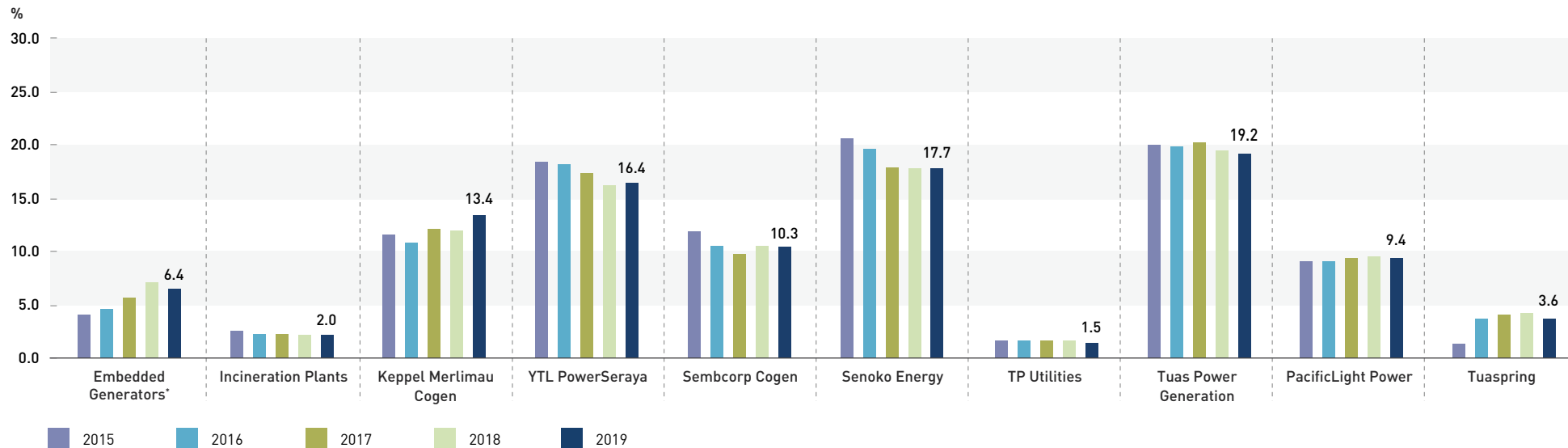
Regulation prices were more volatile in 2019. In 2018, the minimum monthly regulation price was \$11.96/MWh in January and the maximum was \$37.20/MWh in October – a spread of \$25.24/MWh.

In 2019, this spread widened to \$26.45/MWh, with the minimum monthly regulation price of \$6.17/MWh in May and the maximum of \$32.62/MWh in February.

The standard deviation increased from \$6.59/MWh in 2018 to \$8.97/MWh in 2019. The monthly regulation price was higher in January, February, March, July and November in 2019 compared to 2018.

MARKET PERFORMANCE: Competition in the Generation and Retail Markets

Annual Market Share by Generation Company 2015 – 2019 (Based on Scheduled Generation)



* Embedded generators exclude TP Utilities.

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

Competition continues to be keen in generation market

The combined market share of the three leading generation companies (YTL PowerSeraya, Tuas Power Generation and Senoko Energy) increased another 0.1 percentage point in 2019, to 53.3 percent. YTL PowerSeraya's market share increased by 0.3 percentage point to 16.4 percent while Tuas Power

