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Dear Industry Members,

The National Electricity Market of Singapore (NEMS) has concluded its first five years of operations. Our market has performed well, showing continuous growth, ongoing changes and increasing competition, with wholesale prices reflecting the fundamentals of demand and supply.

The NEMS is an important component of the Government's programme to liberalise the electricity industry. The market has helped to keep electricity prices competitive, as efficiency gains and competition among the generation companies have cushioned the impact of high oil prices on electricity prices.

The market has also attracted new investment in generation, with total installed capacity increasing 19 percent since 2003. In 2007, the entry of a new player was one of the factors that led to a decrease in the yearly average Uniform Singapore Energy Price (USEP) by more than 6 percent compared to 2006. This decline occurred despite rising global fuel prices and record-high yearly average electricity demand.

Our governance bodies are key to maintaining a stable and efficient market. I would like to thank all the professionals on these bodies for their significant contributions to evolving the market framework and overseeing market activities. Our sound market would not be possible without their commitments.

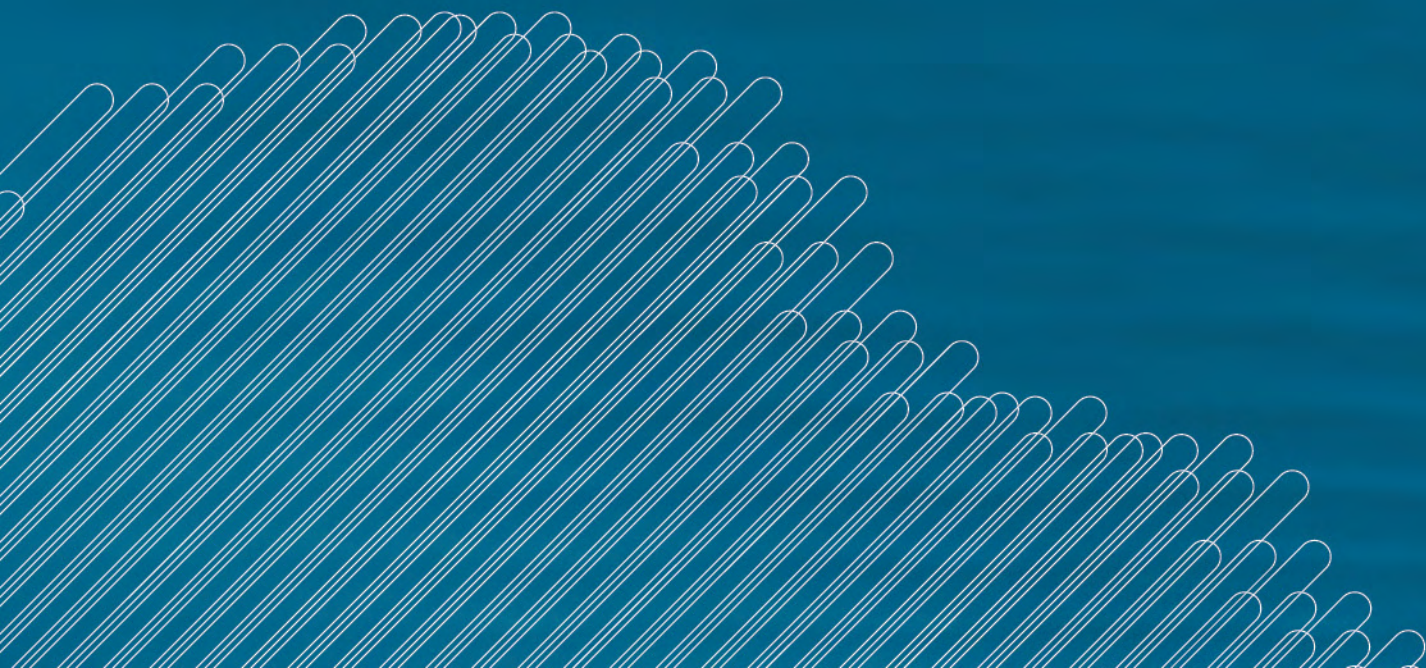
Our market has also seen a sharper focus on development of new and diversified fuel sources. This trend will strengthen in the future, as energy security and environmental sustainability will play an even bigger role globally and in Singapore's competitive electricity market.

Reflecting these trends has been the launch of the National Energy Policy Report by the Government in November 2007. The report outlines a holistic national energy policy framework for Singapore that balances the three objectives of economic competitiveness, energy security and environmental sustainability.

