National Electricity Market of Singapore

MARKET REPORT 2016

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Dear Industry Members

In 2016, a new milestone was reached in the National Electricity Market of Singapore (NEMS). A Demand Response (DR) programme was introduced which enables contestable consumers to curtail their electricity demand voluntarily – typically, when wholesale electricity prices are high or when generation supply is tight. In return, these consumers receive payments when wholesale electricity prices drop as a result of their voluntary curtailment.

The DR programme provides contestable consumers with an additional avenue to take part in the wholesale electricity market. It can also reduce wholesale electricity prices and improve system reliability during peak periods, benefiting both consumers and the power system.

Another significant development was a rise in the number of intermittent generation source (IGS) facilities registered in the wholesale electricity market. While there were no IGS facilities registered in 2015, a total of seven new IGS facilities – all solar facilities – were registered in 2016, with a total capacity of 17.57MW. The new facilities raised the combined registered capacity in the NEMS to 13,366MW.

Aside from new facilities, we also saw a record number of new market participants (MPs). During the year, we welcomed nine new MPs and this brought the total number of MPs in the NEMS to 47.

The majority of the new MPs are either solar energy providers or independent retailers. This is consistent with developments in recent years, including changes to the Singapore Electricity Market Rules and relevant codes to facilitate the participation of solar energy providers, the lowering of the contestability threshold in the retail market to enhance competition, and the launch of electricity futures which enable independent retailers to hedge their risks.

Like any well-functioning competitive market, market concentration continued to fall as a result of increased capacity and MPs. The market share of the three largest generation companies dropped by a further 1.3 percentage points to 57.7 percent in 2016, while that of the top three retailers (excluding SP Services) fell by another 0.4 percentage point to 39.1 percent. SP Services, which has the largest share of the retail market as it is the default retailer of all non-contestable consumers, also saw a 0.7 percentage point drop in its market share.

Looking at the market's performance, I am happy to note that movements in wholesale electricity prices remained driven by fundamental market forces of demand and supply, which is another sign of the NEMS' effectiveness.

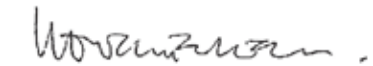
Annual electricity consumption – or metered demand – rose by 2.9 percent in 2016. Annual generation supply increased at the same rate, crossing 8,000MW for the first time in 2016 and driving the supply cushion closer to the 30.0 percent level. The abundant supply, together with lower fuel oil prices, led to more offers in the lower price bands, and resulted in the annual Uniform Singapore Energy Price dropping 34.1 percent to a historical low of $63 per megawatt hour (MWh).

Production efficiency remained high in the NEMS. Over the years, Singapore has seen improving efficiency in its power sector as combined-cycle gas turbines (CCGT) replaced gas and steam turbines in electricity generation. In 2016, although the market share of CCGT units only edged up marginally compared to the previous year, it remained high at 97.6 percent.

We have witnessed many changes in the energy and economic landscape since the NEMS started in 2003. Despite these changes, the NEMS has remained competitive, efficient and stable.

Our governance panels play a big role in the NEMS' success, and I would like to thank the members of the Rules Change Panel, Market Surveillance and Compliance Panel and Dispute Resolution and Compensation Panel for their tremendous support and dedication in evolving the market and overseeing market activities.

The NEMS is an essential part of Singapore's energy policy framework which seeks to balance the three objectives of economic competitiveness, energy security and environmental sustainability. I am confident that it will continue to play its role in helping the country achieve these objectives.



Wong Meng Meng
Chairman
Energy Market Company

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

Corporatisation	1995	Electricity functions of the Public Utilities Board corporatised Singapore Power formed as a holding company
	1996	Singapore Electricity Pool (SEP) design process began
Singapore Electricity Pool (SEP)	1998	SEP commenced PowerGrid is SEP Administrator and Power System Operator (PSO)
	1999	Review of electricity industry
National Electricity Market of Singapore (NEMS)	2000	Decision for further reform to obtain full benefits of competition New market design process began
	2001	Electricity industry legislation enacted Energy Market Authority (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

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

In 2016, the NEMS welcomed nine new market participants (MPs). This is the largest number of new MPs registered in a single year since the start of the market.

The new MPs comprise:

- one generator: Singapore Refining Company;
- five wholesale market traders: GreenSync Holdings, Nanyang Technological University, Singapore District Cooling, Solar C&I Holdings and Sun Electric Energy Assets; and
- three retailers: Charis Electric, Environmental Solutions (Asia) and I Switch.

The year also saw the withdrawal of two MPs from the market – KiWi Power Singapore and Air Products.

With these changes, there are now 14 generators, 17 wholesale market traders and 16 retailers in the NEMS.

Participants and Service Providers in the NEMS

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

The following changes took place in 2016:
- Diamond Energy Supply was renamed Diamond Energy Merchants
- Diamond Energy was renamed Diamond Energy Managers
- CPvT Energy Asia was renamed Red Dot Power
- Singapore Oxygen Air Liquide was renamed Air Liquide Singapore

* Kiwi Power Singapore and Air Products withdrew as MPs from 11 May and 23 December 2016 respectively.

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 65 injection nodes, and the prices at up to 793 withdrawal or off-take nodes[1] 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.

Energy, Reserve and Regulation Products

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

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.

[1] Numbers of injection and withdrawal nodes are as of 31 December 2016.

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.

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

The Rules Change Panel (RCP) administers changes to the Market Rules to improve the efficiency, competitiveness and reliability of the Singapore Wholesale Electricity Market. The Panel acts on behalf of the industry in prioritising and addressing issues raised by interested parties.

For any deregulated electricity market, the curbing of market power is always an area of priority to avoid inefficient outcomes of withheld generation and consequently, inflated prices for consumers. While market power issues are within the purview of the Energy Market Authority (EMA), the RCP took the initiative to address the industry's concern about significant price separation that occurred in late 2015. After examining five proposals, the Panel agreed on the proposal which recommended the imposition of must-run obligations and corresponding compensation for generators that possess locational market power, and urged the EMA to consider the proposal.

In the pursuit of improved competition, any information asymmetry ought to be eliminated, making transparency the linchpin of an exemplary market. A rule change was made to provide the industry real-time estimates of the Hourly Energy Uplift Rebate — a component of the spot price — which would help retailers better understand their exposure to spot price fluctuations and manage such risks. Further, in view of the rapid rise in the adoption of solar energy in Singapore, the RCP accelerated the process of seeking clarification from information holders, and encouraged the provision of solar capacity and generation information to the industry. This culminated in the publication of data on estimated solar generation by the EMA, subsequently leading to the publication of half-hourly metered generation data by facility type by EMC.

The RCP also supported rule changes for information providers to provide relevant information to the EMA directly (instead of through the Market Assessment Unit), and for the first full review of the settlement market manual since the market started. Such administrative proposals are necessary to streamline processes for service providers and align documentation with processes in the interests of the market participants.

When deliberating rule change proposals, the RCP often has to balance the achievement of market principles against practical considerations. For example, the RCP deliberated on the ex-ante assignment of a locationally-reflective price for an islanded generation facility. Although the proposal was more closely aligned with the ex-ante pricing principle, it was dismissed due to the risks and complexity associated with its implementation. The RCP thus decided to maintain the status quo of ex-post price revision for such a facility.

The rule change process is an important pillar in market evolution and independent governance. It has been my pleasure to work alongside professional, dedicated and proactive RCP members for the common good of the industry. In particular, I would like to show my appreciation to Ms Frances Chang, who vacated office in early 2016, for her contribution in representing electricity consumers on the RCP for the past three years. I would also like to express my gratitude to all market participants, the Singapore Power Group, the Power System Operator, EMC's Market Administration and Markets and Operations teams, all RCP members, the EMC Board and the EMA for making 2016 a productive year for the RCP.

The industry is expected to face an electricity landscape with new challenges in the near future, such as increased distributed generation and demand participation. Nevertheless, I am confident that the close collaboration we have among the various stakeholders will help the industry adapt to these challenges via the rule change process.

Paul Poh
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.

Proposed Measures to Mitigate Price Separation

Arising from the significant price separation events that occurred in 2015, the Panel examined five proposals aimed at mitigating the impact of price separation.

Proposal 1: Pay generators a uniform price that is not linked to their location

Currently, generators are paid the energy price at their respective locations. A proposal suggested paying generators a uniform price to eliminate the basis risk faced by generators with affiliated retailing businesses.

However, uniform pricing could distort generators' bidding behaviour and result in offer prices that deviate from true marginal costs. This would compromise economic efficiency. Moreover, nodal pricing is intended to provide efficient price signals for production decisions. If transmission or generation capacity was lacking, nodal prices would rightly reflect this scarcity. The RCP, therefore, did not support Proposal 1.

Proposal 2: Facilitate hedging transactions among stakeholders

A platform facilitating the buying and selling of hedges was suggested. However, since an effective hedge against basis risk should be struck against a generation company's (genco's) nodal price, a platform for such hedging transactions may not be better than bilaterally-arranged hedges as the hedging genco's identity will be revealed in either case. The RCP did not support this proposal.

Proposal 3: Revise prices by relaxing the binding constraints

A third proposal suggested that prices be revised ex-post by relaxing the binding constraints if significant price separation occurred. If the divergences in prices reflect the underlying demand and supply balances at each location and the inputs to the MCE are not erroneous, there is no reason for prices to be revised. This proposal was also not supported.

Proposal 4: Improve information on potential price separation events

No new information which could assist stakeholders in assessing potential price separation events was suggested. Nevertheless, the industry's feedback regarding the timeliness of updates to the annual outage plans and projected gas curtailment schedules was forwarded to the PSO.

Proposal 5: Impose must-run obligations for locational market power with compensation

This proposal suggested that gencos possessing locational market power face must-run obligations for their generation, with corresponding compensation at a reasonable level.

The Panel agreed that regulatory intervention is justifiable if locational market power exists, indicating market failure. One possible form of regulatory intervention is the imposition of must-run obligations on gencos which possess locational market power. Since market power issues are within the purview of the EMA, the Panel has written to the EMA to express its in-principle support for this proposal.

Publication of Half-Hourly Total Solar Export

With the growing installed capacity of solar generation facilities (GFs) in Singapore, a proposal sought to improve the transparency of information available to the industry on the installed capacity and half-hourly generation of solar GFs in Singapore.

A study on the availability and publication of capacity and generation information of intermittent generation facilities (IGFs), which currently comprise of only solar GFs, was conducted and the types of information that could be published were identified as follows:

1. Half-hourly total recorded generation of solar GFs of nameplate rating 0.1MWac or above, to be published by the PSO;
2. Half-hourly total estimated generation of all solar GFs, to be published by the EMA; and
3. Half-hourly total gross and net metered generation of IGFs registered with EMC, to be published by EMC.

After EMC's final consultation with relevant parties on the proposed publication of the relevant information, the PSO shared that, as of October 2016, the total estimated generation of all solar GFs was published on the EMA's website and updated on a minute-by-minute basis. The PSO dismissed the usefulness of the half-hourly total recorded generation as such data was only available to the PSO for a limited subset of solar GFs. Finally, the Panel unanimously supported the proposal for EMC to publish the half-hourly total gross and net metered generation by facility type, and tasked EMC to draft the proposed rule modifications.

Removal of Market Assessment Unit's Obligation to Provide Information to the Energy Market Authority under Section 4.3.10 of Chapter 3 of the Market Rules

The Market Assessment Unit (MAU) is required to develop a set of information requirements to assist the EMA in fulfilling its obligations with respect to competition and abuse of a dominant position under the Electricity Act.

According to the Market Rules, the MAU should collect and market participants (MPs), the MSSL and EMC (collectively referred to as information providers) should provide to the MAU the requisite information stipulated in the set of information requirements. The MAU was then required to provide the information collected to the EMA.

However, as EMC possesses all the information stipulated in the current set of information requirements, it is operationally more efficient for EMC to provide the required information to the EMA directly, rather than through the MAU. Since 2012, the MAU and the Market Surveillance and Compliance Panel have been working with EMC and the EMA to enable EMC to provide the required information directly to the EMA.

A rule change was thus made to establish procedures for the MAU to modify the set of information requirements and require information providers to provide any data referred to in the information requirements directly to the EMA upon the EMA's request. The MAU, upon receiving the EMA's request, would be released from its obligations to provide the same information to the EMA.

Provision of Real-Time Estimates of Hourly Energy Uplift Rebate

The hourly energy uplift rebate (HEUR) captures the differences between total amounts receivable and total amounts payable for energy, reserves and regulation. These differences are distributed to loads based on their metered withdrawal quantities. When there is significant nodal price separation, the HEUR will be a significant component in settlement due to the large difference in total amounts receivable and payable by EMC for energy. However, the value of the HEUR is only finalised ten business days after each trading day as the calculation of the HEUR relies on metered quantities.

A rule change was made to establish procedures for the provision of real-time estimates of the HEUR ("Estimated HEUR"). A methodology which uses parameters in the real-time and/or forecast schedules as substitutes for the metered quantities in the estimation of the HEUR was proposed. The proposed methodology was tested for all settlement intervals in the year 2015, and the results showed that the Estimated HEUR was quite close to the actual HEUR.

The provision of the Estimated HEUR will be beneficial to MPs, especially retailers, because it enables them to better assess their exposure to spot price fluctuations and thus better manage their spot price risk.

Update of Market Operations Market Manual (Settlement)

A full review of the Market Operations Market Manual – Settlement (Chapter 7 of the Market Rules) ("Settlement Market Manual") had never been performed since the market started. A review was thus conducted to ensure that the Settlement Market Manual reflects current procedures and is aligned with the existing Market Rules. Some sections were rewritten for better readability and simplicity.

This review also incorporated proposed changes to other documents and market manuals, namely the Application Form for Market Participant Registration, Application Form for Authorisation of Market Support Services Licensee, and the Market Operations Market Manual – Automatic Financial Penalty Scheme (Chapter 5 of the Market Rules). Changes were made for consistency and to align these forms and market manuals with the updated Settlement Market Manual.

Rule Change Not Supported by the RCP

The RCP also discussed the following proposal but decided not to support it because the potential benefits did not justify the costs.

Price Assignment for Islanded Generation Facilities

When a generation facility is islanded, the market clearing engine (MCE) derives an anomalous market energy price for the facility in the real-time schedule. This creates the need for ex-post price revision via a rerun of the MCE to derive a locational marginal price for the islanded generation facility. The proposal examined the option of deriving a locational marginal price to be assigned to an islanded generation facility ex-ante in the forecast and real-time schedules, so as to obviate the need for ex-post price revision. The rationale of the option is to more closely align the pricing outcome of islanded generation facilities with the ex-ante pricing principle in the market while preserving the locational marginal pricing principle.

