

# MARKET REPORT 2017



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Dear Industry Members

In 2017, oil prices rebounded amidst ongoing supply cuts by top oil producers globally. The increase in oil prices<sup>1</sup>, coupled with a 1.4 percent growth in electricity consumption in Singapore, led to a 27.8 percent jump in the Uniform Singapore Energy Price (USEP) which averaged \$80.90/MWh in 2017.

The increase in the USEP came on the back of historically low prices in the preceding year. Despite the rise, prices in 2017 were still low. In fact, 2017's annual USEP is the second lowest since the market started in 2003.

More importantly, Singapore's electricity prices continue to be driven by market forces of demand and supply – an indication that our competitive market is functioning well.

Another notable trend in 2017 was the intensifying competition in the retail market, ahead of the launch of the Open Electricity Market in 2018 when all consumers, including households, will be able to choose the retailer that they purchase electricity from. Six new retailers joined the National Electricity Market of Singapore (NEMS) in the year, bringing the total number of retailers to 22 by the end of 2017.

With more participants vying for the retail pie, the market share of SP Services (the default retailer for non-contestable or smaller consumers) dropped below 30 percent for the first time since the market started. Aside from SP Services, there were also changes in the market share of the other retailers, indicating healthy competition in the retail scene.

In the generation market, the total registered capacity reached a new high of 13,524MW in 2017 with the addition of eight new facilities. Like many other countries, Singapore continues to see new intermittent generation source (IGS) facilities joining the grid. Of the eight new facilities registered, four were IGS facilities – specifically, solar facilities.

Notwithstanding this, combined-cycle gas turbine (CCGT) generation units continue to be the predominant generation type in the NEMS. We continue to see new CCGT units being registered, with the market share of such facilities reaching 97.8% in 2017. Production efficiency in the NEMS thus remains high as CCGT facilities are the most efficient generation type in the market.

I am pleased to note that after 15 years of trading, the NEMS remains vibrant and continues to attract new participants and investments. We now have 55 market participants who collectively traded \$4.39 billion in the wholesale electricity market last year.

The NEMS' success is testimony of the good work of all industry stakeholders. I would like to thank our governance panels – Rules Change Panel, Market Surveillance and Compliance Panel, and Dispute Resolution and Compensation Panel – for their dedication and support, which are critical in keeping the NEMS stable and efficient.

Looking ahead, the most significant event coming up is the full liberalisation of the retail market in 2018. This marks the final phase of Singapore's journey to deregulate its electricity industry, a journey which started in 1995 when the electricity functions of the Public Utilities Board were corporatised.

With more than 20 electricity retailers already in the market, we can expect many innovative retail offerings in 2018, which will mean more choices for consumers. I look forward to an exciting retail scene, and another robust year of trading in the wholesale market.



**Wong Meng Meng**  
Chairman  
Energy Market Company

<sup>1</sup> The price of high sulphur fuel oil 180 CST (HSFO 180 CST) – which is used as a proxy for fuel price – rose 45.3 percent in 2017.

# MARKET OVERVIEW



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

<b>Corporatisation</b>	1995	Electricity functions of the Public Utilities Board corporatised Singapore Power formed as a holding company
	1996	Singapore Electricity Pool (SEP) design process began
<b>Singapore Electricity Pool (SEP)</b>	1998	SEP commenced PowerGrid is SEP Administrator and Power System Operator (PSO)
	1999	Review of electricity industry
<b>National Electricity Market of Singapore (NEMS)</b>	2000	Decision for further reform to obtain full benefits of competition New market design process began
	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)
	2002	Testing and trialling of wholesale market system began
	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 was 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

# MARKET OVERVIEW: Industry Structure

## Participants and Service Providers in the NEMS

<b>Generators</b>	ExxonMobil Asia Pacific Keppel Merlimau Cogen Keppel Seghers Tuas Waste-To-Energy Plant (Tuas DBOO Trust) National Environment Agency PacificLight Power	Sembcorp Cogen Senoko Energy Senoko Waste-to-Energy Shell Eastern Petroleum Singapore Refining Company TP Utilities	Tuas Power Generation Tuaspring YTL PowerSeraya
<b>Wholesale Market Traders</b>	Air Liquide Singapore Banyan Utilities CGNPC Solar-Biofuel Power (Singapore) Changi Mega Solar Diamond Energy Managers ECO Special Waste Management* Glaxo Wellcome Manufacturing – GlaxoSmithKline Biologicals	GreenSync Holdings Green Power Asia LYS Genco Beta MSD International GmbH (Singapore Branch) Nanyang Technological University Pfizer Asia Pacific Public Utilities Board	Singapore District Cooling Singapore LNG Corporation Solar C&I Holdings/Sembcorp Solar Singapore# Sun Electric Energy Assets Sunseap Leasing Sunseap Leasing Beta
<b>Retailers</b>	Best Electricity Supply Buri Energy/Ohm Energy# Charis Electric Cleantech Solar Singapore Assets Diamond Energy Merchants Energy Supply Solutions Environmental Solutions (Asia) Hyflux Energy	I Switch Just Electric Keppel Electric PacificLight Energy Red Dot Power Sembcorp Power Senoko Energy Supply Seraya Energy	SilverCloud Energy SmartCity Energy Sun Electric Power Sunseap Energy Tuas Power Supply Union Power
<b>Market Support Services Licensee (MSSL)</b>	SP Services		
<b>Market Operator</b>	Energy Market Company		
<b>Power System Operator (PSO)</b>	Power System Operator		
<b>Transmission Licensee</b>	SP PowerAssets		

\*The following changes took place in 2017:

- Solar C&I Holdings was renamed Sembcorp Solar Singapore
- Buri Energy was renamed Ohm Energy

\*ECO Special Waste Management withdrew as MP from 7 December 2017.

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.

## Nine New Market Participants Joined the Market

A total of nine new market participants (MPs) joined the NEMS in 2017.

The new MPs comprise:

- three wholesale market traders: Changi Mega Solar, Public Utilities Board and Sunseap Leasing Beta; and
- six retailers: Cleantech Solar Singapore Assets, Energy Supply Solutions, Just Electric, SilverCloud Energy, SmartCity Energy and Union Power.

There were 14 generators, 19 wholesale market traders and 22 retailers in the NEMS as of end December 2017.

## Generation Licensees

All generators with facilities of 1MW or more that are connected to the transmission system must participate in the NEMS and be registered with EMC. 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

Retailers that sell electricity to contestable consumers are licensed by the EMA. Retailers that are registered as market participants 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 industry 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, depending on their level of electricity usage. Contestable consumers may choose to purchase electricity from a retailer, directly from the wholesale market or indirectly from the wholesale market through the MSSL, SP Services. Non-contestable consumers are supplied by SP Services.

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, reserve 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 every 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 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 71 injection nodes, and the prices at up

## Energy, Reserve and Regulation Products

	Description	Purchaser	Seller
<b>Energy</b>	Generated electricity	Retailers	Generators
<b>Reserve</b>	Stand-by generation capacity or IL that can be drawn upon when there is an unforeseen shortage of supply.  Before 1 October 2017, three classes of reserves were traded: 1) primary reserve (8-second response); 2) secondary reserve (30-second response); and 3) contingency reserve (10-minute response).  From 1 October 2017, two classes of reserves are traded: 1) primary reserve <sup>2</sup> (9-second response); and 2) contingency reserve (10-minute response).	Generators	Generators, Retailers and Wholesale Market Traders
<b>Regulation</b>	Generation that is available to fine-tune the match between generation and load	Generators and Retailers	Generators

to 833 withdrawal or off-take nodes<sup>3</sup> 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.

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.

<sup>2</sup> With effect from 1 October 2017, the primary and secondary reserve classes were combined into a single primary reserve class capable of achieving its scheduled MW response automatically within nine seconds of being triggered by any contingency event, and which shall be able to maintain that scheduled MW response for ten minutes from the time it was triggered.

<sup>3</sup> Numbers of injection and withdrawal nodes are as of 31 December 2017.



## 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 the prevailing power system conditions and the most recent offers made by generators. 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 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. Each year, the RCP establishes and publishes its work plan to ensure that stakeholders remain informed about the likely evolution of the market. The work plan can be found at [www.emcsg.com](http://www.emcsg.com).

## Market Surveillance and Compliance

The Market Surveillance and Compliance Panel (MSCP), comprising professionals independent of the market, is responsible for monitoring, investigating and reporting the behaviour of MPs and the structural efficiency of the market. The Panel identifies market rule breaches and assesses market operations for efficiency and fairness. 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. The Panel produces 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. The dispute resolution process is designed to be a cost-effective way of resolving disputes and preserving market relationships by avoiding court proceedings. This process is managed by the Dispute Resolution Counsellor (DRC).

Dear Industry Members

In this dynamic electricity landscape of new technologies and emerging ideas, the work of the Rules Change Panel (RCP) in examining rule change proposals has become increasingly challenging and important. Amidst major developments in the electricity sector led by the regulator, Energy Market Authority (EMA), the RCP continues to evolve the Singapore Wholesale Electricity Market by addressing the market's concerns that have arisen alongside such developments.

These concerns were reflected in the key issues on the RCP's agenda this year. With the impending Open Electricity Market in 2018, which has led to an influx of retailers who are debtors to the market, the RCP supported two changes to improve the mechanisms to mitigate credit default. Furthermore, with the growing diversity of market participants, potentially participating through innovative technologies and ideas in the near future, the RCP was prompted to review participants' classification and the RCP's composition, as well as Energy Market Company (EMC) and the Power System Operator's (PSO) fees recovery methodologies arising from differences in the participants' use of EMC and the PSO's services.

The RCP also tackled proposals that strived to offer clarity and certainty on existing processes, by stipulating them in the appropriate Market Rules or Market Manuals. For example, the Market Rules were amended to make clear that the PSO should not be constrained to issuing dispatch instructions only to registered facilities with valid offers or bids. This is because prompt response is required for system security reasons, and this supersedes the need to check facilities' offers in making dispatch decisions for market efficiency. In another instance, the System Operation Manual will be amended to explicitly make clear that the PSO updates the Generation Outage Plan in a timely manner.

There was a noteworthy breakthrough in the RCP's endeavour to balance divergent interests. The proposal to introduce compensation for generators adversely affected by price revisions was last discussed in 2008 but back then, an agreement could not be reached on the compensation methodology. This year, the RCP supported a more refined methodology which allows generators to receive at least their offered prices for quantities that were generated in adherence to dispatch instructions, for periods that are subject to price revisions.

I am grateful to all the RCP members for their professionalism, diligence and dedication. In particular, I would like to express my utmost appreciation to Paul Poh who left EMC in November 2017. Paul had been the Chair of the RCP since 2014, and the head of EMC's Market Administration team since 2002. His dedication to market development has contributed to its stability and efficiency, and helped make it one of the best in this region.

The end of 2017 marked the completion of the last Panel's term. I would like to take this opportunity to thank outgoing Panel members for their invaluable contributions: Grace Chiam, Priscilla Chua, Lim Han Kwang, Luke Peacocke, Dallan Kay, Lawrence Lee and Phillip Tan. At the same time, I would like to welcome new Panel members: Vijay Sirse, Tan Jun Jie, Tony Tan, Tan Chian Khong, Matthew Yeo, Ho Yin Shan, Carol Tan and Fong Yeng Keong. This is part of the Panel's renewal process, and I look forward to the fresh perspectives that new Panel members will bring to our discussions.

Finally, I would like to express my gratitude to everyone who has contributed to making 2017 a productive year, including the EMA, the EMC Board, EMC's Market Administration team and all market participants whose valuable inputs have contributed to the success of the rule change process.



**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.

### Publication of Half-Hourly Metered Generation by Facility Type

Previously, EMC released only the daily aggregate metered gross generation (in MWh) of facility types in EMC's weekly trading reports which are accessible only by market participants (MPs) and data subscribers. The facility types included the following categories: combined-cycle gas turbine (CCGT), steam turbine (ST), gas turbine (GT) and 'Others' under which the intermittent generation source (IGS) facility type was subsumed.

In view of the growing installed capacity of solar generation facilities in Singapore, a rule change was made to introduce the publication of half-hourly aggregate gross and net metered generation of all facility types (including a standalone 'IGS' category) on EMC's public website, so as to improve the transparency of generation information to the industry.

### Lead Time for Extension of Commissioning Generation Facility's Registration

Under the Market Rules, the registration of a commissioning generation facility (CGF) expires on the date that the CGF completes its final commissioning tests as stated in the commissioning plan approved by the PSO. Once its registration expires, the CGF is not allowed to generate or withdraw electricity from the grid with immediate effect. If more time is required for the CGF to complete the commissioning tests, the MP has to request for an extension of its CGF registration by submitting a revised commissioning plan to the PSO for approval.

Previously, there were no explicit guidelines on how much lead-time would be required for the PSO to review and approve such a request. In the event that the request was submitted late, there was a possibility that the MP might not have been able to obtain approval for the extension of its CGF registration before the expiry date. This would have caused a disruption to the MP's commissioning activity.

Hence, a rule change was made to clearly stipulate the lead time required for the PSO and EMC to process the extension in the Market Manual and the relevant Market Rules, so as to allow MPs to better plan their activities and minimise disruptions to the commissioning of their generation facilities.

### Enhancement to the Processes of Updating Generation Outage Plan and Security Constraints

The processes of updating the Generation Outage Plan (GOP) and security constraints were examined to ensure that the industry receives timely updates.

While the GOP is generally updated promptly, it was proposed that this process be formalised and an explicit timeline be set out, so as to provide more certainty for the MPs. Information on security constraints, on the other hand, is only updated via advisory notices and not easily retrievable. Hence, it was also proposed that details on security constraints be included in the Adequacy and Security Assessment (ASA) report so as to keep all MPs informed of security constraints that will be in effect for the upcoming trading days.

However, some industry players raised the concern that there could be a potential adverse impact if a lead-time is required for the PSO to update the security constraints.

Eventually, the RCP supported the proposal to formalise the current process in the System Operation Manual (SOM), where the PSO updates the GOP on the same business day that a planned outage is approved.

### Review of Methodology for the Recovery of EMC and PSO's Fees

The administrative costs of EMC and the PSO are currently recovered from the market via fees that are charged based on metered generation and withdrawal quantities. In accordance with the current fee recovery methodology, some MPs are not charged such fees even though they use and/or benefit from the services of EMC and/or the PSO.

Non-fee paying MPs comprise inactive MPs without transactions and active MPs with transactions but zero metered fee quantities. Since all MPs, whether active or inactive, incur ongoing costs and could potentially use and benefit from EMC's services, introducing an annual MP fee and an annual facility fee will ensure a more equitable allocation of fees amongst participants in the Singapore Wholesale Electricity Market (SWEM).

In addition, introducing a registration fee for the registration of each MP and facility would align with the user-pays cost allocation principle since the beneficiaries of registration services can be identifiable.

The Panel agreed with the proposed changes to the fee recovery methodology and has written to the EMA to convey its view.

## Review of Consumer Representatives on the RCP

After the resignation of the representative for large consumers on the RCP in April 2016, none of the then eligible nominating organisations submitted nominations for the replacement. The seat for the representative for large consumers was hence vacant, prompting a review of the eligible nominating organisations.

EMC approached a few suitable consumer organisations for consultation and the Singapore Chemical Industry Council (SCIC) agreed to be added to the list of approved organisations eligible to nominate a suitable candidate to the RCP. A rule change was thus made to formally add the SCIC to the list of organisations eligible to nominate candidates representing electricity consumers to the RCP, so as to ensure that the seats on the RCP are duly filled.