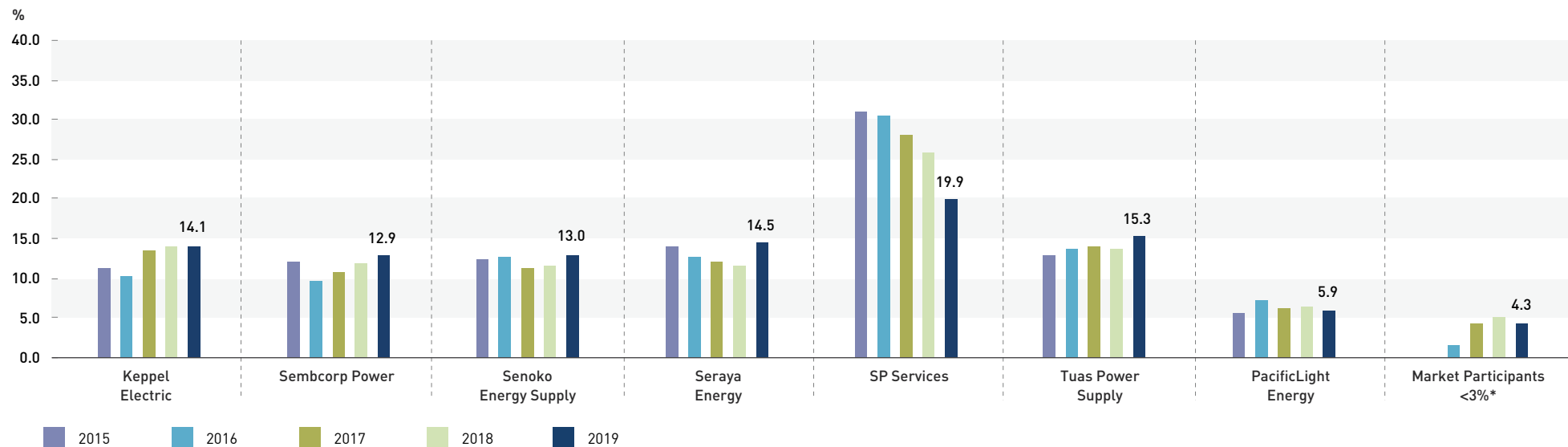
Generation's dropped by 0.2 percentage point to 19.2 percent. Senoko Energy's market share remained the same at 17.7 percent.

Amongst the smaller generation companies, only Keppel Merlimau Cogen's market share improved, rising 1.4 percentage points to 13.4 percent. The market share of Sembcorp Cogen, TP Utilities and

Tuaspring all dropped, by 0.1 percentage point, 0.2 percentage point and 0.6 percentage point respectively, while PacificLight Power's market share remained unchanged. The incineration plants saw a 0.1 percentage point decline in their market share to 2.0 percent, while the EGs registered a 0.6 percentage point decline to 6.4 percent.

MARKET PERFORMANCE: Competition in the Generation and Retail Markets

Annual Market Share of Market Support Services Licensee and Retailers 2015 – 2019 (Based on Withdrawal Energy Quantity)



* Market participants <3% refers to Best Electricity Supply, Cleantech Solar Singapore Assets, Diamond Energy Merchants, Environmental Solutions (Asia), GreenCity Energy, Hyflux Energy, I Switch, Just Electric, MyElectricity, Ohm Energy, Peerer Energy, Red Dot Power, SilverCloud Energy, Sun Electric Power, Sunseap Energy, UGS Energy and Union Power.

Competition among OEM retailers increases

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) will be 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. This allocation was done and reflected in the retailers' market share figures for 2019.

Following the launch of the OEM since 2018, competition remained robust in the retail market in 2019. Among the retailers¹², Seraya Energy replaced Sembcorp Power in the top three positions, together with Tuas Power Supply and Keppel Electric.

The market share of SP Services fell by another 6.1 percentage points¹³ to 19.9 percent in 2019, as consumers continued to switch to their retailers of choice. The market share of Seraya Energy, Tuas Power Supply, Senoko Energy Supply, Sembcorp Power and Keppel Electric increased 2.9, 1.7, 1.5, 1.2 and 0.2 percentage points respectively. PacificLight Energy's market share declined by 0.5 percentage points to 5.9 percent.

The market share of the 'Other Market Participants' category stood at

4.3 percent. This category comprises retailers with a market share of less than 3.0 percent each. During the year, five retailers exited the NEMS.

¹² Excludes consumers who purchase from SP Services.

¹³ The consumption of LP consumers was not allocated back to their respective retailers in 2018.

MARKET PERFORMANCE: Settlement, Prudential Management, Automatic Financial Penalty Scheme and Minimum Stable Load Compensation Scheme

Energy Market Company (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 2019

A margin call is issued when a retailer's estimated net exposure reaches a value that is equivalent to or greater than 70.0 percent of the level of its credit support. In 2019, no margin calls were issued.

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 the MP payment date. In 2019, EMC issued six notices of default. All settlement amounts were remedied and made good on the next business day.

