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Dear Industry Members

The National Electricity Market of Singapore (NEMS) was formed and started trading in January 2003 as part of Singapore’s journey to liberalise the electricity market. Part of the motivation behind reforming the market was to ensure that Singapore benefited from competitive electricity prices and improved efficiency.

The NEMS turned ten in January 2013. The industry has come a long way since the early days, when the power sector was vertically integrated with the Public Utilities Board (and subsequently Singapore Power) owning the generation, transmission and retail segments of the industry.

Today, natural monopolies like the transmission grid have been separated from the competitive segments of generation and retail. Three of Singapore’s largest commercial generators have been divested and are privately owned by foreign investors, and there are now close to 30 market participants in the NEMS comprising commercial generators, embedded generators, wholesale market traders and retailers.

The industry’s evolution and growth are also apparent from the NEMS’ performance. This issue of the NEMS Market Report contains a ten-year overview of key performance indicators.

Overall, the annual value of products traded in the NEMS has grown from $3 billion in 2003, to a record $10.9 billion last year.

Like the rest of Asia, strong economic growth has fuelled the demand for electricity in Singapore in the past ten years. Electricity consumption - or metered demand - grew 36 percent between 2003 and 2012, reaching 44 terawatt hours last year which is the highest level since the start of the wholesale electricity market.

At the same time, the international price of fuel has spiraled upwards especially in the last five years. Singapore relies almost fully on imported fuel to generate electricity and is vulnerable to rising fuel costs. Arising largely from this, the Uniform Singapore Energy Price (USEP) more than doubled between 2003 and 2012, reaching an all-time high of $222 per megawatt hour last year.

While the increase in the USEP may seem sizable, it is important to note that its rate of increase has been slower than the rise in fuel price as a result of efficiency gains and competition from market liberalisation. In the last ten years, fuel price has risen by close to three times.

Competition among generation companies has led to the use of more efficient technologies which reduce generation costs and put downward pressure on prices. Over the years, the more efficient and cleaner burning combined-cycle gas turbine (CCGT) units have replaced steam turbine units as the dominant source of power generation in Singapore. CCGT’s market share stood at 86 percent in 2012, the highest level since the start of the wholesale electricity market.

As the NEMS matures, it is well-placed to take on new challenges and opportunities. To moderate price fluctuations and mitigate risks for market participants, there are plans to introduce greater demand response in the wholesale market and to set up an electricity futures market.

To ensure energy security for Singapore, diversification strategies like the use of liquefied natural gas has been implemented, while electricity imports are being considered.

I would like to take this opportunity to thank our market participants, our regulator, the Energy Market Authority, as well as members of the Rules Change Panel, the Market Surveillance and Compliance Panel and the Dispute Resolution and Compensation Panel, for their continued support in the evolution of the NEMS.

I look forward to another ten years of successful trading for the NEMS.

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. This 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

<table>
<thead>
<tr>
<th>Event</th>
<th>Year</th>
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<tbody>
<tr>
<td><strong>Corporatisation</strong></td>
<td>1995</td>
</tr>
<tr>
<td>Electricity functions of the Public Utilities Board corporatised</td>
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<tr>
<td>Singapore Power formed as a holding company</td>
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<tr>
<td><strong>Singapore Electricity Pool (SEP)</strong></td>
<td>1996</td>
</tr>
<tr>
<td>SEP commenced</td>
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<tr>
<td>PowerGrid is SEP Administrator and Power System Operator (PSO)</td>
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<tr>
<td><strong>National Electricity Market of Singapore (NEMS)</strong></td>
<td>2000</td>
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<tr>
<td>Decision for further reform to obtain full benefits of competition</td>
<td></td>
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<tr>
<td>New market design process began</td>
<td></td>
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<tr>
<td><strong>National Electricity Market of Singapore (NEMS)</strong></td>
<td>2001</td>
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<tr>
<td>Electricity industry legislation enacted</td>
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<tr>
<td>Energy Market Authority (EMA) established as industry regulator and PSO</td>
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<tr>
<td>Energy Market Company (EMC) established as the NEMS wholesale market operator</td>
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<tr>
<td>First phase of retail contestability</td>
<td></td>
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<tr>
<td><strong>National Electricity Market of Singapore (NEMS)</strong></td>
<td>2002</td>
</tr>
<tr>
<td>Testing and trialling of wholesale market system began</td>
<td></td>
</tr>
<tr>
<td><strong>National Electricity Market of Singapore (NEMS)</strong></td>
<td>2003</td>
</tr>
<tr>
<td>NEMS wholesale market trading began</td>
<td></td>
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<tr>
<td><strong>National Electricity Market of Singapore (NEMS)</strong></td>
<td>2004</td>
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<tr>
<td>Vesting contract regime introduced</td>
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<tr>
<td>Interruptible loads (IL) began to participate in the reserves market</td>
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<tr>
<td><strong>National Electricity Market of Singapore (NEMS)</strong></td>
<td>2006</td>
</tr>
<tr>
<td>First wholesale market trader joined the market and commenced trading as IL provider</td>
<td></td>
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<tr>
<td>First commercial generator since 2003 joined the market and started trading</td>
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<tr>
<td>Retail contestability expanded to 75 percent of total electricity demand</td>
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<tr>
<td><strong>National Electricity Market of Singapore (NEMS)</strong></td>
<td>2007</td>
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<tr>
<td>Removal of the Market Registration Application Fee</td>
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<td><strong>National Electricity Market of Singapore (NEMS)</strong></td>
<td>2008</td>
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<tr>
<td>Sale of Tuas Power to China Huaneng Group in March, Senoko Power to Lion Consortium in September, and PowerSeraya to YTL Power in December</td>
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<tr>
<td>Embedded generators (EG) joined the market</td>
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<tr>
<td><strong>National Electricity Market of Singapore (NEMS)</strong></td>
<td>2009</td>
</tr>
<tr>
<td>Revised regulation price cap of $300/MWh was implemented</td>
<td></td>
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<tr>
<td>New EGs, small generators and incineration plants joined and started trading</td>
<td></td>
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<tr>
<td><strong>National Electricity Market of Singapore (NEMS)</strong></td>
<td>2010</td>
</tr>
<tr>
<td>Vesting tender was introduced to tender out a percentage of non-contestable electricity demand to generation companies for bidding</td>
<td></td>
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<tr>
<td><strong>National Electricity Market of Singapore (NEMS)</strong></td>
<td>2012</td>
</tr>
<tr>
<td>NEMS completed ten successful years of trading</td>
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</table>
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.

**Five New Market Participants Joined the Market**

In 2012, the NEMS welcomed five new market participants (MPs) comprising four generators and one retailer.

GMR Energy (Singapore) registered as an MP in January. In the same month, ExxonMobil Asia Pacific joined as an MP and subsequently registered two units, each with a capacity of 110MW, in the second half of the year. ExxonMobil is currently the largest embedded generator in the NEMS.

Tuaspring, a wholly owned subsidiary of Hyflux Ltd, registered as an MP in August. TP Utilities, a Tuas Power group company, registered a 101MW cogeneration facility in September. This is the tenth cogeneration facility registered in the NEMS to date.

On the retail side, existing MP Diamond Energy registered Diamond Energy Supply as a retailer in the NEMS in September. Diamond Energy Supply is the first independent retailer in the NEMS.