However, there were concerns with the risks and complexity associated with the implementation of the option. Upon closer examination of the status quo, it was also found that the recurring costs for ex-post price revision incurred by EMC were low. Therefore, the Panel, by majority vote, supported maintaining the status quo, taking into consideration the limitations of implementing the proposed option and the benefits of the status quo.

Rule Changes Directed by the EMA

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

Rules Modification for the EMA's Final Determination Paper "Implementing Demand Response in the National Electricity Market of Singapore"

To limit the extent of price spikes, the EMA implemented a Demand Response programme where participating contestable consumers can voluntarily reduce their electricity consumption in response to high energy prices, via the submission of energy bids. In return, consumers who are curtailed (i.e., their energy bids are not fully scheduled) will receive an incentive payment if their participation is considered to have reduced the Uniform Singapore Energy Price.

In addition, an ex-post assessment comparing actual metering data with the expected consumption based on a participating facility's dispatch schedule will be conducted to ensure compliance.

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.

DMS 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. Air Liquide Singapore – Lim Yong Yi
2. Best Electricity Supply – Terence Neo
3. Buri Energy – Nerine Teo
4. CGNPC Solar-Biofuel Power (Singapore) – Nelson Ong
5. Charis Electric – Kenneth Lee
6. Diamond Energy Merchants – Muhammad Romzihaizad
7. ECO Special Waste Management – Ethiraj Thirumalai
8. ECO Special Waste Management – Vincent Tang
9. Energy Market Company – Lu Su Ling
10. Environmental Solutions (Asia) – Sivakumar Avadiar
11. ExxonMobil Asia Pacific – Dennis Goh
12. ExxonMobil Asia Pacific – Lim Li Fang
13. GlaxoSmithKline Biologicals – Chew Siou Ping
14. GlaxoSmithKline Biologicals – Wong Joon Jee
15. Green Power Asia – Daniel Ma
16. Hyflux Energy – Cindy Lim
17. Hyflux Energy – Ooi Chel-Lin
18. I Switch – Senthil Kumar
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. PacificLight Energy – Teo Chin Hau
28. PacificLight Power – Calvin Tan
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. Senoko Energy – Luke Peacocke
40. Senoko Energy – Poo Siok Yin
41. Senoko Energy Supply – Eu Pui Sun
42. Senoko Energy Supply – Michelle Lim
43. Senoko Waste-to-Energy – Lee Song Koi
44. Senoko Waste-to-Energy – Lu Qi Min
45. Seraya Energy – Daniel Lee
46. Seraya Energy – Elaine Syn
47. Shell Eastern Petroleum – Grace Chiam
48. Shell Eastern Petroleum – Pak-Juan Koe
49. Singapore District Cooling – Dennis Chong
50. Singapore District Cooling – Liu Yue
51. Singapore LNG Corporation – Lam Zheng Xin
52. Singapore LNG Corporation – Vincent Lam
53. Singapore Refining Company – Aspi Vania
54. Singapore Refining Company – Lai Changli
55. Solar C&I Holdings – James Ong
56. Solar C&I Holdings – Quek Hong Soon
57. SP PowerAssets – Chan Hung Kwan
58. SP PowerAssets – Ong Sheau Chin
59. SP Services – Budiman Roesli
60. SP Services – Lawrence Lee
61. Sun Electric Energy Assets – Eugene Lim
62. Sun Electric Energy Assets – Matthew Peloso
63. Sunseap Energy – Julius Tan
64. Sunseap Leasing – Jonathan Tai
65. Sunseap Leasing – Shawn Tan
66. Tuas DBOO Trust – Chen Zhixuan

67. Tuas DBOO Trust – Lee Song Koi
68. Tuas Power Generation – Priscilla Chua
69. Tuas Power Supply – Jazz Feng
70. Tuas Power Supply – Zhang Ai Jia
71. Tuaspring – Calvin Quek
72. Tuaspring – Chin Shi En
73. YTL PowerSeraya – Jonathan Chew
74. YTL PowerSeraya – Mark New

DRCP Members

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

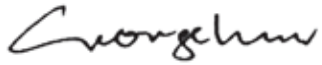
Arbitration Panel

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

Conclusion

I am happy to report that for the past year, no disputes were filed with this office.

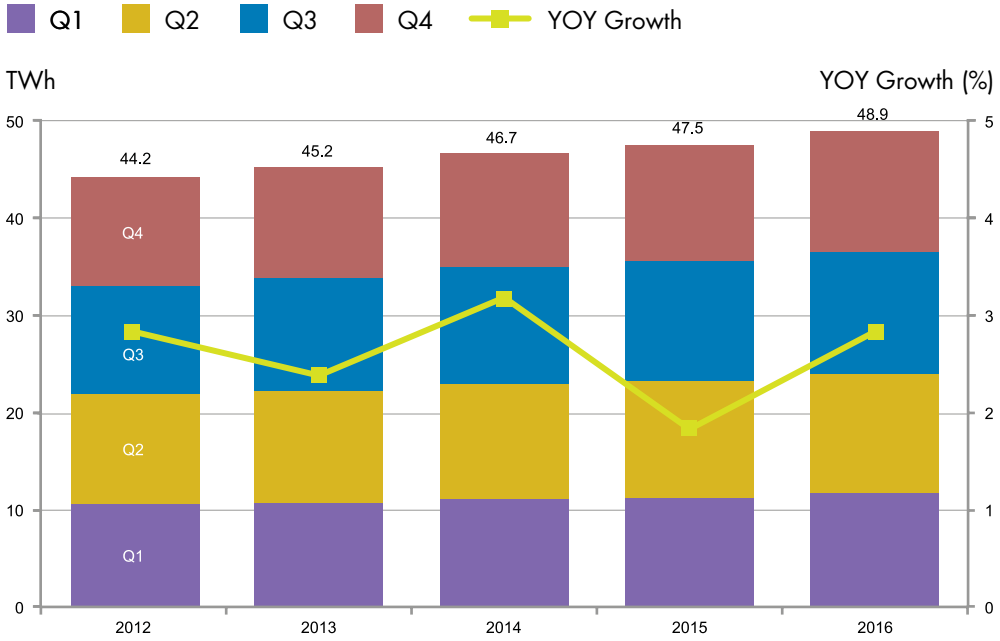
I thank the DRCP members and DMS contacts for their contributions, and look forward to continuing to support the dispute resolution needs of all NEMS market entities in the coming year.



George Lim
Senior Counsel
Dispute Resolution Counsellor

MARKET PERFORMANCE

Annual Electricity Consumption 2012 – 2016



Electricity consumption continues to grow in 2016

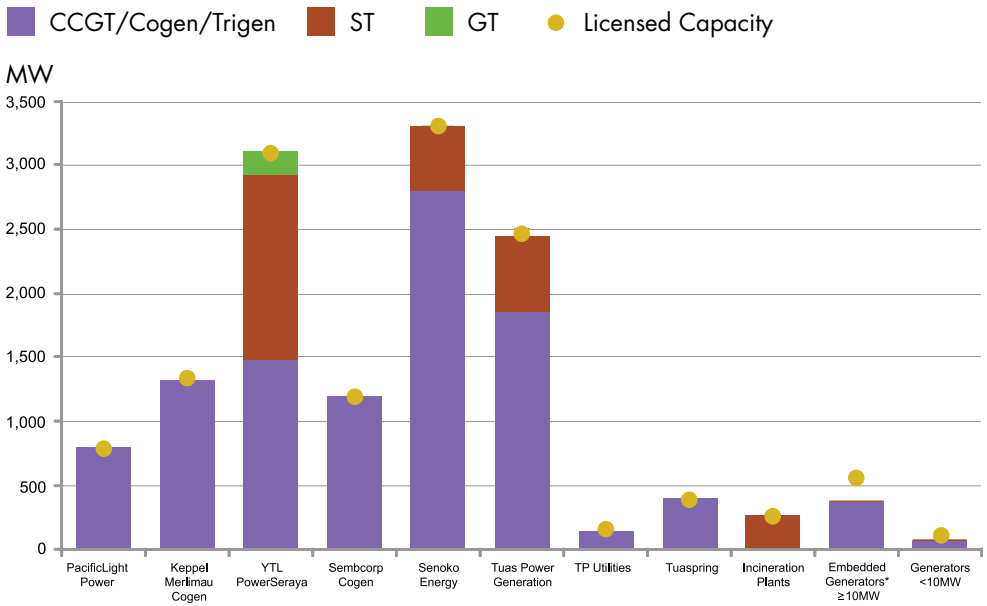
Electricity purchased by market participants (MPs) is settled using electricity consumption data provided by the Market Support Services Licensee (MSSL).

Singapore's economy grew 2.0 percent in 2016[2], similar to the 1.9 percent growth in 2015. In comparison, annual electricity consumption grew 2.9 percent in 2016 to 48.9 terawatt hours (TWh). This was higher than the year-on-year (YOY) growth of 1.8 percent in 2015.

Compared to the same periods in 2015, all quarters in 2016 saw higher YOY electricity consumption. The largest increase was in the fourth quarter, when electricity consumption rose 3.4 percent. The smallest increase was registered in the third quarter, at 2.0 percent.

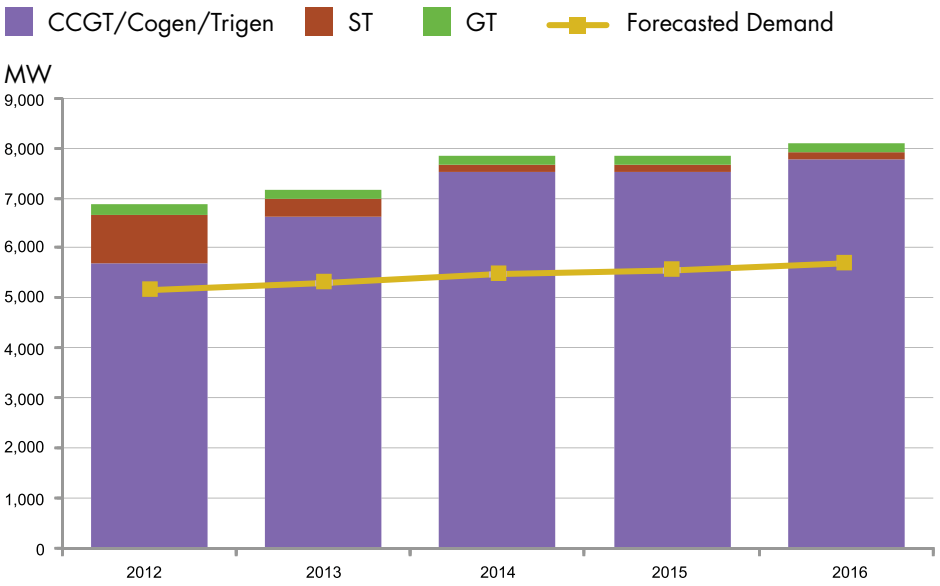
[2] Based on the Singapore Ministry of Trade and Industry press release on 17 February 2017: *MTI Maintains 2017 GDP Growth Forecast at "1.0 to 3.0 Per Cent"*.

Generation Capacity as of 31 December 2016: Registered Versus Licensed



*Embedded generators exclude TP Utilities

Annual Generation Supply by Plant Type 2012 – 2016



Licensed and registered capacities relatively unchanged from 2015 levels

Total licensed capacity in the National Electricity Market of Singapore (NEMS) fell by just 3 megawatts (MW) to 13,667MW in 2016. Other than a downward revision to the capacity of Tuaspring's generator (from 411MW to 395.7MW with effect from 1 March 2016), there were no changes for the rest of the generators with capacity larger than 10MW. On the other hand, the total licensed capacity of smaller generators with capacity below 10MW increased by 17.3 percent to 88MW.

Registered capacity grew 0.1 percent to 13,366MW in 2016 with the addition of seven intermittent generation source (IGS) facilities (see details on page 22).

The proportion of total registered capacity to total licensed capacity stood at 97.8 percent, an increase of 0.1 percent from 2015. The proportion of CCGT/ cogen/trigen registered capacity to total registered capacity remained unchanged at 77.6 percent.

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

[3] Source: Energy Market Authority website.

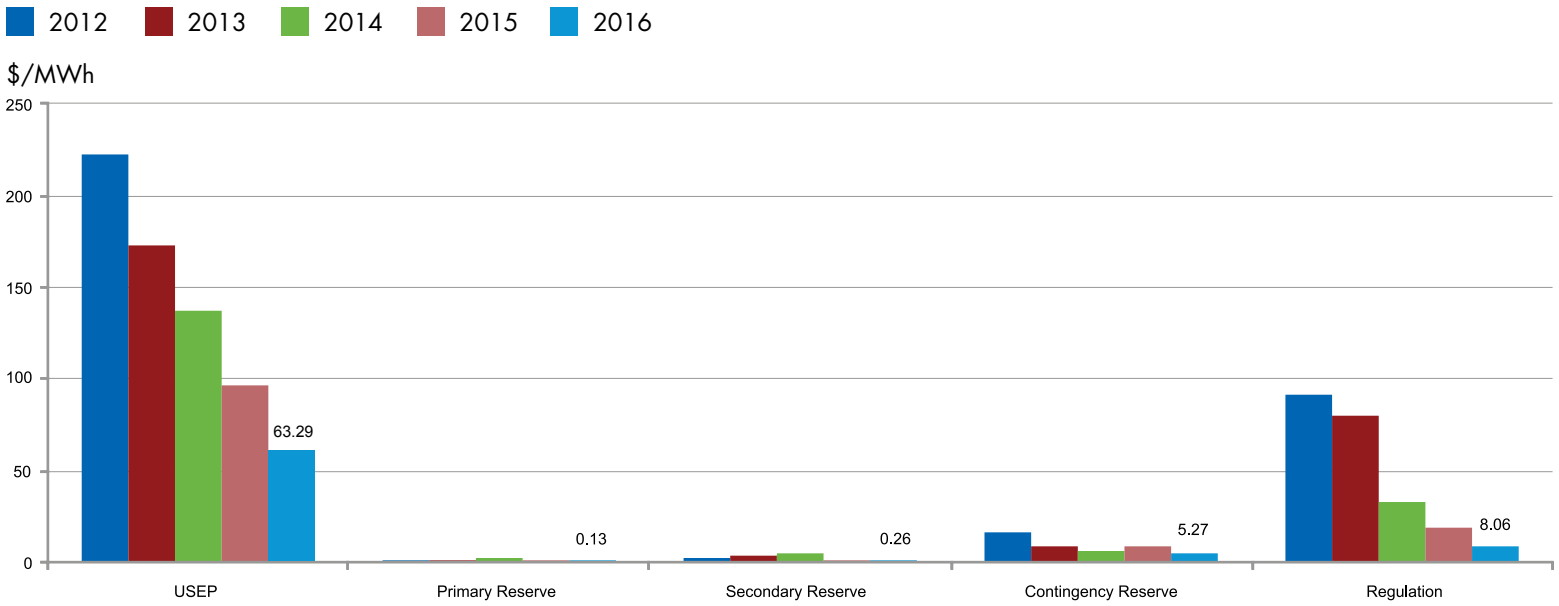
Supply continues to grow and registers new high in 2016

The annual generation supply in 2016 averaged 8,060MW, a 2.9 percent increase from 2015. This was the first time that the annual generation supply had crossed the 8,000MW mark.