Automatic Financial Penalty Scheme (AFPS) and Minimum Stable Load (MSL) Compensation Scheme – 1 January to 31 December 2019

The AFPS is a penalty scheme applied to all GRFs that deviate from their dispatch schedules by more than 10MW. It was implemented in November 2015, in an effort to incentivise GRFs to comply with dispatch instructions. In 2019, there were 62 periods when the AFPS kicked in, and the total penalty collected was \$338,636.02.

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, in an effort to enhance system security and create financial certainty for these facilities in recovering costs. In 2019, \$22,458.60 was paid out for a total of three periods under the MSL compensation scheme. The amount paid out was funded by the market via the monthly energy uplift charges.

MARKET PERFORMANCE: Contracted Ancillary Services

Contracted Ancillary Services – 1 April 2019 to 31 March 2020

Contract Period	Cost of Ancillary Services	Total MW Contracted
1 April 2019 to 31 March 2020	\$11,368,509.29	88.848

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 for example to a limited number of available suppliers, their prices are regulated.

From 1 April 2019 to 31 March 2020, the only contracted ancillary service required was black-start capability. Black-start service ensures 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 \$11.37 million for the period 1 April 2019 to 31 March 2020. The capability was sourced from YTL PowerSeraya, Senoko Energy, Tuas Power Generation, and Keppel Merlimau Cogen.

MARKET PERFORMANCE: 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 2019 to 30 June 2020

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 3 years from 6 th token onwards per MP) \$110 per token (replacement fee for lost or damaged token)
EMC Fee per MWh (\$/MWh)	0.3228

PSO Fixed Fees – 1 July 2019 to 30 June 2020

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

PSO Net Fees – 1 April 2019 to 31 March 2020

PSO Net Fees (\$'000)	26,337
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ADDITIONAL
INFORMATION



ADDITIONAL INFORMATION: Letter from the Chair, Market Advisory Panel

Dear Industry Members

The National Electricity Market of Singapore (NEMS) is still facing strong headwinds due to overcapacity in generation, even with some generating assets de-registering from the NEMS in 2019. This, coupled with the winding down of vesting contracts by 2023, further creates a challenging operating environment for our generation companies.

In addition, the exponential uptake of renewables in the last few years, particularly solar installations, is expected to continue given Singapore's commitment to combatting climate change. However, this increase in solar installations may represent a challenge for

Singapore, particularly if it reduces the availability of conventional generation which provides ancillary services to overcome the intermittency issue of solar generation sources. Lastly, with the emergence of more distributed generation resources in Singapore, there is also a need to review how the NEMS can evolve to encourage and accommodate new technologies.

Developing strategies and long-term solutions to address current and upcoming market challenges and opportunities in Singapore's electricity market requires the combined commitment and effort of many industry

stakeholders. With this in mind, a Market Advisory Panel (MAP) was set up in 2019. The Panel, which comprises senior executives from Singapore's energy sector and is supported by renowned international energy experts, aims to provide thought leadership and drive discussions on broad, strategic issues that might affect the long-term sustainability and development of the NEMS.

I would like to thank the MAP members and energy experts for their time and invaluable perspectives, as well as the industry working group members supporting the MAP, for their dedication and

hard work. My sincere appreciation also to our regulator, the Energy Market Authority, for its support of this important initiative.

We will continue to partner the industry to put forth recommendations that will benefit the NEMS in the long run.



Toh Seong Wah

Chair

Market Advisory Panel

ADDITIONAL INFORMATION: Overview of Market Advisory Panel

Objectives

The main objectives of the Market Advisory Panel (MAP) are as follows:

- Prepare the NEMS for the future: Understanding challenges, obstacles and risks that the industry should focus on;
- Provide market thought leadership: Guiding the industry's strategic development and providing practitioners' perspectives to guide policies;
- Put forward recommendations: Presenting recommendations to the Energy Market Authority (EMA) on policy changes, or the Rules Change Panel (RCP) on changes to the Market Rules; and
- Develop assessment framework: Developing framework of objectives to be assessed, which is aligned with the aim of achieving market-wide economic efficiency.

Composition of the MAP

The MAP is a high-level panel comprising senior executives of the Singapore electricity industry. The Panel, which is nominated by the market participants and stakeholders of the NEMS, aims to have a balanced representation to cover a wide set of industry interests.