**Participants and Service Providers in the NEMS**

| Generators                                      | ExxonMobil Asia Pacific                  |
|                                                | GMR Energy (Singapore)                   |
|                                                | Keppel Merlimau Cogen                    |
|                                                | National Environment Agency              |
|                                                | Sembcorp Cogen                          |
|                                                | Senoko Energy                           |
|                                                | Senoko Waste-to-Energy                   |
|                                                | Shell Eastern Petroleum                  |
|                                                | Keppel Sengkers Tuas Waste-To-Energy Plant (Tuas DBOO Trust) |
|                                                | TP Utilities                            |
|                                                | Tuas Power Generation                    |
|                                                | Tuaspring                                |
|                                                | YTL PowerSeraya*                         |

| Wholesale Market Traders                      | Air Products                            |
|                                                | Banyan Utilities                        |
|                                                | Diamond Energy                          |
|                                                | Green Power Asia                        |
|                                                | ISK Singapore                           |
|                                                | Pfizer Asia Pacific                     |
|                                                | MSD International Gmbh (Singapore Branch) |
|                                                | Singapore Oxygen Air Liquide             |

| Retailers                                      | Diamond Energy Supply                   |
|                                                | Keppel Electric                         |
|                                                | Sembcorp Power                          |
|                                                | Senoko Energy Supply                    |
|                                                | Seraya 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                          |

*YTL PowerSeraya took over the generation business of PowerSeraya with effect from 1 April 2012.*
Market Overview: Industry Structure

Generation Licensees
All generators that are connected to the transmission system are licensed by the EMA unless their facilities are less than 10MW. 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.

Wholesale Market Traders
Wholesale Market Traders are companies, other than generators or retailers, that are licensed by the EMA to trade in the wholesale electricity markets.

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 consumer registration and transfer, meter reading and meter data management, retail settlements and billing for contestable consumers. SP Services is the only MSSL.

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 market surveillance and the compliance and dispute resolution processes.

Transmission License – 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 supply of electricity to consumers. The PSO controls the dispatch of generation facilities, co-ordinates scheduled outages and power system emergency planning and directs the operation of the high-voltage 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 being 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; and
- near real-time dispatch.

**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, then selects the optimal mix of generation and interruptible loads (IL) 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 ILs are matched with the system demand forecast and system security requirements. The MCE produces 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-hour to determine the:

- dispatch quantity that each generation unit is to produce;
- reserve and regulation capacity that each generation unit is required to maintain;
- level of IL that is required; and
- corresponding prices for energy, reserve 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 44 injection nodes, and the prices at up to 698 withdrawal or off-take nodes 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.

**Energy, Reserve and Regulation Products**

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<tr>
<th>Description</th>
<th>Purchaser</th>
<th>Seller</th>
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<tr>
<td>Energy</td>
<td>Generated electricity</td>
<td>Retailers</td>
</tr>
<tr>
<td>Reserve</td>
<td>Stand-by generation capacity or IL that can be drawn upon when there is an unforeseen shortage of supply. Three classes of reserve are traded: 1) primary reserve (8-second response) 2) secondary reserve (30-second response) and 3) contingency reserve (10-minute response)</td>
<td>Generators</td>
</tr>
<tr>
<td>Regulation</td>
<td>Generation that is available to fine-tune the match between generation and load</td>
<td>Generators and Retailers</td>
</tr>
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**Near Real-Time Dispatch**

Market prices and dispatch quantities for energy, reserve 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.

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1 Number of injection and withdrawal nodes are as of 31 December 2012.
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 the 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 consistent 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 in which 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) plays a crucial role in guiding the evolution of the Singapore Electricity Market Rules, ensuring that they stay relevant and promote efficiencies in Singapore’s wholesale electricity market. The proposals that the RCP deals with often conflate a range of different economic, finance and engineering issues.

To enhance current processes, the RCP deals with administrative proposals such as reviewing the suspension order hearing and dispute resolution processes, and updating the market operations market manual. These changes reflect the industry’s tireless stance to continually improve on the status quo.

The RCP also regularly examines ways to fine-tune the Market Clearing Engine (MCE) to promote market efficiency and security, given its pivotal scheduling function. One enhancement addressed this year incorporated a tie-breaking algorithm that apportioned scheduled quantities based on the respective proportion of tied offers. This reduces possible dispatch instability arising from the MCE’s current random allocation of tied offers.

Often, the Panel tackles issues that require a careful balance of differing objectives. For example, the RCP studied if regulation charges should be charged based on the impact of a given generation unit’s volatility on system stability. While the proposal was fundamentally sound, the Panel decided not to proceed after careful consideration of the associated costs and benefits. Another example is the issue of whether the Value of Lost Load (VoLL) should be raised, which would have important ramifications on the price discovery process. Again, after contemplation of various factors, the RCP decided to hold off any changes for the moment, until such time when the market is less concentrated or there are better risk management mechanisms in place to mitigate the effects of a higher VoLL.

I am proud of the rigorous analyses and constructive deliberations by the Panel when evaluating the rule changes, and glad that they have contributed to the continued operation of an efficient market.

Let me take this opportunity to express my gratitude to all who have contributed to making 2012 a fruitful year for the RCP: my fellow Panel members for their professionalism, dedication and expertise; our EMA regulators and the EMC Board for collaboratively considering rule changes supported by the RCP; and all market participants who have actively contributed to the rule change process through their valuable comments and suggestions. I would also like to thank EMC’s Market Administration Team for their diligent efforts and insightful analyses, which are a great help to the RCP in arriving at appropriate decisions.

Dave Carlson
Chair
Rules Change Panel
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.

Review of Suspension Order Hearing Process

This review incorporated three rule changes pertaining to the suspension order hearing process.

1. Extension of the duration of the suspension order hearing

Previous Market Rules required a defaulting MP to remedy its default within two business days, failing which EMC would submit a request to the MSCP to suspend the MP. The MSCP would then conduct and conclude a suspension order hearing within two business days, providing the MP with an opportunity to show cause as to why a suspension order should not be issued against it. The MSCP considered two business days inadequate for the conduct of the hearing, and proposed an extension.

Extending the suspension order hearing process increases prudential requirements and, consequently, costs to the market. The RCP thus supported EMC’s counterproposal to shorten the time that MPs have to remedy their default, while lengthening the duration of the suspension order hearing to four business days. By doing so, there will be no change to prudential requirements, or additional costs to the market.

2. Clarification that the MSCP should seek the EMA’s approval before suspending a generation or transmission licensee, or the Market Support Services Licensee

The previous drafting of the Market Rules required a circular reading to conclude that the MSCP should seek the EMA’s approval before suspending a generation or transmission licensee, or the MSSL. A second rule change was supported to reflect the intended meaning more clearly.

3. Greater flexibility for the MSCP to issue suspension order and/or other orders

Previously, upon the conclusion of a suspension order hearing, the MSCP could issue a suspension order and make other orders pertaining to the defaulting MP. However, the MSCP could not make other orders without first issuing a suspension order. A third rule change was thus implemented to give the MSCP greater flexibility in its determinations.

Number of Business Days Allowed for Dispute to be Resolved through Mediation

Under the previous Market Rules, a mediator was required to conduct a mediation session within 20 business days of its appointment. A disputing party could submit the matter for arbitration only if the matter was not resolved within 40 business days of the same appointment date.