This is the first year that the NEMS Market Report and the Market Surveillance and Compliance Panel (MSCP) Annual Report are published at the same time. Together, the reports should give our market participants and all the other interested parties a comprehensive overview of how the NEMS has performed over the past year, and how it has evolved over the past five years. In addition, the MSCP report provides an assessment of competitiveness and compliance within the NEMS.



Tan Soo Kiang
Chairman
Energy Market Company



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 (SEP), 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

Corporatisation	1995	Electricity functions of the Public Utilities Board corporatised
	1996	Singapore Power formed as a holding company Singapore Electricity Pool (SEP) design process began
Singapore Electricity Pool (SEP)	1998	SEP commenced PowerGrid is SEP Administrator and Power System Operator (PSO)
	1999	Review of electricity industry
National Electricity Market of Singapore (NEMS)	2000	Decision for further reform to obtain full benefits of competition New market design process began
	2001	Electricity industry legislation enacted Energy Market Authority (EMA) established as industry regulator Energy Market Company (EMC) established as the NEMS wholesale market operator Initial phase of retail contestability
	2002	Draft market rules issued Testing and trialling of wholesale market system began
	2003	NEMS wholesale market trading began Further batches of large consumers introduced to retail contestability
	2004	Vesting contract regime introduced 2004 Interruptible loads (IL) began to participate in the reserves market
	2005	New wholesale market trader joined the market Wholesale market trader commenced trading as IL provider
	2006	New wholesale market trader and new generation licensee joined the market Retail contestability expanded to 75 percent of the total electricity demand New generation licensee started trading
	2007	Sales process of Tuas Power, Senoko Power and PowerSeraya commenced by their owner, Temasek Holdings Removal of the Market Registration Application Fee EMA started pilot testing of Electricity Vending System (EVS)

Since starting operation on 1 January 2003, the NEMS has performed well, showing continuous growth and ongoing changes, with wholesale prices moving in line with the fundamentals of demand and supply. On the whole, market reforms have increased competition among industry players and benefited consumers. Market liberalisation has resulted in downward pressure on electricity prices, as efficiency gains and competition among the generation companies have cushioned the impact of oil prices on electricity prices (2003 to 2007). There is also evidence of active retail competition.

Furthermore, a review of the performance of the NEMS as compared to the previous pool, i.e., the SEP — commissioned by the Energy Market Authority (EMA) and undertaken by PricewaterhouseCoopers — revealed a net benefit of \$128.6 million to the economy for the period 1 January 2003 to 31 March 2005 and suggested that the net benefits from 2005 to 2015 would total \$522 million (at present value).

The NEMS has matured and evolved over the past five years in various ways. Many changes were the result of changes to the Market Rules, enhancing the efficiency of the NEMS and maintaining a level playing field; other changes were the result of competition, driven by the search for more efficient market outcomes and the global challenge for greater energy security and sustainability. Some of the most significant changes that affect the market are:

Vesting contracts

On 1 January 2004 the EMA introduced vesting contracts for generators, with the objective of mitigating a potential exercise of market power when the supply side of the industry is concentrated among a small number of generators. The EMA reduced the vesting contract level from 65 percent to 55 percent in the third quarter of 2007.

More details are in the Market Monitoring/The Energy Market/Energy Market Performance section on page 6 of the Market Surveillance and Compliance Panel Annual Report 2007 (MSCP report).

Interruptible Load

1 January 2004 also saw the introduction of interruptible load (IL) to further increase competition in the reserve market, which may result in significant savings and efficiency gains in the electricity industry. Under the IL regime, a load facility can offer to have its power interrupted in the event of a power system disturbance. The load facility can choose to offer its IL through a retailer or as a direct wholesale market trader. In return for offering to have its power supply interrupted, a load facility receives a payment for every half-hour that its offer is accepted in the reserve market. IL facilities are allowed to participate in all three classes of reserve market within the NEMS. IL provides a high quality source of reserve, as it is not dependent upon fuel supply.

New market participants and more efficient generation

The entry of new market participants — Keppel Merlimau Cogen (Keppel Merlimau) and two wholesale market traders, Air Products and Diamond Energy — has increased competition in the energy and reserve markets. Over the past five years, the market has also seen increased generation load and capacity.