MAP Members

1. Toh Seong Wah, Energy Market Company, Chief Executive Officer (Chair)
2. Andrew Koscharsky, ISwitch, Chief Commercial Officer
3. Atul Nargund, Sembcorp Industries, Executive Vice President
4. Bernard Esselinckx, Senoko Energy, Chief Executive Officer
5. Cheong Zhen Siong, Air Liquide Singapore, Director
6. Janice Bong, Keppel Infrastructure Holdings, General Manager
7. Jerome Baco, CleanTech Solar Singapore Assets, Chief Operating Officer
8. Jomar Eldoy, Ohm Energy, Managing Director
9. Laurence Kwan, Sunseap Group of Companies, Director
10. Loh Sze Wei, Shell Energy Singapore, General Manager
11. Michael Wong, Tuas Power Generation, Senior Vice President
12. Poa Tiong Siaw, Energy Market Company, Senior Vice President
13. Sim Meng Khuan, YTL PowerSeraya Group, Senior Vice President
14. Soh Yap Choon, Energy Market Authority, Deputy Chief Executive (Power System Operator)
15. Vijay Sirse, Red Dot Power, Chief Executive Officer
16. Yu Tat Ming, PacificLight Power, Chief Executive Officer

MAP Observers

1. Ang Kok Kiat, National Environment Agency, Director
2. Soh Sai Bor, Energy Market Authority, Assistant Chief Executive

MAP Energy Experts

1. Ben Skinner, Australian Energy Council, General Manager
2. Phillip Harris, Consultant and former Chief Executive Officer, President and Chairman of PJM Interconnection
3. Stephen Woodhouse, AFRY Management Consulting, Director

ADDITIONAL INFORMATION: Overview of Market Advisory Panel

Governance for the MAP

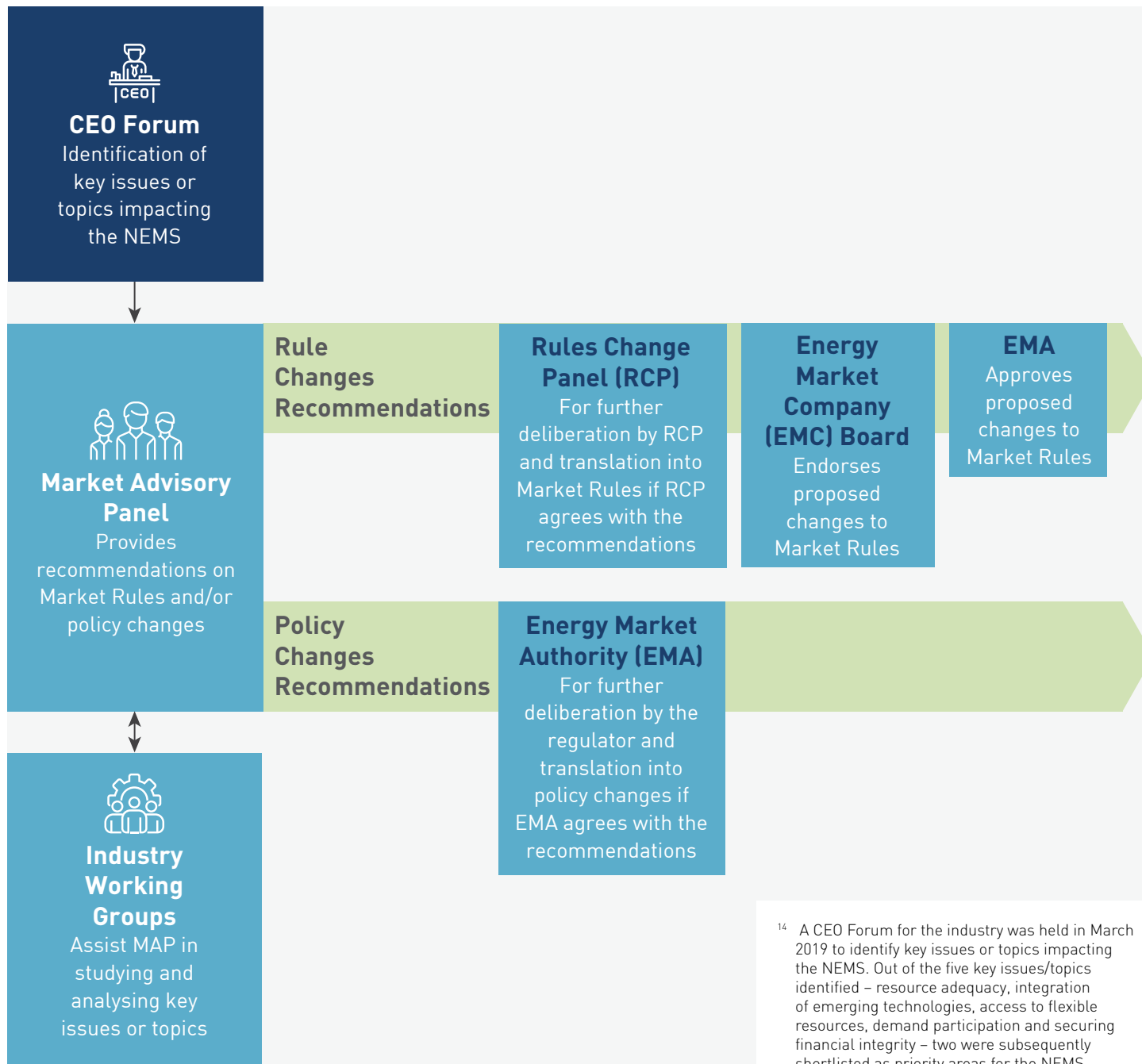
The MAP does not vote on issues but works towards consensus building for recommendations. All recommendations, as well as points of disagreement, will be noted and submitted to either the EMA or the RCP for consideration. The flow chart on the right demonstrates the process guiding the work of the MAP.