The DRC proposed allowing the disputing party to submit an unresolved dispute for arbitration within 20 business days after the appointment of a mediator instead of the previous 40 business days. This was because most mediation sessions could be completed within a day, and the Market Rules already provided for disputing parties to extend the timeline to complete the mediation, if required. The DRC was thus of the view that if, after 20 business days, disputing parties were unable to resolve their dispute or agree to extend the timeline to continue the mediation, they would be unlikely to resolve their dispute through mediation. The rule change thus streamlines the process to allow disputing parties to submit the matter for arbitration earlier, rather than wait until the end of the 40 business days of the mediator’s appointment. The RCP agreed to implement the proposed rule change to allow for a more efficient dispute resolution process.

Correction of Typographic Errors in the Description of Export Limit

The export limit was previously described in the Market Rules as “a limit on the total net energy flows out of Singapore across all connections, including interties, from facilities outside of Singapore”. As the limit relates to export quantities, it should be imposed on the total net energy flows “to” (instead of “from”) facilities outside of Singapore. A rule change was thus made to correct this typographic error in the description of the export limit.


The Market Operations Market Manual (Standing Offers, Offer Variations and Standing Capability Data) was last updated on 28 June 2011. As there were subsequent changes to the Market Rules and market operations systems, a review of the Market Manual was conducted to reflect these changes. This review also incorporated a rule change to reflect that offers accepted as valid prior to the commencement of any market schedule run would be used, removing the previous provision that valid offers received five minutes prior to a market schedule run were not guaranteed to be included.
Exceptions to Gate Closure During an Emergency Operating State

Under the previous Market Rules, offer changes for a given dispatch period were not allowed 65 minutes prior to the start of a given dispatch period. This 65-minute period is termed “gate closure”, and is imposed to provide advance notice to both the PSO and generation companies. There were, however, exceptions to this rule for system security reasons, such as when offer changes can alleviate an energy surplus or an energy/reserve/regulation shortfall situation, in response to a market advisory.

Some inflexibility was inherent with the previous arrangements, as market advisories were issued at fixed intervals in conjunction with market schedule runs. A proposal was thus implemented for offer changes to be accepted so long as an Emergency Operating State (EOS) is declared by the PSO. Specifically, when an EOS is triggered by a shortage of energy, reserve or regulation, additional offers for the respective product are allowed even within the gate closure period. This allows for greater responsiveness in alleviating shortfall situations and enhances system security.

Tie-Breaking of Offers

Currently, the MCE clears tied offers (i.e., offers for the same product at the same effective price) in a random manner, compromising dispatch stability. A rule change was thus proposed to incorporate a tie-breaking algorithm so that such ties are resolved in a predictable manner that enhances dispatch stability.

Essentially, where tied offers between a pair of facilities are not allocated in the proportion of their offers, the MCE attributes a very small penalty factor of $10^{-6}$ to the objective function. As such, the MCE resolves such ties by scheduling these facilities in proportion to their offers as far as possible, but not to the extent of compromising other aspects of the objective function. This algorithm will be applied across all products and all types of facilities.

Proposed Rule Changes Not Supported by the RCP

The RCP also discussed the following proposals but decided not to support them, either because the current arrangement was deemed more appropriate, the timing was not right for implementation, or the potential benefits did not justify the costs.

Application of Cap on Reserve and Regulation Charges Imposed on Embedded Generators

Currently, embedded generators (EGs) pay non-reserve charges on a net basis (i.e., withdrawal energy quantities net of injection energy quantities), though they are still required to pay reserve charges (including reserve and regulation costs) on a gross basis (i.e., sum of withdrawal and injection energy quantities). A proposal was made to cap the reserve and regulation charges payable by EGs, on the basis that they are unable to self-hedge against reserve and regulation price spikes since they are currently not qualified to provide reserve and regulation (even though the Market Rules allow them to).

EMC’s analysis supports the current reserve and regulation cost allocation methodology. Firstly, EGs cause the same need for reserve and regulation and thus, should be charged in the same manner as commercial generators. Secondly, reserve and regulation cost considerations should have been factored into EGs’ decisions – if EGs consider reserve and regulation charges to be too high, they could have explored risk mitigation measures (such as building frequency-responsive features or purchasing reserve or regulation contracts), improve the reliability of their generators or reduce their output to manage these costs.

The RCP supported EMC’s recommendation that the current cost allocation mechanism is equitable and consistent with the causer-pay principle and thus, no changes were made.

Allocation of Regulation Costs

A proposal suggested that since “variable” loads cause the need for more regulation compared to more “stable” loads, the former should pay a greater proportion of regulation costs in line with the causer-pay principle.

EMC’s analysis found that charging regulation costs based on the relative variability of load and generation is currently practised by the Australian Energy Market Operator. Essentially, the deviation of a generator’s actual injection, or a load’s actual withdrawal, from its assigned reference trajectory is compared against the system frequency to ascertain the unit’s impact on system stability, which in turn determines the unit’s respective share of the regulation costs.

However, EMC concluded that since regulation payments comprise only 0.5 percent of the overall market, the implementation costs of this proposal may not be justifiable. This is especially so since the proposal would have resulted in a re-allocation, rather than a reduction, of regulation costs. The proposal was thus not supported.
Review of the Value of Lost Load

The Value of Lost Load (VoLL) measures the value an average consumer puts on an unsupplied unit of energy, or the average willingness to pay to avoid an additional hour without power. This important figure sets the reference price level for constraint violation penalties, and plays a key role in the price discovery process (e.g., setting prices when there are inadequate energy offers in the system).

The current VoLL at $5,000/MWh was estimated using the country’s gross domestic product divided by its total electricity consumption at market start. A proposal suggested raising it to $10,000/MWh to provide greater incentives for future capacity investment. After considering the potential effects of a higher VoLL on investment incentives, price risks, and the market structure in the near term, the RCP decided to retain the VoLL at its current level.

Management of Transmission Congestion

Singapore has a robust transmission network with adequate transmission resources to serve all generating units, barring ad-hoc transmission maintenance or outage cases. Moving forward, however, there could be transmission tightness in the Southwest block, where a surge in new generation plantings may lead to a surplus of generation capacity and corresponding transmission constraints. This expected congestion should be relieved with the upcoming substation and connecting undersea cable tunnel which will link Jurong Island to the mainland.

A proposal suggested identifying the presence of transmission constraints ex-ante, and compensating generation units that are given “must run” obligations due to congestion causes. The RCP discussed these suggestions, and unanimously agreed on the following:

a. There is no need to identify transmission constraints ex-ante, as forecast locational marginal prices are sufficient to incentivise generation companies to relieve the congestion.

b. MPs may seek compensation from the EMA if their generation costs under “must-run” obligations are greater than the locational marginal prices they receive.

c. There is no value in considering Financial Transmission Rights (FTRs) at this juncture, as they do not address the root cause of transmission congestion in Singapore’s context, and their significant implementation costs are unjustifiable given that the projected network constraint is temporary.

In view of the above, no rule changes were necessary.