CCGT/cogen/trigen supply increased 3.0 percent to 7,746MW in 2016. This was the highest level since the market started. The CCGT/cogen/trigen supply in 2016 was 36.2 percent above forecasted demand, which is the second largest gap between the two since the market started, just behind the 36.9 percent level seen in 2014.

ST and GT supply, on the other hand, fell marginally in 2016. GT and ST supplies were 0.9 percent and 1.2 percent lower respectively compared to 2015.

Annual USEP and Ancillary Prices 2012 – 2016



Almost all prices fall to record low levels

Market prices for energy, reserves and regulation are calculated five minutes before the start of each half-hour trading period. This ensures that the prices reflect the prevailing power system conditions and the most recent offers made by the generators.

The 2016 annual average Uniform Singapore Energy Price (USEP) of $63.29 per megawatt hour (MWh) is a historical low. This was also a 34.1 percent drop from 2015's level, the biggest YOY drop since the market started. The low USEP was in line with lower fuel oil prices[4], which dropped 19.5 percent to USD243 per metric tonne (MT) in 2016. Another contributing factor was the higher supply level in 2016.

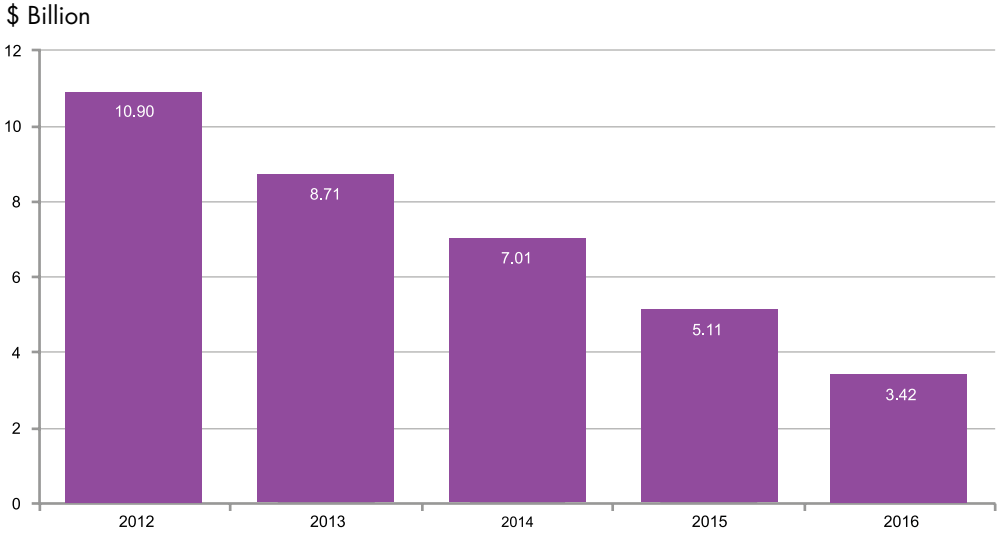
Primary and secondary reserve prices fell 83.3 percent and 35.0 percent respectively, to $0.13/MWh and $0.26/MWh. These are also record low levels for the respective reserve prices since the market started, and can be attributed to cheaper offers and lower requirements seen in 2016.

Contingency reserve price fell 42.9 percent to $5.27/MWh, a new low since the level of $3.93/MWh seen in 2004. Likewise, the low contingency reserve price was a result of cheaper offers and lower requirements.

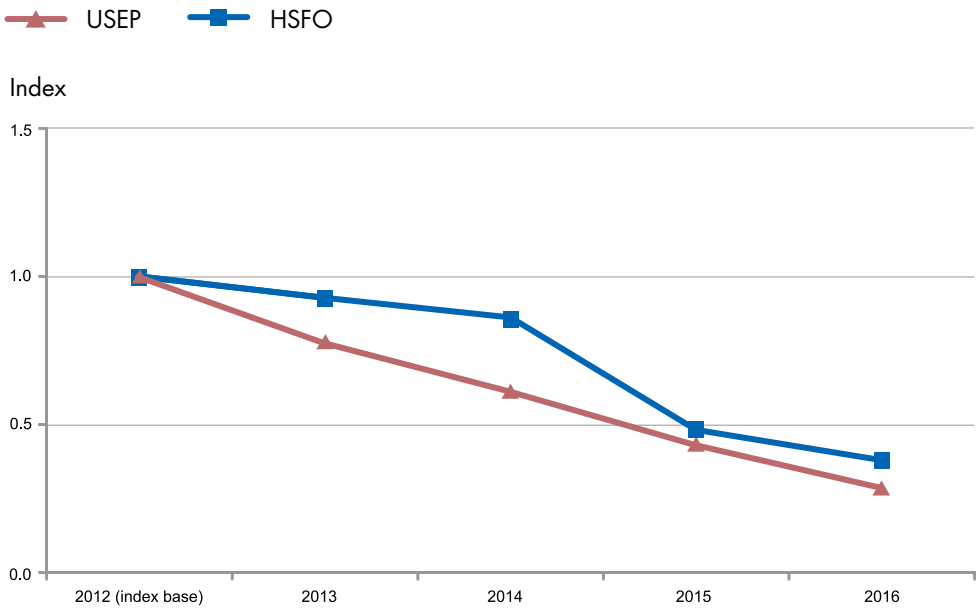
Regulation price also fell to a record low of $8.06/MWh in 2016, a 55.8 percent drop from 2015. The lower regulation price was largely due to a downward revision of regulation requirement, from 126MW to 105MW since 1 February 2016.

[4] Based on HSFO 180 CST price which is used as a proxy for fuel price.

Annual Value of Products Traded 2012 – 2016



Annual USEP and Fuel Price (HSFO) Movements 2012 – 2016



Annual value of products traded continues to decline, registering the third lowest level since market started

The value of products traded shows the transacted value for all energy, reserve and regulation products traded in the NEMS. EMC uses the metered demand and generation data from the MSSL as well as market prices in the NEMS to settle market transactions on a daily basis.

The annual value of products traded fell to $3.42 billion in 2016. This was the third lowest level since the market started. The lowest was $3.08 billion registered in 2004, followed by $3.29 billion in 2003.

The fall in the value of products traded was a result of increased competition in the NEMS which caused energy prices to drop further in 2016. There were a total of 14 generation companies, 17 wholesale market traders and 16 retailers in the NEMS in 2016, up from five generation companies and five retailers when the market first started in 2003.

In 2016, 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.

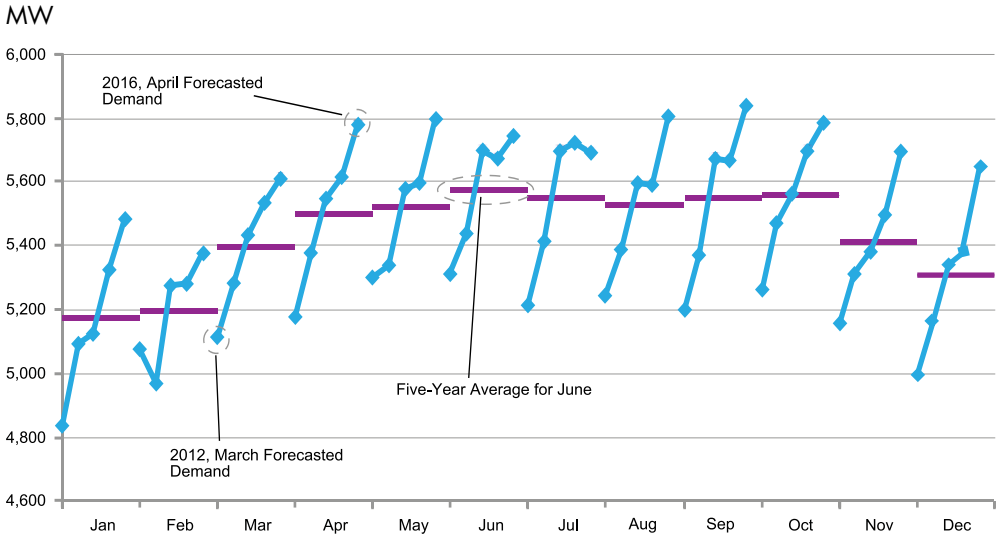
Fall in USEP parallels that of fuel price index[5]

The USEP index continued falling for the fourth consecutive year, reaching an all-time low of 0.3. With the global fuel oil glut continuing to the end of 2016, the fuel price index also fell for the fourth straight year, to 0.4.

In 2016, the gap between the USEP and fuel price indices widened slightly from 2015, reflecting a slightly faster pace of decline in the USEP index compared to the fuel price index.

[5] The index is computed using 2012 as the index base. Therefore, the USEP index in 2012 is 1, while the USEP index in 2013 is 0.8 (computed using the 2013 USEP of $173/MWh divided by the 2012 USEP of $222/MWh).

Monthly Forecasted Demand 2012 – 2016



Rise in forecasted demand seen in all months except July

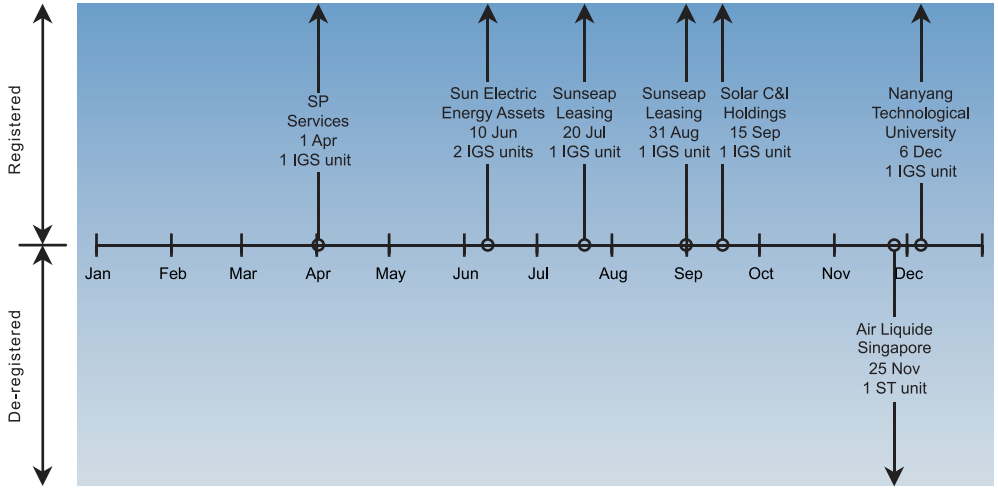
Forecasted demand refers to the projected electricity consumption in Singapore. The forecast is provided in real-time by the Power System Operator (PSO) and is a key component in determining the USEP.

Comparing YOY, demand was higher in all months except July. This could be due to cooler weather observed in July compared to the previous year, with the average temperature falling 0.6 degree Celsius to 28.3 degree Celsius. The highest monthly average forecasted demand in 2016 was in September at 5,833MW, while the lowest was in February at 5,377MW.

With the exception of July, the forecasted demand in all other months in 2016 reached new monthly highs. While the highest monthly forecasted demand in both 2014 and 2015 was registered in July, the forecasted demand in July 2016 fell 0.6 percent instead.

The annual forecasted demand in 2016 averaged 5,688MW, an increase of 2.5 percent from 2015.

Generation Facilities Registered and De-registered in 2016



2016 welcomes the entry of intermittent generation source facilities

At the end of 2016, the total registered capacity in the NEMS stood at 13,366MW. The additional registered capacity came from SP Services, Sun Electric Energy Assets, Sunseap Leasing, Solar C&I Holdings and Nanyang Technological University, which collectively contributed seven intermittent generation source (IGS) facilities to the market.

The entrants to the market consisted of:

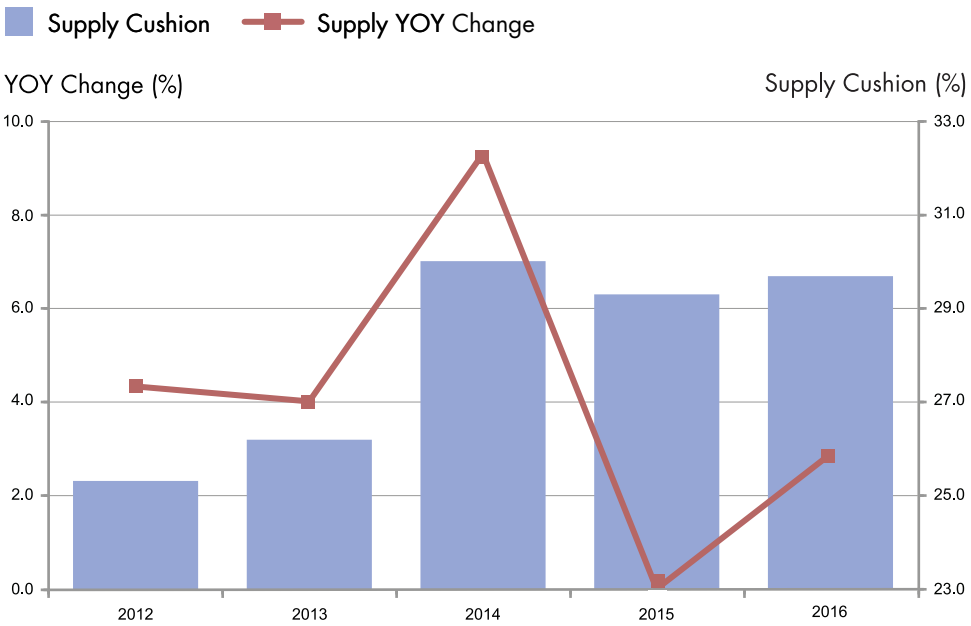
Market Participant	Generation Type	Registered Capacity
SP Services (aggregated)	1 IGS unit	0.224MW
Sun Electric Energy Assets	2 IGS units	0.082MW each
Sunseap Leasing	1 IGS unit	1.518MW
Sunseap Leasing	1 IGS unit	9.131MW
Solar C&I Holdings	1 IGS unit	1.560MW
Nanyang Technological University	1 IGS unit	4.971MW
Total	7 IGS units	17.568MW

One ST facility[6] from Air Liquide Singapore was de-registered in 2016.