Industry Working Groups

As part of the MAP's efforts to study the broad and strategic issues affecting the development of the NEMS, the MAP created industry working groups (IWGs) to study and analyse two topics that have been identified¹⁴ as priority areas for the NEMS – resource adequacy and the integration of emerging technologies.

IWG 1 has been tasked by the MAP to study and analyse the issues regarding resource adequacy and the EMA's proposed Forward Capacity Market (FCM). The Group aims to provide the MAP's endorsed recommendations to the EMA before the high-level design of the FCM is finalised in the third quarter of 2020.

The other IWG (IWG 2) will work on the integration of emerging technologies, and study and analyse related issues. It aims to propose feasible solutions which will facilitate the integration of new technologies to the EMA.



¹⁴ A CEO Forum for the industry was held in March 2019 to identify key issues or topics impacting the NEMS. Out of the five key issues/topics identified – resource adequacy, integration of emerging technologies, access to flexible resources, demand participation and securing financial integrity – two were subsequently shortlisted as priority areas for the NEMS.

ADDITIONAL INFORMATION: Glossary

ancillary services

The additional services necessary 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 balance vesting quantity.

black-start ancillary service

A service to ensure that there is initial generation for system restoration 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)

DR enables contestable consumers to reduce their electricity demand voluntarily 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 that is the basis for the supply and consumption of energy, and the supply of reserve and regulation in the market.

embedded generators (EG)

Generation units that generate electricity to their onsite load principally for self consumption.

energy

The flow of electricity.

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)

A contestable consumer of electricity that participates in the wholesale market and allows its supply of electricity to be interrupted in the event of a system disturbance in exchange for reserve payment. The activation of interruptible loads is by the PSO.

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 the 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.

ADDITIONAL INFORMATION: Glossary

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.

metered demand

The electricity consumption which 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 settlements 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)

In an event when a retailer becomes unable or loses the right to retail electricity to its customers, one or more retailers will take responsibility for the failed retailer's customers. Such a retailer is called the retailer of last resort.

supply cushion

The supply cushion 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 USEP is the weighted-average of the nodal prices at all off-take nodes.

vesting contract

A vesting contract is 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)

The VCHP is calculated by the MSSSL, 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 MSSSL 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' from July 2013.

withdrawal energy quantity (WEQ)

Withdrawal energy quantity (in MWh) refers to the amount of electricity withdrawn by load facilities. It is provided by the MSSSL, SP Services.

wholesale market

The transactions made between generation companies and retail companies.

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