Rule Change Directed by the EMA

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

Modification of Market Rules for the Liquefied Natural Gas (LNG) Vesting Scheme

To encourage the uptake of regasified LNG, the EMA introduced the LNG Vesting Scheme in 2010. This scheme modifies the current vesting contract regime to factor in regasified LNG as a fuel source, when determining the vesting price. The LNG Vesting Scheme will come into effect from the start of the first complete quarter following the commercial operation date of Singapore’s first LNG terminal.
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 a 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 Products - Tay Wee Ann
2. Air Products - Shawn Zhang
3. Diamond Energy - Yang Huiqiang
4. Energy Market Company - Abdul Aziz Yam
5. Energy Market Company - Coco Choo
6. ExxonMobil - Elaine Lee
7. Green Power Asia - Daniel Ma
8. Keppel Electric - Janice Bong
9. Keppel Electric - Joelyn Wong
10. Keppel Merlimau Cogen - Sean Chan
11. Keppel Merlimau Cogen - Tini Mulyawati
12. National Environment Agency - Teresa Tan
14. Pfizer - Lee Chin Hoo
15. Pfizer - Tan Meng Tong
16. Power System Operator - Yong Thi Yen
17. Power System Operator - Nick Wong
18. Sembcorp Cogen - Chua Gwen Heng
19. Sembcorp Cogen - Aeron Hong
20. Sembcorp Power - HC Chew
21. Senoko Energy - Eveline How
22. Senoko Energy - Josiah Poh
23. Senoko Energy - Eu Pui Sun
24. Senoko Energy - Michelle Lim
25. Seraya Energy - Elaine Syn
26. Seraya Energy - Daniel Lee
27. Singapore Oxygen Air Liquide - Lim Yong Yi
28. SP PowerAssets - Chan Hung Kwan
29. SP PowerAssets - Ong Sheau Chin
30. SP Services - Lawrence Lee
31. SP Services - Budiman Roesli
32. Tuas Power Generation - Philip Tan
33. Tuas Power Generation - Priscilla Chua
34. Tuas Power Supply - Jazz Feng
35. Tuas Power Supply - Zhang Ai Jia
36. YTL PowerSeraya - Calvin Quek
37. YTL PowerSeraya - Albert Siah

As part of my responsibilities, I help to provide training in dispute resolution and the Market Rules for the DMS contacts.

On 31 August 2012, the DMS contacts visited the Supreme Court and the Singapore Mediation Centre to get a better understanding of dispute resolution processes. The visit to the Supreme Court was organised and supported by EMC’s Market Assessment Unit.

DRCP Members

The DRCP members are:

Mediation Panel

1. Chandra Mohan
2. Daniel John
3. Danny McFadden
4. Geoff Sharp
5. Associate Professor Joel Lee
6. Associate Professor Lim Lei Theng
7. Dr Peter Adler
8. Robert Yu
9. Shirli Kirschner

Arbitration Panel

1. Giam Chin Toon, Senior Counsel
2. Gregory Thorpe
3. Professor Lawrence Boo
4. Naresh Mahtani
5. Phil Harris
6. Raymond Chan
7. Dr Robert Gaitskell, Queen’s Counsel
8. Professor Tan Cheng Han, Senior Counsel

Conclusion

I am happy to report that no disputes were filed with me over the past year. 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: Overview of the Year

Annual USEP and Ancillary Prices 2003/12

In 2012, the annual average Uniform Singapore Energy Price (USEP) was $222.49 per megawatt hour (MWh). Compared to 2011, the USEP was 3.6 percent higher which was in line with the increase in electricity demand and high sulfur fuel oil (HSFO) price of 2.8 percent and 3.5 percent respectively. The USEP trended above the vesting contract hedge price (VCHP) for the first half of 2012 due to upstream gas curtailment and low supply cushion. From July 2012, the USEP trended below the VCHP due to improved supply conditions.

Prices for reserves were mostly lower and this was broadly attributed to a shift of offers to the cheaper offer tranches. Secondary reserve price decreased by $0.28/MWh to $1.91/MWh, contingency reserve price decreased by $0.18/MWh to $15.89/MWh and primary reserve price rose slightly by $0.14/MWh to $0.46/MWh.

Regulation price also rose. It averaged $91.53/MWh, the second highest since the market started. This was due to a lower regulation supply against a higher regulation requirement.

Over the last ten years, the following were observed for the prices of various products in the National Electricity Market of Singapore (NEMS):

- The USEP generally rose in tandem with the HSFO price. Compared to 2003, the average USEP in 2012 more than doubled to $222.49/MWh.

Prices for primary and secondary reserves were comparatively lower than the other products and averaged $6.78/MWh and $2.55/MWh respectively over ten years. From 2007 to 2012, contingency reserve price was the highest amongst the three reserves; over ten years, contingency reserve price averaged $10.60/MWh.

- Regulation price climbed steadily for the first five years, and then decreased in 2008. Thereafter, it started on an upward trend again except in 2011. On a ten-year average, regulation price was $64.22/MWh.

- Based on HSFO 180 CST price which is used as a proxy for fuel price.
Market Performance: Overview of the Year

Annual USEP and Fuel Price (HSFO) Movements 2003/12

USEP movements mostly in line with fuel price movements

The USEP trended with the HSFO\(^3\) price most of the time between 2003 and 2012, with the exception of 2007.

In 2007, the USEP fell as the combined-cycle gas turbine (CCGT) offer availability increased, leading to the proportion of energy offers for the offer price band below $100/MWh to increase from 66.9 percent in 2006 to 81.8 percent in 2007.

Compared to 2003, the HSFO price was 2.7 times higher in 2012, whereas the USEP was only 2.4 times higher.

\(^3\)Based on HSFO 180 CST prices which were converted from US dollars to Singapore dollars. The currency conversion rates were from www.exchangerate.com. HSFO 180 CST price is used as a proxy for fuel price.
Growth in energy market a main driver for pushing annual value of products traded above $10 billion

The annual value of products traded in the NEMS recorded a new high of $10.9 billion in 2012, surpassing the 2011 figure by $1.2 billion. This was attributed mainly to the growth in the energy and regulation markets of 5.8 percent and 0.2 percent respectively. The reserve market also grew but registered an increase of only 0.04 percent.

For 2012, the energy market accounted for 98.4 percent of all products traded, while the reserve and regulation markets accounted for 0.8 percent and 0.7 percent respectively.

The ten-year average for the annual value of products traded from 2003 to 2012 was $6.4 billion. The annual trading value in 2012 had multiplied by more than three times since 2003.
Annual Electricity Consumption 2003/12

Electricity consumption increases by more than one third over ten years

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

Electricity consumption exceeded 44 terawatt hours (TWh) in 2012, with a 2.8 percent increase over 2011. The largest increase was in the fourth quarter, when electricity consumption rose by 5.9 percent year-on-year (YOY).

The growth of electricity consumption in 2012 from 2003 was 35.6 percent.

The ten-year average consumption in the NEMS was 38.5 TWh, with an average annual growth rate of 3.5 percent over the ten years. The YOY growth was lowest in 2009 due to the general economic downturn at that time (coinciding with the global financial crisis). For each year, consumption is typically lowest in quarter one and highest in quarter two or three. The lower consumption in the first quarter is due to a smaller number of calendar days as well as the Chinese New Year holidays. The higher consumption in quarter two or three correlates with higher temperatures during those quarters.
More incoming capacity, CCGT and cogen\(^4\) technologies lead in registered capacity

As of 31 December 2012, the licensed capacity\(^5\) of 13,923MW surpassed the registered capacity of 10,810MW in the NEMS, indicating a potential 28.8 percent increase or 3,114MW of incoming capacity by 2015.

The bulk of the incoming capacity will be of the CCGT and cogen plant types. Based on the licensed capacity, it is expected that the share of CCGT/cogen/trigen facilities registered in the NEMS will expand from 72.3 percent on 31 December 2012 to a potential 78.4 percent by 2015.