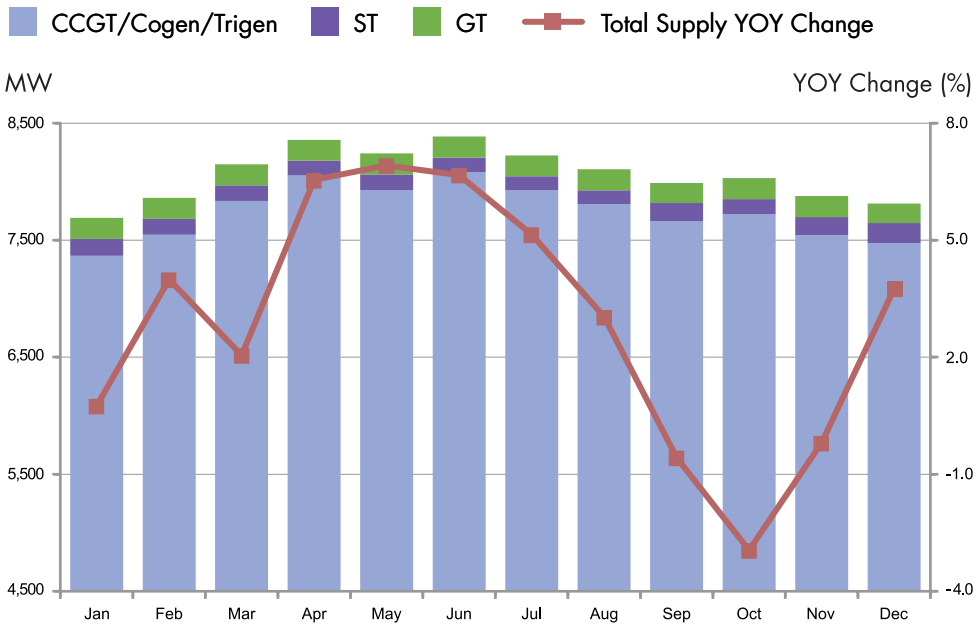
Of the registered capacity in 2016, 77.6 percent or 10,373MW belonged to the CCGT/cogen/trigen category. The total number of generation facilities registered as of 31 December 2016 was 65.

[6] Air Liquide Singapore consolidated its two ST facilities into one

Annual Supply Cushion 2012 – 2016



Monthly Supply by Plant Type 2016



Supply cushion rebounds, registering 29.5 percent in 2016

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 would remain constant.

In 2016, the total supply increased at a slightly faster rate than forecasted demand. The supply cushion increased to 29.5 percent from 29.3 percent in 2015. This was the second highest supply cushion level seen since the market started, after 2014's 30.0 percent.

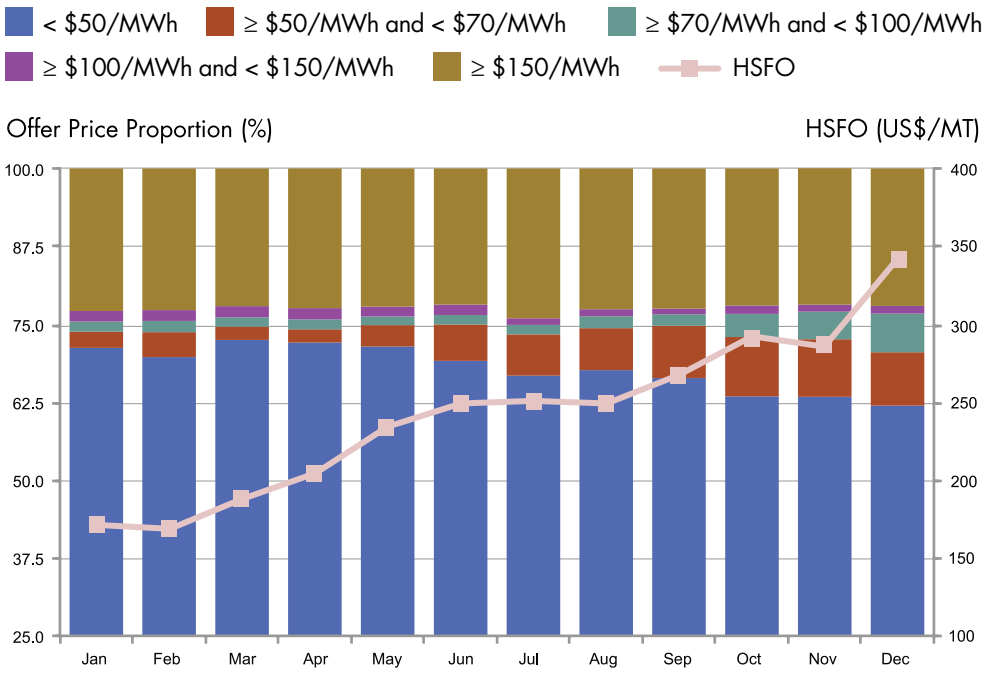
Total supply increases despite negative YOY growth registered for three months

In 2016, nine out of 12 months registered positive YOY growth for supply. For the months of February to August, supply grew at above 2.0 percent YOY consistently, with the largest increase registered in May at 6.9 percent. The increase in supply in these months can be attributed to fewer units on planned maintenance as well as the completion of the commissioning testing of Tuaspring's CCGT unit in the first quarter of 2016.

In terms of market share, CCGT continued to dominate with a 96.1 percent share of the total supply. This was a 0.2 percentage point increase from 2015's level and the biggest CCGT market share since the market started. The market share of ST and GT both decreased by 0.1 percentage point, to 1.7 percent and 2.2 percent respectively.

The peak monthly supply at 8,385MW in June was the highest level seen since the market started. There were seven months when supply surpassed the 8,000MW level in 2016, compared to just two months in 2015.

Monthly Energy Offer Price Proportion and HSFO Price 2016



Higher percentage of energy offers in lower price bands

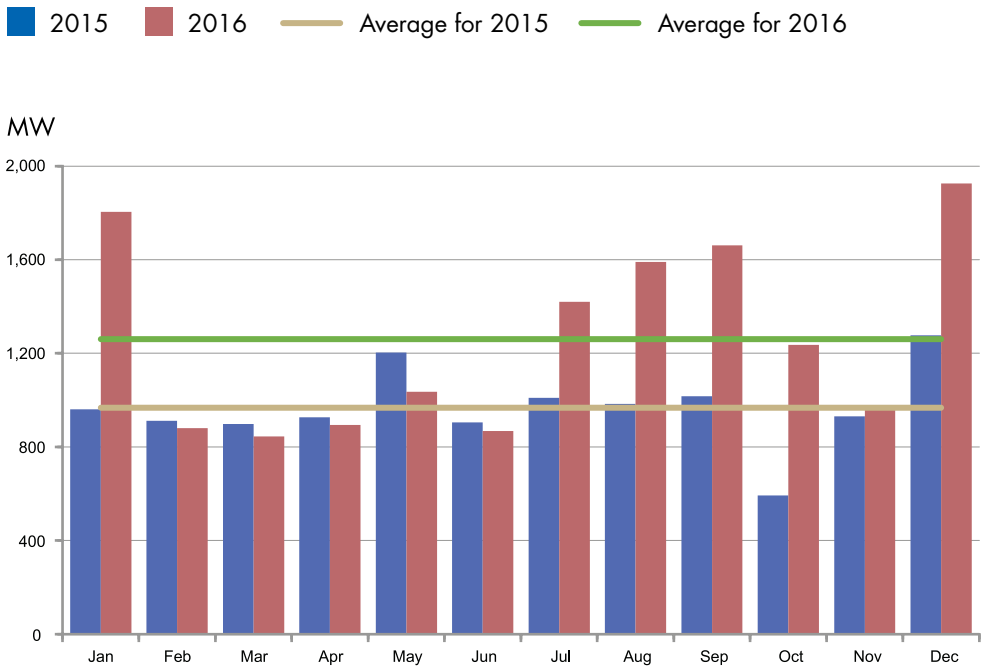
Throughout 2016, energy offers in the lower price band (below $50/MWh) made up more than 60.0 percent of the total offers each month. The percentage of energy offers priced below $50/MWh increased from 60.0 percent in 2015 to 68.0 percent in 2016, and was the main contributing factor behind the record low USEP for the year.

Lower fuel oil prices tend to shift energy offer prices into the lower price bands. This correlation was evident in the first five months of 2016, when a lower fuel oil price was observed and along with that, a higher percentage of energy offers priced below $50/MWh.

As fuel oil prices increased steadily from $176/MT in the first quarter to $307/MT in the fourth quarter, energy offers priced below $50/MWh decreased while energy offers in the higher price bands (between $50/MWh and $100/MWh) increased. The proportion of energy offers priced below $50/MWh averaged 71.2 percent in the first quarter and fell to 62.9 percent in the fourth quarter. In contrast, the proportion of energy offers in the higher price bands (between $50/MWh and $100/MWh) increased 9.3 percentage points over the same duration.

The offers priced above $100/MWh saw marginal fluctuations throughout the year, averaging between 23.0 to 25.1 percent each month.

Monthly Generation Maintenance 2015 Versus 2016



Generation maintenance increases in 2016

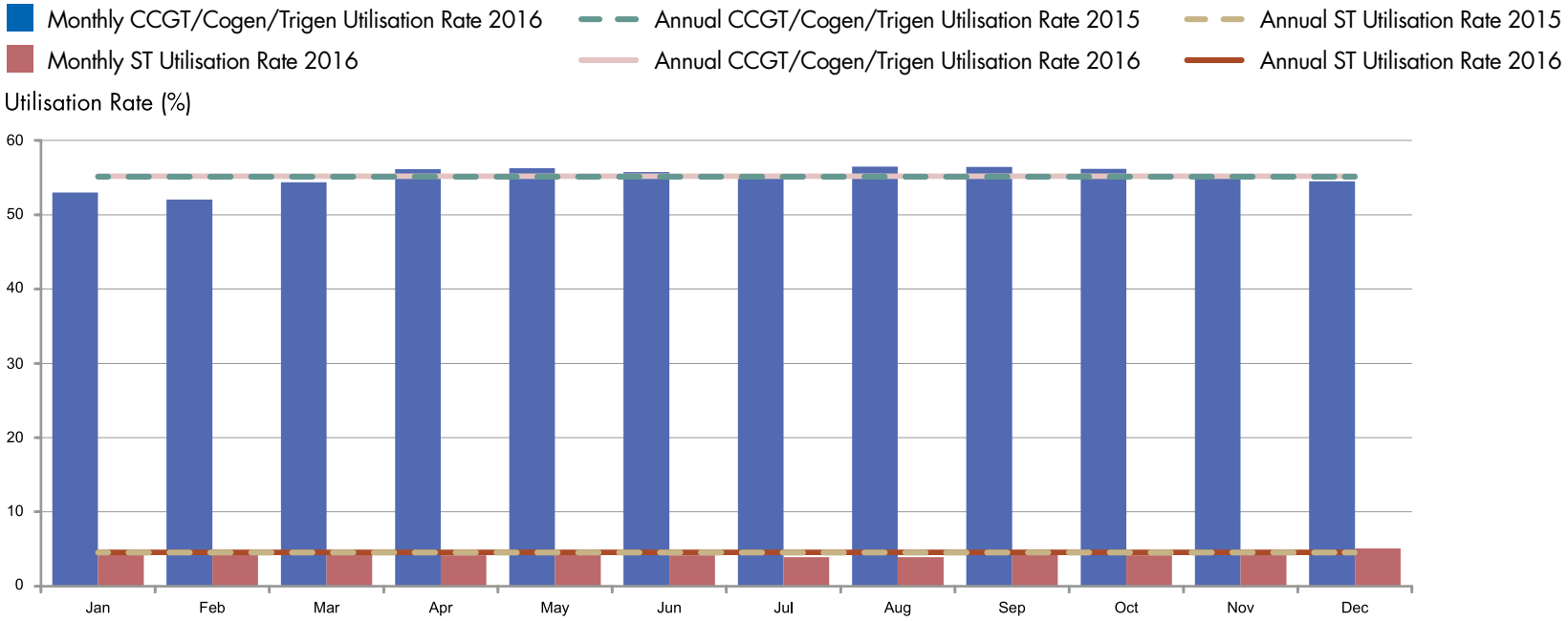
Annual average generation maintenance levels[7] rose 33.5 percent in 2016 and averaged 1,260MW. While the months of February to June saw YOY decreases in maintenance levels, the average drop in these months was just 6.2 percent. For the remaining months when generation maintenance levels increased, the magnitude of increase was significantly bigger, at 59.5 percent on average. The highest level of generation maintenance was 1,925MW registered in December, when at least three generation units were out on maintenance every day.

The standard deviation of monthly generation maintenance increased from 168MW in 2015 to 402MW in 2016. The monthly generation maintenance level ranged from 845MW to 1,925MW in 2016, compared to a narrower range of between 593MW and 1,276MW in 2015.

The ratio of generation maintenance to registered capacity increased to 9.4 percent in 2016, up from 7.1 percent in 2015.