The NEMS has offered incentives for efficient power generation and the market has seen a structural shift from oil to more efficient and cleaner natural gas-fired combined-cycle gas turbine (CCGT) generation, which has lower carbon dioxide emissions. A recent government report stated that between 2000 and 2006 the overall power generation efficiency improved from 38 to 44 percent.

The electricity industry in Singapore has also contributed significantly to the reduction of carbon dioxide by switching from fuel oil to natural gas for a significant proportion of power generation, while keeping electricity prices competitive. To further diversify Singapore's sources of natural gas, the Government announced the introduction of liquefied natural gas (LNG) by 2012.

Other technologies that can improve fuel utilisation and reduce emissions have emerged; several cogeneration companies have started operations and trigeneration plants (e.g., Pfizer Asia Pacific) are being built. Cogeneration refers to the integrated production of heat and electricity, while trigeneration refers to the integrated production of heat, electricity and chilled water.

Renewable Energy

The NEMS allows renewable energy to be bought and sold, and the removal of the market registration application fee in 2007 eliminates a barrier for renewables to participate in the market. However, there is a limit on the total amount of generation capacity from intermittent power sources (e.g., solar) that can be connected to the grid without compromising system security. System capacity for such sources is currently limited to 200 megawatts (MW).

Sale of generation companies

New investment and market players will be entering the market with the sale of the three generation companies (PowerSeraya, Senoko Power and Tuas Power) currently owned by Temasek Holdings. The sale of the generation companies was announced in April 2007 and all three companies are expected to be sold by early 2009. Tuas Power is the first generation company to be divested; the sale is expected to be completed by mid-2008.

Retail competition

Retail contestability is being introduced into the NEMS in stages; the first phase commenced 1 June 2003. By 2007, over 10,000 consumers — whose average monthly consumption exceeds 10,000 kilowatt hours (kWh), representing 75 percent of the electricity consumed in Singapore — were contestable and free to choose their suppliers.

Under Singapore's approach to contestability, contestable customers can choose to buy electricity from a retailer, directly from the wholesale market or indirectly from the wholesale market through SP Services. The remaining 25 percent, comprising mainly household consumers who are not yet contestable, continue to be serviced by SP Services at regulated tariffs.

The EMA is exploring ways to leverage new technologies to extend contestability to these 1.2 million non-contestable consumers. In 2007, the EMA embarked on the Electricity Vending System (EVS) prototype project as a possible technology for small consumers to buy electricity by choosing from a list of competitive price schemes offered by the retailers. If the EVS is found feasible, it would provide a platform through which retail contestability for small consumers can be introduced.

The benefits of competition have been passed on to all consumers, including non-contestable consumers. Without liberalisation, electricity prices in Singapore would be higher for all consumers.

NEMS market systems

Over the past five years, the NEMS market systems and its applications have evolved through:

- Changes to, and modifications to comply with changes to, the Market Rules (see the Rules Change Panel for details) and
- Ongoing enhancement and adoption of proven technologies to ensure reliable, secure and efficient market performance.

Some of these key enhancements include the replacement of the NEMS trading servers and the migration of existing applications to the new computing platform. The new platform's functionality enables market participants to leverage web applications and services to perform offer submission to the NEMS systems, and automates the retrieval of offer and advisory information. Over the past five years, there have also been significant enhancements to the security, backup and recovery of the systems.

In addition, Energy Market Company has established proven Disaster Recovery Plan (DRP) and Business Continuity Plan (BCP), and has conducted comprehensive and regular disaster recovery preparedness and business continuity exercises to ensure preparedness for any crisis situation.

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.

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 the Power System Operator (PSO).

Wholesale Market Traders

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.

MSSL

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

Energy Market Company (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 Licensee — SP PowerAssets

SP PowerAssets owns and is responsible for maintaining the transmission system.

PSO

The PSO (a division of the EMA) is responsible for ensuring the reliable supply of electricity to consumers and for arranging the secure operation of the power system. The PSO controls the dispatch of generation facilities, co-ordinates 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.