## Removal of Provisions Relating to Forward Sales Contracts from the Market Rules

Provisions relating to forward sales contracts (FSC) were introduced into the Market Rules on 1 July 2015, with the intent for FSC settlement to be part of the SWEM's settlement process.

However, the EMA subsequently decided to suspend the settlement of FSCs via the SWEM's settlement process. Instead, FSCs are now settled bilaterally between FSC holders and the MSSL. Since the previously introduced provisions were no longer in use, a rule change was made to remove them.

## Review of Sections 9.1.2.2 and 9.1.3 of Chapter 5

Previously, Chapter 5 of the Market Rules provided that the PSO might issue dispatch instructions only to registered facilities with valid offers or bids under the following situations:

- (i) when the real-time dispatch schedule (RTDS) was not released by EMC (Section 9.1.2.2); or
- (ii) to prevent the system from entering into a high-risk or emergency operating state (Section 9.1.3).

However, the PSO should not be encumbered by the need to check for valid offers or bids prior to making dispatch decisions in real-time, given that the PSO has to respond promptly to maintain system security.

A rule change was thus made to establish procedures for the PSO to override dispatch instructions for the above scenarios, as follows:

- (i) In the absence of a RTDS, the PSO shall issue dispatch instructions in accordance with the procedure specified in the SOM – which is for the PSO to use the latest available forecast schedule for dispatch, since forecast schedules are produced using offers and bids submitted. Correspondingly, the requirement to issue dispatch instructions to registered facilities with valid offers or bids was removed.
- (ii) To prevent the system from entering into a high risk or emergency operating state, the PSO is allowed to issue dispatch instructions to any registered facility, without having to consider the presence of valid offers or bids.

## Compensation for Generators Adversely Affected by Price Revisions

The adoption of marginal uniform pricing in the SWEM is intended to encourage generators to offer close to their true marginal costs. However, for periods that are subject to price revisions, generators are currently not guaranteed of receiving at least their offer prices. A generator could incur out-of-pocket costs (relative to its offer price) if the revised price is lower than its offer price, even if it had generated based on its real-time schedule. The absence of provisions for compensation under such situations could increase uncertainty for generators and undermine industry players' confidence in market prices.

A rule change was supported by the RCP to introduce compensation for generators, such that for periods that are subject to price revisions, the generators will receive at least their offered prices for quantities that are generated in adherence to dispatch instructions. This arrangement strikes a balance between being fair to generators and the costs of compensation, which are borne by consumers.

## Review of Mechanisms to Mitigate Credit Default

A review of the mechanisms to mitigate credit default in the SWEM led to two changes relating to prudential requirements that will take effect in April 2018.

The prudential requirement for each MP is determined based on the MP's estimated average daily exposure, using 90 days of historical data. As new MPs do not have sufficient historical data, their estimated average daily exposure currently relies solely on the forecasted trading exposure that they provide. To improve the risk exposure monitoring in the interim before sufficient data is available for new MPs, the first change supported by the RCP is to revise the prudential requirement formula to take into account the new MPs' actual withdrawal quantity once such data is available.

Further, there could be insufficient credit support being held by EMC due to an "ex-post" revision of bilateral contract quantities upon an MP's default. To limit this risk, the second change which the RCP supported is to bring forward the deadline for the submission of bilateral contract quantities, from T+4 business days to T-10 calendar days.

## Rule Changes Not Supported by the RCP

The RCP also discussed the following proposals but decided not to support them.

### Review of MPs' Classification and RCP's Composition

The growing diversity of MPs in the SWEM necessitated a review of their classification as well as representation on the RCP.

On MPs' classification, it was clarified that the MPs' classes are aligned with the MPs' licence types, and that there is currently no Market Rule that applies specifically to any sub-type of the existing MP classes. The RCP hence concluded that there was no need to change the MPs' classification.

On MPs' representation on the RCP, it was highlighted that the market governance arrangement complements the representation model to achieve the desirable characteristics of the RCP. In addition, the equivalents of the RCP in other jurisdictions were studied. Arising from observations from the study, the RCP supported the recommendation of not deviating from the current representation model, as well as retaining the current composition of the RCP.

## Review of Dispute Resolution Procedures

As part of its three-yearly review of the dispute resolution procedures (DRP), the RCP received one proposal to establish model arbitration rules, so as to standardise arbitration procedures and minimise differences among different arbitration tribunals.

Currently, a set of model arbitration rules is published by EMC and serves as a guide in carrying out arbitration. Given that there has been no arbitration case since the start of the SWEM, the RCP was of the view that the model arbitration rules should continue to serve as a guide.

The RCP thus concluded this round of review with no changes made to the DRP.

## Rule Changes Directed by the EMA

In addition to the rule changes considered by the RCP, EMC also implemented the following rule change as directed by the EMA pursuant to Section 46(2)(b) of the Electricity Act.

### Rules Modification for the EMA's Final Determination Paper "Enhancement to the Spinning Reserve Requirements for the Singapore Power System"

To ensure that Singapore's power system is ready for the future connection of larger-sized power plants (e.g. H-Class CCGT) and large-scale deployment of IGS facilities (e.g. solar generation facilities), the EMA implemented the new Primary Reserve framework which combines the former Primary Reserve and Secondary Reserve classes into a new single Primary Reserve class. Correspondingly, the reserve response time and capability requirements were revised.

This enhancement will potentially bring about the following benefits:

- (i) Achieve simpler offer submissions and market clearing engine (MCE) scheduling;
- (ii) Increase in supply cushion, which will lead to increased competition and potentially lower market clearing prices; and
- (iii) Faster system frequency recovery following forced outages of generators.

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

### Arbitration Panel

1. Ang Cheng Hock, Senior Counsel
2. Ben Giaretta
3. Chelva Rajah, Senior Counsel
4. Giam Chin Toon, Senior Counsel
5. Gregory Thorpe
6. Harry Elias, Senior Counsel
7. Kenneth Tan, Senior Counsel
8. Professor Lawrence Boo
9. N Sreenivasan, Senior Counsel
10. Naresh Mahtani
11. Philip Jeyaretnam, Senior Counsel
12. Phillip Harris
13. Raymond Chan
14. Dr Robert Gaitskell, Queen's Counsel
15. Tan Chee Meng, Senior Counsel
16. 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. CGNPC Solar-Biofuel Power (Singapore) – Mike Ong
3. Charis Electric – Kenneth Lee
4. Cleantech Solar Singapore Assets – Andre Nobre
5. Diamond Energy Merchants – Muhammad Asya'ari
6. Energy Market Company – Tan Yi Lin
7. Energy Supply Solutions – Jace Lee
8. Environmental Solutions (Asia) – Sivakumar Avadiar
9. ExxonMobil Asia Pacific – Lim Li Fang
10. ExxonMobil Asia Pacific – Priska
11. GlaxoSmithKline Biologicals – Chew Siou Ping
12. GlaxoSmithKline Biologicals – Wong Joon Jee
13. GreenSync Holdings – Cash van Halder
14. Green Power Asia – Daniel Ma
15. Hyflux Energy – Cindy Lim
16. Hyflux Energy – Ooi Chel-Lin



17. I Switch – Senthil Kumar
18. Just Electric – Wittman Wah
19. Keppel Electric – Joelyn Wong
20. Keppel Electric – Nicholas Tan
21. Keppel Merlimau Cogen – Sean Chan
22. Keppel Merlimau Cogen – Tini Mulyawati
23. LYS Genco Beta – Jonathan Chong
24. Nanyang Technological University – Muhammed Isa Lee Teck Kwang
25. National Environment Agency – Siew Weng Soon
26. National Environment Agency – Teresa Tan
27. Ohm Energy – Nerine Teo
28. PacificLight Energy – Teo Chin Hau
29. PacificLight Power – Linda Wen
30. Pfizer Asia Pacific – Lee Chin Hoo
31. Pfizer Asia Pacific – Tan Meng Tong
32. Power System Operator – Loh Poh Soon
33. Power System Operator – Oh Chai Choo
34. Red Dot Power – Vijay Sirse
35. Sembcorp Cogen – Agnes Low
36. Sembcorp Cogen – Ang Geok Chuan
37. Sembcorp Power – Jenny Lye
38. Sembcorp Power – Valerie Lee
39. Sembcorp Solar Singapore – Fendy Nursalim
40. Senoko Energy – Luke Peacocke
41. Senoko Energy – Poo Siok Yin
42. Senoko Energy Supply – Eu Pui Sun
43. Senoko Energy Supply – Michelle Lim
44. Senoko Waste-to-Energy – Francis Ng
45. Senoko Waste-to-Energy – Lee Song Koi
46. Seraya Energy – Daniel Lee
47. Seraya Energy – Elaine Syn
48. Shell Eastern Petroleum – Grace Chiam
49. Shell Eastern Petroleum – Pak-Juan Koe
50. SilverCloud Energy – Lee Hock Lim
51. Singapore District Cooling – Dennis Chong
52. Singapore District Cooling – Liu Yue
53. Singapore LNG Corporation – Lam Zheng Xin
54. Singapore LNG Corporation – Vincent Lam
55. Singapore Refining Company – Ho Weng Foo
56. Singapore Refining Company – Balasubramaniam Sundararaj Mohanakkannan
57. SmartCity Energy – Teo Kok Meng
58. SP PowerAssets – Chan Hung Kwan
59. SP PowerAssets – Ong Sheau Chin
60. SP Services – Hilda Toh
61. SP Services – Ho Yin Shan
62. Sun Electric Energy Assets – Eugene Lim
63. Sun Electric Energy Assets – Matthew Peloso
64. Sunseap Energy – Lawrence Kwan
65. Sunseap Leasing – Jonathan Tai
66. Sunseap Leasing – Shawn Tan
67. Sunseap Leasing Beta – Shawn Tan
68. Tuas DBOO Trust – Victor Fong
69. Tuas DBOO Trust – Wilfred Tan
70. Tuas Power Generation – Priscilla Chua
71. Tuas Power Supply – Jazz Feng
72. Tuas Power Supply – Zhang Ai Jia
73. Tuaspring – Calvin Quek
74. Tuaspring – Chin Shi En
75. Union Power – Ellen Teo
76. Union Power – Eric Lim
77. YTL PowerSeraya – Jonathan Chew
78. YTL PowerSeraya – Ong Yi Zha

## Dispute Resolution Workshop

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

On 20 June 2017, Professor Nadja Alexander, a mediator on the DRCP, and I conducted a half-day workshop on negotiation for the 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.



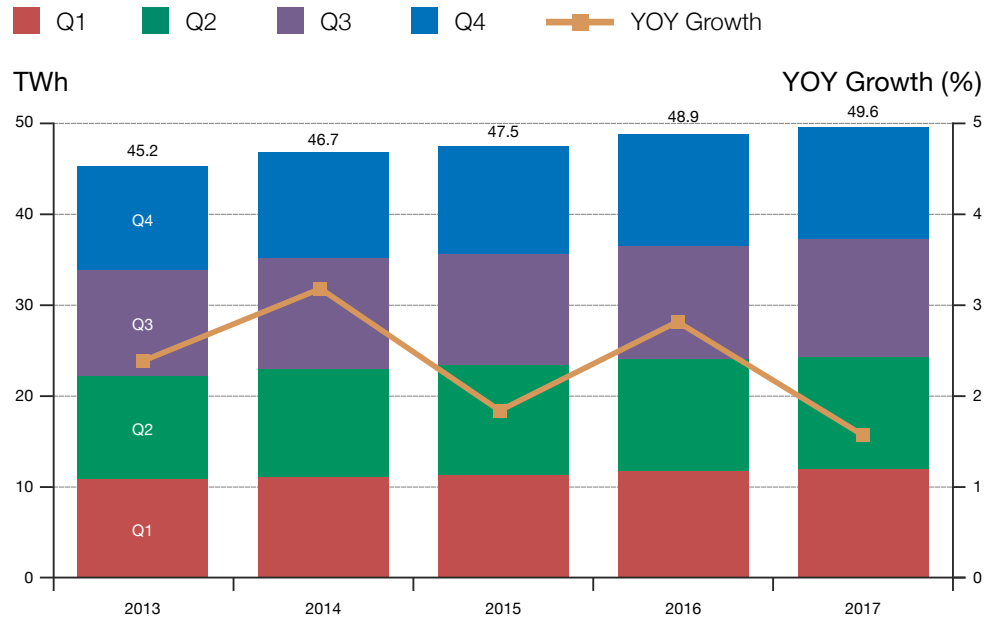
**George Lim**

Senior Counsel  
Dispute Resolution Counsellor

# MARKET PERFORMANCE



## Annual Electricity Consumption 2013 – 2017



### Electricity consumption growth continues in 2017 albeit at a low rate

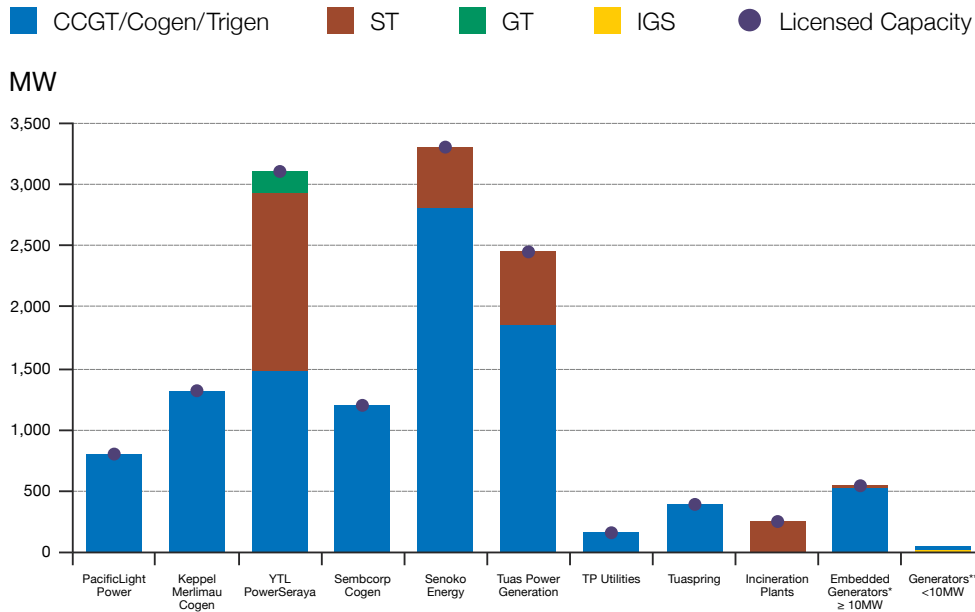
Electricity purchased by market participants (MPs) is settled using electricity consumption data provided by the Market Support Services Licensee (MSSL).

Despite Singapore's economy growing at 3.6 percent in 2017<sup>4</sup>, the year-on-year (YOY) growth in electricity consumption was only 1.4 percent. This was the slowest growth since 2011's growth rate of 1.3 percent. Total electricity consumption continued to move towards the 50.0 terawatt hours (TWh) level and registered 49.6TWh in 2017.

Compared to the same periods in 2016, all quarters in 2017 saw higher YOY electricity consumption. The largest increase was in the third quarter, when electricity consumption rose 2.8 percent. The smallest increase of 0.6 percent was registered in the second quarter.

<sup>4</sup> Based on the Singapore Ministry of Trade and Industry press release on 14 February 2017: "MTI Expects GDP Growth in 2018 to Moderate but Remain Firm".