\(^4\)Cogen refers to cogeneration where a generation facility is capable of delivering combined heat and power (CHP).

\(^5\)Licensed capacity calculated from the Energy Market Authority’s data and Schedule A published on its website as of 7 January 2013.

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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.
Generation Facilities Registered and De-registered in 2012

There were 10,810MW of registered capacity in the NEMS as of 31 December 2012. An 8.8 percent net increase from 2011, the additional registered capacity in 2012 were from Keppel Merlimau Cogen, Senoko Energy, and newcomers ExxonMobil and TP Utilities.

The entrants to the market consisted of:

- Close to 11,000MW of registered capacity in the NEMS in 2012
- ExxonMobil 2 GT cogeneration units 220MW
- Keppel Merlimau Cogen 1 CCGT cogeneration unit 406MW
- Senoko Energy 2 CCGT units 862MW
- TP Utilities 1 ST cogeneration unit 101MW

One exit occurred in 2012, where a 600MW ST generating unit was de-registered from Tuas Power Generation.

Of the registered capacity in 2012, 26.3 percent (2,840MW) belonged to cogeneration and trigeneration facilities which are able to produce steam and/or chilled water in addition to electricity.
Generation supply expands by 4.3 percent, aided by a boost in CCGT/cogen/trigen supply in 2012

CCGT/cogen/trigen supply rose in 2012 by 8.7 percent, GT supply stayed almost the same while ST supply fell by 4.4 percent. The overall generation supply increased by 4.3 percent to 6,891 MW, as the increase in CCGT/cogen/trigen supply of 576 MW outpaced the decrease in ST supply of 290 MW.

Although the average registered capacity was 10,729 MW, the generation supply was 64.2 percent of this amount. The gap was attributed to maintenance, forced outages, or generation companies not offering their full capacities into the NEMS. Relative to their registered capacities by plant type, CCGT/cogen/trigen supply was at 79.5 percent and ST supply at 29.7 percent in 2012.

On a ten-year average, generation supply was 6,028 MW. Other observations for supply over the ten years:

- The average expansion of supply was 3.1 percent per annum.
- The biggest expansion was in 2010 where supply increased by 8.1 percent.
- CCGT/cogen/trigen supply almost doubled while ST supply decreased by more than half.
- For the fourth time on an annual average since the market started, CCGT/cogen/trigen supply exceeded demand. The surplus of CCGT/cogen/trigen supply over demand was the highest in 2012, averaging at 533 MW.
Annual Market Share by Plant Type 2003/12

CCGT/cogen/trigen market share surges above 86 percent

In 2012, the annual market share for CCGT/cogen/trigen surged above 86 percent. Throughout the year, the CCGT/cogen/trigen market share maintained above 86 percent except from February to June and in August, when it ranged between 81.3 percent and 85.9 percent. The CCGT/cogen/trigen market share was highest in October, at 91.4 percent.

Overall, the increase in CCGT/cogen/trigen market share was in line with the increase in the CCGT/cogen/trigen supply.

Over the past ten years, a general trend observed was the increasing market share of CCGT/cogen/trigen units. This was most evident in the first four years following the start of the market. Subsequently, CCGT/cogen/trigen market share stabilised at about 80 percent before moving up to its highest level in 2012.

The market share is computed based on scheduled generation. The market share for GT was 0.00 percent in 2012, 0.01 percent in 2007, 2008, 2010 and 2011, 0.02 percent in 2009 and 0.03 percent in 2005. GT units did not participate in the market in 2003.

Note: The percentages in this chart may not add up to 100% due to rounding.
**Market Performance: Energy Demand**

**Monthly Forecasted Demand 2008/12**

- **Demand rise seen in most months except January and July**

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

  Comparing YOY, forecasted demand was higher for all months except January and July. Overall, the forecasted demand rose by 2.4 percent in 2012.

  Compared to 2011, the monthly forecasted demand profile for 2012 trended in a similar fashion from February to June and in December. The forecasted demand was highest in the months of May and June in 2012 instead of July and September in 2011.

  The highest monthly average was 5,316 MW in June, and peak forecasted demand was registered on period 32 of 15 August, at 6,386 MW (74 MW higher than the peak in 2011).
Monthly Generation Supply by Plant Type 2012

More increases in CCGT/cogen/trigen supply as ST supply cuts back

The YOY changes in monthly supply were all positive in 2012, where the increases in CCGT/cogen/trigen supply compensated for the decreases in ST supply (except in February where the YOY change in ST supply was also positive). The monthly CCGT/cogen/trigen supply averaged 5,704MW, which was 10.1 percent higher than in 2011. The minimum monthly CCGT/cogen/trigen supply in 2012 increased by 700MW to 5,200MW compared to 2011. For ST supply, the 2012 average fell by 29.6 percent against 2011 to 975MW.

Generation maintenance increases in 2012 as more generation units register in the NEMS

Overall, the increases in supply, compared to 2011, were the highest in the months of February and August. The highest supply was 7,241MW in August.

Generation maintenance levels increased by 7.4 percent in 2012 and averaged 1,012MW. Compared to 2011, generation maintenance increased for seven months – in March, from May to September and in December. June 2012 registered the highest level of generation maintenance, as there were at least two generation units out on maintenance every day.

Overall, the ratio of generation maintenance to registered capacity increased from 9.5 percent in 2011 to 9.7 percent in 2012.

6Generation maintenance levels are calculated based on the annual generation overhaul program (AGOP) provided by the PSO.
Throughout 2012, offers below $200/MWh formed the bulk of the offers, with each monthly average being above 70 percent. However, this percentage declined from 77.3 percent in 2011 to 74.1 percent in 2012. The monthly average of offers below $300/MWh also declined. It fell from 82.5 percent in 2011 to 79.4 percent in 2012.

Higher fuel prices\(^7\) tend to depress cheaper energy supply (the proportion of offers below $200/MWh) and this can be seen with the overall HSFO price increasing from US$649.04 per metric tonne (MT) in 2011 to US$671.48/MT in 2012.

\(^7\)Based on HSFO 180 CST price which is used as a proxy for fuel price.
The utilisation rate measures the scheduled energy as a percentage of registered capacity.

For CCGT/cogen/trigen, the utilisation rate ranged between 57.9 percent and 66.0 percent. For ST, the utilisation rate ranged between 14.8 percent and 28.3 percent. Of the 12 months in 2012, the utilisation rates were higher in January, February and March for CCGT/cogen/trigen, and in February, May and June for ST. Utilisation rates ranked highest in the months of March, April and November for GT.

As a result of more commissioning units from the CCGT/cogen/trigen category in 2012, which typically run below their optimal capacities, the CCGT/cogen/trigen utilisation rate fell compared to 2011. For ST, the utilisation rate in 2012 also fell compared to 2011, but this was due to a displacement of supply away from ST into CCGT/cogen/trigen.
Market Performance: Energy Prices

**Market Performance**

**Energy Prices**

Monthly USEP, VCHP and Supply Cushion 2012

<table>
<thead>
<tr>
<th>Month</th>
<th>USEP</th>
<th>VCHP</th>
<th>Supply Cushion %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td></td>
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<td>Feb</td>
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<td>Dec</td>
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</tbody>
</table>

$/MWh

**Monthl USEP 2012**

(Categorised by Average, Peak, Shoulder and Off-peak)

<table>
<thead>
<tr>
<th>Day Type</th>
<th>Peak</th>
<th>Shoulder</th>
<th>Off-peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>P18-41</td>
<td>P16-17, P42-48</td>
<td>P1-15</td>
</tr>
<tr>
<td>Saturday</td>
<td>-</td>
<td>P1, P17-47</td>
<td>P2-16, P48</td>
</tr>
<tr>
<td>Sunday/Public Holiday</td>
<td>-</td>
<td>P21-46</td>
<td>P1-20, P47-48</td>
</tr>
</tbody>
</table>

**USEP falls in second half of 2012 with a supply cushion boost**

During the year, the monthly average USEP varied between $194/MWh and $266/MWh, whilst the VCHP varied between $206/MWh and $225/MWh. The USEP pulled away from the VCHP the most in May as the supply cushion dropped to one of its lowest points in the year.

