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Dear Industry Members

Singapore’s economy grew by a spectacular 14.5 percent in 2010. Fuelled by the buoyant economy, the National Electricity Market of Singapore (NEMS) saw a year of record performance with trading surpassing the $7 billion mark for the first time in the history of the NEMS.

The recovery in the NEMS seen in the second half of 2009 continued in 2010. Demand was strong throughout the year, with the first two quarters registering the highest growth rates compared to the same periods last year. Overall, demand for the year reached 42 terawatt hours, an increase of 8.3 percent from 2009 and a new record for the market.

In tandem with the strong demand, the annual Uniform Singapore Energy Price (USEP) reached its highest level ever in 2010 at $171 per megawatt hour. Higher price levels were recorded in the first half of the year. During the first six months, a combination of strong demand, facility maintenance and forced outages led to tight supply conditions which drove the USEP above $200 per megawatt hour for a total of 43 days. The USEP eased in the second half of 2010 with the start of operations of two new combined-cycle gas turbine (CCGT) units that were registered in late 2009.

The two new CCGT units led to increased competition among generation companies in the NEMS. In addition, the market saw the entrance of two new market participants (MPs) in 2010, which started trading in the NEMS as embedded generators and added a total of three new steam turbine units collectively. These additional generation facilities, together with the overall higher demand and lower maintenance levels in 2010, pushed annual supply above 6,500 megawatts for the first time since the market started.

The demand, supply and price movements in the NEMS in 2010 are testimony of a competitive market at work. To ensure continued fair and efficient trading in the NEMS and the dynamic evolution of the market, governance bodies and enforcement panels play an important role. I would like to thank the members of the Rules Change Panel, the Market Surveillance and Compliance Panel as well as the Dispute Resolution and Compensation Panel for their commitment and ongoing efforts in addressing rule changes, monitoring market behavior and training MPs in dispute resolution.

As the wholesale electricity market evolves, I am confident that it will continue to attract new investment, thereby promoting competition and driving efficiency. I look forward to another year of robust trading for the NEMS in 2011.

Wong Meng Meng
Chairman
Energy Market Company
MARKET OVERVIEW
Market Overview: Market History

The opening of the National Electricity Market of Singapore (NEMS) in January 2003 was the culmination of a number of structural reforms to Singapore’s electricity industry. Singapore’s journey through 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 operation. On 1 April 2001, a new legal and regulatory framework was introduced that formed the basis for a new electricity market.

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 Description</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporatisation</td>
<td>1995</td>
</tr>
<tr>
<td>Electricity functions of the Public Utilities Board corporatised</td>
<td></td>
</tr>
<tr>
<td>Singapore Power formed as a holding company</td>
<td></td>
</tr>
<tr>
<td>Singapore Electricity Pool (SEP), design process began</td>
<td>1996</td>
</tr>
<tr>
<td>Singapore Electricity Pool (SEP)</td>
<td>1998</td>
</tr>
<tr>
<td>SEP commenced</td>
<td></td>
</tr>
<tr>
<td>PowerGrid is SEP Administrator and Power System Operator (PSO)</td>
<td></td>
</tr>
<tr>
<td>Review of electricity industry</td>
<td>1999</td>
</tr>
<tr>
<td>National Electricity Market of Singapore (NEMS)</td>
<td>2000</td>
</tr>
<tr>
<td>Decision for further reform to obtain full benefits of competition</td>
<td></td>
</tr>
<tr>
<td>New market design process began</td>
<td></td>
</tr>
<tr>
<td>Electricity industry legislation enacted</td>
<td>2001</td>
</tr>
<tr>
<td>Energy Market Authority (EMA) established as industry regulator and PSO</td>
<td></td>
</tr>
<tr>
<td>Energy Market Company (EMC) established as the NEMS wholesale market operator</td>
<td></td>
</tr>
<tr>
<td>Initial phase of retail contestability</td>
<td></td>
</tr>
<tr>
<td>Draft Market Rules issued</td>
<td>2002</td>
</tr>
<tr>
<td>Testing and trialling of wholesale market system began</td>
<td></td>
</tr>
<tr>
<td>NEMS wholesale market trading began</td>
<td>2003</td>
</tr>
<tr>
<td>More large consumers introduced to retail contestability</td>
<td></td>
</tr>
<tr>
<td>Vesting contract regime introduced</td>
<td>2004</td>
</tr>
<tr>
<td>Interruptible loads (IL) began to participate in the reserves market</td>
<td></td>
</tr>
<tr>
<td>New wholesale market trader joined the market and commenced trading as IL provider</td>
<td>2005</td>
</tr>
<tr>
<td>Keppel Merlimau Cogen joined the market and started trading</td>
<td>2006</td>
</tr>
<tr>
<td>Retail contestability expanded to 75 percent of total electricity demand</td>
<td></td>
</tr>
<tr>
<td>Removal of the Market Registration Application Fee</td>
<td>2007</td>
</tr>
<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>
<td>2008</td>
</tr>
<tr>
<td>Embedded generators joined the market</td>
<td></td>
</tr>
<tr>
<td>On 14 May, revised regulation price cap of $300/MWh was implemented</td>
<td>2009</td>
</tr>
<tr>
<td>New embedded generators, small generators and incineration plants joined and started trading</td>
<td></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>2010</td>
</tr>
<tr>
<td>Shell Eastern Petroleum joined the market as an embedded generator and started trading</td>
<td></td>
</tr>
</tbody>
</table>
Market Overview: Industry Structure

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

New Market Participants Joined the Market

2010 saw the entry of two new generators into the market. Shell Eastern Petroleum joined the NEMS on 20 April with a 60MW generation facility, while Singapore Oxygen Air Liquide participated from 8 October with a generation capacity of 15MW. Both new market participants have been granted net settlement and price neutralisation by the EMA. This increases the total number of embedded generators in the NEMS to five.