## Generation Capacity as of 31 December 2017: Registered Versus Licensed



\*Embedded generators exclude TP Utilities  
 \*\*Licensed capacity for generators <10MW excluded as the information is no longer publicly available

### Licensed capacity falls and registered capacity rises in 2017

Total licensed capacity in the National Electricity Market of Singapore (NEMS) of generators with capacity larger than 10 megawatts (MW) fell by 8.3MW to 13,571MW in 2017. The drop in licensed capacity came entirely from the embedded generators (EG) category – Singapore Refining Company’s licensed capacity was revised downwards from 84.0MW to 77.0MW, and Air Liquide Singapore’s licensed capacity dropped from 14.9MW to 13.6MW.

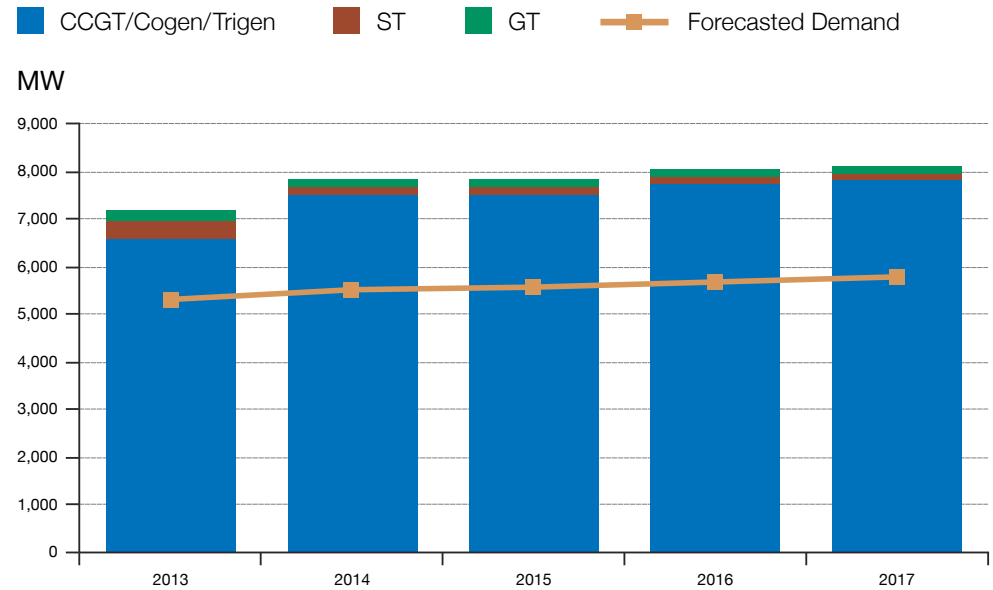
Registered capacity grew 1.2 percent to 13,524MW in 2017. This was contributed by the addition of eight new facilities in the NEMS (see details on page 22).

The proportion of total registered capacity to total licensed capacity increased to 99.7 percent, an increase of 1.9 percentage points from 2016.

The proportion of CCGT/cogen/trigen registered capacity to total registered capacity remained relatively unchanged at 77.7 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 by Plant Type 2013 – 2017



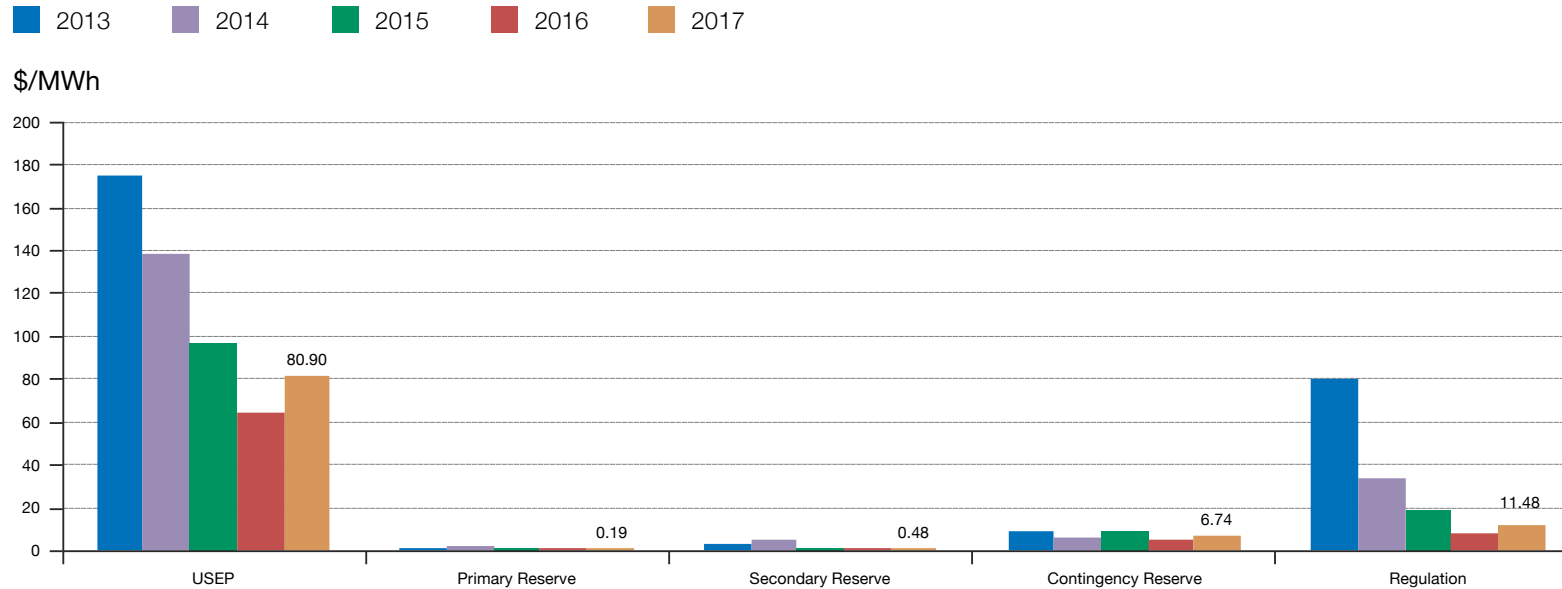
### Annual generation supply sees small increase in 2017

The annual generation supply increased 0.1 percent in 2017, registering a new high of 8,070MW since the market started.

CCGT/cogen/trigen supply also recorded a new high since the market started with a 0.8 percent increase to 7,808MW in 2017. CCGT/cogen/trigen supply continued to stay above forecasted demand by a margin of 35.9 percent. This margin was 0.3 percentage point narrower compared to 2016 primarily because of the higher demand in 2017.

Both ST and GT supplies, on the other hand, fell in 2017. ST and GT supplies were 6.5 percent and 24.6 percent lower respectively compared to 2016.

## Annual USEP and Ancillary Prices 2013 – 2017



### USEP and ancillary services prices rise across the board

The annual average Uniform Singapore Energy Price (USEP) rose 27.8 percent from 2016's historical low, to \$80.90 per megawatt hour (MWh) in 2017 which is the second lowest level since the market started. This was the result of higher fuel oil prices<sup>5</sup> which rose 45.3 percent to USD353.25 per metric tonne (MT) in 2017.

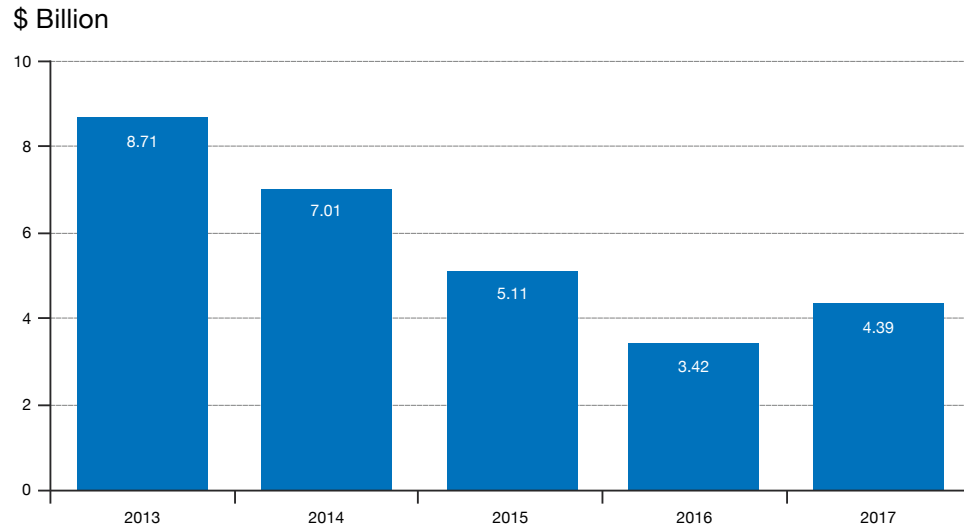
Primary, secondary and contingency reserves saw more offers in the more expensive price tranches in 2017. As a result, prices of these three reserve classes rose 46.2 percent, 84.6<sup>6</sup> percent and 27.9 percent to \$0.19/MWh, \$0.48/MWh and \$6.74/MWh respectively.

Regulation price rose 42.4 percent to \$11.48/MWh. One of the factors for the increase was the upward revision of the regulation requirement from 105MW to 111MW, starting from 1 February 2017.

<sup>5</sup> Based on high sulphur fuel oil 180 CST (HSFO 180 CST) price which is used as a proxy for fuel price.

<sup>6</sup> On 1 October 2017, the primary and secondary reserve classes were combined into a new, single primary reserve class as directed by the regulator. Hence, secondary reserve class prices were computed using 2016's full-year average and 2017's average for January to September.

## Annual Value of Products Traded 2013 – 2017



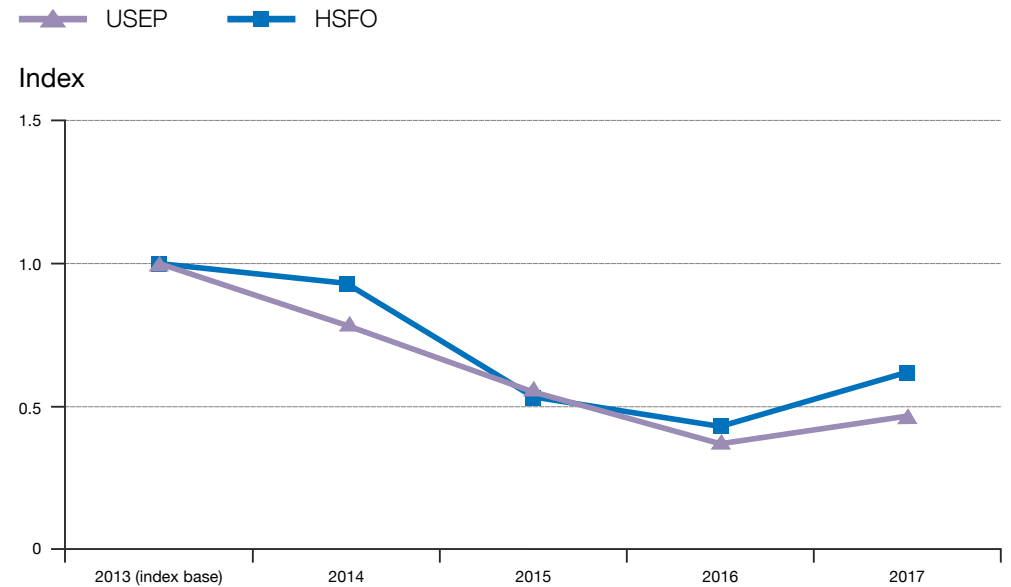
### Annual value of products traded rebounds from 2016's level

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 increased 28.4 percent from 2016, to register \$4.39 billion in 2017. This was the result of a 27.8 percent increase in the USEP. It was also the first YOY growth in the annual value of products traded after four consecutive years of decline starting from 2013.

In 2017, the energy market accounted for 98.8 percent of all products traded, while the reserve and regulation markets accounted for 0.9 percent and 0.3 percent respectively.

## Annual USEP and Fuel Price (HSFO) Movements 2013 – 2017



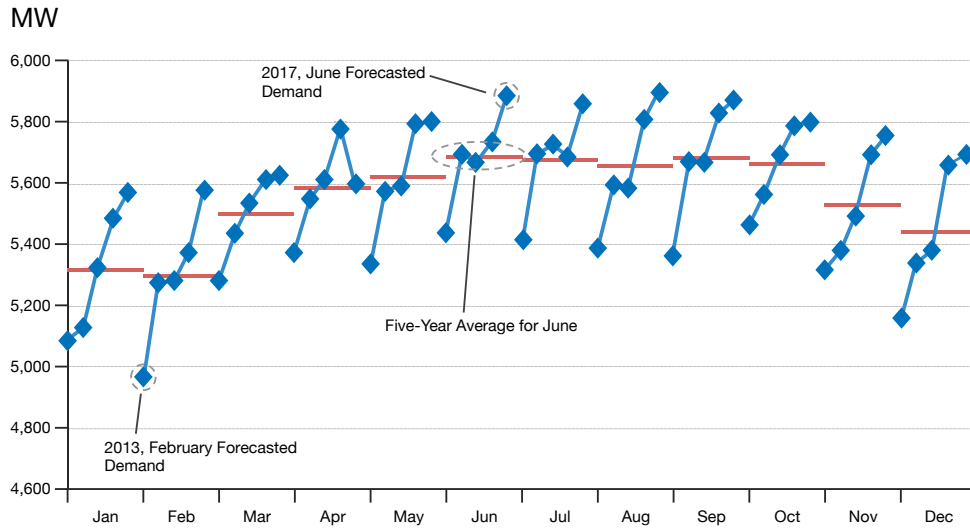
### Both USEP and fuel price indices rebound

The USEP index<sup>7</sup> rebounded in 2017 but at 0.47, it was still less than 50.0 percent of the 2013 level. The HSFO index rose to 0.62 in 2017.

This was the first time that both indices have risen since 2013. The gap between the USEP and fuel price indices has also widened, reflecting a slower pace of increase of the USEP index compared to that of the fuel price index.

<sup>7</sup> The USEP index is computed using 2013 as the index base. Therefore, the USEP index in 2013 is 1, while the USEP index in 2017 is 0.47 (computed using the 2017 USEP of \$80.90/MWh divided by the 2013 USEP of \$173.24/MWh).

## Monthly Forecasted Demand 2013 – 2017



### Demand rises in all months except April

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.

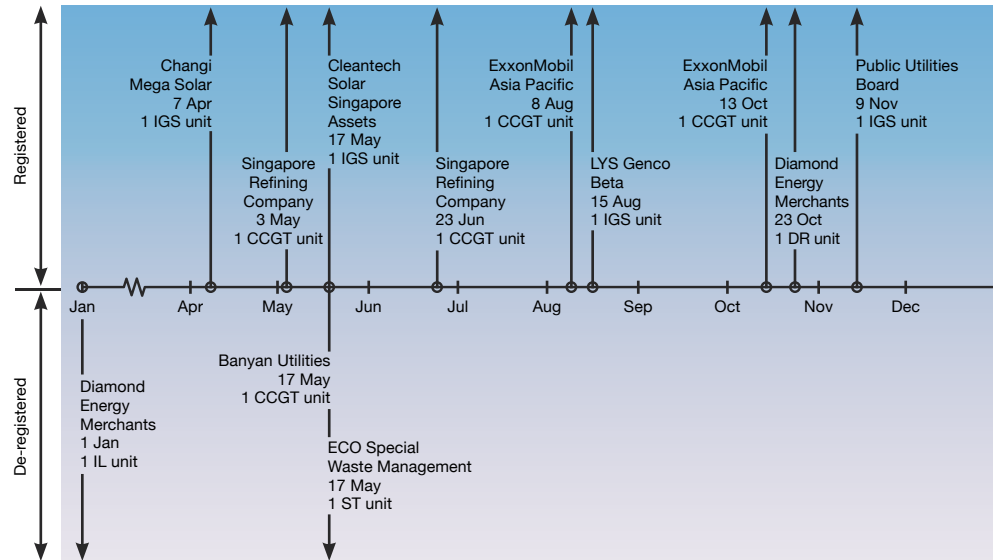
The annual forecasted demand rose 1.0 percent in 2017 to 5,747MW.