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

Monthly Utilisation Rate by Plant Type 2016



Utilisation rate for CCGT/cogen/trigen plants remains the same while that of ST plants falls marginally

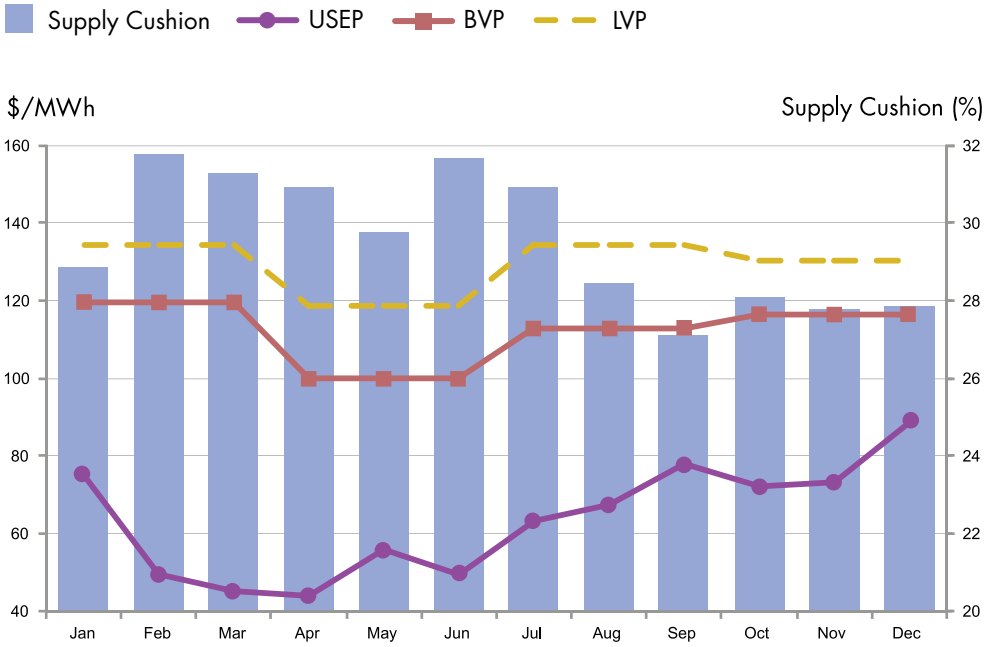
The utilisation rate measures the energy dispatch scheduled as a percentage of registered capacity.

In 2016, the monthly CCGT/cogen/trigen utilisation rate ranged between a low of 52.0 percent in February and a high of 56.5 percent in August.

Overall, the utilisation rate for CCGT/cogen/trigen in 2016 remained the same as 2015's level at 55.1 percent.

The monthly ST utilisation rate ranged between 3.9 percent and 5.1 percent in 2016, with December registering the highest rate. The annual ST utilisation rate was marginally lower in 2016 at 4.4 percent, compared to the 4.5 percent registered in 2015.

Monthly USEP, BVP, LVP and Supply Cushion 2016



USEP stays below BVP and LVP benchmarks throughout the year

LNG Vesting Quantity refers to the percentage of total allocated vesting quantity that is pegged to LNG. The remaining percentage of the total allocated vesting quantity which is pegged to piped natural gas is known as the Balance Vesting Quantity.

Correspondingly, LNG Vesting Price (LVP) is the price for the allocated LNG Vesting Quantity, while Balance Vesting Price (BVP) is the price for the allocated Balance Vesting Quantity. Starting from the third quarter of 2013, the LVP and BVP replaced the Vesting Contract Hedge Price (VCHP) as a benchmark against the USEP.

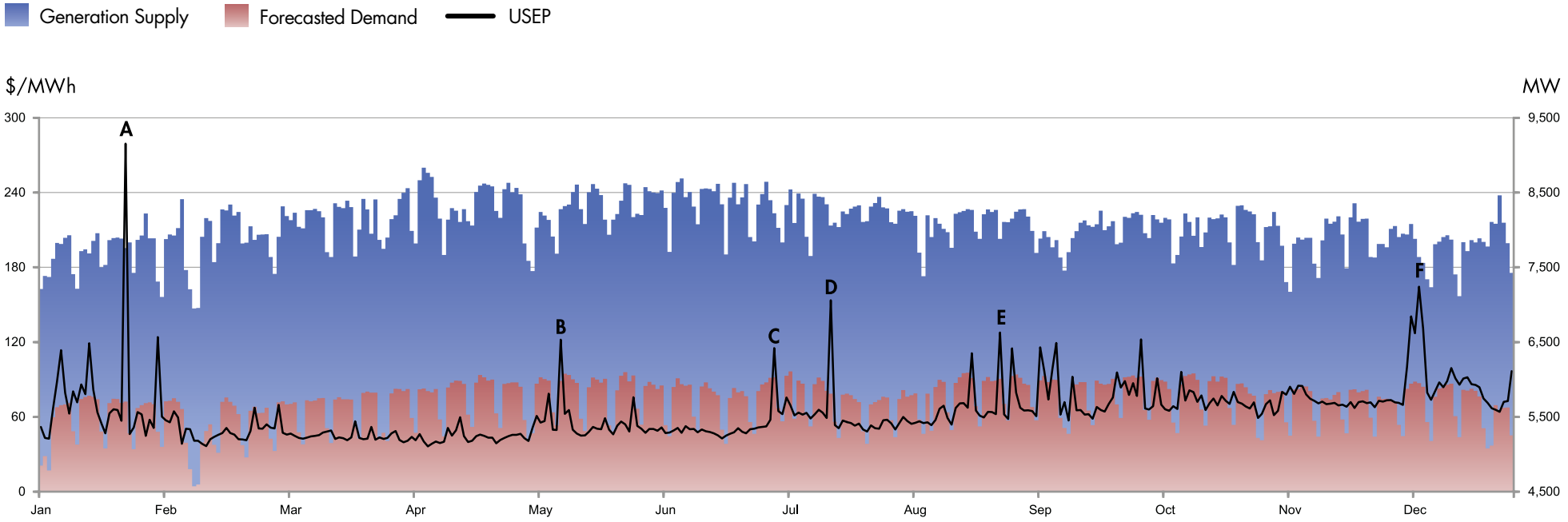
In 2015, the USEP registered below the BVP and LVP in 11 out of the 12 months. In 2016, the USEP trended below the BVP and LVP in all 12 months. The monthly USEP was less volatile in 2016 – the gap between the monthly minimum USEP and the monthly maximum USEP narrowed from $150.19/MWh in 2015 to $44.83/MWh in 2016. The monthly USEP in 2016 ranged between $43.60/MWh and $88.43/MWh. The lowest monthly USEP of $43.60/MWh, which was registered in April, was also the lowest monthly level since the market started.

While the BVP in 2016 fell compared to 2015, the fall in the USEP was greater. The gap between the annual average BVP and the annual average USEP increased from $45.22/MWh in 2015 to $48.84/MWh in 2016. At the monthly level, the largest gap between the USEP and the BVP was observed in March when the BVP was 166.6 percent above the USEP. The annual average BVP of $112.13/MWh in 2016 was 77.2 percent higher than the annual average USEP of $63.29/MWh.

The gap between the annual average LVP and the annual average USEP also increased, from $56.75/MWh in 2015 to $66.08/MWh in 2016. The largest gap between the monthly USEP and the monthly LVP was in March, when the LVP was 199.5 percent above the USEP. The annual average LVP of $129.37/MWh in 2016 was 104.4 percent higher than the annual average USEP of $63.29/MWh.

The supply cushion in 2016 increased by just 0.2 percent compared to 2015. The weakest supply cushion was observed in September at 27.1 percent, while the strongest was in February at 31.8 percent.

Daily USEP, Forecasted Demand and Generation Supply 2016



The key observations on USEP fluctuations in 2016 are as follows:

Point A: On 22 January, the daily USEP averaged $279.21/MWh. A CCGT forced outage in Period 21, along with the planned maintenance of four other CCGT facilities (including two CCGT facilities which extended their planned maintenance beyond the original scheduled end period) and one embedded generation (EG) facility, dampened supply availability (total CCGT capacity unavailable[8] was 2,069MW or 15.5 percent of total registered capacity). The CCGT forced outage, which lasted 14 periods (from Period 21 to Period 34), coincided with the peak hours that day. The lower CCGT supply coupled with higher forecasted demand during the peak hours, caused the supply cushion to fall below 18.0 percent and the USEP to rise above $500.00/MWh during these periods. The USEP peaked at $903.66/MWh in Period 30, when the supply cushion fell to a low of 16.2 percent. The average USEP between Period 21 and Period 34 was $822.27/MWh. Contingency reserve violation ranging from 42MW to 163MW was recorded for a total of 15 periods (Periods 21 to 35), and a GT facility was scheduled for a total of three periods (Periods 27 to 29). The violation was the result of the implementation of Stepwise Constraint Violation Penalty (CVP) whereby the market clearing engine (MCE) would choose to 'violate' reserve requirements if the cost of violating them is less than that of scheduling more expensive offers in the market, thereby lowering overall cost to the market.

Point B: On 9 May, the daily USEP averaged $121.91/MWh. Two CCGT forced outages in Period 31 coupled with three CCGT facilities being on planned maintenance dragged supply lower (total CCGT capacity unavailable was 1,634MW or 12.3 percent of total registered capacity), causing the supply cushion to fall below 18.0 percent in Periods 31, 32 and 33. In response, the USEP rose above $500.00/MWh for these periods and hit a high of $1,010.75/MWh in Period 31. One GT facility was scheduled for two periods (Periods 33 and 34) and another GT facility was scheduled for five periods (Periods 31 to 35). Contingency reserve violation ranging from 66MW to 88MW was recorded in Periods 31 to 35 and interruptible load (IL) was activated for Periods 29 to 36.

Point C: On 1 July, one CCGT facility and one ST facility were on planned maintenance. Separately, there was a CCGT facility forced outage in Period 30 (total CCGT capacity unavailable was 467MW or 3.7 percent of total registered capacity). Higher demand coupled with the above conditions pushed the USEP above $1,000.00/MWh in Periods 31 and 32. The supply cushion in these two periods fell below 18.0 percent and one GT facility was scheduled for one period (Period 31). Contingency reserve violation ranging from 21MW to 80MW was recorded in Periods 31 to 33. The daily average USEP was $115.25/MWh.

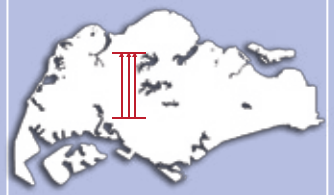
Point D: On 15 July, the daily USEP averaged $153.60/MWh. In Periods 20 and 21, a sharp drop in offer quantities together with higher demand resulted in the USEP hitting $902.63/MWh and $902.77/MWh for the two periods respectively. One GT facility was scheduled for a total of two periods (Periods 22 and 24). Separately, a CCGT facility forced outage in Period 31, together with two CCGT facilities and two ST facilities being on planned maintenance, resulted in lower supply availability (total CCGT capacity unavailable was 433MW or 3.2 percent of total registered capacity). The USEP hit a high of $501.20/MWh in Period 32 when the supply cushion dropped to 20.9 percent. IL was activated for Periods 31 and 32.

Point E: In September, prices were more volatile compared to all other months in 2016. Supply was tight that month as there were five CCGT units out on planned maintenance during weekends, with an average capacity of 1,661MW per day. On the other hand, there were 21 days in September when the daily average demand rose above 5,900MW, the highest number of days that demand exceeded this level in a month in 2016. The monthly average demand in September 2016 at 5,833MW was the highest since the market started. The combined effect of weaker supply and stronger demand resulted in generally higher USEP levels that month. There were three days in September when the USEP crossed the $100.00/MWh level – 5 September (USEP was $115.83/MWh), 9 September (USEP was $119.24/MWh) and 30 September (USEP was $122.21/MWh).

Point F: In December, there were five days when the USEP registered above $100/MWh. High demand coupled with higher priced offers were the main reasons for the high prices. On 8 December, the USEP averaged $164.41/MWh. Four CCGT facilities were on planned or unplanned maintenance and another CCGT facility was on partial planned maintenance. These conditions coupled with a CCGT facility forced outage in Period 22 (total CCGT capacity unavailable was 1,411MW or 10.6 percent of total registered capacity) suppressed the supply cushion to a low of 10.5 percent in Period 24. The low supply cushion propelled the periodic USEP to a high of $1,252.59/MWh in Period 24, the highest periodic USEP observed in 2016. IL was activated for Periods 22 to 29 and a GT facility was scheduled for ten periods (Periods 26 to 34, and Period 42). Contingency reserve violations ranging from 31MW to 178MW were recorded in Periods 24, 25, 26 and 28.

[8] EG facility is categorised under CCGT/cogen/trigen combined category for the calculation of total CCGT capacity unavailable.

Summary of Security Constraints in 2016

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
2	Three transformers in the Southwest block 	1,150MW	4 September 2015	31 December 2016
3	Three lines between Ayer Rajah and the North block 	460MW	3 September 2015	20 May 2016

Application of security constraints in 2016

In 2011, the Energy Market Authority (EMA) published a paper titled *Developments in the Singapore Electricity Transmission Network*[9]. This paper explained that the rise in new generation facilities in upcoming years could lead to excess supply in the network, particularly during the early years of these new plantings. In order to mitigate this scenario, transmission constraints (or security constraints) may be needed to limit the amount of generation in certain areas of the system.

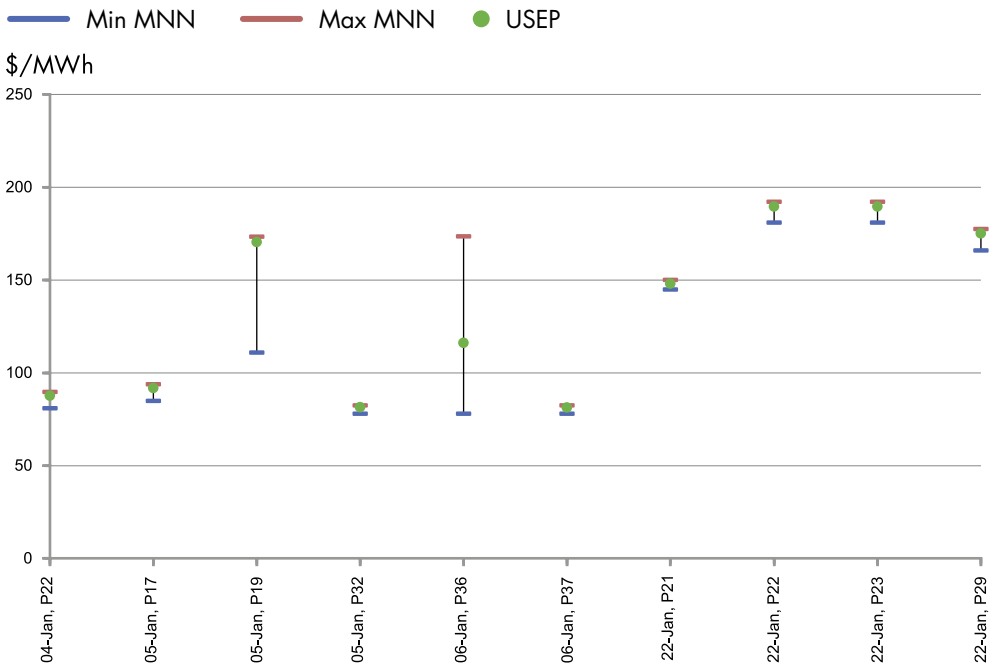
In light of the reliability of the grid and system security, the PSO continued to implement security constraints in 2016. Similar to 2015, security constraints were applied throughout the year in 2016. In 2016, security constraint binding occurred for a total of ten periods. This was a drastic drop from the 200 periods in 2015. There were no new security constraints applied in 2016.