<table>
<thead>
<tr>
<th>Participants and Service Providers in the NEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Generators</td>
</tr>
<tr>
<td>Keppel Merlimau Cogen</td>
</tr>
<tr>
<td>National Environment Agency</td>
</tr>
<tr>
<td>PowerSeraya</td>
</tr>
<tr>
<td>Sembcorp Cogen</td>
</tr>
<tr>
<td>Senoko Energy Pte Ltd</td>
</tr>
<tr>
<td>Senoko Waste-to-Energy</td>
</tr>
<tr>
<td>Shell Eastern Petroleum</td>
</tr>
<tr>
<td>Keppel Seghers Tuas Waste-To-Energy Plant Pte Ltd (Tuas DBOO Trust?)</td>
</tr>
<tr>
<td>Tuas Power Generation</td>
</tr>
<tr>
<td>Wholesale Market Traders</td>
</tr>
<tr>
<td>Air Products</td>
</tr>
<tr>
<td>Banyan Utilities</td>
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<tr>
<td>Diamond Energy</td>
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<tr>
<td>IUT Singapore</td>
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<tr>
<td>ISK Singapore</td>
</tr>
<tr>
<td>Pfizer Asia Pacific</td>
</tr>
<tr>
<td>Schering-Plough</td>
</tr>
<tr>
<td>Singapore Oxygen Air Liquide</td>
</tr>
<tr>
<td>Active Retailers</td>
</tr>
<tr>
<td>Keppel Electric</td>
</tr>
<tr>
<td>Sembcorp Power</td>
</tr>
<tr>
<td>Senoko Energy Supply</td>
</tr>
<tr>
<td>Seraya Energy</td>
</tr>
<tr>
<td>Tuas Power Supply</td>
</tr>
<tr>
<td>Market Support Services Licensee (MSSL)</td>
</tr>
<tr>
<td>SP Services</td>
</tr>
<tr>
<td>Market Operator</td>
</tr>
<tr>
<td>Energy Market Company</td>
</tr>
<tr>
<td>Power System Operator (PSO)</td>
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<tr>
<td>Power System Operator</td>
</tr>
<tr>
<td>Transmission Licensee</td>
</tr>
<tr>
<td>SP PowerAssets</td>
</tr>
</tbody>
</table>

1 In January 2010, Senoko Energy Pte Ltd took over the business previously held by Senoko Power Limited as part of its restructuring.
2 In June 2010, Tuas DBOO Trust was formed to take over the assets and business undertaking of Keppel Seghers Tuas Waste-to-Energy Plant Pte Ltd as part of a restructuring exercise.
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 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 the market surveillance and compliance process and the dispute resolution process.

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.
Market Overview: Market Features

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

- co-optimisation of energy, reserve and regulation products;
- security-constrained dispatch and nodal pricing; 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
- the 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 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 45 injection nodes and the prices at approximately 699 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.

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.

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.

<table>
<thead>
<tr>
<th>Energy, Reserve and Regulation Products</th>
<th>Description</th>
<th>Purchaser</th>
<th>Seller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>Generated electricity</td>
<td>Retailers</td>
<td>Generators</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, Retailers and Wholesalers</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>
<td>Generators</td>
</tr>
</tbody>
</table>
MARKET GOVERNANCE
Market Governance: Overview

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, the RCP members are drawn from 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 of the many sectors of the industry.

The rule change process is designed to maximise both 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), comprised of professionals independent of the market, is responsible for monitoring, investigating and reporting on 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 a MP is not compliant with the Market Rules, it may take enforcement action, including levying a penalty. The MSCP also recommends remedial actions to mitigate any rule breaches or inefficiencies identified. The panel publishes 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 Counselor.
Dear Industry Members

The wholesale market operations of the NEMS are governed by the Singapore Electricity Market Rules. Given ongoing changes to the macroeconomic climate, government policies and market structure, the Market Rules constantly evolve to stay relevant and ensure the market’s efficient operations. The RCP is tasked with the mandate of guiding the evolution of the Market Rules.

This year, the RCP tackled complex issues that required an in-depth examination of trade-offs and cost-benefit analyses. Against this challenging backdrop, I would like to express my gratitude to all Panel members for carrying out their duties with professionalism, independence and diligence.

Looking back at the proposals tackled by the Panel, one central theme stood out – the revisitation of fundamental market design principles, including:

- Gate Closure for Generator Offers (Review of Economic Incentives for Generator Reliability);
- Ex-ante Pricing Regime (Proposed Extension of Type 4 Price Re-Runs);
- Self-commitment of Generating Units (Requirement for Generation Registered Facilities to Submit Positive Energy Offer Quantities Unless Physically Unavailable);
- Basis of Regulation Procurement (Compensation for Excess Regulation); and
- Principle of Reserve Cost Allocation (Allocation of Reserve Costs to Load and Generation Settlement Facilities).

I think it is healthy to re-evaluate the relevance of these principles, now that the industry is equipped with several years of experience and knowledge since the commencement of the NEMS. I am heartened to note the fact that no significant rule changes were needed, which attests to the soundness of the original market design.

Many issues addressed by the RCP this year also required a considered balance between divergent and often contradicting objectives. For example, the study Modeling of Multi-Unit Contingency Risk weighed the benefit of enhancing system security against the costs of procuring additional reserve; the deliberation to release more market operations data pitted market transparency against the possibility of facilitating collusion.

I am proud of the constructive debate by the Panel when evaluating the trade-offs, and I am sure all members went away with a deeper appreciation of the wholesale market design.