Comparing YOY, stronger demand was observed for all months except April. The drop in April's forecasted demand could be attributed to lower temperatures – the average temperature in April 2017 was 2.0 degrees Celsius lower than April 2016. The highest monthly average forecasted demand in 2017 was in August at 5,900MW, while the lowest was in January at 5,572MW.

With the exception of April, the forecasted demand reached new monthly highs in all months in 2017.

The peak half-hourly forecasted demand of 6,967MW was recorded in Period 22 on 1 August 2017. This was higher than 2016's peak half-hourly forecasted demand of 6,846MW seen in Period 29 on 10 May 2016.

## Generation and Load Facilities Registered and De-registered in 2017



### Eight new generation facilities and one new load facility registered in 2017

At the end of 2017, the total registered capacity of generation facilities in the NEMS stood at 13,524MW. Out of this, 77.7 percent or 10,508MW belonged to the CCGT/cogen/trigen category. The total number of generation facilities registered as of 31 December 2017 was 71.

In the year, eight new generation facilities were added from six market participants – Changi Mega Solar, Singapore Refining Company, Cleantech Solar Singapore Assets, ExxonMobil Asia Pacific, LYS Genco Beta and Public Utilities Board – which collectively contributed a total of four intermittent generation source (IGS) facilities and four CCGT facilities to the market.

A breakdown of the new generation facilities is as follows:

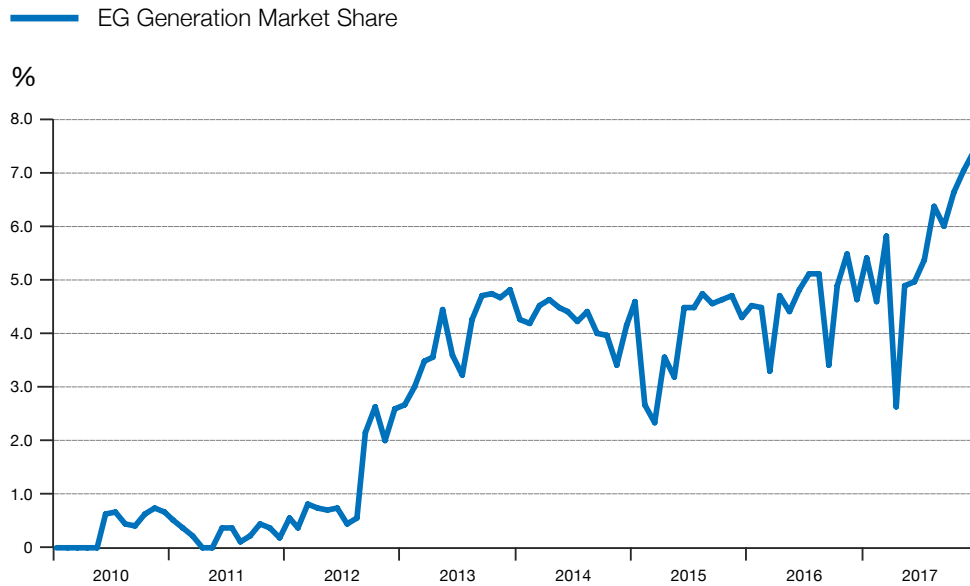
Market Participant	Generation Type	Registered Capacity
<b>Changi Mega Solar</b>	1 IGS unit	2.844MW
<b>Singapore Refining Company</b>	2 CCGT units	39.45MW, 37.50MW
<b>Cleantech Solar Singapore Assets</b>	1 IGS unit	1.260MW
<b>ExxonMobil Asia Pacific</b>	2 CCGT units	40.39MW, 40.39MW
<b>LYS Genco Beta</b>	1 IGS unit	1.860MW
<b>Public Utilities Board</b>	1 IGS unit	0.803MW
<b>Total</b>		164.497MW

At the same time, two generation facilities were de-registered in 2017 – a 5.0MW CCGT unit from Banyan Utilities and a 1.48MW ST unit from ECO Special Waste Management.

For load facilities, Diamond Energy Merchants de-registered a 10.0MW IL facility in 2017, and registered a 7.20MW facility under the Demand Response (DR) programme.



## Embedded Generator Generation Market Share



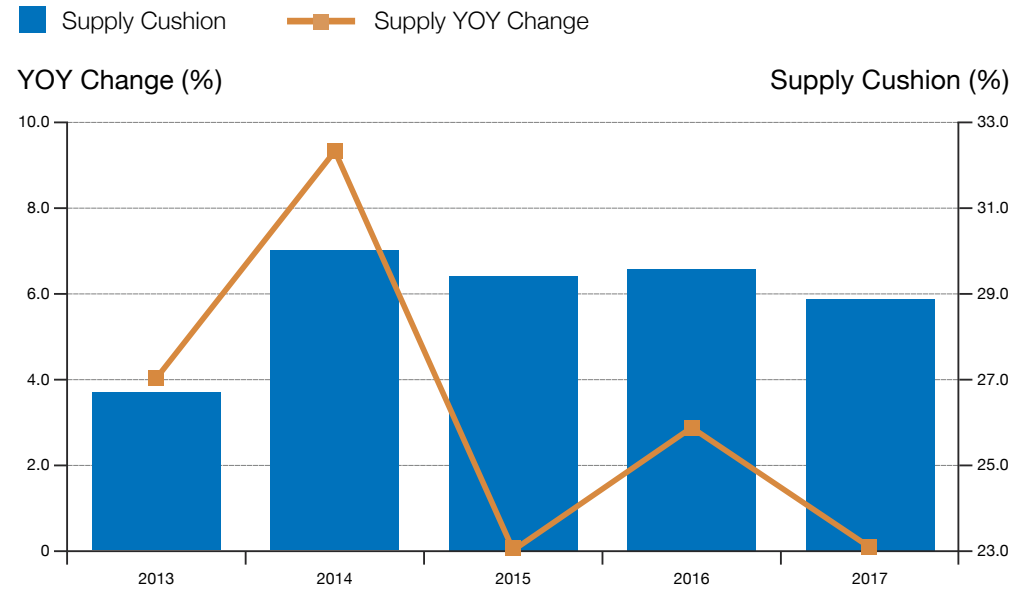
### Embedded generator generation market share continues to increase in 2017

The EG generation market share in the NEMS has been increasing steadily, from an average of 0.3 percent in 2011 to an average of 5.6 percent in 2017. This is due to an increasing number of EGs joining the NEMS over time. In 2017, seven<sup>8</sup> new EGs were registered which added another 163.7MW of registered capacity.

2017 also saw the highest monthly EG generation market share since EGs joined the market in 2008. In the year, the highest monthly EG generation market share was registered in December at 7.3 percent and the lowest was in April at 2.7 percent. The standard deviation was 1.3 percent, up from 2016's standard deviation of 0.7 percent.

<sup>8</sup> The seven new EGs registered were from Changi Mega Solar (1 unit), Singapore Refining Company (2 units), Cleantech Solar Singapore Assets (1 unit), ExxonMobil Asia Pacific (2 units), and LYS Genco Beta (1 unit).

## Annual Supply Cushion 2013 – 2017



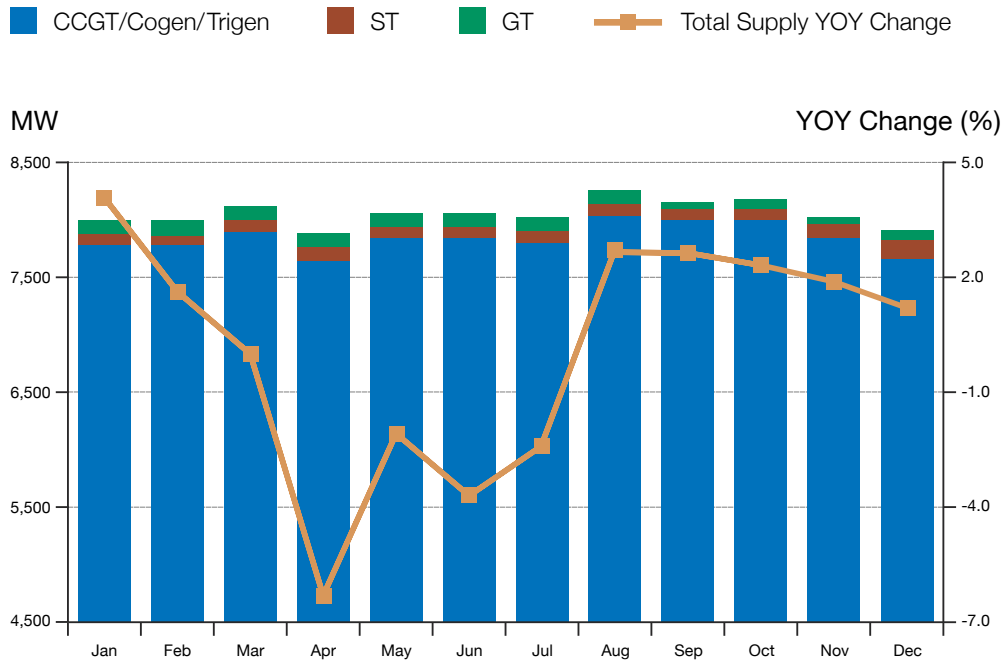
### Supply cushion falls in 2017

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. If both total supply and forecasted demand rise in tandem, the supply cushion will remain constant.

In 2017, the forecasted demand increased at a faster rate than total supply. This resulted in a small dip of 0.6 percentage point in the supply cushion to 28.9 percent, which was the lowest level of annual supply cushion since 2014. The supply cushion continued to stay below 30.0 percent for the third consecutive year.

# MARKET PERFORMANCE: Energy Supply

## Monthly Supply by Plant Type 2017



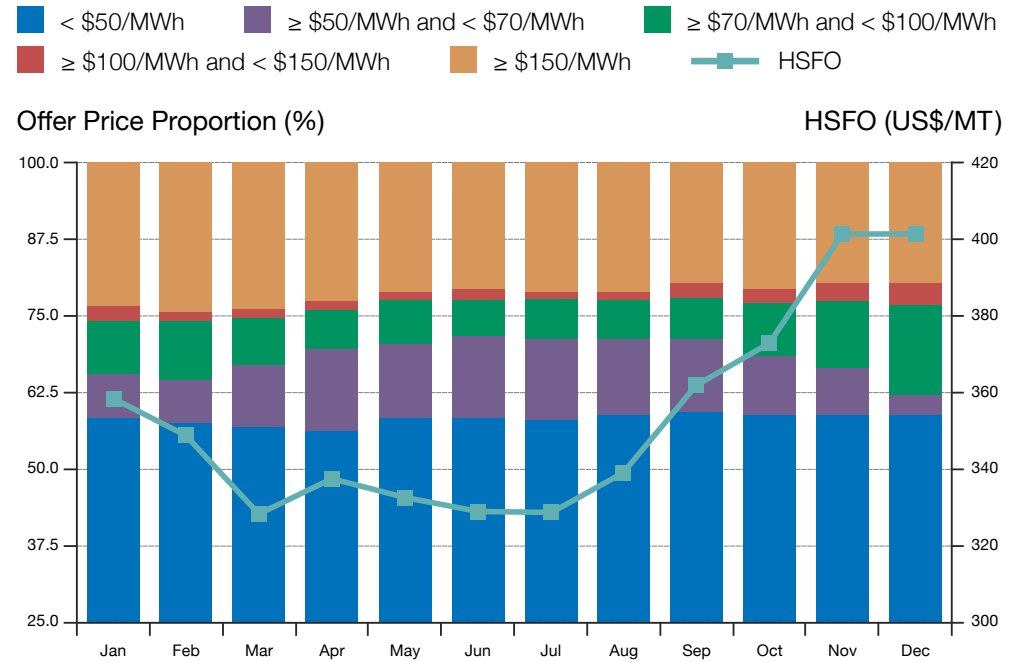
### Total supply remains largely unchanged

In 2017, negative YOY growth of between -6.1 percent and -2.1 percent was registered for supply between April and July. Nevertheless, total supply for the year was marginally higher compared to 2016 as the positive growth in the remaining eight months outweighed the four months of negative growth.

In terms of market share, CCGT/cogen/trigen continued to dominate with a 96.7 percent share of the total supply. This was a 0.6 percentage point increase over 2016's level, and a new high for the category. The market shares of ST and GT, on the other hand, decreased 0.1 percentage point and 0.5 percentage point, to 1.6 percent and 1.7 percent respectively.

In 2017, there were nine months when supply surpassed the 8,000MW level, the highest number in any one year since the market started. The monthly supply was the highest in August at 8,325MW.

## Monthly Energy Offer Price Proportion and HSFO Price 2017



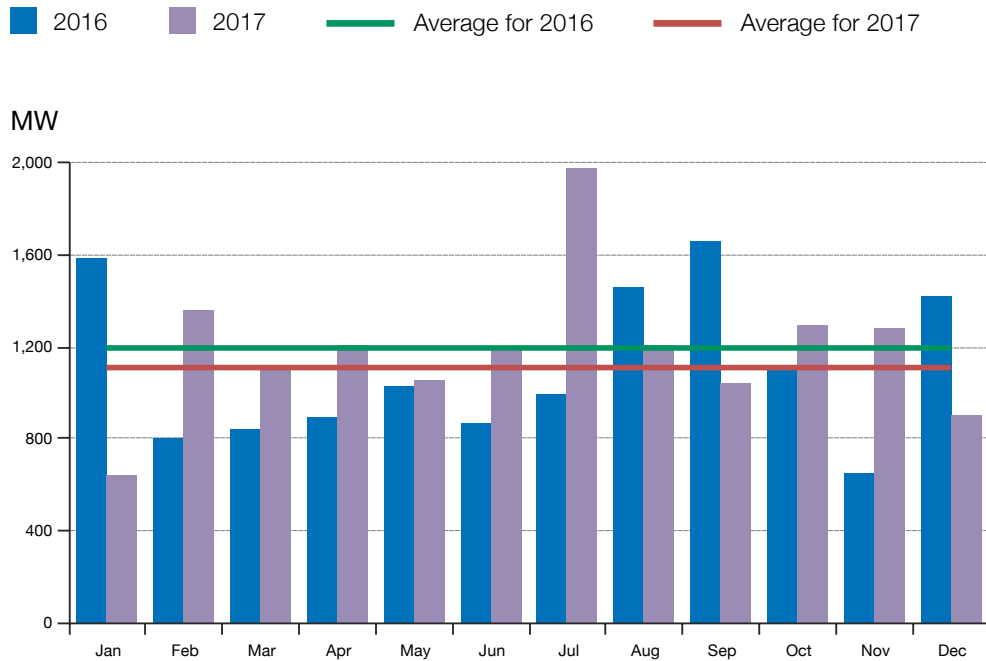
### Energy offer prices move in tandem with oil price movement

In 2017, HSFO prices ranged between USD300/MT and USD420/MT, with the lowest levels of around USD330/MT being registered from March to August. In these six months, energy offers in the price band of between \$50.00/MWh and \$70.00/MWh averaged 12.3 percent.

In the last four months of 2017, the percentage of offers in the price band of between \$50.00/MWh and \$70.00/MWh started to decline, hitting a low of 3.7 percent in the month of December. This corresponded with an increase in the HSFO price.