The first security constraint which commenced on 24 April 2014 consisted of a 1,150MW limit on three lines in the Jurong Island area (Security Constraint 1). This security constraint will be in place until Period 48 on 31 December 2018. The second security constraint on three transformers with a limit of 1,150MW that was applied since Period 1, 4 September 2015 expired on 31 December 2016. Lastly, a third security constraint with a limit of 460MW was imposed on Period 28, 3 September 2015 between Ayer Rajah and the North block of the transmission grid. The expiry date of this line was brought forward to Period 48, 20 May 2016 from the initial 31 December 2020.

Periodically, whenever any of the affected transmission lines or transformers was on scheduled maintenance, the PSO modified these three security constraints by adjusting the limits or changing the number of lines within the constraint, or both.

[9] Source: EMA website, policy paper #2 published on 5 April 2011.

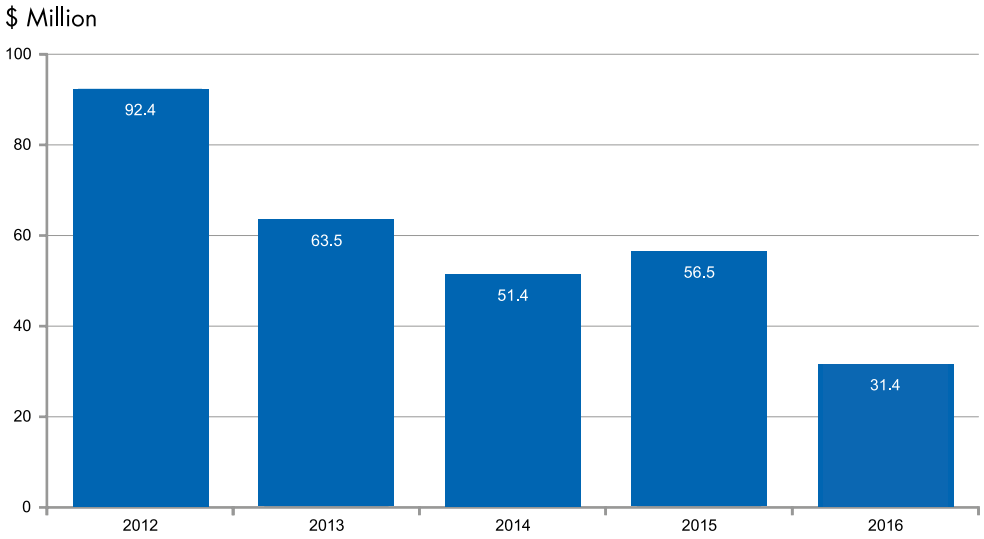
Security Constraint Binding Periods in 2016 with Minimum and Maximum MNN Prices and USEP



Typically, the difference between the minimum and maximum Market Network Node[10] (MNN) prices is less than $10/MWh, but this widens when the security constraint limit is reached. The chart shows the periods in 2016 when security constraint binding took place, and the associated minimum and maximum MNN prices and the USEP. Compared to 2015, the volatility in the MNN prices was greatly reduced in 2016. The differences between the maximum and minimum MNN prices also decreased from more than $1,000MWh in 2015, to less than $100/MWh in 2016.

[10] 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 2012 – 2016



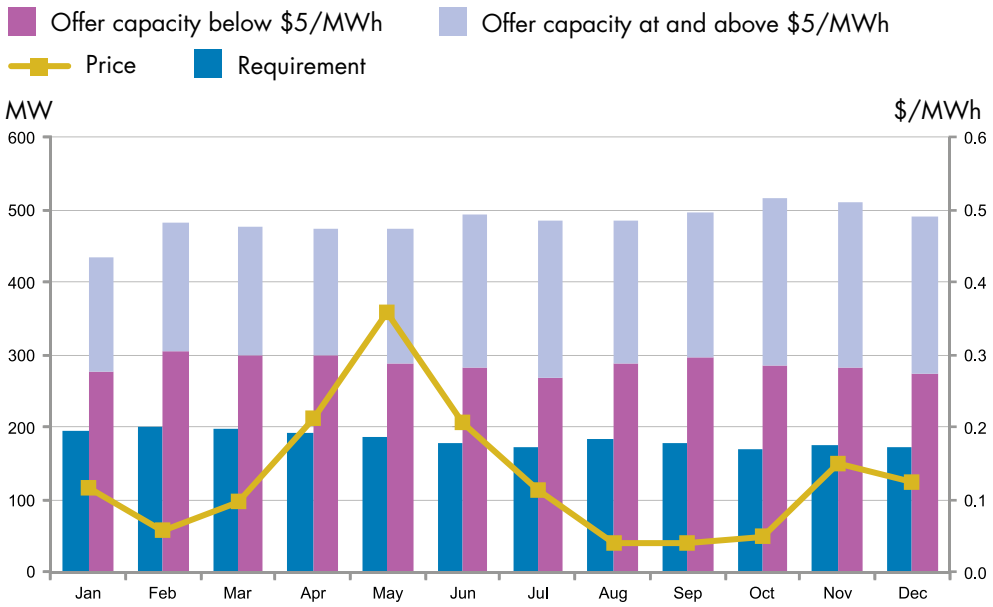
Annual reserve payment drops to lowest level since market started

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 are traded: primary, secondary and contingency reserves. Each reserve has its own price and response time, the latter being eight seconds for primary reserve, 30 seconds for secondary reserve and ten minutes for contingency reserve. The generators bear the cost of providing the reserves.

Reserve costs decreased 44.4 percent to $31.4 million in 2016, the lowest reserve payment collected since the market started. This was mainly driven by the decline in the prices of all three classes of reserves. In 2016, primary and secondary reserve prices recorded the lowest annual average levels since the market started. Primary and secondary reserve prices fell 83.3 percent and 35.0 percent respectively, while primary and secondary reserve requirements decreased 6.0 percent and 2.6 percent respectively. Contingency reserve price dropped 42.9 percent in 2016 but contingency reserve requirement remained similar to 2015's level.

Over the year, the highest reserve payments occurred in January and September, when the monthly reserve payments exceeded $4.0 million. Reserve payment peaked in January at $5.0 million, when the monthly average contingency reserve price was the highest at $10.38/MWh. The January reserve payment accounted for 16.0 percent of the annual total. Likewise, September's contingency reserve price at $8.68/MWh was the second highest level in 2016, and this contributed to the large reserve payment that month which accounted for 13.3 percent of the annual total.

Monthly Primary Reserve Price, Requirement and Supply 2016



Primary reserve price falls and stays below $0.40/MWh in all months

Throughout the year, the monthly primary reserve price and requirement stayed below $0.40/MWh and 200MW respectively.

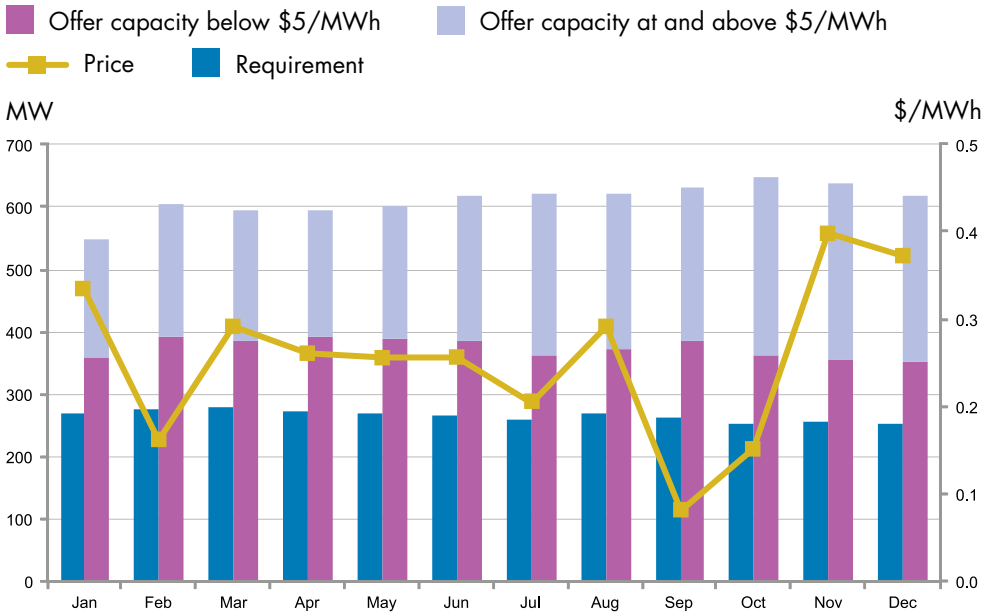
The annual average primary reserve price fell 83.3 percent to $0.13/MWh in 2016. The peak monthly primary reserve price was seen in May at $0.36/MWh, while the lowest monthly average was seen in the months of August and September at $0.04/MWh.

The annual average primary reserve requirement dipped 6.2 percent to 183MW in 2016. Annual primary reserve offers, on the other hand, were 6.4 percent higher at 484MW compared to 2015. For the price tranche below $5.00/MWh, annual primary reserve offers averaged 286MW, a marginal dip of 2MW compared to 2015. For the price tranche above $5.00/MWh, annual primary reserve offers increased 31MW to 198MW. On a monthly basis, the primary reserve offers were highest in October at 515MW, and lowest in January at 433MW. Overall, the lower reserve requirements along with the increase in supply translated into the lower primary reserve prices seen in 2016.

There were no changes to the Risk Adjustment Factor (RAF)[11] in 2016. It was set at 1.0 for primary reserve.

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

Monthly Secondary Reserve Price, Requirement and Supply 2016



Secondary reserve price falls on the back of greater offers and lower requirements

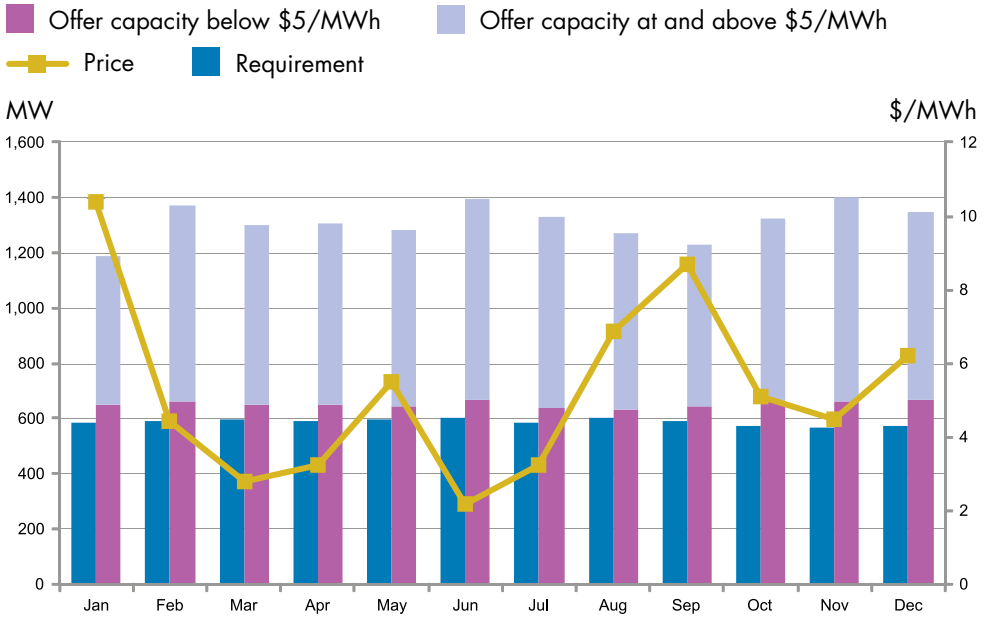
The monthly secondary reserve price stayed between $0.10/MWh and $0.40/MWh for most months and averaged $0.26/MWh in 2016, which was the lowest annual level since the market started. The highest monthly secondary reserve price registered was $0.40/MWh in November, while the lowest was $0.08/MWh in September.

Despite the increase in secondary reserve requirement in February, the monthly average price decreased due to greater supply as well as more offers in the cheaper price tranche. Overall, offers increased from 549MW in January to 605MW in February, with offers priced below $5.00/MWh increasing from 360MW in January to 391MW in February. For September, the drop in secondary reserve price was attributed to a dip in secondary reserve requirement as well as greater supply availability. Comparing against August, September's secondary reserve requirement fell 2.6 percent to 261MW, while offers increased 1.9 percent to 631MW.

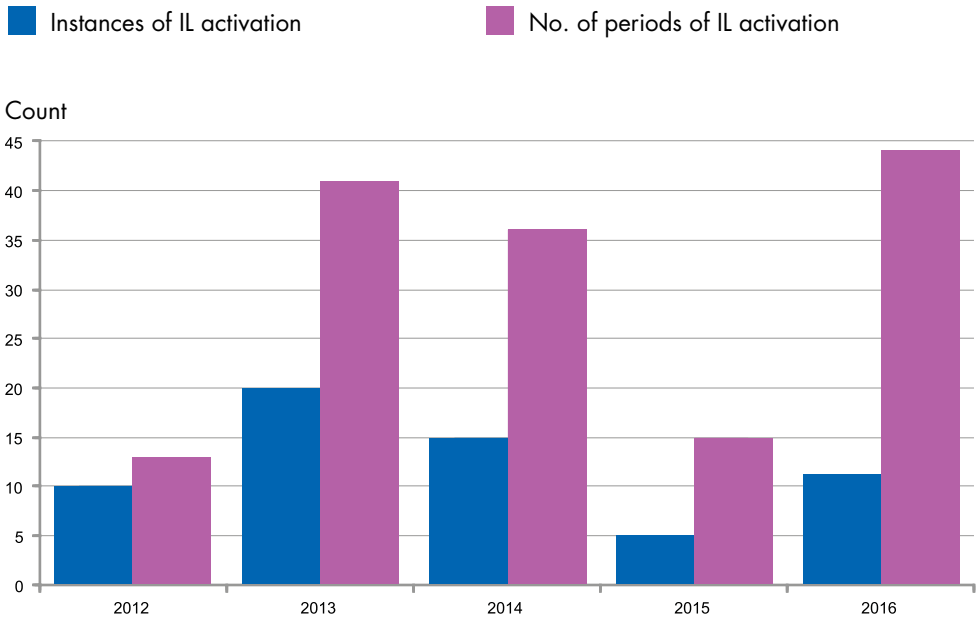
The annual average secondary reserve requirement decreased 2.6 percent to 265MW in 2016, while the annual average secondary reserve offers increased 6.8 percent to 611MW. Offers priced below $5.00/MWh remained unchanged while offers above $5.00/MWh increased 19.5 percent. The increase in offers above $5.00/MWh had negligible impact on the secondary reserve price, as offers priced below $5.00/MWh exceeded the secondary reserve requirements by a buffer of 33.0 to 48.0 percent in all months.