Let me take this opportunity to thank the RCP members who have stepped down over the course of the year for their valuable contributions: Mr Brendan Wauters, Mr Yeo Lai Hin, Mr Sim Meng Khuan and Ms Annie Tan. At the same time, I would like to welcome their replacements to the Panel: Mr Luke Peacocke, Mr Kng Meng Hwee, Mr Daniel Lee and Mr Sean Chan. This is part of the Panel’s rejuvenation process, and I am excited to tackle the rule change proposals in the coming year with fresh perspectives from the new members.

Beyond the Panel, I would like to thank all other parties who have contributed to making 2010 a success, including our EMA regulators and the EMC Board, the Market Administration Team at EMC and all MPs who have contributed in one way or other to the rule change process.

Dave Carlson
Chair
Rules Change Panel
Market Governance: Market Evolution

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

Review of Economic Incentives for Generator Reliability

In 2008, the EMA engaged KEMA Consulting to review existing generation reliability practices in the Singapore Wholesale Electricity Market (SWEM). KEMA Consulting was of the opinion that the current Market Rules are not stringent enough to require a Generation Registered Facility (GRF) to immediately re-bid its energy offer following a trip, thus leading to the artificial suppression of spot prices and system security concerns. KEMA Consulting proposed to set a timeline of 30 minutes for GRFs to submit re-declarations following a trip or failure to synchronise, and introduce an automatic penalty scheme to penalise GRFs that fail to comply.

Based on a legal review of KEMA Consulting’s proposal and current market design principles, the RCP supported EMC’s conclusion that the current rules already impose a stringent obligation on GRFs to revise their offers to reflect their physical capability, and that the proposed penalty scheme is not congruent with SWEM’s design principle of self-commitment. Notwithstanding, the review surfaced the opportunity to clarify how current re-declaration rules work in relation to the gate closure rules; specifically, a GRF should not revise its offers to the extent of their physical capability, and that the proposed penalty scheme is not congruent with SWEM’s design principle of self-commitment. Notwithstanding, the review surfaced the opportunity to clarify how current re-declaration rules work in relation to the gate closure rules; specifically, a GRF should not revise its offers to the extent of their physical capability, and that the proposed penalty scheme is not congruent with SWEM’s design principle of self-commitment.

Amendment to PSO’s Budget & Fees Review Process

Currently the Market Rules provide for the industry’s feedback on the PSO’s budget to be given through the RCP’s review of the proposed annual budget. The RCP provides its views on the budget to the PSO and the EMA for their consideration.

At the 49th RCP Meeting, the Panel supported a Market Rules change relating to the PSO’s budget, which was for the PSO to publish its proposed budget to the public, given that consumers ultimately bear all fees in the NEMS. Interested parties can then provide their views on the PSO’s proposed budget to the PSO and the EMA for their consideration. The proposed modification will revise the PSO’s budget and fees review process as follows:

a. 60 days before the beginning of each five-year period comprising five consecutive fiscal years, the PSO to publish its proposed budget and fees for the period on the EMA website for public comments;

b. Once the EMA has finalised the PSO’s budget and fees for a given five-year period, the PSO to publish them on the EMA website and provide a copy of the finalised fees to EMC;
c. As soon as reasonably feasible after the end of each fiscal year, the PSO to determine if actual expenditure for the fiscal year was, due to exogenous factors (i.e. events, circumstances or factors not anticipated by the EMA or PSO at the time of publication), more than the published expenditure (“under-recovery”), or less than the published expenditure (“over-recovery”). With the EMA’s approval, the PSO is to publish the expenditure on the EMA website and provide a copy of the finalised fees to EMC;

d. Adjustments will be made to the budget and fees should actual expenditure differ from the published expenditure, for which the PSO will inform the EMA.

Requirement for Market Participant Invoice to Show Details of EMC Settlement Clearing Account

Currently, the Market Rules require EMC’s invoices to MPs to show details of the EMC settlement account and recovery. The PSO is to provide a copy of the revised PSO’s budget and fees adjusted for the under- or over-recovery. The PSO is to provide a copy of the revised PSO’s fees to EMC. Such revised fees shall, when published by the PSO, take effect for the remainder of the relevant five-year period.

Modeling of Multi-Unit Contingency Risk

As reserve is meant to cover the cost of any GRF dispatched to provide energy, the reserve requirement is set based on the single largest GRF’s scheduled quantity. However, the PSO was concerned that some contingency events could lead to the loss of multiple GRFs simultaneously, resulting in inadequate reserve in the system. For example:

- where there are two or more co-dependent GRFs within the same Power Station, the tripping of one GRF may lead to the loss of the remaining GRFs;
- where only one transmission facility connects two or more GRFs from the same Power Station to the grid, the tripping of the transmission facility can lead to the loss of all connected GRFs; or
- when there is a disruption of gas supply, the system may lose multiple gas-fired GRFs supplied by the same pipeline.

To address these scenarios, “multi-unit contingency groups” were proposed whereby GRFs vulnerable to any multi-unit contingency event will be grouped together as a combined risk-setter to better manage the cause of the risk, compared to the current practice of adjusting the risk adjustment factor for the various reserve classes, so that the reserve requirements can be correspondingly determined. The RCP voted not to support this proposal due to cost considerations.

Compensation for Excess Regulation

Some MPs noted that their GRFs were called upon to provide more regulation than scheduled for short instances, and suggested that they should be compensated for providing this excess regulation. EMC’s analysis concluded...
that since the regulation requirement is determined based on the average forecast demand and actual system demand across the period, regulation procured should similarly be taken as the average across the whole period, rather than the maximum value within the period. On this basis, the study found excess regulation provision to be insignificant on a system-wide level.

Notwithstanding, some GRFs were observed to be more responsive than others in providing regulation. Thus, EMC proposed to adjust regulation payments based on each GRF’s responsiveness in providing regulation, using assigned regulation effectiveness factors (REFs). The RCP, however, decided not to implement an REF regime, given the difficulty in determining the factors using historical or technical data.