Throughout 2017, the percentage of energy offers priced below \$100.00/MWh remained relatively constant, ranging between 74.5 percent in the months of January and February, to 78.3 percent in September.

## Monthly Generation Maintenance 2016 Versus 2017



## Generation maintenance increases in 2017

The annual average generation maintenance level<sup>9</sup> increased 7.1 percent<sup>10</sup> in 2017 and averaged 1,190MW. There were mixed movements in the monthly generation maintenance levels when comparing YOY. While the months of February to July, October and November saw an average of 45.5 percent increase in maintenance levels, the remaining months saw a drop of 38.0 percent. The highest level of monthly generation maintenance took place in July at 1,980MW.

The standard deviation of monthly generation maintenance decreased from 336MW in 2016 to 316MW in 2017. Despite the smaller standard deviation in 2017, the monthly generation maintenance level ranged from 643MW to 1,980MW, compared to the narrower range of between 651MW and 1,661MW in 2016.

The ratio of generation maintenance to registered capacity rose to 8.8 percent in 2017, from 8.3 percent in 2016.

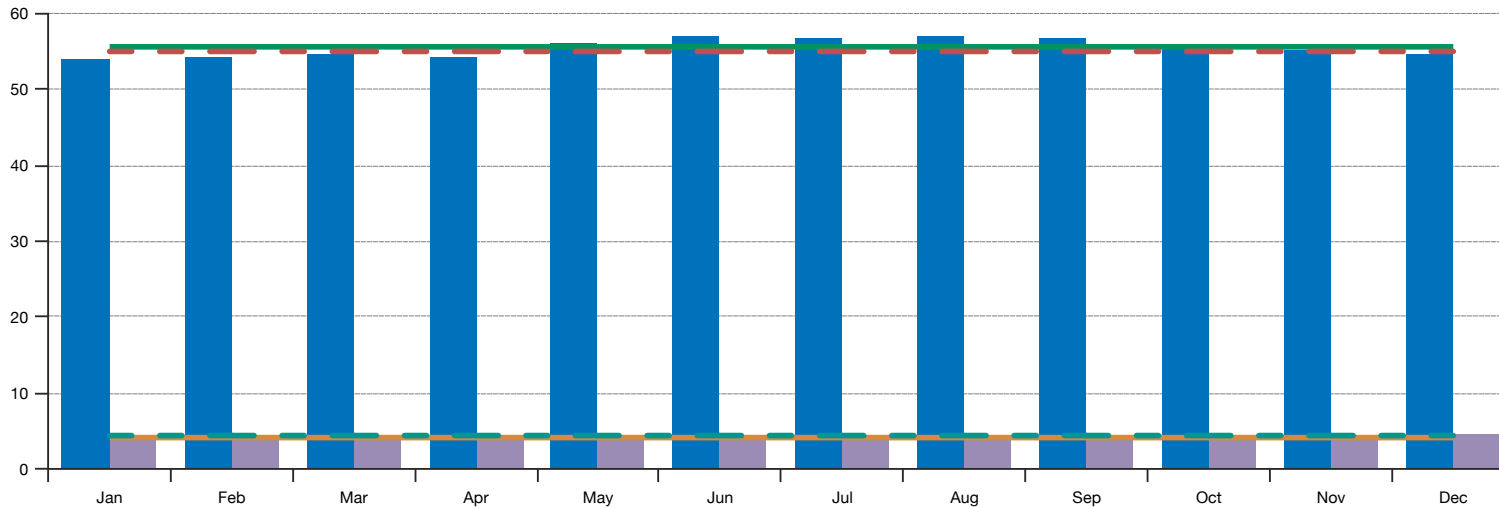
<sup>9</sup> Generation maintenance refers to the overhaul and retrofitting of generation facilities. Generation maintenance levels are calculated based on the Annual Generator Outage Programme (AGOP) provided by the PSO.

<sup>10</sup> Due to a technical error, the 2016 generation maintenance level has been revised from 1,260MW published in the NEMS Market Report 2016, to 1,111MW.

## Monthly Utilisation Rate by Plant Type 2017

■ Monthly CCGT/Cogen/Trigen Utilisation Rate 2017    
 — Annual CCGT/Cogen/Trigen Utilisation Rate 2016    
 — Annual ST Utilisation Rate 2016  
■ Monthly ST Utilisation Rate 2017    
 — Annual CCGT/Cogen/Trigen Utilisation Rate 2017    
 — Annual ST Utilisation Rate 2017

Utilisation Rate (%)



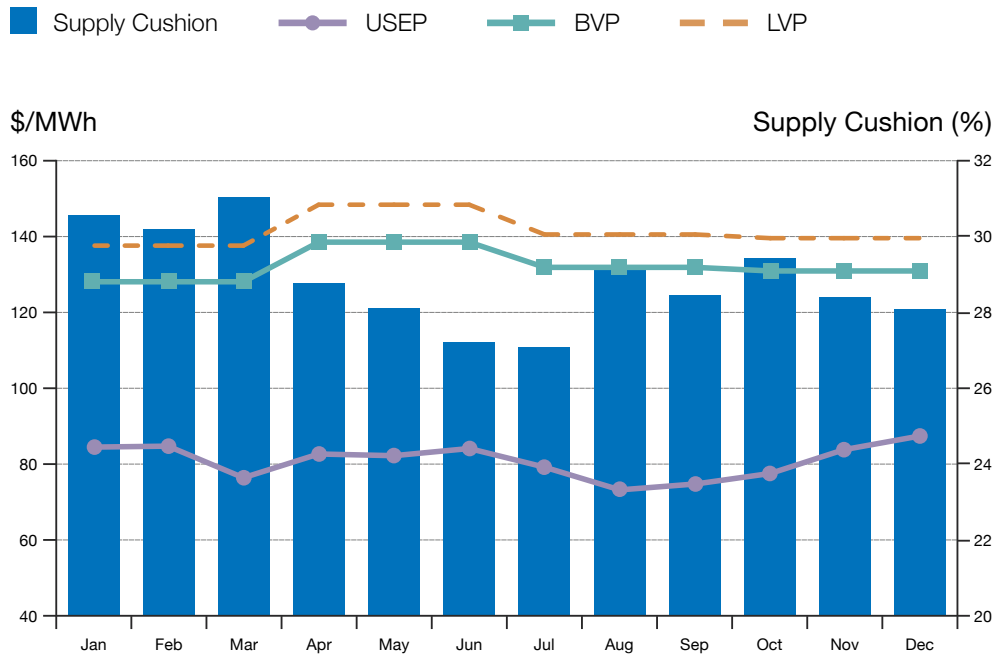
### Utilisation rates largely unchanged for CCGT/cogen/trigen and ST plant types

In 2017, the monthly CCGT/cogen/trigen utilisation rate ranged between a low of 54.1 percent in January and a high of 57.2 percent in June. Compared to 2016, the utilisation rate improved in all months except April and October. In April, an average of four CCGT units was out on planned maintenance per day and this dampened the generation level for the CCGT/cogen/trigen plant type. Similarly, in October, an average of three CCGT units was out on planned maintenance per day.

The utilisation rates for the remaining months improved, bringing the annual utilisation rate for the CCGT/cogen/trigen plant type to 55.7 percent, up from the 55.1 percent seen in 2016.

The monthly ST utilisation rate ranged between 3.9 percent and 4.7 percent. This range is smaller than the range of between 3.9 percent and 5.1 percent observed in 2016. The monthly ST utilisation rate was lower than 2016 in eight out of the 12 months, which led to a lower annual ST utilisation rate of 4.2 percent compared to 2016's 4.4 percent.

## Monthly USEP, BVP, LVP and Supply Cushion 2017



### USEP stays below BVP and LVP benchmarks throughout the year

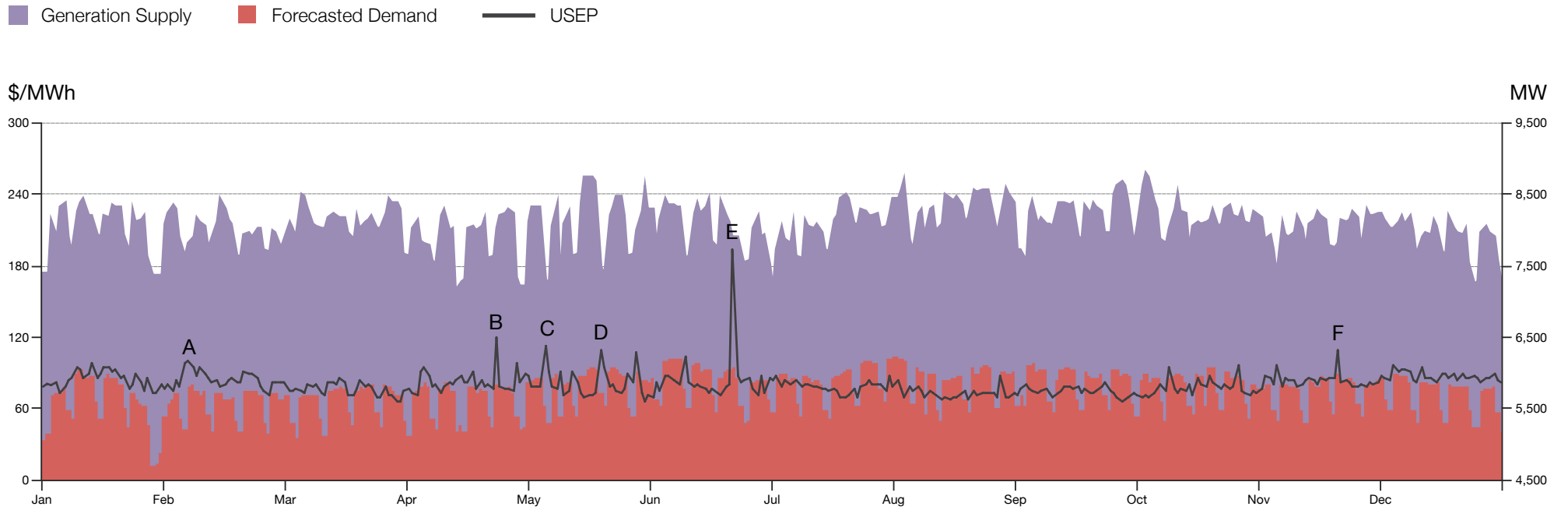
In 2017, the USEP movements corresponded with that of the Balance Vesting Price (BVP) and the LNG Vesting Price (LVP) throughout the year. Compared to 2016, the spread between the monthly minimum USEP of \$73.40/MWh and the monthly maximum USEP of \$87.44/MWh was smaller, with a gap of just \$14.04/MWh.

The annual average BVP of \$132.46/MWh in 2017 was \$51.56/MWh higher than the annual average USEP of \$80.90/MWh. This was an increase from the \$48.84/MWh gap observed in 2016. At the monthly level, the largest gap between the USEP and the BVP was observed in August, when the BVP was \$58.70/MWh above the USEP. The smallest gap was observed in February, when the BVP was \$43.30/MWh above the USEP.

On the other hand, the gap between the annual average LVP and the annual average USEP decreased from \$66.08/MWh in 2016 to \$60.58/MWh in 2017. The largest gap between the monthly USEP and the monthly LVP also occurred in August, when the LVP was \$67.02/MWh above the USEP. The smallest gap was observed in December, when the LVP was \$52.34/MWh above the USEP.

The supply cushion was high in the first three months of 2017, maintaining an average of 30.6 percent. Thereafter, it dropped to an average of 28.3 percent from April to December. Compared to 2016, the annual supply cushion was lower by 0.6 percentage point at 28.9 percent in 2017.

## Daily USEP, Forecasted Demand and Generation Supply 2017



The key observations on the USEP fluctuations in 2017 are as follows:

**Point A:** On 6 February, there were three CCGT units on planned maintenance and three CCGT units on unplanned maintenance, and one CCGT unit on partial planned maintenance. The daily average USEP was \$100.29/MWh while the peak periodic USEP was \$126.68/MWh. The supply cushion stayed above 20.0 percent for most periods in the day, with only three periods - Periods 20, 22 and 23 - registering a supply cushion of less than 20.0 percent. As the supply cushion was at 22.6 percent in Period 42 when the peak periodic USEP was observed at \$126.68/MWh, changes in offers (with more offers moving into the higher price tranches) were more likely to be the predominant cause.

**Point B:** On 24 April, the daily USEP averaged \$119.99/MWh, with 15 periods registering USEP levels above \$100.00/MWh. There were four CCGT units on full planned maintenance and one CCGT unit on unplanned maintenance that day. That, coupled with offer changes, caused the USEP to hit a high of \$522.61/MWh in Period 24. The supply cushion for the 15 periods when the USEP exceeded \$100.00/MWh ranged between 21.0 and 25.0 percent, which was comparatively lower than the average periodic supply cushion for the day of 27.6 percent.


**Point C:** On 6 May, the daily average USEP was \$113.19/MWh. There were three CCGT units on planned maintenance that day, and the average demand for that particular Saturday was also relatively high at 5,533MW. The PSO advised that the power system was at a high risk/emergency operating state for a total of five periods, from Periods 20 to 24. During these five periods, the supply cushion fell below 20.0 percent, with the lowest periodic supply cushion registered in Period 22 at 17.8 percent.

**Point D:** On 20 May, the daily average USEP was \$109.19/MWh. As this was a Saturday, the peak demand soared to 6,245MW in Period 22, resulting in the peak periodic USEP of \$463.16/MWh. The PSO advised that the power system was at a high risk/emergency operating state starting from Period 21, and the power system was back to normal operating state from Period 24 onwards. The supply cushion fell below 20.0 percent for seven periods, with the lowest level of 17.6 percent registered in Period 22 when the USEP hit the daily high.

**Point E:** On 22 June, demand hit a high of 6,769MW in Period 22 while the average demand for the day was 6,072MW. Supply was also tight as a result of two CCGT units on full planned maintenance and three CCGT units on unplanned maintenance. These factors collectively resulted in prices clearing at higher price tranches. The power system was at a high risk/emergency operating state for a total of six periods. The supply cushion fell to a low of 15.0 percent in Period 22, and the corresponding USEP registered a high of \$902.94/MWh which was also the highest periodic USEP recorded in 2017.

**Point F:** On 20 November, there was one CCGT unit on full planned maintenance, two CCGT units on unplanned maintenance and one CCGT unit on partial maintenance. The periodic USEP peaked at \$353.78/MWh in Period 22 and averaged above \$100.00/MWh for 19 periods. Demand in Period 22 reached a high of 6,748MW and the corresponding supply cushion was at a low of 15.9 percent. There were a total of 24 periods when the supply cushion fell below 20.0 percent.

## Summary of Security Constraints in 2017

Security Constraint	Affected Region	Limit	Start Date	Expiry Date
1	Three lines between Jurong Island and Tembusu 	1,150MW	24 April 2014	31 December 2018

Date	Period	MIN MNN Price (\$/MWh)	MAX MNN Price (\$/MWh)	USEP (\$/MWh)
18 April 2017	25	122.81	162.59	161.05
	27	122.81	203.69	200.95
	28	175.72	203.69	202.27
	29	177.40	303.01	298.78

### Application of security constraints in 2017

Grid reliability and system security continued to improve in 2017.

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 throughout the year and will be in place until 31 December 2018.

Security constraint binding occurred for a total of four periods in 2017, which was an improvement from the ten periods seen in 2016.