The USEP trended above the VCHP for the first half of the year due to upstream gas curtailment and low supply cushion. The USEP stayed below the VCHP for most of the second half of the year with improved upstream gas supply and a larger supply cushion from July onwards resulting mainly from the commercial operations of two new Senoko CCGT generation units.

The average USEP in November would have been below the VCHP, and would have registered as the lowest monthly average in 2012, if not for price spikes on 26 November which saw the daily USEP peak at a record of $997/MWh.

Throughout each month in 2012, the spare capacity stayed above 1,500MW and averaged at 1,706MW. The annual average spare capacity increased by 8.0 percent from 2011. Taking the spare capacity as a percentage of supply, the supply cushion in 2012 stayed above 23 percent, averaging 25.2 percent per month. This was 1.4 percent higher than the average in 2011.

**Larger gap in USEP between peak and off-peak periods in April, July and November**

The following periods are categorised by the MSSL as peak, shoulder and off-peak:

<table>
<thead>
<tr>
<th>Day Type</th>
<th>Peak</th>
<th>Shoulder</th>
<th>Off-peak</th>
</tr>
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<td>P2-16, P48</td>
</tr>
<tr>
<td>Sunday/Public Holiday</td>
<td>-</td>
<td>P21-46</td>
<td>P1-20, P47-48</td>
</tr>
</tbody>
</table>

The peak period USEP deviated strongly from the USEP in off-peak periods in the months of April, July and November, where the difference was more than $75/MWh.

8 More details on the instances of higher daily USEP can be found in the “Daily USEP, Forecasted Demand and Offer Capacity 2012” section on pages 28 and 29.

Looking at the yearly average, the USEP for the peak, shoulder and off-peak categories all rose compared to 2011, by 5.6 percent, 6.8 percent and 0.2 percent respectively.
Points A, C, F and J were beyond $340/MWh.
Energy price spikes mostly in the first half of the year

2012 saw less fluctuations in the daily USEP compared to the year before. The key observations on some of the daily spikes in the USEP in 2012 (higher than $300/MWh) are as follows:

**Point A:**
The daily USEP averaged $447/MWh on 21 January where within the day, the USEP rose above $500/MWh for eight periods. During those eight periods, the supply cushion ranged between 12.0 and 17.2 percent. The lower supply cushion was due to higher demand and lower CCGT supply. The lower CCGT supply was caused by four CCGT forced outages that day, as well as two CCGT units being out on maintenance. GT was scheduled for the eight periods when the USEP had exceeded $500/MWh and during those periods, the average GT utilisation rate was 14.0 percent.

**Point B:**
On 25 February, the daily USEP averaged $321/MWh. The USEP rose above $500/MWh for seven periods when the supply cushion ranged between 19.7 and 21.0 percent. The lower supply cushion was caused by a combination of higher demand and lower CCGT supply as two CCGT units were out on maintenance. GT was scheduled for the seven periods when the USEP had exceeded $500/MWh and during those periods, the average GT utilisation rate was 2.3 percent.

**Point C:**
On 23 and 24 March, the daily USEP averaged $419/MWh and $355/MWh respectively. The USEP registered above $500/MWh for 29 periods when the supply cushion was between 15.7 and 23.2 percent. The low supply cushion was on the back of higher demand and lower CCGT supply as three CCGT units were out on maintenance. GT was scheduled for 19 of the 29 periods, when the supply cushion was 18.9 percent or less. During those 19 periods, the average GT utilisation rate was 16.6 percent.

**Point D:**
On 13 April, the daily USEP averaged $308/MWh. There were a total of seven periods when the USEP registered above $500/MWh due to a lower supply cushion of between 12.5 and 16.7 percent. The low supply cushion was on the back of a lower ST supply following a ST forced outage, as well as a lower CCGT supply due to two CCGT units being out on maintenance. GT was scheduled for five of the seven periods, when the supply cushion was 15.9 percent or less. During those five periods, the average GT utilisation rate was 12.4 percent.

**Point E:**
On 16 April, the daily USEP averaged $317/MWh. There were a total of five periods when the USEP registered above $500/MWh due to a lower supply cushion of between 19.5 and 23.4 percent. The low supply cushion was on the back of a lower supply following a ST forced outage in the earlier part of the day, and two CCGT forced outages in the later part of the day. GT was scheduled for one period, when the supply cushion was 19.5 percent. In that period, the average GT utilisation rate was 1.5 percent.

**Point F:**
On 4 May, the daily USEP averaged $364/MWh. There were 15 periods when the USEP registered above $500/MWh due to a lower supply cushion of between 15.4 and 19.1 percent. The low supply cushion was on the back of a lower CCGT supply following a CCGT forced outage and two CCGT units being out on maintenance. GT was scheduled for all 15 periods during which the average GT utilisation rate was 1.1 percent.

**Point G:**
On 16 May, the daily USEP averaged $304/MWh. The USEP registered above $500/MWh for one period when the supply cushion was 19.7 percent. Contributing to the price spike was the combination of one CCGT forced outage and two-and-a-half CCGT units being out on maintenance.

**Point H:**
On 18 May, the daily USEP averaged $307/MWh. There were three periods when the USEP registered above $500/MWh, when the supply cushion was between 17.2 and 18.9 percent. Contributing to the first price spike was lower CCGT supply resulting from one partial CCGT forced outage, one CCGT unit being out on maintenance, and one CCGT unit being out on partial maintenance. The other two price spikes were caused by lower CCGT supply as well as higher demand. GT was scheduled for one period, when the supply cushion was 18.9 percent. In that period, the average GT utilisation rate was 0.2 percent.

**Point I:**
On 26 June, the daily USEP averaged $335/MWh. There were five periods when the USEP registered above $500/MWh, when the supply cushion was between 18.2 and 19.1 percent. The price spikes were due to lower supply and two CCGT units being out on maintenance.

**Point J:**
On 26 Nov, the daily USEP averaged $997/MWh. This was the highest daily USEP since the market started. There were 15 periods when the USEP registered above $500/MWh. Out of those 15 periods, nine were above $3,000/MWh. During those 15 periods, the supply cushion was only between 7.6 and 14.2 percent. The tight supply caused an energy shortfall for one period that day. It also affected the contingency and regulation markets, where there were six periods of contingency reserve shortfalls and nine periods of regulation shortfalls.

Contributing to the price spikes were two CCGT units out on maintenance, two forced outages in the morning, and extremely low supply from ST.

GT was scheduled for all 15 periods, during which the average GT utilisation rate was 31.5 percent.