Participants and service providers in the NEMS

Active Generators

Keppel Merlimau Cogen
National Environment Agency
PowerSeraya
SembCorp Cogen
Senoko Power
Tuas Power

Wholesale Market Traders

Air Products
Diamond Energy
Pfizer Asia Pacific

Active Retailers

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

Energy, reserve and regulation products

	Description	Purchaser	Seller
Energy	Generated electricity	Retailers	Generators
Reserve	Stand-by generation capacity or interruptible load (IL) that can be drawn upon when there is an unforeseen shortage of supply. Three classes of reserve are traded: <ul style="list-style-type: none"> • primary reserve (8-second response), • secondary reserve (30-second response) and • contingency reserve (10-minute response onwards) 	Generators	Generators, Retailers and Wholesalers
Regulation	Generation that is available to fine-tune the match between generation and load	Generators and Retailers	Generators

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, where the market clearing engine (MCE) considers the costs and requirements of all products together and then selects the optimal mix of generation and 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:

- available generation capacity,
- ability of generation capacity to respond (ramping),
- relationship between the provision of energy and 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 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 39 injection nodes and the prices at approximately 380 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 investment into new power system infrastructure in the long term.

EMC uses metered demand and generation from the MSSL and market prices to settle market transactions on a daily basis. Generators receive the market price for energy that is determined at their point of connection to the transmission network (injection node). Retailers pay the Uniform Singapore Energy Price (USEP) for energy, which is the weighted-average of the nodal prices at all off-take nodes.

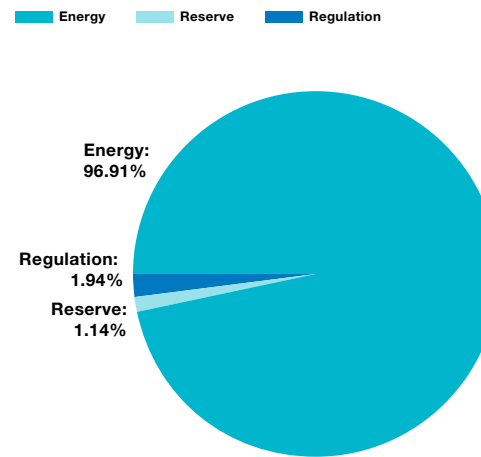
Generators pay for reserve according to how much risk they contribute to the system. Regulation is paid for by retailers in proportion to their energy purchase and by dispatched generators up to a ceiling of 5MWh for each trading period.

Near real-time dispatch

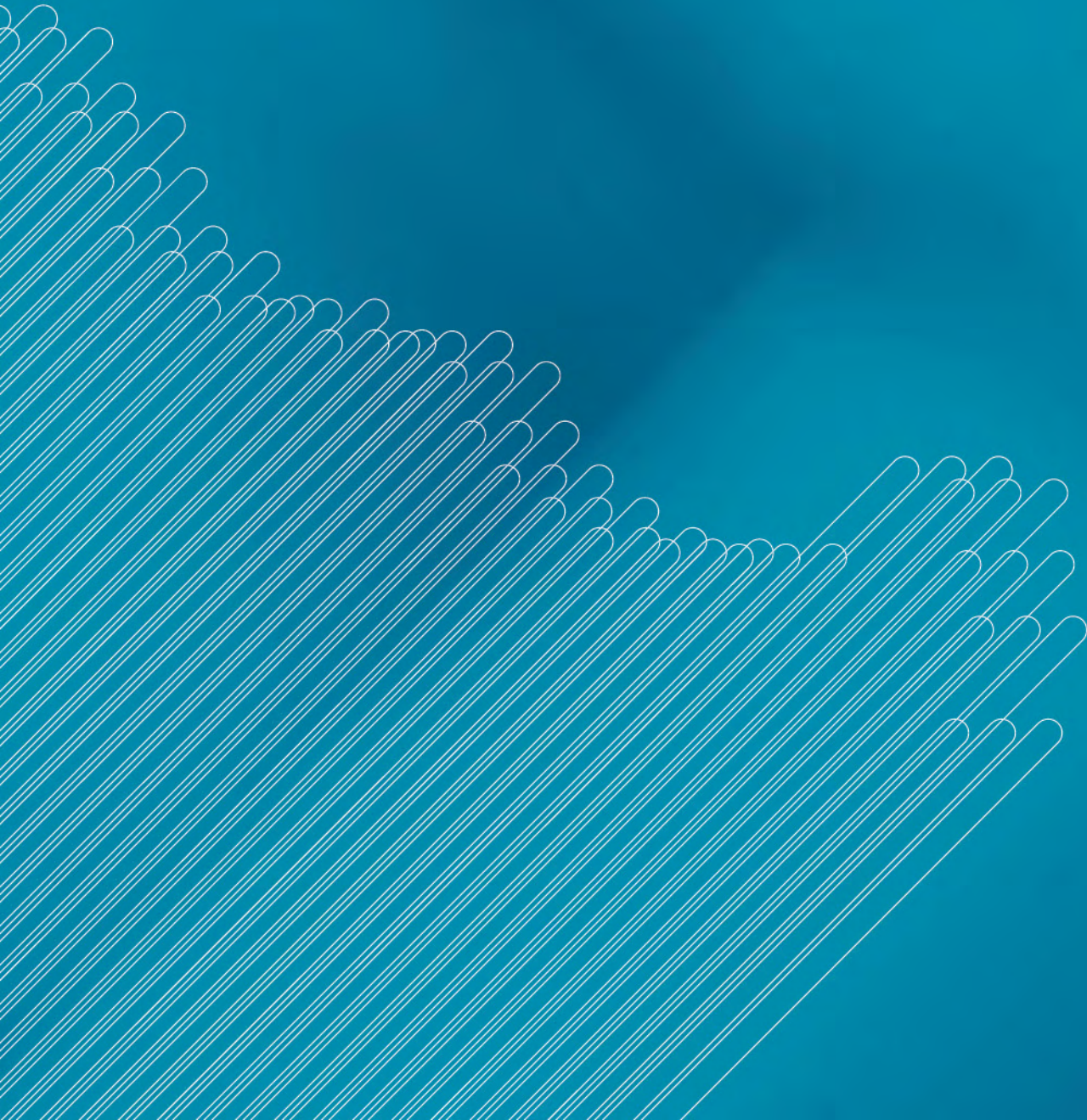
Market prices and dispatch quantities for energy, reserve and regulation are calculated five minutes before the start of each half-hour trading period. This ensures that the market outcomes reflect the prevailing power system conditions and the most recent offers made by generators. The result of near real-time calculation of dispatched generation quantities ensures as little real-time intervention as possible, and hence a 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 market participants have the information they need to adjust their trading positions prior to physical dispatch.