### Periods with security constraint binding in 2017

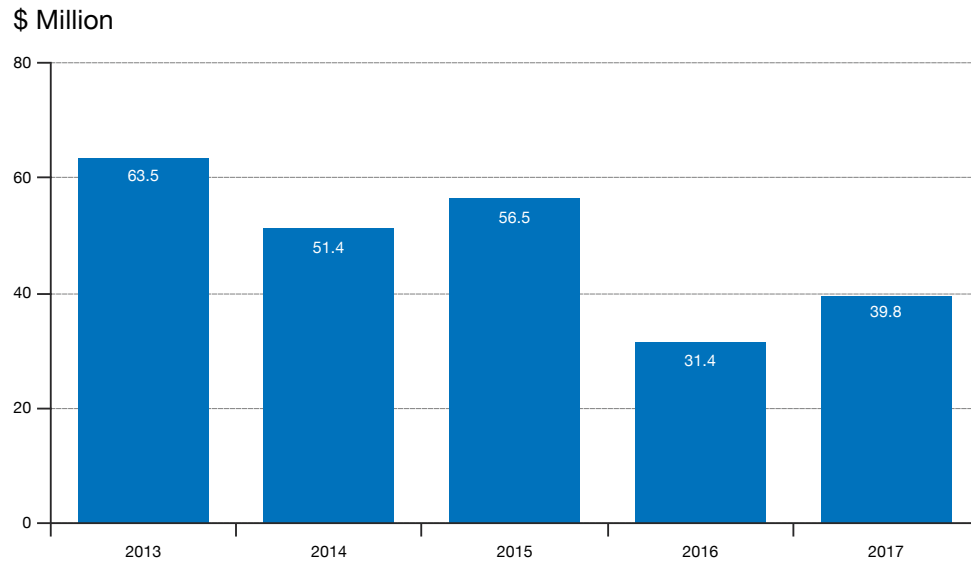
Typically, the difference between the minimum and maximum Market Network Node<sup>11</sup> (MNN) prices is less than \$10/MWh, but this widens when the security constraint limit and/or transmission limit is reached.

In 2017, there was just one day when the security constraint limit was reached. This took place on 18 April for a total of four periods – Periods 25, 27, 28 and 29 when one CCGT tripped. The largest difference between the minimum and maximum MNN prices was \$125.61/MWh in Period 29. This was higher than the largest difference of \$95.60/MWh observed in 2016.

<sup>11</sup> Market Network Node (MNN) refers to a point of settlement uniquely associated with a single dispatch network node and with a single market participant.



## Annual Reserve Payment 2013 – 2017



### Higher reserve payment in 2017

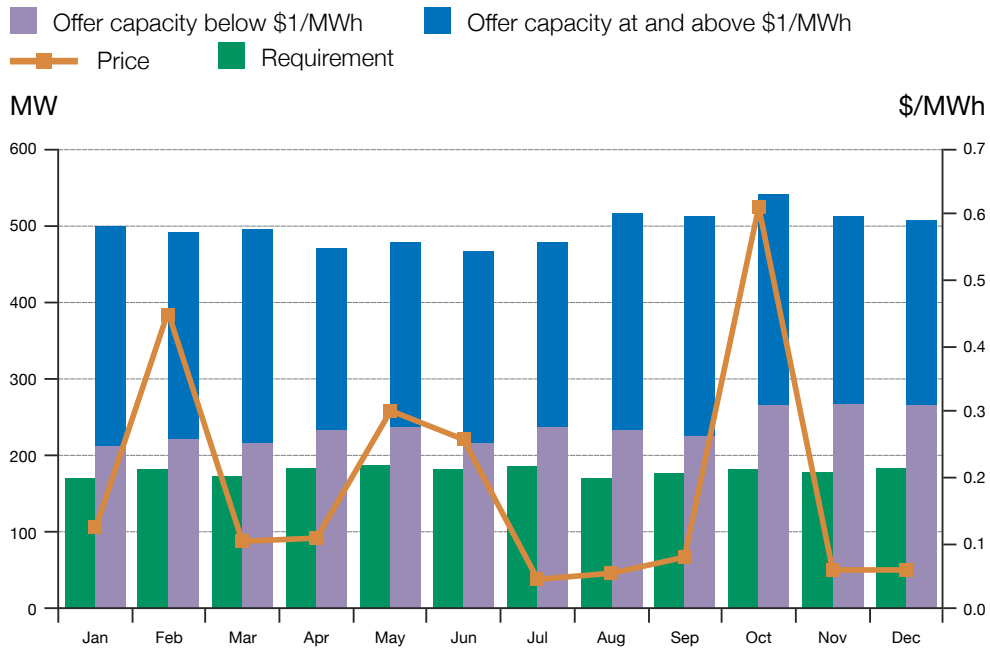
Reserves serve as a backup in the electricity market for unexpected outages caused by generators tripping. The amount of reserves required is determined by the amount needed should the largest on-line generator trip. In the NEMS, three reserve products were previously traded: primary, secondary and contingency reserves. With effect from 1 October 2017, the primary and secondary reserve classes were combined into a single primary reserve class. The generators bear the cost of providing the reserves.

Reserve costs increased 26.8 percent to \$39.8 million in 2017 as a result of higher reserve prices for all three reserve classes. Primary reserve price rose 46.2 percent to \$0.19/MWh while contingency reserve price increased 27.9 percent to \$6.74/MWh. Secondary reserves saw a 84.6 percent increase in price to \$0.48/MWh when comparing the full year 2016 average with the average for the first nine months in 2017.

The largest reserve payments were made in the months of February, May and June at \$4.0, \$4.6 and \$5.2 million respectively. These three months collectively accounted for 34.7 percent of the total annual reserve payments.

In contrast, due to changes in the reserve classes with effect from 1 October, total reserve payments for the months of October, November and December were lower at \$7.2 million and accounted for just 18.1 percent of total reserve payments in 2017. The reserve payments for the last three months were \$2.2 million in October, \$2.3 million in November and \$2.7 million in December.

## Monthly Primary Reserve Price, Requirement and Supply 2017



### Increase in primary reserve offer prices pushes up primary reserve prices

The annual average primary reserve price was 46.2 percent higher at \$0.19/MWh in 2017. The highest monthly primary reserve price was seen in October at \$0.61/MWh, while the lowest monthly average was observed in July at \$0.05/MWh.

The annual average primary reserve requirement fell by 2.2 percent to 179MW in 2017. The annual primary reserve offers, on the other hand, were 2.7 percent higher at 497MW. The percentage of primary reserve offers in the price tranche below \$1.00/MWh was 47.5 percent, which was slightly lower than the 50.1 percent in 2016. The percentage of primary reserve offers in the more expensive price tranche of more than \$1.00/MWh, however, increased by 2.6 percentage points.

Overall, the increase in primary reserve offers in the more expensive price tranche resulted in the higher primary reserve price in 2017.

On a monthly basis, the primary reserve requirement remained relatively constant throughout the year, ranging between the lowest level of 170MW seen in January, and the highest level of 187MW registered in May. The monthly primary reserve offers were lowest in June at 465MW and highest in October at 540MW.

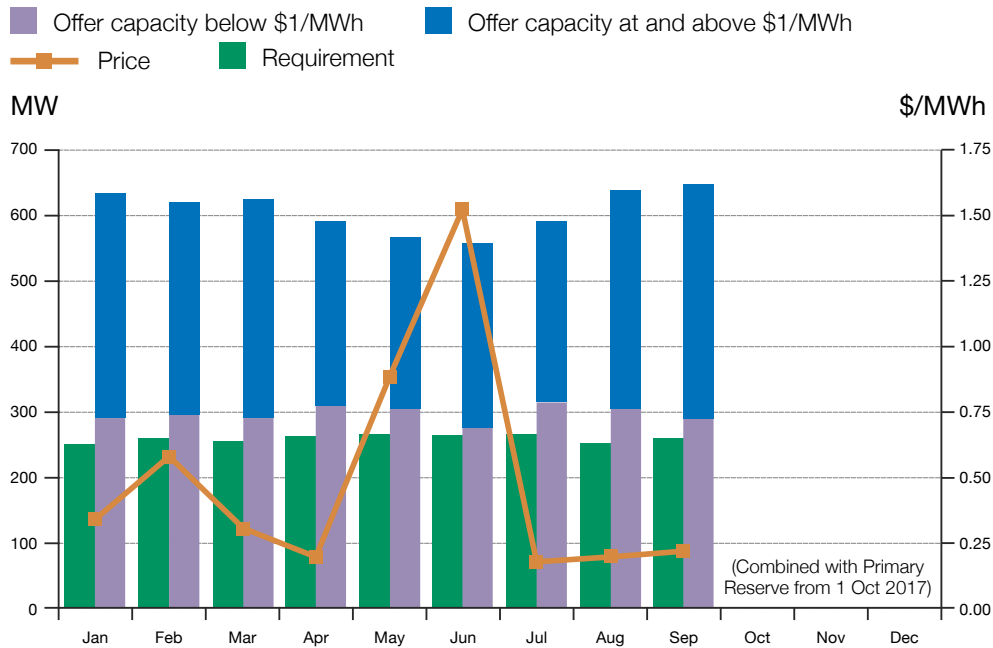
The month of October saw the highest primary reserve price. Following the shutdown of both intertie connections between Singapore and Malaysia from 15 October to 17 October, Singapore's power system was in isolated mode. This resulted in an increase in primary reserve requirements which, in turn, resulted in much higher daily prices registered on these three days – \$1.18/MWh on 15 October, \$12.37/MWh on 16 October and \$4.49/MWh on 17 October. The exceptionally high prices on these three days skewed prices up in the month of October.

There were no changes to the Risk Adjustment Factor (RAF)<sup>12</sup> in 2017. It was set at 1.0 for primary reserve.

<sup>12</sup> 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.

## Monthly Secondary Reserve Price, Requirement and Supply 2017



### No more secondary reserve from October 2017

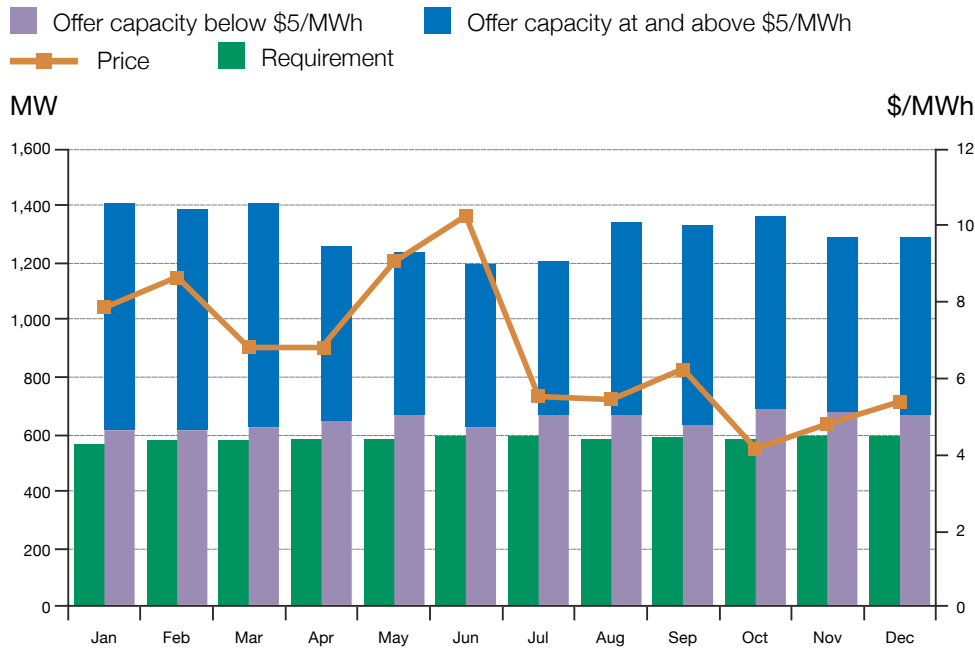
Secondary reserves were traded in the NEMS in the first nine months of 2017, before the primary and secondary reserve classes were combined in October. Based on the data from the first nine months of 2017, the annual average secondary reserve price rose to \$0.48/MWh in 2017, from \$0.26/MWh in 2016. The highest monthly secondary reserve price was seen in June at \$1.52/MWh while the lowest was registered in July at \$0.17/MWh.

The annual secondary reserve requirement fell 1.9 percent and averaged 260MW in 2017. The annual average secondary reserve offers also fell marginally by 0.7 percent to 607MW. Secondary reserve offers in the price tranche below \$1.00/MWh fell 8.3 percentage points to 49.0 percent. The higher prices observed for secondary reserves were therefore largely a result of more offers moving into the more expensive price tranche of above \$1.00/MWh.

At the monthly level, the lowest secondary reserve requirement was observed in January at 251MW while the peak secondary reserve requirement was observed in May and July at 267MW. The monthly secondary reserve offers were highest in September at 645MW, and lowest in June at 555MW.

There were no changes to the RAF in 2017. It was set at 1.0 for secondary reserve.

## Monthly Contingency Reserve Price, Requirement and Supply 2017



### Contingency reserve price rises and averages \$6.74/MWh

The annual average contingency reserve price rose 27.9 percent to \$6.74/MWh in 2017. The highest monthly contingency reserve price was seen in June at \$10.30/MWh while the lowest was registered in October at \$4.14/MWh.

The annual average contingency reserve requirement was mostly unchanged, registering 588MW in 2017. The annual average contingency reserve offers also remained the same as 2016 at 1,313MW.

At the monthly level, the lowest contingency reserve requirement was observed in January at 572MW and the peak contingency reserve

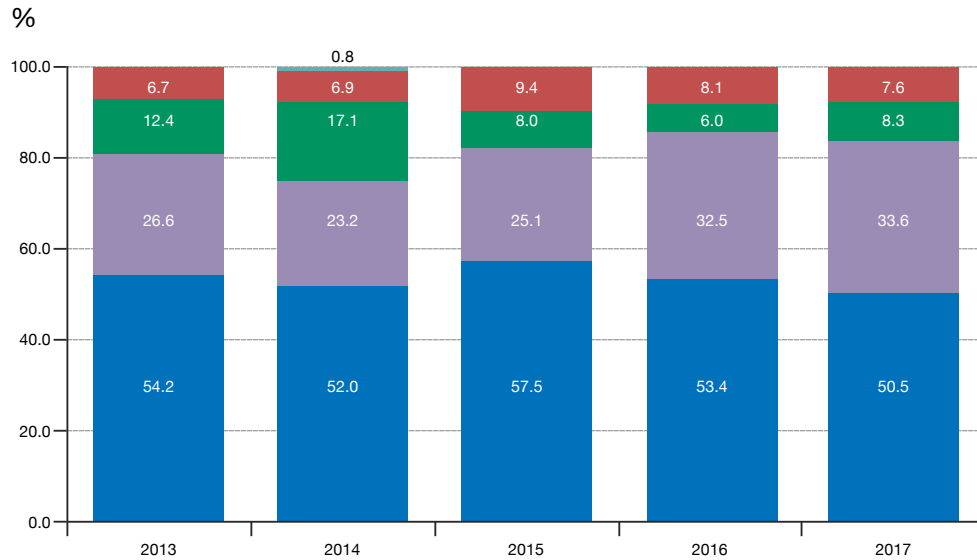
requirement was observed in December at 598MW. The monthly contingency reserve offers were highest in March at 1,414MW, and lowest in February at 1,392MW.

The highest daily average contingency reserve price was registered on 6 May 2017 when there was a contingency reserve shortfall arising from the triggering of the Constraint Violation Penalty (CVP). The average contingency price on that day was \$29.37/MWh, with five periods of contingency CVP observed at \$90.00/MWh.

There were no changes to the RAF in 2017. It was set at 1.5 for contingency reserve.