Proposed Extension of Type 4 Price Re-Runs

This study assessed the proposal to extend Type 4 price re-runs to price separation incidents, where a transmission line that was modeled in the market clearing engine to have reached its maximum capacity did not do so in reality. This involved a review of the principle of ex-ante pricing in SWEM to ensure a consistent application of sound market principles.

EMC analysed both ex-ante and ex-post pricing methodologies in terms of economic efficiency and equity, and recommended that given Singapore’s low demand volatility and the costs of implementing an ex-post pricing regime, the current ex-ante pricing arrangement should be retained. The RCP supported EMC’s recommendation and voted not to extend Type 4 price re-runs as proposed, as it would be inconsistent with the ex-ante market design principles.

Shortlist of Data Types Considered For Release in SWEM

To enhance transparency in the SWEM, the RCP approved a shortlist of data types to be reviewed for release, selected from five data categories from the 2007 CRA survey of data release practices in centrally-dispatched electricity markets. These include the following data groups:

- load flow model;
- hourly dispatch schedules for energy, reserve and regulation (either masked or with generating unit IDs); and
- unit-specific operational parameters and unit commitment data

Given the EMAs clarification that information related to the load flow model should not be released as it is critical to system security, and that the release of dispatch schedules is addressed in a separate study, this exercise focused on whether unit-specific operational parameters and unit commitment data should be released. EMC’s study found that releasing such data would derive no material benefit, yet incur implementation costs and raise concerns over the commercial sensitivity of such data. The RCP thus supported EMC’s recommendation not to release the data.

Publication of Historical Dispatch Schedules

An MP proposed publishing historical dispatch schedules by generating unit ID, suggesting that this allowed MPs to analyse market movements without compromising sensitive pricing information or facilitating the exercise of market power or collusion. However, EMC’s analysis found that doing so could facilitate the exercise of market power, and would not significantly enhance economic efficiency or facilitate market monitoring. In spite of EMC’s recommendations, the RCP supported the proposal and felt that access to such data would even the playing field.

Before making a determination, the EMA engaged IHS CERA to review the impact of the proposal on consumers. IHS CERA concluded that while most jurisdictions encouraged information disclosure to enhance transparency in the market, the unique characteristics of the NEMS, including the high market concentration, did not support such disclosure. The EMA accepted IHS CERA’s recommendations and decided not to approve the proposal until such time when there are more market players and a lower market concentration in the NEMS.

Requirement for GRFs to Submit Positive Energy Offer Quantities Unless Physically Unavailable

Currently, generation companies (gencos) are allowed to submit zero energy quantity offers if they choose not to run up their GRFs, even if these units are physically available. A proposal was received suggesting that GRFs should be required to offer positive energy quantities into the market, at all periods when they are physically available. This is to prevent any capacity withholding or undue exercise of market power.

However, the RCP supported EMC’s recommendation not to accept the proposal, given that:

- the SWEM operates on the principle of self-commitment, which is driven by a desire for both economic efficiency and increased commercial sovereignty; and
- the EMA had confirmed that the objective of the vesting contracts is to curb the exercise of market power and not to impose an obligation on gencos to offer positive energy quantities.

Allocation of Reserve Costs to Load and Generation Settlement Facilities

Reserve costs are charged only to generation facilities with scheduled energy of more than 10MW, with a larger share of the costs allotted to facilities with higher energy schedules or less reliable performance. An MP proposed to apportion some reserve costs to load and generation facilities with scheduled energy below 10MW.

Based on market design principles, reserve costs are allocated to generation facilities rather than load because the generation facilities cause the need for reserve (e.g., when they trip), and they can best manage reserve cost risks in the system (e.g., through their energy and reserve offers). Further, outages by generation facilities with scheduled energy below 10MW will already be adequately covered by regulation without requiring reserve activation. These facilities should therefore be exempted from reserve charges. As such, the RCP supported EMC’s recommendation not to proceed with the rule change proposal.

Conflict of Interest for Dispatch Coordinator

As the dispatch coordinator (DC) of an MP could act as the DC of another MP, there were concerns that this could lead to a possible conflict of interest or market power concentration. However, after much discussion, the RCP supported EMC’s proposal not to change the Market Rules given the following:

- market power issues resulting from the use of agent DCs are best addressed through the EMAs policies and MP license conditions; and
- the EMAs clarification that MPs wishing to appoint the DC of another GRF as its agent DC must first seek the EMAs prior approval, which already acts as a layer of oversight.
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 DMS contacts are:

1. Air Products – Tay Wee Ann
2. Air Products – Shawn Zhang
3. Diamond Energy – Mohammed Rozainan Rosidi
4. Energy Market Company – Abdul Aziz Yatim
5. Energy Market Company – Coco Choo
6. Keppel Electric – Janice Bong
7. Keppel Electric – Joelyn Wong
8. Keppel Merlimau Cogen – Sean Chan
9. Keppel Merlimau Cogen – Tini Mulyawati
12. Pfizer – Lee Chin Hoo
13. Pfizer – Tan Meng Tong
14. PowerSeraya – Calvin Quek
15. PowerSeraya – Albert Siah
17. Power System Operator – Kwok Foo Seng
18. Schering-Plough – Kanagasabai Ravichandran
19. Semibcorp Cogen – Loh Chin Seng
20. Semibcorp Cogen – Chua Gwen Heng
21. Semibcorp Power – Geraldine Tan
22. Semibcorp Power – Aeron Hong
23. Senoko Energy – Eu Pui Sun
24. Senoko Energy – Michelle Lim
26. Senoko Energy – Sim Mei Ling
27. Seraya Energy – Elaine Syn
28. Seraya Energy – Daniel Lee
29. Singapore Oxygen Air Liquide – Lim Yong Yi
30. Singapore Oxygen Air Liquide – Jason Loo
31. SP PowerAssets – Chan Hung Kwan
32. SP PowerAssets – Ong Sheau Chin
33. SP Services – Lawrence Lee
34. SP Services – Budiman Roesli
35. Tuas Power Generation – Philip Tan
36. Tuas Power Generation – Priscilla Chua
37. Tuas Power Supply – Jazz Feng