There were no changes to the RAF in 2016. It was set at 1.0 for secondary reserve.

Monthly Contingency Reserve Price, Requirement and Supply 2016



Annual Interruptible Load (IL) Activations for Contingency Reserve Market 2012 – 2016



Contingency reserve price falls on the back of greater supply and averages $5.27/MWh

The monthly contingency reserve price stayed below $8.00/MWh for most of the year. The two highest monthly contingency reserve prices registered were $10.38/MWh and $8.68/MWh in January and September respectively.

In January, sporadic periods of tight supply conditions resulted in a total of 29 periods of contingency reserve shortfalls. In these 29 periods, the contingency reserve price hit a high of $90.00/MWh and this contributed to the overall higher monthly average price. In September, the contingency reserve price rose on the back of lower offer availability, and there was one period of contingency reserve shortfall. The monthly average contingency reserve offers in September was the second lowest monthly level in 2016, after January.

Overall for the year, the contingency reserve requirement remained unchanged at 588MW compared to 2015, while the contingency reserve offers increased 5.0 percent to 1,313MW. This resulted in the annual average contingency reserve price falling by $3.96/MWh to $5.27/MWh.

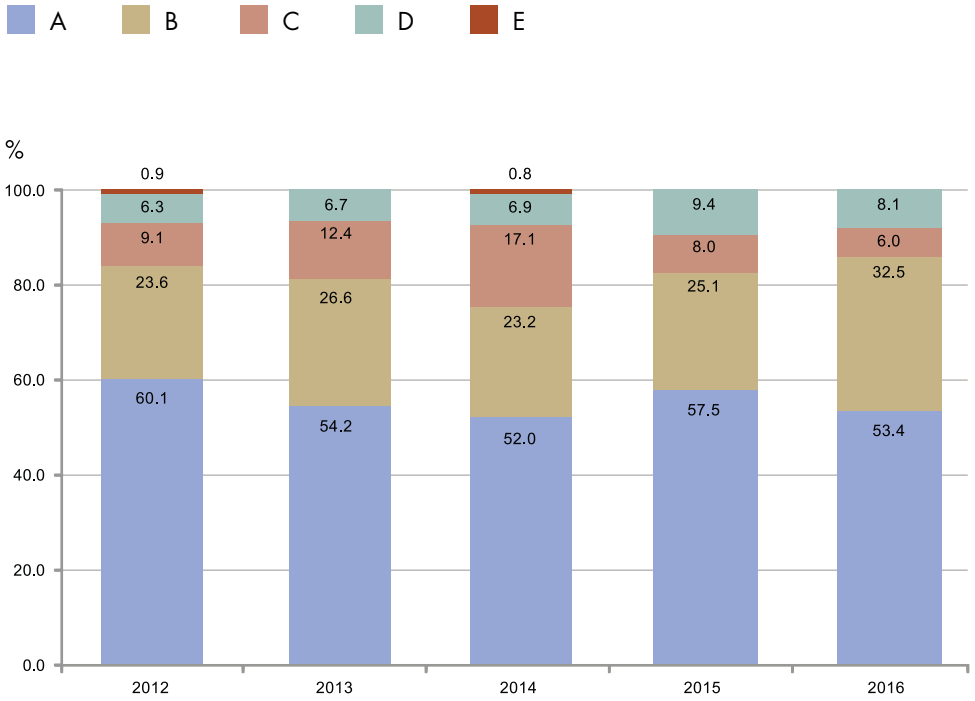
There were no changes to the RAF in 2016. It was set at 1.5 for contingency reserve.

Instances and number of periods of IL activation increase in 2016

As of 31 December 2016, the total registered capacity for IL remained the same as 2015 at 23.2MW for primary and secondary reserves. For contingency reserve, one new IL facility was registered with the NEMS in 2016, raising the total registered capacity to 37.2MW in 2016.

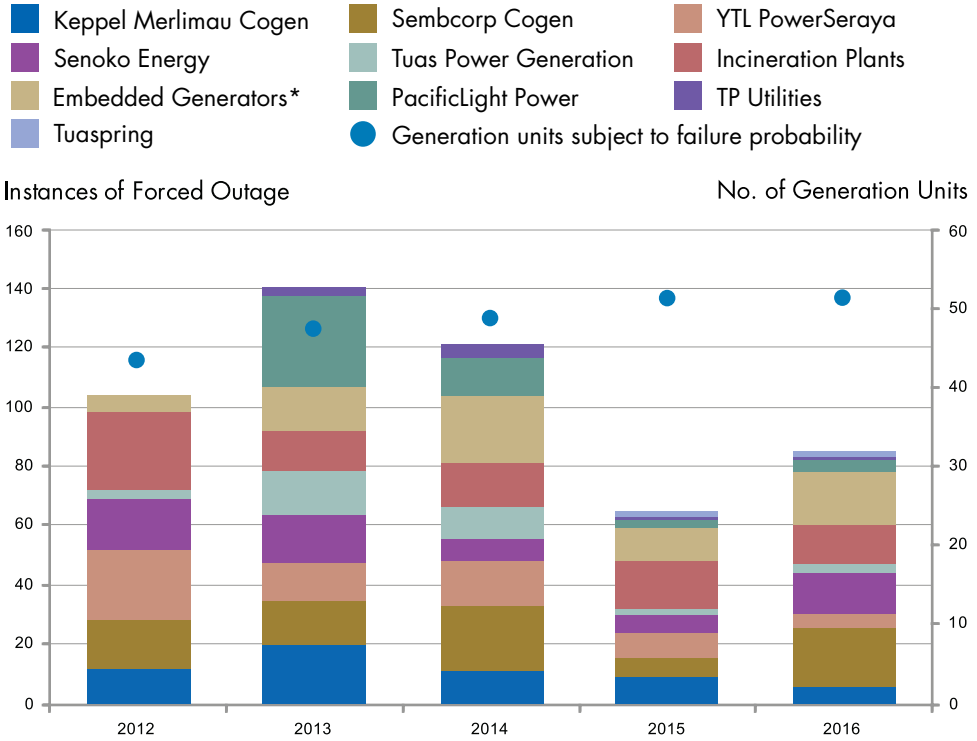
In 2016, the number of IL activations for contingency reserve doubled from 2015 to 11, and the total number of periods when IL was activated for contingency reserve increased to 44. January had the highest concentration of IL activations by number of periods, with one instance of IL activation lasting for nine straight periods. This was similar to the month of May in 2015.

Reserve Provider Group Effectiveness for Primary and Secondary Reserve Classes (Aggregate) 2012 – 2016



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

Annual Forced Outages by Generation Companies 2012 – 2016



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

Reserve provider group effectiveness improves for second consecutive year

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.

Similar to 2015, the overall performance of reserve providers improved in 2016, with those in Groups C and D shifting to Group B. The 7.4 percentage point increase in Group B reserve providers outweighed the 4.1 percentage point drop in Group A reserve providers. The total percentage of reserve providers in Groups A and B rose to 85.9 percent in 2016, the highest level since the market started. Groups C and D reserve providers dropped by 2.0 percentage points and 1.3 percentage points, to 6.0 percent and 8.1 percent respectively. Like 2015, there were no reserve providers in the Group E category.

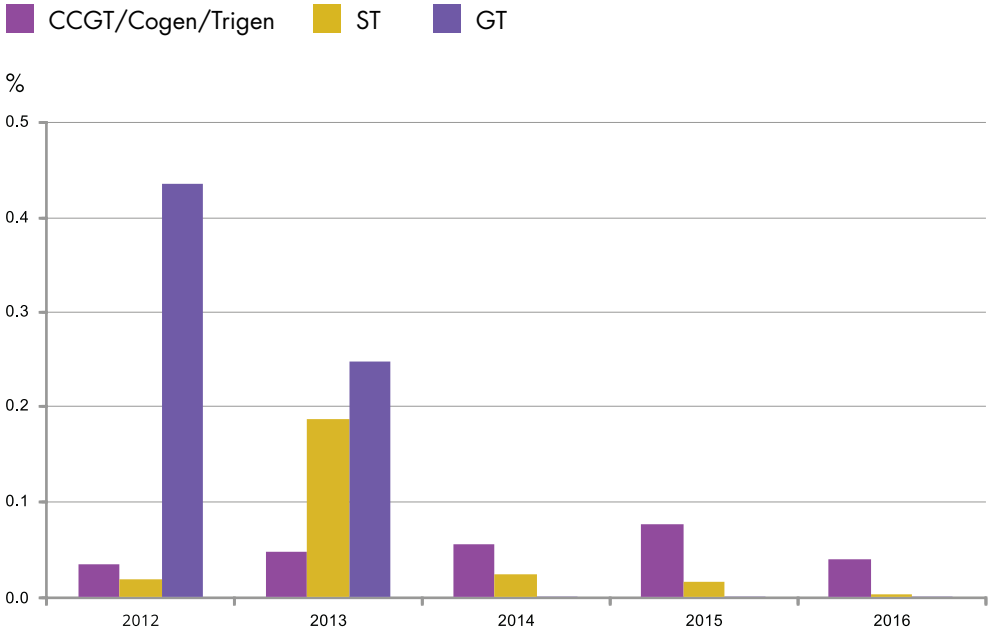
All contingency reserve providers were classified in Group A.

Total number of forced outages increases in 2016

There were a total of 86 forced outages in 2016, up from 65 in 2015. Despite a 32.3 percent increase in the number of forced outages, this was still the third lowest level since the market started.

Most of the generation companies experienced an increase in the number of forced outages, contributing to the overall increase in 2016.

Average Failure Probability by Year 2012 – 2016



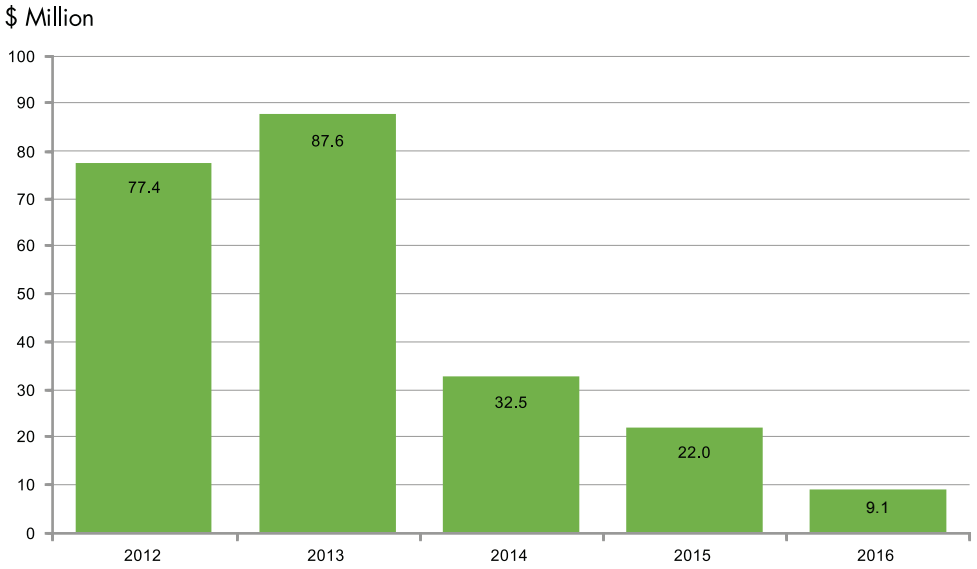
Reliability of generation facilities at highest level since 2009

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.

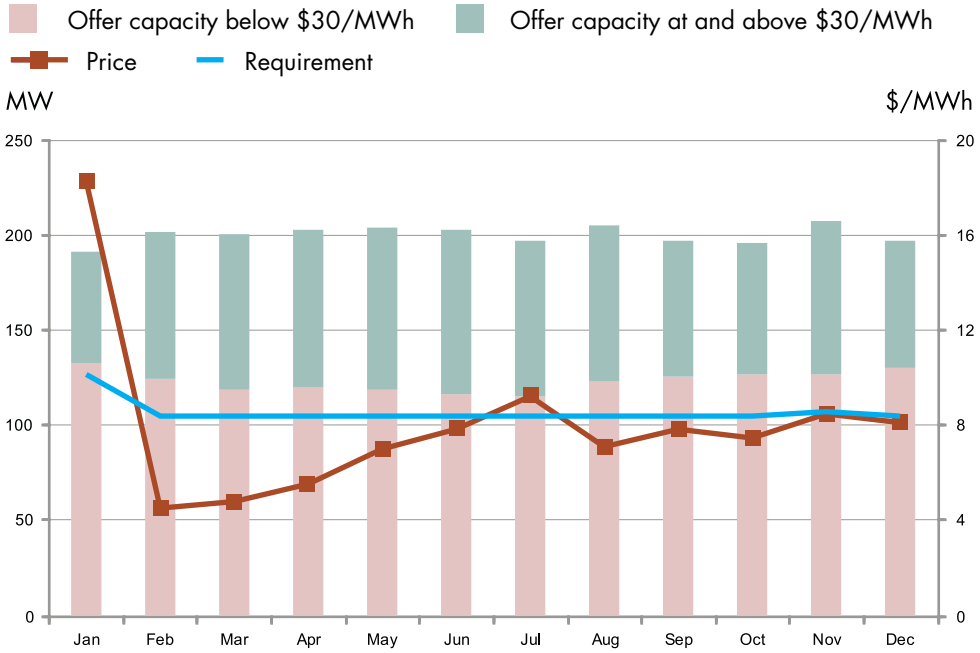
In 2016, the average failure probabilities for CCGT/cogen/trigen, ST and GT facilities were 0.042 percent, 0.005 percent and 0.001 percent respectively. Compared to 2015, the failure probabilities of the CCGT/cogen/trigen and ST categories have decreased, while that of the GT category remained the same. The failure probability of ST facilities was at a record low in 2016.

The overall improved performance reflected in the lower failure probability levels is aligned with the relatively low number of forced outages.

Annual Regulation Payment 2012 – 2016



Monthly Regulation Price, Requirement and Supply 2016



Regulation payment continues to fall

Regulation payment in 2016 dropped 58.7 percent to $9.1 million, extending the downward trend that started since 2014. This was the lowest regulation payment collected since the market started.