## Reserve Provider Group Effectiveness for Primary and Secondary Reserve Classes (Aggregate) 2013 – 2017

■ A ■ B ■ C ■ D ■ E



Statistics exclude IL providers.

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

### Reserve provider group effectiveness drops marginally

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

2017 saw some of the reserve providers in the top and bottom groups moving into the middle tier groups of B and C. The percentage of reserve providers in Group A fell 2.9 percentage points, while the percentage of reserve providers in Group D rose 0.5 percentage point. As a result, the proportion of reserve providers in Group A fell to a new low since 2011, at 50.5 percent. In contrast, Group B recorded the highest proportion of 33.6 percent since the market started.

Overall, the reserve provider group effectiveness fell marginally in 2017. The total percentage of reserve providers in Groups A and B dropped to 84.1 percent, while the total percentage of reserve providers in Groups C and D increased to 15.9 percent.

Similar to 2016, there were no reserve providers in the Group E category.

All contingency reserve providers were classified in Group A.

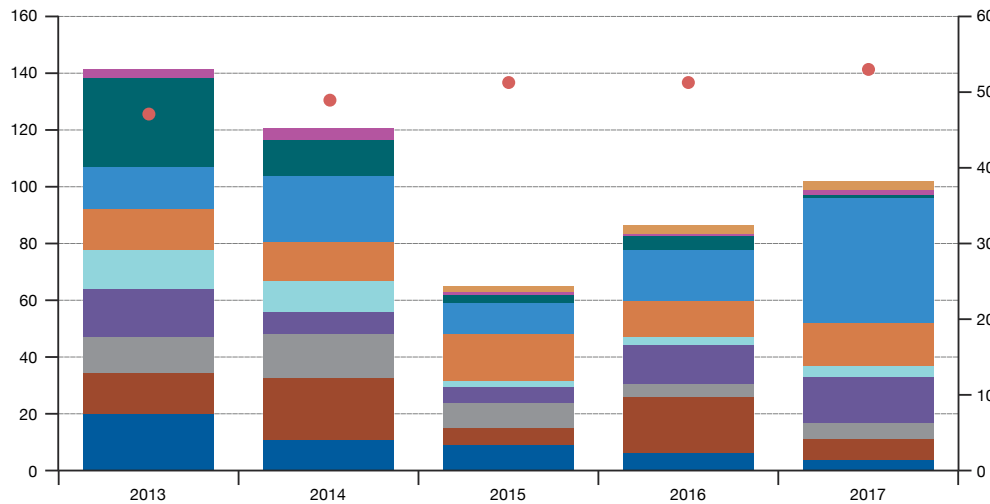
# MARKET PERFORMANCE: Ancillary Markets

## Annual Forced Outages by Generation Companies 2013 – 2017



Instances of Forced Outage

No. of Generation Units



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

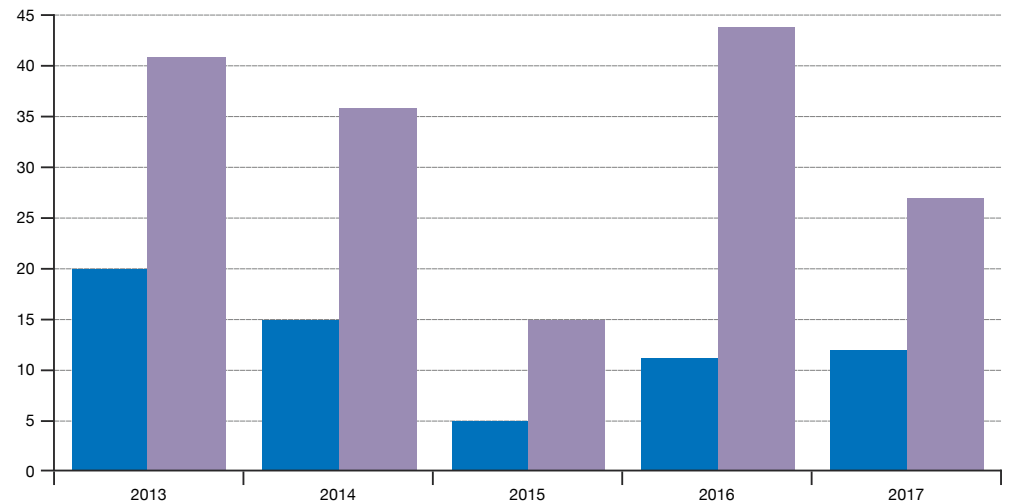
There were a total of 102 forced outages in 2017, up from 86 in 2016. This was the highest level seen in the last three years.

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

## Annual Interruptible Load (IL) Activations for Contingency Reserve Market 2013 – 2017



Count



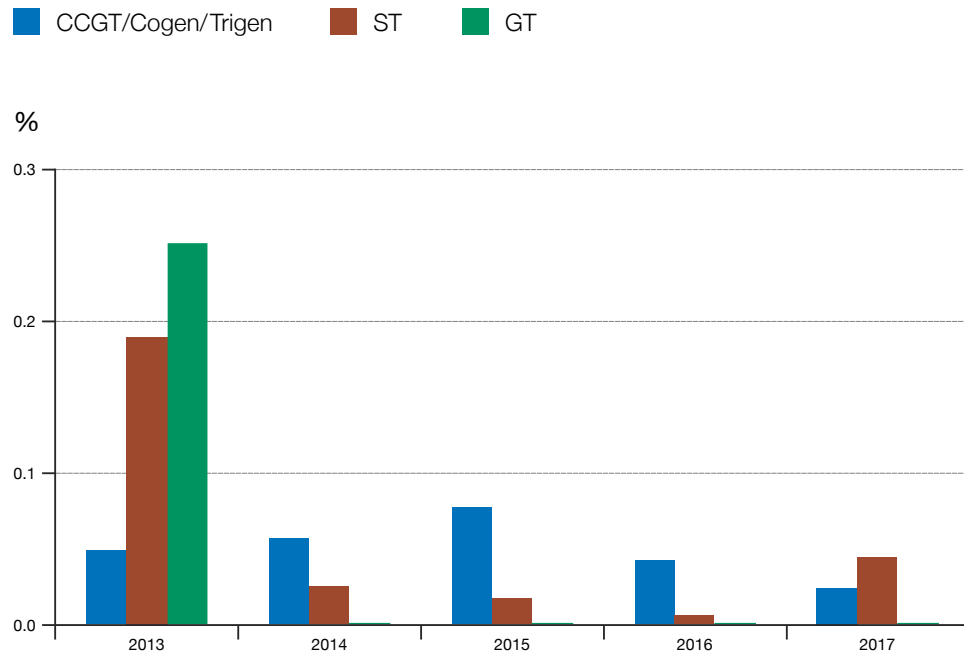
## Instances of IL activation increase while the number of periods of IL activation declines

As of 31 December 2017, the total registered capacity for IL fell for primary reserve when compared to 2016, from 23.2MW to 13.2MW. For contingency reserve, one IL facility of 10MW was de-registered in the NEMS in 2017, resulting in the total registered capacity falling to 27.5MW.

In 2017, the number of IL activations for contingency reserve increased by one count

to 12 and the total number of periods when IL was activated for contingency reserve fell to 27. The longest continuous stretches of IL activations took place on 6 October from Period 36 to Period 38, 5 November from Period 34 to Period 36, 28 November from Period 37 to Period 39, and 17 December from Period 23 to Period 25. This was an improvement from 2016, when there was one instance of IL activation which lasted for nine continuous periods.

## Average Failure Probability by Year 2013 – 2017



### Reliability of generation facilities continues to improve

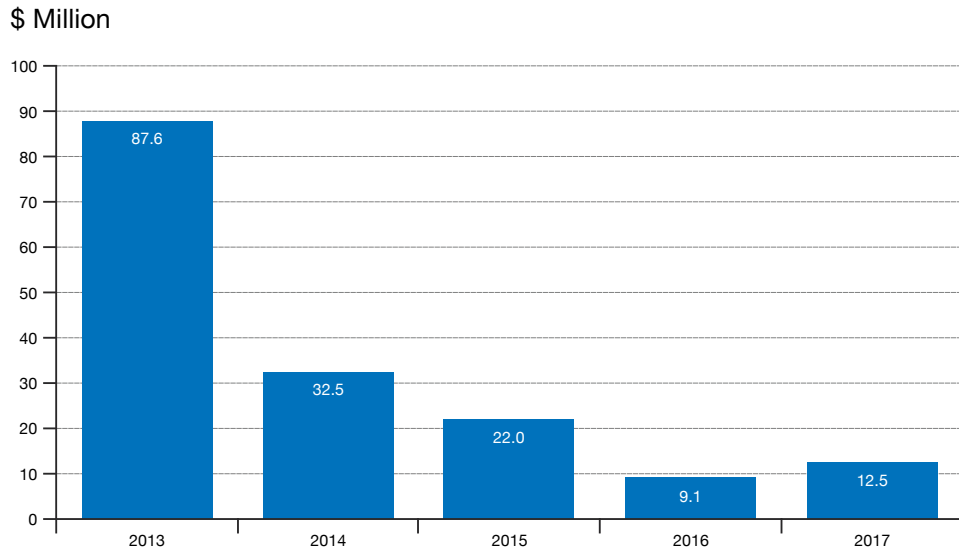
The average failure probability for a Generation Registered Facility (GRF) is the probability that after being dispatched by the PSO for a settlement interval, the GRF will cease operating, disconnect from the transmission system, or both, during that settlement interval, even if no other GRF fails. 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 2017, the average failure probabilities for CCGT/cogen/trigen, ST and GT facilities were 0.023 percent, 0.044 percent and 0.001 percent respectively. Compared to 2016, the failure probability of the CCGT/cogen/trigen category decreased while that of the ST category saw an increase. The failure probability for the GT category remained the same.

Overall, the performance of generation facilities has improved as a result of fewer occurrences of CCGT forced outages. Despite the increase in the failure probability of ST facilities, this category represents just 1.6 percent of the overall market share of generation facilities and hence has minimal impact on overall generation reliability.

## Annual Regulation Payment 2013 – 2017

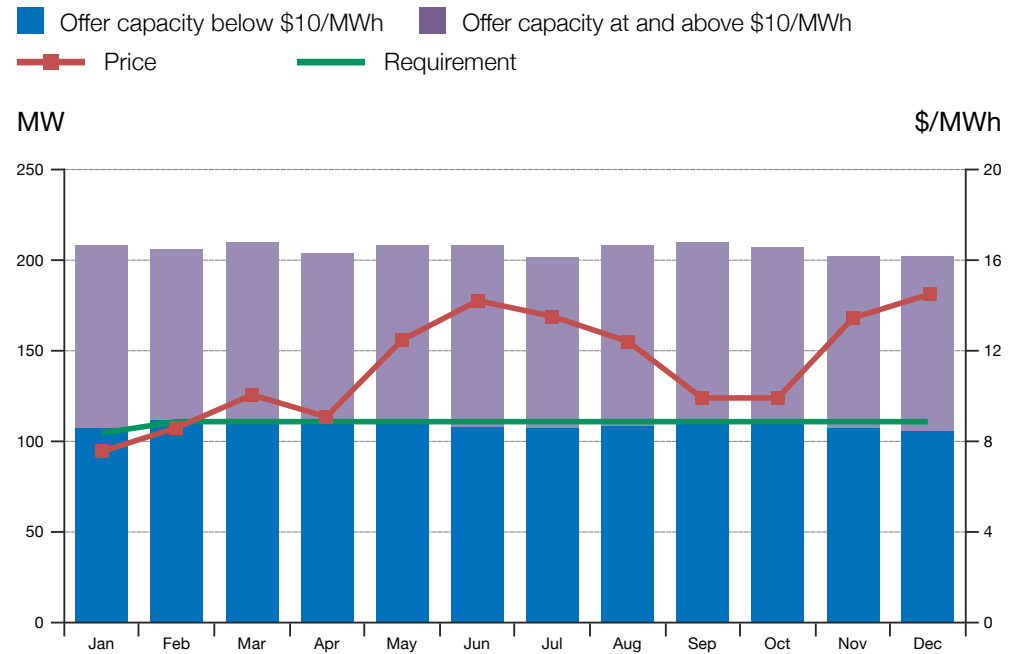


### Regulation payment rises after three consecutive years of decline

Regulation payment rose 37.4 percent from the historical low registered in 2016, to \$12.5 million in 2017. Both regulation requirement and price increased in 2017, resulting in the rise in regulation payment.

Regulation requirement increased from 105MW to 111MW with effect from 1 February 2017. Compared to 2016, regulation payment increased for all months in the year. While there was only one month in 2016 when regulation payment crossed the \$1.0 million level, in 2017, regulation payment exceeded \$1.0 million for a total of six months – May to August, November and December. The highest regulation payment was \$1.3 million in December, while the lowest was \$0.7 million in January.

## Monthly Regulation Price, Requirement and Supply 2017



### Less volatility in regulation prices

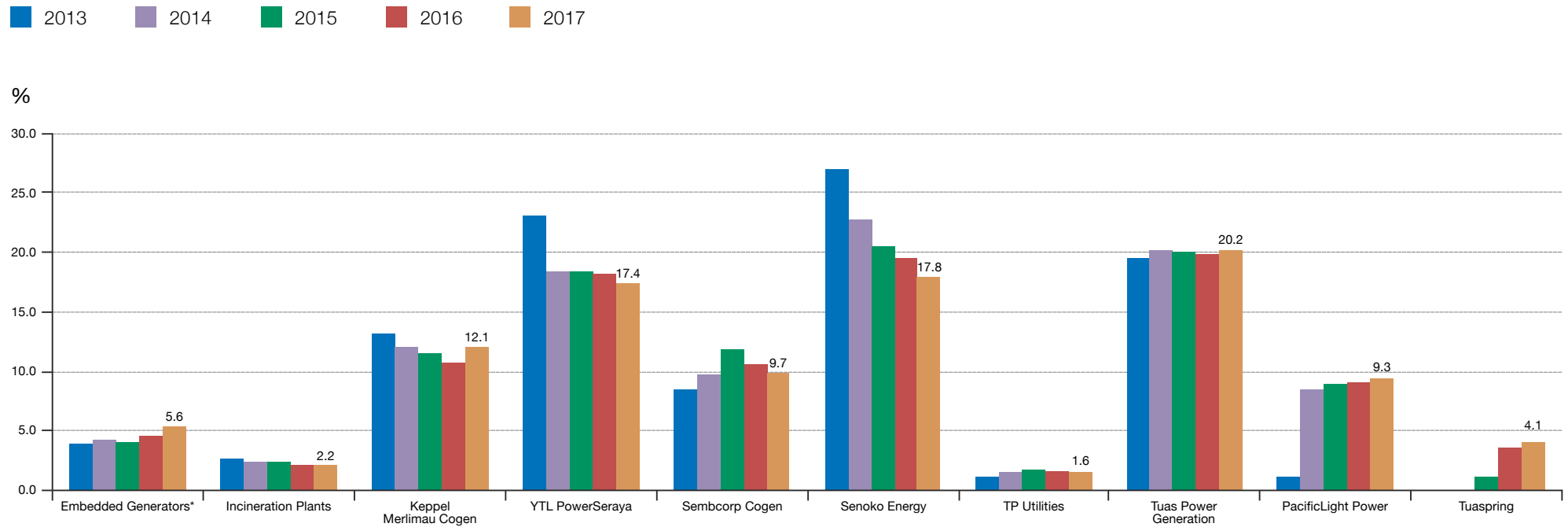
In 2017, regulation price rose 42.4 percent to \$11.48/MWh, recovering from a historical low of \$8.06/MWh in 2016. Regulation prices were above \$10.00/MWh for all months except January, February and April.