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*Two of the four forced outages that day were partial forced outages.*
Market Performance: Ancillary Markets

Annual Reserve Payment 2003/12

Annual reserve payment averages $77 million over ten years. Reserve payment higher in 2012, following higher requirement

The reserves act to restore system stability in the event of an unexpected generation outage. In the NEMS, reserve requirements are set to cater for the loss of the largest on-line generation unit. The reserve price is the market price determined for each of the three classes of reserve products traded (primary, secondary and contingency). The cost of reserve products is borne by the generators.

For the past ten years these payments varied between $31.6 million and $114.3 million. The largest deviation occurred in 2008 and 2009, when the costs were the lowest and highest respectively. In 2008 the reserve cost was lowest as all reserve prices were below $6/MWh, and in 2009, the reserve cost was record high as both the secondary and contingency reserve prices reached a record high. In 2009, the secondary reserve price rose on the back of a fall in supply, rise in requirement and a shift of offers into the price tranche above $5/MWh. The contingency reserve price rose on the back of a fall in supply and a rise in requirement.

In 2012, the reserve payments increased 4.9 percent to $92.4 million. This was due to a rise in requirements across all three classes of reserves.

Over the year, the highest reserve payments occurred in May and December, when the monthly reserve payments exceeded $11 million. Reserve payments peaked in December at $17.4 million, when the monthly average contingency reserve price was the highest. Reserve payments in 2012 ranked the fourth highest since the market started.
Primary reserve price moves up slightly, despite being below $0.60/MWh in most months

Throughout the year, the monthly primary reserve price stayed mostly below $0.60/MWh, except for March, August and December.

In March and August, the primary reserve price rose due to higher offer prices\(^{10}\). For December, the primary reserve price rose on the back of lower supply. In March and December, higher primary reserve requirements also pushed the reserve price upwards.

Overall, the primary reserve supply fell by 2.7 percent while there was a negligible change in requirement. This caused the primary reserve price to rise slightly by $0.14/MWh in 2012, to average at $0.46/MWh. Notably, the highest primary reserve price for a trading period in 2012 was only $105.21/MWh, the lowest since the market started.

Secondary reserve price falls on the back of cheaper offers, and averages $1.91/MWh

The monthly secondary reserve price stayed between $1/MWh and $3/MWh for most of the year. The three highest monthly secondary reserve prices registered were $3.08/MWh, $3.64/MWh and $4.10/MWh in March, June and December respectively.

For both March and June, the high secondary reserve prices were due to an increase in secondary reserve requirement and higher offer prices\(^{11}\). For December, the high secondary reserve price was due to the fall in secondary reserve supply outweighing the fall in secondary reserve requirement.

Overall, both the secondary reserve requirement and supply increased by 4.0 percent and 0.9 percent respectively. Although the requirement increased, the increase in the secondary reserve supply together with a higher proportion of offers in the offer tranche below $5/MWh, caused the secondary reserve price to fall by $0.28/MWh in 2012. It averaged $1.91/MWh. Notably, the highest secondary reserve price in 2012 for a trading period was only $134.35/MWh, the lowest since the market started.

\(^{10}\)Higher proportion of offers in the offer tranche above $5/MWh.

\(^{11}\)Higher proportion of offers in the offer tranche above $5/MWh.
Contingency reserve price falls on the back of cheaper offers, and averages $15.89/MWh

The monthly contingency reserve price stayed below $15/MWh for most of the year. The three highest monthly contingency reserve prices registered were $24.83/MWh, $36.01/MWh and $37.19/MWh in May, November and December respectively.

In May, the contingency reserve price rose on the back of higher contingency reserve requirement and lower supply. In November, the contingency reserve price rose on the back of higher contingency reserve requirement, higher offer prices and contingency reserve price spikes on 26 November when there were six instances of contingency reserve shortfall due to tight supply. The shortfall caused the contingency reserve price to hit the ceiling of $3,250/MWh for six trading periods. The contingency reserve price averaged $659.90/MWh for the day, a record high since the market started. In December, the contingency reserve price rose on the back of lower contingency reserve supply.

Overall for the year, the contingency reserve price fell by $0.18/MWh against 2011 to average $15.89/MWh, despite an increased requirement of 7.7 percent and a decreased supply of 10.0 percent. This was due to a 10.0 percent increase in offers in the offer tranche below $5/MWh.

12Higher proportion of offers in the offer tranche above $5/MWh.
As of 31 December 2012, the total registered capacity for IL remained the same as last year at 21MW for each class of reserve.

However, the percentage of registered capacity of IL against the total fell for all three classes of reserves. The percentage of registered capacity by IL for reserves in 2012 was 2.3 percent for the primary reserve, 1.9 percent for the secondary reserve and 0.7 percent for the contingency reserve. This was in contrast to 2.4 percent for the primary reserve, 2.1 percent for the secondary reserve and 1.0 percent for contingency reserve in 2011.

In 2012, the number of IL activations for contingency reserve rose to 11 but the total number of periods when IL was activated for contingency reserve fell by 30.0 percent to 14. There was no IL activation for primary and secondary reserves in 2012.

Overall, payment to IL totalled $0.86 million in 2012, up by 5.5 percent from $0.81 million in 2011.
Reserve Provider Group Effectiveness for Primary and Secondary Reserve Classes (Aggregate) 2003/12

Better ratings for reserve providers

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. Hence, reserve providers have been incentivised to be more responsive over the last ten years.

As with the previous years, 2012 continued to see the largest group of reserve providers – an average of 60.1 percent of them – categorised under Group A. The overall level of responsiveness improved in 2012, as apparent from the increase in the percentage of reserve providers in Group A by 8.6 percent. On average, 2012 saw the highest percentage of reserve providers categorised under Group A, and the lowest percentage of reserve providers categorised under Group E.

13Since 1 June 2012, there was a change in the incentives assigned to Groups A, D and E according to the system operations manual (SOM) from the PSO.
Average Failure Probability by Year

The probability of failure 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 unit with a lower failure probability will be allocated less reserve cost compared to one with a higher failure probability.

In 2012, the average failure probability for CCGT/cogen/trigen, ST and GT was 0.035 percent, 0.020 percent and 0.436 percent respectively. Compared against 2011, both the maximum failure probability and the standard deviation increased. This is partially attributed to the higher number of commissioning units in 2012.

Overall, the average failure probability over the ten years from 2003 to 2012 for CCGT/cogen/trigen is 0.059 percent which is the lowest amongst the three categories. It remained below 0.05 percent from 2008 to 2012.
Annual Forced Outages by Generation Companies 2003/12

Instances of Forced Outage

- Keppel Merlimau Cogen
- Sembcorp Cogen
- Tuas Power Generation
- YTL PowerSeraya
- Sembcorp Cogen Incineration Plants
- Embedded Generators
- Senoko Energy
- TP Utilities

No. of generation units

Number of forced outages increases with a higher number of generating units registered

The total number of generation forced outages was 105 in 2012, the fifth highest since the market started. This was partly due to a larger number of generating units in the NEMS.

The number of generation units refers to the number of generation units registered in the NEMS which are subject to reserve responsibility share.
Annual Regulation Payment 2003/12

Regulation payment averages $56 million over ten years, regulation payment in 2012 is second highest since 2003

Following a rise in the regulation price from 2011 to 2012, the regulation payment rose by 40.4 percent to $77.4 million. Compared to the previous years, the regulation payment in 2012 was the second highest since the market started.