Mix of Products Traded 2007



The total value of products traded on the wholesale market in 2007 was \$5.26 billion, a decrease of 1.43 percent from 2006. For 2007 energy remained the largest proportion of products traded, at 96.91 percent, with regulation at 1.94 percent and reserve at 1.14 percent.



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 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 for 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. The EMA is required to consider the interests of consumers when approving changes to the Market Rules. 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 on the behaviour of market participants. The panel identifies market rule breaches and assesses market operations for efficiency and fairness. In circumstances in which the MSCP determines that a market participant 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 an annual report; the 2007 MSCP Annual Report is published together with this 2007 NEMS Market Report.

Dispute resolution

The Market Rules contain a process that facilitates the resolution of disputes between market participants 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.

Dear Industry Members,

2007 was another eventful year for the RCP. As we expected, rule change issues on the table tested the fundamental underpinnings of the wholesale market design. We did not expect any resolution to be easy. Therefore, it makes me all the more proud to report that the panel was able to produce decisions that reflect the adoption of good design principles.

On the market clearing front, the Market Clearing Engine (MCE) was improved by several modelling changes. Among them, two types of artificial lines were re-modelled to ensure that the MCE always produces locational system marginal prices (LSMP) at each node. Accurate identification of LSMPs reflects pricing efficiency. A new mixed integer programming approach was also introduced to the MCE (which is linear programming based) to model constraints on regulation. Together, these changes markedly improve the ability of the MCE to produce dispatch and pricing solutions that are the most efficient.

Arguably, an even more profound impact may result from the resolution of two equity related issues that have been with the panel for some time. First, the panel was able to conclude a review of the price revision arrangement. Detailed rules reflecting the panel's decision remain to be drafted, but the key agreements are that price revision should be allowed for defined scenarios, notwithstanding our ex-ante pricing regime; and that a compensation methodology consistent with economic principles should be in place.

Second, the concern that there was inequity between the treatment of load facilities and generation facilities in providing reserve was thoroughly investigated. Using fact-based analyses and economic rationale, the panel was able to agree that no change to the existing arrangement is warranted. More significantly, the effort put into resolving these two issues generated much additional clarity and agreement on design rationale. These decisions will become important building blocks for future work on improving market design.

On the membership front, we welcomed two additional members, bringing the size of the panel to 14. Dr Goh Bee Hwa (nominated by the Consumer Association of Singapore) and Mr Michael Lim (nominated by the Singapore International Chamber of Commerce) joined the panel as representatives of electricity consumers. Two replacements were made, as Dr Kang Cheng Guan replaced Mr Kng Meng Hwee as the PSO representative, while Mr Lawrence Lee replaced Mr Lim Ah Kuan as the MSSL representative. We owe debts of gratitude to both Mr Kng and Mr Lim, who have made extensive contributions during their membership terms. Both gentlemen will be sorely missed.