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

On 15 July 2010, the workshop “Getting the Most Out of a Dispute” was conducted by Associate Professor Lim Lei Theng of the Law Faculty, National University of Singapore, for all DMS contacts. Participants gave positive feedback on the workshop, and indicated that they would like to attend similar workshops in the future. The session provided a good opportunity for them to learn more about resolving disputes, and build rapport with their counterparts.

DRCP Members

The DRCP members are:

Mediation Panel

1. Chandra Mohan
2. Daniel John
3. Associate Professor Joel Lee
4. Associate Professor Lim Lei Theng
5. Robert Yu
6. Shirli Kirschner
7. Tan Ching Tong
8. Sir Tony Fitzgerald

Arbitration Panel

1. Giam Chin Toon
2. Professor Lawrence Boo
3. Naresh Mahatani
4. Phil Harris
5. Raymond Chan
6. Dr Robert Gaitskell
7. Professor Tan Cheng Han

Conclusion

I am happy to report that no disputes were filed with me in 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
Market Performance: Overview of the Year

Energy and regulation prices climbed in 2010 while reserve prices decreased

2010 turned out to be a notably strong year for the National Electricity Market of Singapore (NEMS). Electricity demand saw a robust recovery from the slump in late 2008 and early 2009, rising by 8.8 percent which was well above the trend seen in the preceding years. This sizable increase in demand was well accommodated by supply which was boosted by two new combined-cycle gas turbine (CCGT) units that were added to the NEMS in late 2009. Total installed capacity of CCGT units was well above 6,000 megawatts (MW).

In 2010, the Uniform Singapore Energy Price (USEP) climbed to its highest yearly level ever at $171 per megawatt hour (MWh). However, it remained lower than the vesting contract hedge price (VCHP) of $172.29/MWh. The regulation price also rose to its second highest yearly level at $76/MWh. All three reserve prices fell during the year, with the primary reserve price falling to its second lowest yearly level at $0.75/MWh. The contingency reserve price, at $11/MWh, was the highest among the three reserves.
Market Performance: Overview of the Year

Annual Value of Products Traded 2006/10

NEMS set a new high in the total products traded

The annual value of products traded in the NEMS moved up to a new level, crossing the $7 billion mark in 2010. This was attributed to the growth in the energy and regulation markets, which grew 24.1 percent and 0.2 percent respectively, surpassing the drop in the three reserve markets.

For 2010, the energy market represented 98.5 percent of all products traded, while the reserve market represented 0.8 percent and the regulation market, 0.7 percent.

Annual Electricity Consumption 2006/10

Electricity consumption grew at the highest rate ever in 2010

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

In line with the steady growth of the local economy, electricity consumption surpassed 40 terawatt hours (TWh) for the first time in the NEMS’ history, reaching 42TWh in 2010. This represented an increase of 8.3 percent from 2009, the largest increase from a preceding year since the market’s start.
Market Performance: Overview of the Year

Generation Capacity 2010: Registered Versus Licensed

- **CCGT** - Combined-Cycle Gas Turbine
- **ST** - Steam Turbine
- **GT** - Gas Turbine
- **Others** - generation units with generation capacity less than 10MW.
- **Licensed Capacity**

The registered capacity for Senoko Energy and Keppel Merlimau Cogen was below their licensed capacity as of 31 December 2010. This is because Senoko Energy is repowering two CCGT units which are expected to be completed in 2012, and Keppel Merlimau Cogen is constructing new generation facilities.

A total of three new ST units were registered with the NEMS in 2010. Shell Eastern Petroleum registered one ST unit in late April with a generation capacity of 60MW, while Singapore Oxygen Air Liquide registered two ST units in early October with a total generation capacity of 14.9MW. All three ST units are classified as Generation Registered Facilities (GRFs) in the NEMS, and are subject to the Power System Operator’s (PSO) dispatch.

In addition, these three new ST units are also embedded generators. As of 31 December 2010, the total registered capacity in the NEMS was 10,013MW, 61 percent of which was CCGT, 35 percent was ST and 4 percent was GT.

Generation Facilities Registered and De-registered in 2010

- **Registered**: Shell Eastern Petroleum, one ST unit; Singapore Oxygen Air Liquide, two ST units
- **De-registered**: Shell Eastern Petroleum, one ST unit

CCGT = Combined-Cycle Gas Turbine
ST = Steam Turbine
GT = Gas Turbine
Embedded generators (EG) = generation units that generate electricity to its onsite load for self consumption.
Others = generation units with generation capacity less than 10MW.
Market Performance: Overview of the Year

Annual Generation Offer Capacity by Plant Type 2006/10

<table>
<thead>
<tr>
<th>Year</th>
<th>CCGT (MW)</th>
<th>ST (MW)</th>
<th>GT (MW)</th>
<th>Demand</th>
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<tbody>
<tr>
<td>2006</td>
<td>7,000</td>
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<td>2009</td>
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<td>2010</td>
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CCGT offer capacity reached a new high in 2010

With two new CCGT units registered in late 2009, CCGT offer capacity expanded strongly in 2010, nearing 5,000MW for the year. This represented the highest level since the market’s inception. In addition to a stronger CCGT offer capacity, the ST offer capacity also rose to a five-year high in 2010 to an average of 1,354MW.