In 2012, the regulation payment was highest in December at $8.0 million, following the highest regulation price in December.
Market Performance: Ancillary Markets

Monthly Regulation Price, Requirement and Supply 2012

Regulation prices rise on the back of higher regulation requirement and lower regulation supply, and averages 91.53/MWh.

The monthly regulation price stayed within the range of $80/MWh and $100/MWh in 2012 for most of the year. In December, the regulation price rose on the back of a lower proportion of offers in the regulation offer tranche below $30/MWh.

Overall, the average regulation price increased 37.0 percent to 91.53/MWh in 2012. This was due to a combination of higher regulation requirement and lower supply, where the regulation requirement rose by 4.6 percent to 87MW and the regulation supply decreased by 1.0 percent to 155MW.
Keen competition among generators as different players take the podium over the ten years

In 2012, the three leading generation companies saw shifts of more than one percent each. The top gainer for 2012 was Senoko Energy whose market share improved by 2.1 percent to 27.0 percent. Tuas Power Generation’s market share dropped by 1.9 percent to 25.3 percent, while YTL PowerSeraya’s market share also decreased by 1.2 percent to 25.9 percent. The smaller market players mostly gained market share in 2012, with the larger gains of 0.9 and 0.5 percent going to the embedded generators and Keppel Merlimau Cogen respectively.

Overall, there was keen competition as market share leaders for generation shifted over the ten years. On a ten-year average, the largest market share held was 28.9 percent by Senoko Energy.
Keen competition among retailers over ten years

The two most significant shifts in the retail landscape in 2012 were the 2.3 percent gain by Senoko Energy and the 3.6 percent loss by Tuas Supply. Overall, there was keen competition as market share leaders for retailers shifted over the ten years. On a ten-year average, the largest market share held in the retail market, besides that of SP Services, was 16.1 percent by Seraya Energy.
Energy Market Company (EMC) is the financial clearing house for the wholesale market and settles the following transactions:

- energy;
- ancillary market products - three classes of reserve (primary, secondary 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 market participants (MPs) from payment defaults. EMC reviews the risk exposure of MPs on a daily basis.

A margin call is issued when a retailer’s estimated exposure reaches a value equal to or greater than 70 percent of the level of its credit support. In 2012, EMC issued 15 margin calls, and all were met within the required time frame of two business days.

In 2012, the value of total retail settlement payments was $4.174 billion and the value of credit support on 31 December 2012 was $535.77 million.
In addition to the co-optimised 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 2012 to 31 March 2013, 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 68.848MW of black-start service at a cost of $10.29 million. The capability was sourced from YTL PowerSeraya, Senoko Energy and Tuas Power Generation.

<table>
<thead>
<tr>
<th>Cost incl. GST (million)</th>
<th>Quantity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black-start Service</td>
<td>10.29</td>
</tr>
<tr>
<td>68.848</td>
<td></td>
</tr>
</tbody>
</table>
The costs associated with the wholesale functions of the NEMS are recovered directly from the wholesale market or from MPs and consumers.

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

**EMC Net Fees and PSO Fees Recovered Directly from the NEMS – 1 April 2012 to 31 March 2013**

<table>
<thead>
<tr>
<th></th>
<th>Total Fees '000</th>
<th>Fees/MWh* $</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMC Net Fees</td>
<td>27,162</td>
<td>0.3024</td>
</tr>
<tr>
<td>PSO Net Fees</td>
<td>17,667</td>
<td>0.1967</td>
</tr>
<tr>
<td><strong>Total Fees</strong></td>
<td><strong>44,829</strong></td>
<td><strong>0.4991</strong></td>
</tr>
</tbody>
</table>

*The volume is estimated at 44,915MWh based on actual volumes up to September 2012 being annualised.

**Fees Recovered Directly from MPs and Consumers**

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Service</th>
<th>Method of Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP PowerAssets</td>
<td>Transmission charges</td>
<td>Levied based on actual usage</td>
</tr>
<tr>
<td>SP Services (MSSL)</td>
<td>Meter reading and data management</td>
<td>Levied on a per meter basis</td>
</tr>
</tbody>
</table>
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 reserve. The black-start ancillary service is contracted by Energy Market Company (EMC) on an annual basis.

black-start ancillary service
A service to ensure that there is initial generation for system restoration following a complete blackout.

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.

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.

load
The consumption of electricity.

load
The consumption of electricity.

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

market participant (MP)
A person who has an electricity licence issued by the Energy Market Authority (EMA) and has been registered with EMC as a market participant.

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. Nodal pricing is also commonly referred to as locational marginal pricing.

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, SP Services.

net treatment of non-reserve charges for embedded generators
With effect from June 2011, non-reserve charges (EMC fees, Power System Operator fees and Monthly Energy Uplift Charges) for embedded generation facilities will be administered based on their amount of net withdrawal (consumption) from, or net injection (generation) into the grid. To qualify for this treatment, an embedded generation facility requires approval from the EMA and registration with EMC as an embedded generation facility.

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.

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
Metered demand is the electricity consumption which is proxied by the withdrawal energy quantity (WEQ).

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.

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

load
The consumption of electricity.

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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, SP Services.
regulation
Generation that is on standby to fine-tune the match between generation and load.

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 produce 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 every three months. It is determined using the long-run marginal cost (LRMC) 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.

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.

wholesale market
The transactions made between generation companies and retail companies.
### Additional Information: Market Entities’ Contact Details

| **Generator Licensees** | ExxonMobil Asia Pacific  
| GMR Energy (Singapore)  
| Keppel Merlimau Cogen  
| Keppel Seghers Tuas Waste-To-Energy Plant Pte Ltd  
| in its capacity as Trustee of Tuas DBOO Trust  
| National Environment Agency  
| Sembcorp Cogen  
| Senoko Energy  
| Senoko Waste-To-Energy Pte Ltd (in its capacity as Trustee of Senoko Trust)  
| Shell Eastern Petroleum  
| TP Utilities  
| Tuas Power Generation  
| Tuaspring  
| YTL PowerSeraya | www.exxonmobil.com.sg  
| www.gmrgroup.in  
| www.keppelenergy.com  
| www.keppelseghers.com  
| www.nea.gov.sg  
| www.sembcorp.com  
| www.senokoenergy.com.sg  
| www.kie.com.sg  
| www.shell.com.sg  
| www.tuaspower.com.sg  
| www.tuaspower.com.sg  
| www.hyflux.com  
| www.ytlpowerseraya.com |

| **Retailer Licensees** | Diamond Energy Supply  
| Keppel Electric  
| Sembcorp Power  
| Senoko Energy Supply  
| Seraya Energy  
| www.keppelenergy.com  
| www.sembcorp.com  
| www.senokoenergy.com.sg  
| www.serayaenergy.com.sg  
| www.tpsupply.com.sg |

| **Wholesale Market Traders** | Air Products Singapore  
| Banyan Utilities  
| Diamond Energy  
| Green Power Asia  
| ISK Singapore  
| MSD International GmbH (Singapore Branch)  
| Pfizer Asia Pacific  
| Singapore Oxygen Air Liquide | www.airproducts.com.sg  
| www.diamond-energy.com.sg  
| www.greenpowerasia.com  
| www.isktuas.com  
| www.msd-singapore-ltd.com  
| www.pfizer.com.sg  
| www.soaxal.com |

| **Market Operator** | Energy Market Company | www.emcsg.com |

| **Market Support Services Licensee** | SP Services | www.spservices.com.sg |


| **Transmission Licensee** | SP PowerAssets | www.sppowerassets.com.sg |
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