Regulation prices in 2017 were a lot less volatile. In 2016, the minimum monthly regulation price was \$4.57/MWh in February, and the maximum was \$18.29/MWh in January. In 2017, this narrowed to between \$7.86/MWh in January and \$14.44/MWh in December. The standard deviation also decreased from \$3.54/MWh in 2016 to \$2.28/MWh in 2017.

Compared to 2016, regulation offers priced below \$10.00/MWh decreased 2.5 percentage points to 53.6 percent, with a monthly average regulation offer of 111MW. This, coupled with a higher regulation requirement, led to the increase in regulation price.



## Annual Market Share by Generation Company 2013 – 2017 (Based On Scheduled Generation)



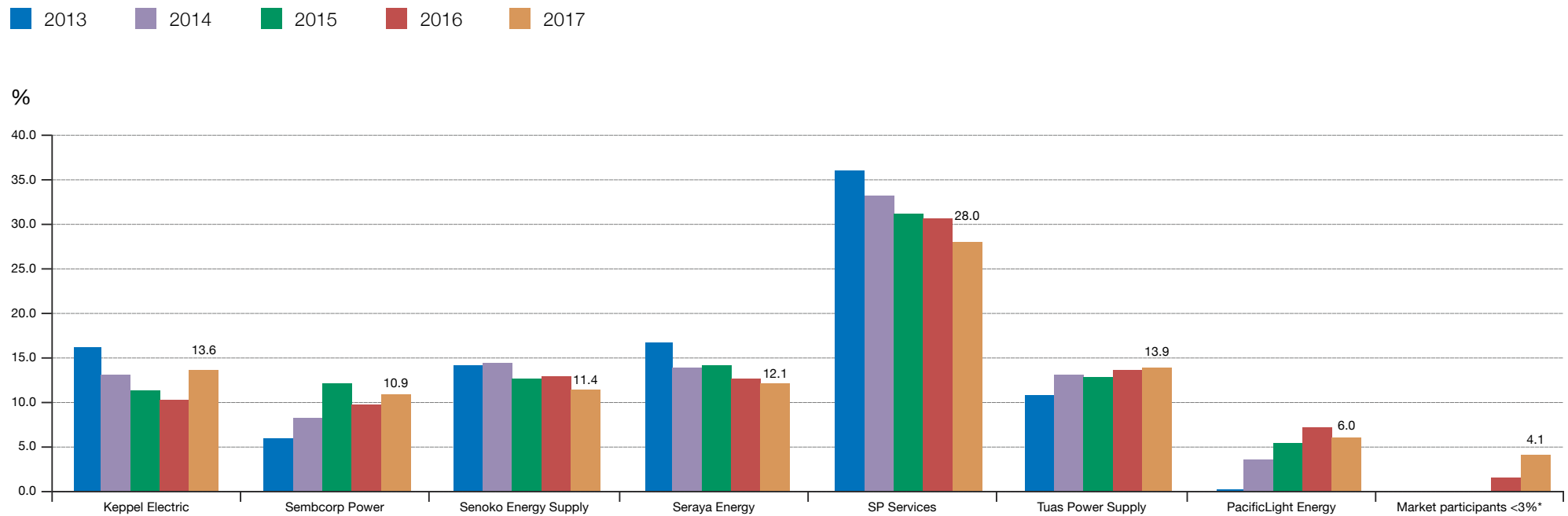
\*Embedded generators exclude TP Utilities

### Keen competition in the generation market continues

The combined market share of the three leading generation companies (Tuas Power Generation, Senoko Energy and YTL PowerSeraya) continued to decline in 2017, falling by another 2.3 percentage points to 55.4 percent. Senoko Energy's market share dropped 1.8 percentage points to 17.8 percent in 2017, followed by YTL PowerSeraya whose market share fell by 0.8 percentage point to 17.4 percent. Tuas Power Generation saw a small increase of 0.4 percentage point in its market share, to 20.2 percent.

Amongst the smaller generation companies, TP Utilities' market share remained the same at 1.6 percent, while Sembcorp Cogen's market share fell by 0.8 percentage point to 9.7 percent. Keppel Merlimau Cogen and PacificLight Power saw increases in their market share by 1.4 percentage points and 0.2 percentage point, to 12.1 percent and 9.3 percent respectively. The incineration plants maintained their market share of 2.2 percent, while the EGs saw a 1.0 percentage point increase in their market share to 5.6%.

## Annual Market Share of Market Support Services Licensee and Retailers 2013 – 2017 (Based on Withdrawal Energy Quantity)



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

### Market shares of smaller retailers see significant increase

Amidst intense competition in the retail market, the market share of smaller retailers in the 'Other Market Participants' category saw a significant increase. Among the larger retailers, joining Tuas Power Supply and Seraya Energy in the top three positions<sup>13</sup> was Keppel Electric, which replaced Senoko Energy Supply.

In 2017, Tuas Power Supply saw an increase in its market share, which rose 0.3 percentage point to 13.9 percent. The market share of Senoko Energy Supply and Seraya Energy dropped 1.3 percentage points and 0.6 percentage point, to 11.4 percent and 12.1 percent respectively.

Keppel Electric saw the largest increase in market share among all the retailers – its market share increased 3.3 percentage points to 13.6 percent. The market share of SP Services fell further in 2017, declining 2.6 percentage points to 28.0 percent as more consumers switched to the retailers of their choice.

The market share of the 'Other Market Participants' category stood at 4.1 percent. This category comprises retailers with market share of less than 3.0 percent each.

<sup>13</sup> Excludes SP Services which is the default retailer for non-contestable or smaller consumers.

Energy Market Company (EMC) is the financial clearing house for the wholesale market and settles the following transactions:

- energy;
- ancillary market products – three classes of reserve (primary, secondary<sup>14</sup> 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.

<sup>14</sup> With effect from 1 October 2017, the primary and secondary reserve classes were combined into a single primary reserve class.

## Margin Calls and Notices of Default – 1 January to 31 December 2017

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 2017, EMC issued a total of ten margin calls.

A notice of default is issued when an MP is unable to remit to the EMC settlement clearing account by the end of the business day following the MP payment date. In 2017, EMC issued two notices of default. Both notices of default were closed a week later after receiving payment as well as additional top-up (as requested by EMC) from the MP.

## Automatic Financial Penalty Scheme (AFPS) and Minimum Stable Load (MSL) Compensation Scheme – 1 January to 31 December 2017

The AFPS is a penalty scheme applied to all Generation Registered Facilities (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 2017, there were 92 periods when the AFPS kicked in, and the total penalty collected was \$530,283.45. 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. No payment was made in 2017 under the MSL compensation scheme.

## Contracted Ancillary Services – 1 April 2017 to 31 March 2018

Contract Period	Cost of Ancillary Services	Total MW Contracted
1 April 2017 to 31 March 2018	\$11,514,038.88	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 are unable to be procured competitively, for example, due to a limited number of available suppliers, their prices are regulated.

From 1 April 2017 to 31 March 2018, 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 \$11.51 million for the period 1 April 2017 to 31 March 2018. 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.

EMC and PSO fees are recovered from both generator and retailer class MPs in proportion to the quantity of energy that they trade.

## EMC Budgeted Net Fees – 1 July 2017 to 30 June 2018

Period	1 July 2017 to 31 March 2018	1 April 2018 to 30 June 2018*
<b>EMC Fee per MWh (\$/MWh)</b>	0.2450	N.A.
<b>Budgeted Volume (GWh)</b>	71,268	24,476
<b>Budgeted Net Fees (\$'000)</b>	17,461	N.A.

\*EMC's current five-year regulatory revenue regime will end on 31 March 2018. EMC's fee under the new revenue regime from 1 April 2018 has not been determined.

## PSO Net Fees – 1 April 2017 to 31 March 2018

	Total Fees (\$'000)
<b>PSO Net Fees</b>	24,861

# ADDITIONAL INFORMATION



## 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 three classes of reserves (primary, secondary 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.

## contestable consumers

Consumers that have the right to choose to purchase electricity from a retail supplier, directly from the wholesale market, or indirectly from the wholesale market through the Market Support Services Licensee (MSSL), SP Services. Consumers qualify to be contestable based on their level of electricity consumption.

## co-optimisation

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

## dispatch schedule

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

## 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.

## 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

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

## lng vesting price (LVP)

This refers to 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.

## 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).

### **non-contestable consumers**

Consumers that are supplied by the MSSL, SP Services, at a regulated tariff. These consumers have not been given the right to choose to purchase electricity from either a retail supplier, directly from the wholesale market or indirectly from the wholesale market through the MSSL.

### **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.

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

### **wholesale market**

The transactions made between generation companies and retail companies.



## ADDITIONAL INFORMATION: Market Entities' Contact Details

<b>Generator Licensees</b>	<p>ExxonMobil Asia Pacific                      Keppel Merlimau Cogen                      Keppel Seghers Tuas Waste-To-Energy Plant (Tuas DBOO Trust)                      National Environment Agency                      PacificLight Power                      Sembcorp Cogen                      Senoko Energy                      Senoko Waste-To-Energy                      Shell Eastern Petroleum                      Singapore Refining Company                      TP Utilities                      Tuas Power Generation                      Tuaspring                      YTL PowerSeraya</p>	<p><a href="http://www.exxonmobil.com.sg">www.exxonmobil.com.sg</a>  <a href="http://www.kepinfra.com">www.kepinfra.com</a>  <a href="http://www.keppelseghers.com">www.keppelseghers.com</a>  <a href="http://www.nea.gov.sg">www.nea.gov.sg</a>  <a href="http://www.pacificlight.com.sg">www.pacificlight.com.sg</a>  <a href="http://www.sembcorp.com">www.sembcorp.com</a>  <a href="http://www.senokoenergy.com">www.senokoenergy.com</a>  <a href="http://www.kepinfra.com">www.kepinfra.com</a>  <a href="http://www.shell.com.sg">www.shell.com.sg</a>  <a href="http://www.src.com.sg">www.src.com.sg</a>  <a href="http://www.tputilities.com.sg">www.tputilities.com.sg</a>  <a href="http://www.tuaspower.com.sg">www.tuaspower.com.sg</a>  <a href="http://www.hyflux.com">www.hyflux.com</a>  <a href="http://www.ytlpowerseraya.com.sg">www.ytlpowerseraya.com.sg</a></p>
<b>Retailer Licensees</b>	<p>Best Electricity Supply                      Charis Electric                      Cleantech Solar Singapore Assets                      Diamond Energy Merchants                      Energy Supply Solutions                      Environmental Solutions (Asia)                      Hyflux Energy                      I Switch                      Just Electric                      Keppel Electric                      Ohm Energy#                      PacificLight Energy                      Red Dot Power                      Sembcorp Power                      Senoko Energy Supply                      Seraya Energy                      SilverCloud Energy                      SmartCity Energy                      Sun Electric Power                      Sunseap Energy                      Tuas Power Supply                      Union Power</p>	<p><a href="http://www.bestelectricity.com.sg">www.bestelectricity.com.sg</a>  <a href="http://www.chariselectric.com.sg">www.chariselectric.com.sg</a>  <a href="http://www.cleantechsolar.com">www.cleantechsolar.com</a>  <a href="http://www.diamond-energy.com.sg">www.diamond-energy.com.sg</a>  <a href="http://www.energysupplysolutions.com.sg">www.energysupplysolutions.com.sg</a>  <a href="http://www.espower.sg">www.espower.sg</a>  <a href="http://www.hyfluxenergy.com">www.hyfluxenergy.com</a>  <a href="http://www.iswitch.com.sg">www.iswitch.com.sg</a>  <a href="http://www.justelectric.sg">www.justelectric.sg</a>  <a href="http://www.keppelectric.com">www.keppelectric.com</a>  <a href="http://www.ohm.sg">www.ohm.sg</a>  <a href="http://www.pacificlight.com.sg">www.pacificlight.com.sg</a>  <a href="http://www.reddotpower.com.sg">www.reddotpower.com.sg</a>  <a href="http://www.sembcorp.com">www.sembcorp.com</a>  <a href="http://www.senokoenergy.com">www.senokoenergy.com</a>  <a href="http://www.serayaenergy.com.sg">www.serayaenergy.com.sg</a></p> <p><a href="http://www.sunelectric.com.sg">www.sunelectric.com.sg</a>  <a href="http://www.sunseap.com">www.sunseap.com</a>  <a href="http://www.tpsupply.com.sg">www.tpsupply.com.sg</a>  <a href="http://www.unionpower.com.sg">www.unionpower.com.sg</a></p>

## ADDITIONAL INFORMATION: Market Entities' Contact Details

<b>Wholesale Market Traders</b>	<p>Air Liquide Singapore                  Banyan Utilities                  CGNPC Solar-Biofuel Power (Singapore)                  Changi Mega Solar                  Diamond Energy Managers                  Glaxo Wellcome Manufacturing – GlaxoSmithKline Biologicals                  GreenSync Holdings                  Green Power Asia                  LYS Genco Beta                  MSD International GmbH (Singapore Branch)                  Nanyang Technological University                  Pfizer Asia Pacific                  Public Utilities Board                  Sembcorp Solar Singapore#</p> <p>Singapore District Cooling                  Singapore LNG Corporation                  Sun Electric Energy Assets                  Sunseap Leasing                  Sunseap Leasing Beta</p>	<p><a href="https://industry.airliquide.sg/">https://industry.airliquide.sg/</a></p> <p><a href="http://www.cgnpc.com.cn">www.cgnpc.com.cn</a>  <a href="http://www.sinenergy.com.sg">www.sinenergy.com.sg</a>  <a href="http://www.diamond-energy.com.sg">www.diamond-energy.com.sg</a>  <a href="http://www.gsk.com">www.gsk.com</a>  <a href="http://www.greensync.com.au">www.greensync.com.au</a>  <a href="http://www.greenpowerasia.com">www.greenpowerasia.com</a>  <a href="http://www.lysenergy.com">www.lysenergy.com</a>  <a href="http://www.msd-singapore.com">www.msd-singapore.com</a>  <a href="http://www.ntu.edu.sg/odfm">www.ntu.edu.sg/odfm</a>  <a href="http://www.pfizer.com.sg">www.pfizer.com.sg</a>  <a href="http://www.pub.gov.sg">www.pub.gov.sg</a>  <a href="http://www.sembcorp.com/en/our-businesses/utilities/energy">www.sembcorp.com/en/our-businesses/                  utilities/energy</a>  <a href="http://www.spgroup.com.sg">www.spgroup.com.sg</a>  <a href="http://www.slng.com.sg">www.slng.com.sg</a>  <a href="http://www.sunelectric.com.sg">www.sunelectric.com.sg</a>  <a href="http://www.sunseap.com">www.sunseap.com</a>  <a href="http://www.sunseap.com">www.sunseap.com</a></p>
<b>Market Support Services Licensee (MSSL)</b>	SP Services	<a href="http://www.spgroup.com.sg">www.spgroup.com.sg</a>
<b>Market Operator</b>	Energy Market Company	<a href="http://www.emcsg.com">www.emcsg.com</a>
<b>Power System Operator (PSO)</b>	Power System Operator	<a href="http://www.ema.gov.sg">www.ema.gov.sg</a>
<b>Transmission Licensee</b>	SP PowerAssets	<a href="http://www.spgroup.com.sg">www.spgroup.com.sg</a>

# The following changes took place in 2017:  
 - Buri Energy was renamed Ohm Energy  
 - Solar C&I Holdings was renamed Sembcorp Solar Singapore



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