Annual Market Share by Plant Type 2006/10

<table>
<thead>
<tr>
<th>Year</th>
<th>CCGT (%)</th>
<th>ST (%)</th>
<th>GT (%)</th>
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<tbody>
<tr>
<td>2006</td>
<td>78.0</td>
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<td>2008</td>
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<tr>
<td>2010</td>
<td>79.5</td>
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Based on scheduled generation. The market share for GT was 0.01 percent in 2010, 2008, 2007 and 2006, and 0.02 percent in 2009.

After slipping in 2009, the CCGT market share continued to weaken and fell under the 80 percent mark in 2010. The drop was more prominent in the first half of the year, when the CCGT market share averaged below the 80 percent mark for a total of five months, with May hitting the lowest level at 76 percent.

This drop was attributed mainly to the increase in demand which surpassed the increase in CCGT offer capacity. Also, the CCGT offer capacity was lower in the first half of the year because of commissioning tests.
Market Performance: Energy Demand

Monthly Forecasted Demand 2006/10

Forecasted demand is the projected electricity consumption in Singapore. The forecast is provided in real-time by the PSO and is a key component in determining the USEP.

Strong rise in demand seen in all twelve months of 2010

Demand was upbeat all year round and grew steadily every month. Year-on-year (YOY), demand rose at a double-digit rate from January through April, and continued to grow at an average of 6.6 percent for the rest of the year. The highest monthly average was 5,161MW in May, which also saw the year’s peak demand level of 6,294MW on period 30 of 25 May.

Quarterly Electricity Consumption 2009/10

A strong rebound in electricity consumption for all four quarters of 2010

The YOY change in demand showed a strong rebound in the first quarter of 2010, with an increase of 14.2 percent over the same period in 2009. The YOY change eased to 8.6 percent in the second quarter, and decreased further to less than 6 percent in the last two quarters of the year.

In terms of terawatt hours, electricity consumption was above 10TWh in all four quarters, with the highest level in the third quarter at 10.7TWh.

"YOY change" measures the change compared with the corresponding quarter in the previous year.
Market Performance: Energy Supply

Monthly Generation Offer Capacity by Plant Type 2010

The CCGT offer capacity averaged well above 4,000MW in 2010, with a record number of five months in which it crossed the 5,000MW mark. The ST offer capacity stood above 1,200MW for all 12 months and hit a high of 1,591MW in May. There was an increase in overall supply for all 12 months YOY, and there were three months (August, September and November) of double-digit expansion.

Monthly Generation Maintenance 2009/10

Generation maintenance levels for 2010 stayed below 1,200MW in all twelve months. These were well below the high maintenance level of more than 1,700MW seen in January 2009.

The standard deviation of generation maintenance was 210MW in 2010, while it was slightly higher at 213MW in 2009. The ratio of generation maintenance to registered capacity was 8.5 percent in 2010 as compared to 12.5 percent in 2009.
2010 recorded a remarkable increase in the ST utilisation rate, which rose above 30 percent for seven out of 12 months, a level not seen since October 2007. One main contributor to the rise in the ST utilisation rate was the decommissioning of ST generation units from Senoko Energy and PowerSeraya, which resulted in a drop in the ST registered capacity. In addition, the large increase in demand also led to higher ST scheduled generation which helped to lift the ST utilisation rate.

Oil price continued to exert influence on offer prices

The offer price proportion varied at a modest rate in 2010 as the price of the West Texas Intermediate (WTI) crude oil was more stable than the last two years.

The WTI fluctuated between US$70 per barrel (bbl) and US$90/bbl.

ST utilisation rate improved strongly in 2010

2010 recorded a remarkable increase in the ST utilisation rate, which rose above 30 percent for seven out of 12 months, a level not seen since October 2007. One main contributor to the rise in the ST utilisation rate was the decommissioning of ST generation units from Senoko Energy and PowerSeraya, which resulted in a drop in the ST registered capacity. In addition, the large increase in demand also led to higher ST scheduled generation which helped to lift the ST utilisation rate.

Conversely, the CCGT utilisation rate shrunk in 2010, averaging 71 percent as compared to 73 percent in 2009. The drop in the CCGT utilisation rate was attributed to two new CCGT units that were registered in end 2009 but only became operational during 2010.
Market Performance: Energy Prices

**Monthly USEP, VCHP and Spare Capacity 2010**

The VCHP showed little change throughout the year, moving between $171/MWh and $177/MWh for the first three quarters and settling lower at $165.71/MWh in the last quarter.

The USEP fluctuated more than the VCHP in 2010. It started with higher levels in the first few months, rising above $200/MWh in March. Thereafter, the USEP decreased from May through August, before increasing slightly towards the end of the year. The USEP traded higher than the VCHP in January, February, March, May, November and December.

**USEP deviated from VCHP occasionally when spare capacity changed**

A new component was established in the vesting regime in 2010. From the second quarter of the year, the Energy Market Authority (EMA) tendered out portions of the non-contestable load in order to introduce competitive pricing for the setting of the non-contestable tariff. While the tender vesting price is determined by the outcome of the tender, the tender vesting quantities and the tenure of the tender contract are determined by the EMA, taking into consideration the tender offers received and the impact of the tender on the wholesale electricity market. The tender vesting price is excluded from the calculation of the VCHP for the chart above.

The VCHP showed little change throughout the year, moving between $171/MWh and $177/MWh for the first three quarters and settling lower at $165.71/MWh in the last quarter.

The USEP fluctuated more than the VCHP in 2010. It started with higher levels in the first few months, rising above $200/MWh in March. Thereafter, the USEP decreased from May through August, before increasing slightly towards the end of the year. The USEP traded higher than the VCHP in January, February, March, May, November and December.