Compared to 2015, when the monthly regulation payment averaged above $1.0 million in all 12 months, January was the only month in 2016 when the regulation payment crossed that level. Regulation payment in January was $2.0 million, the highest monthly average in 2016, and this fell to an average of $0.6 million per month for the rest of the year. This was in line with the downward revision in regulation requirement to 105MW from 1 February 2016. Prior to this revision, the average regulation requirement was 126MW between 1 February 2015 and 31 January 2016.

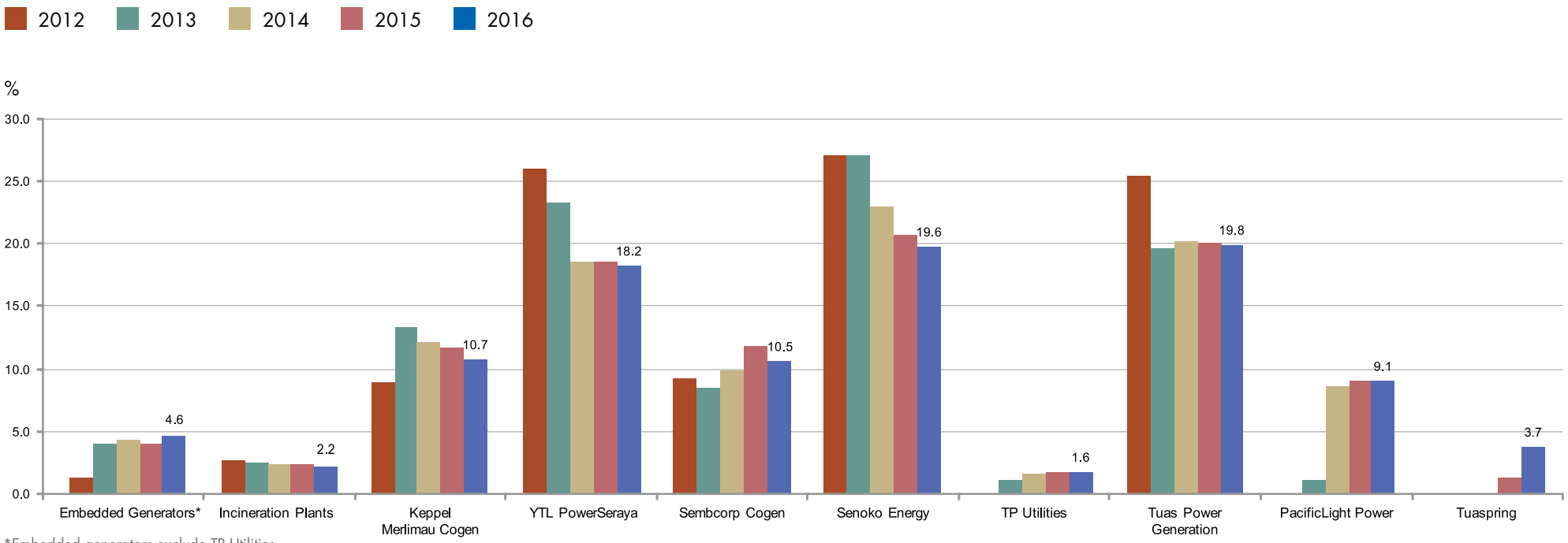
Regulation price hits record low

Regulation price in 2016 fell 55.8 percent to an average of $8.06/MWh, down from $18.23/MWh the year before. This was the lowest annual average regulation price since the market started. Apart from January, all other months saw regulation prices falling below $10.00/MWh. The lowest monthly regulation price was observed in February at $4.57/MWh, while the highest was seen in January at $18.29/MWh.

Since the downward revision in regulation requirement from February 2016, the regulation price stayed low. From February to April, regulation price displayed lower volatility and averaged below $6.00/MWh. In the remaining months of the year, regulation price averaged below $10.00/MWh. The peak monthly regulation price in 2016 was 42.6 percent lower compared to 2015.

Compared to 2015, regulation offers priced below $30.00/MWh reduced by 5.8 percent, while offers above the $30.00/MWh offer price tranche increased 6.9 percent. The reduction in regulation requirement outweighed the drop in cheaper supply, resulting in an overall lower regulation price in 2016.

Annual Market Share by Generation Company 2012 – 2016 (Based On Scheduled Generation)



*Embedded generators exclude TP Utilities
Note: The percentages in this chart may not add up to 100% due to rounding.

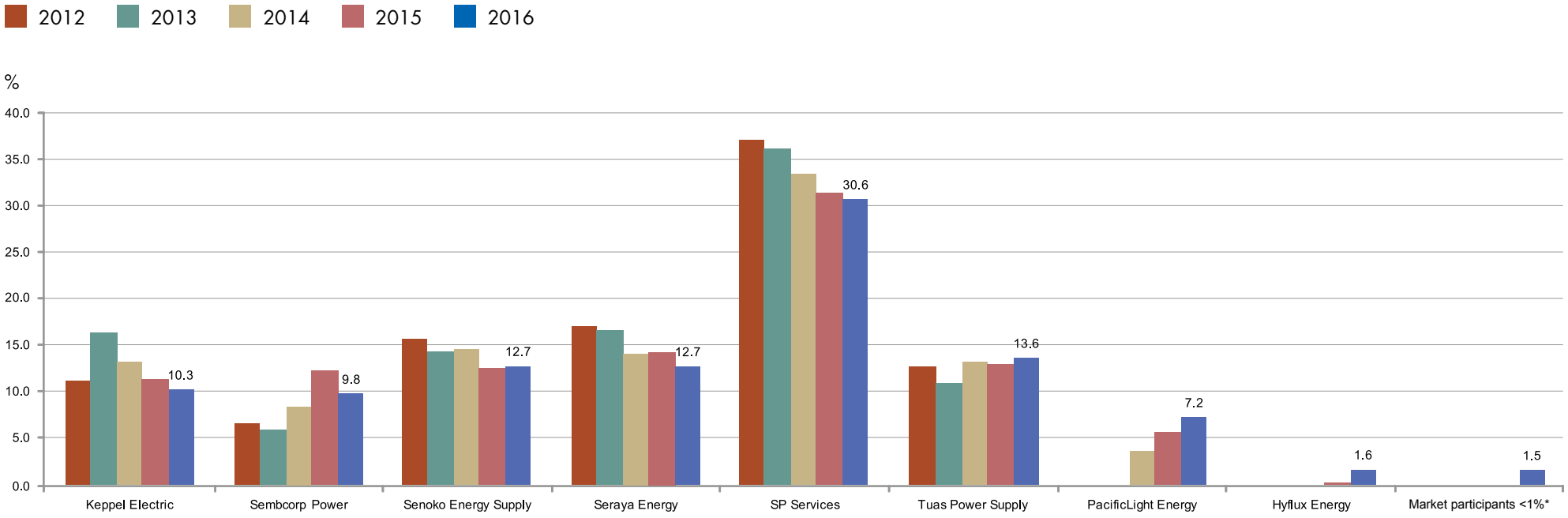
Market shares of three generators improve while that of seven others fall

The combined market share of the three leading generation companies (YTL PowerSeraya, Tuas Power Generation and Senoko Energy) has declined consistently since 2014, falling by another 1.3 percentage points to 57.7 percent in 2016. Senoko Energy's market share dropped 1.0 percentage point to 19.6 percent in 2016, followed by Tuas Power Generation whose market share fell by 0.2 percentage point to 19.8 percent. YTL PowerSeraya's market share also fell by 0.2 percentage point, to 18.2 percent.

Amongst the smaller generation companies, Sembcorp Cogen's market share dipped 1.3 percentage points to record the largest loss in 2016. This was followed by Keppel Merlimau Cogen which lost 0.8 percentage point in market share, TP Utilities which lost 0.1 percentage point, and the incineration plants which lost 0.2 percentage point.

The fall in the market share of the above mentioned generation companies was picked up mainly by Tuaspring, the embedded generators (EGs) and PacificLight Power. Tuaspring was the top gainer in 2016 as its market share increased 2.5 percentage points to 3.7 percent. The EGs' market share rebounded from the dip in 2015 to a gain of 0.6 percentage point in 2016, to 4.6 percent. PacificLight Power continued to expand its market share for the fourth consecutive year, with an increase of 0.1 percentage point to 9.1 percent in 2016.

Annual Market Share of Market Support Services Licensee and Retailers 2012 – 2016 (Based on Withdrawal Energy Quantity)



*Market participants <1% refers to Best Electricity Supply, Charis Electric, Diamond Energy Merchants, Environmental Solutions (Asia), I Switch, Red Dot Power, Sun Electric Power and Sunseap Energy

Influx of independent retailers creates greater competition in retail pool

With keen market competition, the two most observable shifts in the retail pool in 2016 were the 2.3 percentage point drop in market share by Sembcorp Power, and the 1.7 percentage point increase in market share by PacificLight Energy.

Apart from Sembcorp Power, Keppel Electric, Seraya Energy and SP Services also saw a reduction in their market share. Besides PacificLight Energy, the other retailers which gained market share in 2016 included Hyflux Energy, Senoko Energy Supply and Tuas Power Supply, whose market share increased to 1.6 percent, 12.7 percent and 13.6 percent respectively.

In 2016, three new independent retailers joined the market, expanding the retail composition to 16 retailers. The collective market share of the independent retailers[12] was 1.2 percent of the total retail pool.

[12] The independent retailers are Best Electric Supply, Charis Electric, Diamond Energy Merchants, Environmental Solutions (Asia), I Switch and Red Dot Power.

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

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

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

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

Margin Calls and Notices of Default – 1 January to 31 December 2016

A margin call is issued when a retailer's estimated net exposure reaches a value that is equivalent to or greater than 70 percent of the level of its credit support. In 2016, EMC issued a total of eight margin calls.

A notice of default is issued when an MP is unable to remit to the EMC settlement clearing account by the end of the business day following the MP payment date. In 2016, EMC issued one notice of default. This notice of default was closed the following day after receiving payment from the MP.

In 2016, the value of total retail settlement payments (net of bilateral offsets) was $2.06 billion and the value of credit support on 31 December 2016 was $320.6 million.

Automatic Financial Penalty Scheme (AFPS) and Minimum Stable Load (MSL) Compensation Scheme – 1 January to 31 December 2016

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 2016, there were 104 periods when the AFPS kicked in, and the total penalty collected was $544,846.25. The penalty amount collected was returned to the market via the monthly energy uplift charges.

The MSL compensation scheme compensates participating GRFs when they are constrained for energy at their MSLs and their offer prices are higher than the marginal clearing price. It was implemented in November 2015, in an effort to enhance system security and create financial certainty for these facilities in recovering costs. In 2016, $431.48 was paid out for a total of four periods under the MSL compensation scheme. The amount paid out was funded by the market via the monthly energy uplift charges.

Contracted Ancillary Services – 1 April 2016 to 31 March 2017

Contract Period	Cost of Ancillary Services	Total MW Contracted
1 April 2016 to 31 March 2017	$15,151,777.80	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 2016 to 31 March 2017, 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 $15.15 million for the period 1 April 2016 to 31 March 2017. The capability was sourced from YTL PowerSeraya, Senoko Energy, Tuas Power Generation and Keppel Merlimau Cogen.

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 2016 to 30 June 2017

Period	1 July 2016 to 31 March 2017	1 April 2017 to 30 June 2017
EMC Fee per MWh ($/MWh)	0.2530	0.2450
Budgeted Volume (GWh)	71,438	24,132
Budgeted Net Fees ($'000)	18,073	5,911
Total Budgeted Net Fees ($'000)	23,984	

PSO Net Fees – 1 April 2016 to 31 March 2017

	Total Fees ($'000)
PSO Net Fees	24,331

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.

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.

Generator Licensees	ExxonMobil Asia Pacific	www.exxonmobil.com.sg
	Keppel Merlimau Cogen	www.kepinfra.com
	Keppel Seghers Tuas Waste-To-Energy Plant (Tuas DBOO Trust)	www.keppelseghers.com
	National Environment Agency	www.nea.gov.sg
	PacificLight Power	www.pacificlight.com.sg
	Sembcorp Cogen	www.sembcorp.com
	Senoko Energy	www.senokoenergy.com.sg
	Senoko Waste-to-Energy	www.kepinfra.com
	Shell Eastern Petroleum	www.shell.com.sg
	Singapore Refining Company	www.src.com.sg
	TP Utilities	www.tputilities.com.sg
	Tuas Power Generation	www.tuaspower.com.sg
	Tuaspring	www.hyflux.com
	YTL PowerSeraya	www.ytlpowerseraya.com
Retailer Licensees	Best Electricity Supply	www.bestelectricity.com.sg
	Buri Energy	www.burienergy.com
	Charis Electric	www.chariselectric.com.sg
	Diamond Energy Merchants#	www.diamond-energy.com.sg
	Environmental Solutions (Asia)	www.espower.sg
	Hyflux Energy	www.hyfluxenergy.com
	I Switch	www.iswitch.com.sg
	Keppel Electric	www.keppelelectric.com
	PacificLight Energy	www.pacificlight.com.sg
	Red Dot Power#	www.reddotpower.com.sg
	Sembcorp Power	www.sembcorp.com
	Senoko Energy Supply	www.senokoenergy.com.sg
	Seraya Energy	www.serayaenergy.com.sg
	Sun Electric Power	www.sunelectric.com.sg
	Sunseap Energy	www.sunseap.com
	Tuas Power Supply	www.tpsupply.com.sg

Wholesale Market Traders	Air Liquide Singapore# Banyan Utilities CGNPC Solar-Biofuel Power (Singapore) 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 Singapore District Cooling Singapore LNG Corporation Solar C&I Holdings Sun Electric Energy Assets Sunseap Leasing	https://industry.airliquide.sg www.cgnsedc.com.cn www.diamond-energy.com.sg www.eco.com.sg www.gsk.com www.greensync.com.au www.greenpowerasia.com www.lysenergy.com www.msd-singapore.com www.ntu.edu.sg www.pfizer.com.sg www.spgroup.com.sg www.slng.com.sg www.sunelectric.com.sg www.sunseap.com
Market Support Services Licensee (MSSL)	SP Services	www.spgroup.com.sg
Market Operator	Energy Market Company	www.emcsg.com
Power System Operator (PSO)	Power System Operator	www.ema.gov.sg
Transmission Licensee	SP PowerAssets	www.spgroup.com.sg

The following changes took place in 2016:
- Diamond Energy Supply was renamed Diamond Energy Merchants
- Diamond Energy was renamed Diamond Energy Managers
- CPvT Energy Asia was renamed Red Dot Power
- Singapore Oxygen Air Liquide was renamed Air Liquide Singapore

Important Notice

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