**From January to March, USEP rose significantly in the peak periods**

The USEP experienced higher volatility in the first three months of the year, when the difference between the peak and off-peak periods was significantly larger than the rest of the year. This was mainly due to the high and prolonged price spikes during these three months.
Market Performance: Energy Prices

Daily USEP, System Demand and Offer Capacity 2010
Periodical mismatch of demand and supply resulted in a series of price spikes

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System Demand Forecast  Offer Capacity  USEP
The key observations on the USEP fluctuations in 2010 are:

Point A:
On 6 January, the USEP averaged $270/MWh after experiencing offer changes. Also, one of the largest base load generators, a CCGT unit, was on maintenance.

Point B:
The strong demand growth during the first few months of the year resulted in tight supply conditions that started in late January and lasted until the end of March. Between 30 January and 15 February, the average USEP was above $200/MWh for seven days out of the 17 days. During this period, one of the largest CCGT units was on maintenance for 14 days.

Point C:
The tight supply conditions mentioned in point B also caused the average USEP to rise above $200/MWh for a total of 14 out of the 22 days from 22 February to 15 March. This rise in USEP was also contributed by supply disruptions arising from commissioning tests, one CCGT unit being on maintenance for nine days, and twelve instances of generator forced outages.

Point D:
Between 22 and 30 March, the USEP averaged above $200/MWh for a total of six out of the nine days due to offer changes.

Point E:
The USEP averaged above $200/MWh for six of the first ten days of May, with 2 May setting the highest price in the month at $239/MWh. These high USEP levels were caused by tight supply arising from a total of six generator forced outages and two CCGT units under maintenance.

Point F:
With two to three CCGT units out for maintenance between 21 November and 15 December, the USEP averaged above $200/MWh for a total of 11 days. The offer capacity was also strained by ten generator forced outages between late November and mid-December, as well as gas curtailment* that took place during this period.

*Source: Energy Market Authority. A gas curtailment is the reduction in gas supply which is the main fuel for CCGT units.
Market Performance: Ancillary Markets

Annual Reserve Cost 2006/10

From the high seen in 2009, reserve cost fell in 2010

Reserve prices started at higher levels in 2010 before decreasing thereafter. As a whole, all three reserve prices for 2010 ended lower than 2009. This was due to a drop in reserve cost, which fell from $105 million in 2009 to $66 million in 2010. However, the reserve cost in 2010 was still about $30 million higher than the all-time low in 2008.

Higher prices were seen in the first five months of the year

The primary reserve price hit a high of $3.11/MWh in February 2010 due to the commissioning tests of two new CCGT units. As both newly commissioned CCGT units completed their commissioning tests, the primary reserve price was relatively lower in the following months.

The rise in primary reserve price in May was attributed to the changes in the primary reserve risk adjustment factor.

The primary reserve price averaged $0.75/MWh for the year.

Monthly Primary Reserve Price, Requirement and Offer Capacity 2010

Requirement
Offer capacity below $5/MWh
Offer capacity at and above $5/MWh
Price

This was due to a drop in reserve cost, which fell from $105 million in 2009 to $66 million in 2010. However, the reserve cost in 2010 was still about $30 million higher than the all-time low in 2008.

The rise in primary reserve price in May was attributed to the changes in the primary reserve risk adjustment factor.

The primary reserve price averaged $0.75/MWh for the year.
Market Performance: Ancillary Markets

Monthly Secondary Reserve Price, Requirement and Offer Capacity 2010

March set the third highest price level for a month since market start

The secondary reserve price hit its peak for the year in March at $16/MWh. This was in tandem with the high USEP levels in the same month.

In general, the secondary reserve price was higher between January and March because of higher energy prices and lower reserve supply during these three months.

The secondary reserve price averaged $5.14/MWh in 2010.

Co-optimisation and low reserve supply led price to peak in February

Like the primary reserve price, the contingency reserve price hit a peak in February at $31/MWh. And as with the secondary reserve price, the contingency reserve price was higher in the first three months of the year. These were caused by tight supply conditions arising from co-optimisation and lower reserve supply.

The contingency reserve price averaged $10.94/MWh for 2010. It was the highest of the three reserve prices due to higher reserve requirements.
As of 31 December 2010, the total registered capacity for interruptible load (IL) was about 211MW for each class of reserve. The IL market share for 2010 was 4.4 percent for the primary reserve, 3.2 percent for the secondary reserve and 1.3 percent for the contingency reserve.

Following a drop in 2009, 2010 continued to record fewer IL activations for the contingency reserve, with six instances and a total of 12 periods of activation. Typically, each instance of IL activation lasted for about two periods in 2010. There was no IL activation for primary and secondary reserves.

Similar to 2009, the majority (43 to 50 percent) of the reserve providers were categorised under Group A in 2010. The last two groups (Group D and Group E) registered notable shifts during the year, with the proportion of reserve providers in these groups reducing from 12 percent in each group in the first quarter of the year, to 7 and 4 percent respectively in the last quarter.
Market Performance: Ancillary Markets

Quarterly Weighted-Average Failure Probability 2006/10

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.

The rise in failure probability was in line with more generation forced outages occurring during the year. The total number of generation forced outages was 126 in 2010.

Failure probability rebounded slightly in 2010

The declining trend of failure probability seen in 2009 came to an end in 2010. Compared to the same periods in 2009, all four quarters in 2010 registered increases in failure probabilities. This was due to commissioning activities that took place during the year.

More instances of forced outages in 2010

The rise in failure probability was in line with more generation forced outages occurring during the year. The total number of generation forced outages was 126 in 2010.

While this was the highest number seen in the last five years, it was still lower than the peak of 162 in 2005.
Market Performance: Ancillary Markets

Annual Regulation Payment 2006/10

- The annual regulation payment increased to $57 million in 2010, its second highest level ever. However, it remained well below the high seen in 2007.

- The regulation payment in 2010 was lower than 2006 in spite of a higher regulation price because of a lower regulation requirement.

Monthly Regulation Price, Requirement and Offer Capacity 2010

- The rising regulation price trend in 2010 was supported by the decline in regulation offer capacity. The offer capacity below $30/MWh for regulation slipped in 2010.

- The regulation price crept up in 2010, starting at an average of $49/MWh in January, it rose across the year and peaked in November at $105/MWh.

Changes in offer capacity led to higher regulation price

- The regulation payment in 2010 was lower than 2006 in spite of a higher regulation price because of a lower regulation requirement.
Market Performance: Competition in the Generation and Retail Markets

Annual Market Share by Generator 2006/10 (Based on Scheduled Generation)

Changes took place in generation market share during 2010, with PowerSeraya increasing its share for the second consecutive year to 28.4 percent of the market. Tuas Power Generation also captured more of the market in 2010 with a 25.2 percent share.

Apart from these two generation companies and incineration plants, the rest of the generation companies saw a dip in their market share in 2010. The year also marked the inclusion of embedded generators for scheduled generation, contributing to 0.4 percent of the market.

Annual Market Share of Market Support Services Licencee and Retailers 2006/10

The retail market experienced some notable changes in 2010, with SP Services and Sembcorp Power seeing a drop in their market share. Sembcorp Power experienced a larger drop in its market share, from 9.5 percent in 2009 to 7.6 percent in 2010.

Apart from SP Services, Seraya Energy remained as the market leader for the fourth consecutive year, commanding the largest share of 18.9 percent in 2010.
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 2010, EMC issued 26 margin calls and these calls were met within the time frame of two business days.

In 2010, the value of total retail settlement payments (excluding bilateral contracts between MPs) was $3.246 billion and the value of credit support on 31 December 2010 was $355.42 million.

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, e.g., due to a limited number of available suppliers, their prices are regulated.

From 1 April 2010 to 31 March 2011, 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 $10.78 million. The capability was sourced from PowerSeraya, Senoko Energy and Tuas Power Generation.

### Contracted Ancillary Services 1 April 2010 to 31 March 2011

<table>
<thead>
<tr>
<th>Cost incl. GST (million)</th>
<th>Quantity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black-start Service</td>
<td>$10.78</td>
</tr>
</tbody>
</table>
Market Performance: Market Fees

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 and PSO Fees Recovered Directly from the NEMS 1 April 2010 to 31 March 2011

<table>
<thead>
<tr>
<th></th>
<th>Amount</th>
<th>Rate/MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMC</td>
<td>$28.833 million</td>
<td>*$0.368/MWh</td>
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<tr>
<td>PSO</td>
<td>$17.276 million</td>
<td>*$0.221/MWh</td>
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<tr>
<td>Total</td>
<td>$46.109 million</td>
<td>*$0.589/MWh</td>
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</table>

* Total volume of electricity assumed at 39,181GWh

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>Leved based on actual usage</td>
</tr>
<tr>
<td>SP Services (MSSL)</td>
<td>Meter reading and data management</td>
<td>Leved on a per meter basis</td>
</tr>
</tbody>
</table>
ADDITIONAL INFORMATION
The flow of electricity.

energy

The market.

dispatch schedule

A schedule produced by the market clearing engine every half-hour that is the basis for the dispatch period.

market clearing engine (MCE)

The linear computer program 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 EMA 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.

net treatment of non-reserve charges for non-injecting embedded generators

Since December 2007, non-reserve charges (EMC fees, PSO fees and Monthly Energy Uplift Charges [MEUC]) for non-injecting generation facilities will be administered on their amount of net withdrawal (consumption) from the grid. To qualify for this treatment, an embedded generator requires approval from the EMA and registration with EMC as a non-injecting generation facility.

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.

non-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.

contestable consumers

Those 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.

contestable consumers

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

black-start ancillary service

A generation facility that is able to synchronise with the power system and begin generation at a defined level within a specified time.

full retail competition (FRC)

A situation in the retail market in which all consumers are contestable consumers, i.e., have 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.

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)

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.

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.

nondispatchable generation

Generation that is on stand-by to fine-tune the match between generation and load.

net treatment of non-reserve charges for non-injecting embedded generators

Since December 2007, non-reserve charges (EMC fees, PSO fees and Monthly Energy Uplift Charges [MEUC]) for non-injecting generation facilities will be administered on their amount of net withdrawal (consumption) from the grid. To qualify for this treatment, an embedded generator requires approval from the EMA and registration with EMC as a non-injecting generation facility.

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.

regulation

Generation that is on stand-by 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.
## Additional Information: Market Entities’ Contact Details

<table>
<thead>
<tr>
<th>Active Generator Licensees</th>
<th>Keppel Merlimau Cogen</th>
<th><a href="http://www.kepkelenergy.com">www.kepkelenergy.com</a></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Keppel Seghers Tuas Waste-To-Energy Plant Pte Ltd</td>
<td><a href="http://www.keppelseghers.com">www.keppelseghers.com</a></td>
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<tr>
<td></td>
<td>National Environment Agency</td>
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<td></td>
<td>PowerSeraya</td>
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<td>Shell Eastern Petroleum</td>
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<td></td>
<td>Tuas Power Generation</td>
<td><a href="http://www.tuaspower.com.sg">www.tuaspower.com.sg</a></td>
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<th>Active Retailer Licensees</th>
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<td></td>
<td>Singapore Oxygen Air Liquide</td>
<td><a href="http://www.soxal.com">www.soxal.com</a></td>
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<td>Banyan Utilities</td>
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</tbody>
</table>


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