I am strongly encouraged by the panel's achievements in 2007. They give me ample confidence that 2008 will be another fruitful year for market evolution. I want to express deep gratitude to and respect for each of my fellow panel members, who have been professional, hardworking and enjoyable to work with. I am thankful to the companies and institutions that make them available for the betterment of the NEMS. I also want to thank EMC's Market Administration Team for delivering the usual high-quality analyses used in the panel's decision-making.

Finally, I want to thank everyone who has responded to our various public consultations on rule changes. I look forward to another year of terrific support from the industry as we continue our mission to unlock market efficiencies.



Dave Carlson
Chair
Rules Change Panel

Significant Rule Changes

The RCP considered over 100 rule change proposals in 2003–2007, of which 93 were implemented.

The most significant rule changes for 2003–2006, discussed in greater detail in the NEMS Market Reports of the past four years, were the following:

The interruptible load (IL) regime was introduced in 2003 to allow consumers to voluntarily offer their consumption into the reserve market. This change improved market efficiency by allowing loads to participate with generators to provide reserve, and enhanced system security by creating a new source of reserve.

2004 saw the implementation of a new short-term schedule (STS) as a new market forecast schedule that improved the suite of information available to market participants and the PSO to make trading and operational decisions. That year the offer gate closure time was reduced from four hours to two hours (and subsequently to 65 minutes in 2005) and the rules around it were tightened. Together with the adoption of dynamic load participation factors, these changes greatly improved the efficiency of market clearing and price discovery.

The automated wholesale settlement re-run regime was devised in 2004 and took effect in April 2005 to improve the efficiency of wholesale market settlement to deal with metering errors. The MCE has been modified in various ways to enhance pricing and dispatch efficiency, system security, the ability to send the right economic signals and improve market efficiency.

To further improve the decision-making process of the RCP, in 2006 two seats were created for consumer representatives to allow them to participate in the early stages of market rule changes.

The past four years have also seen streamlining of the rule change process, refinements of the working mechanisms of the Market Rules and the continued use of plain English drafting for clarity and readability.

2007 saw the following most notable market evolution initiatives:

Pricing and dispatch efficiency

Three rule changes were made to the MCE formulation:

- Remodelling of type 2 artificial lines
- Remodelling of type 1 artificial lines
- Mixed integer programming based regulation constraints

Remodelling type 2 artificial lines

The MCE is a marginal pricing model. Without network congestion, all nodal prices reflect the LSMP. When congestion occurs, two or more isolated systems can be created. There could then be different system marginal prices and the nodes within different systems will reflect their respective system marginal prices. This outcome is referred to as price separation.

This rule change was made to correct instances in which nodal prices associated with disconnected generation units do not reflect the LSMP. For each dispatch period, the MCE must model each generation facility as if it were connected to the grid so that the facility can qualify to be dispatched. The connection status of a facility is read from a network status file, which periodically takes a snapshot of all physical connections on the grid. Hence, facilities not physically connected when the snapshot is taken will be treated as disconnected. However, for the purpose of dispatch and pricing, the MCE artificially connects these disconnected facilities to the network model using type 2 artificial lines.

But the specification of a type 2 artificial line was found to be inadequate when instances of nodal prices not reflecting the LSMP were discovered at nodes associated with facilities connected by type 2 artificial lines. The problem was traced to an inability of the MCE to schedule a reverse flow through these artificial lines. The solution was to model type 2 artificial lines using the same electrical characteristics of real lines.

Remodelling type 1 artificial lines

This rule change was made to correct for instances in which nodal prices associated with multi-unit facilities do not reflect the LSMP. Multi-unit facilities are combined-cycle plants with two or more constituent generating units. Each combined-cycle plant is, however, represented in the MCE as a single notional facility linked to a single market network node. To achieve this representation, the MCE uses type 1 artificial lines to notionally connect the constituent generating units to the market network node.

Instances of unusually low nodal prices associated with multi-unit facilities and thus not reflecting their LSMP were discovered in February 2007. The cause was traced to a capacity constraint on type 1 artificial lines. This problem occurs only when a multi-unit is dispatched at full capacity for energy. The solution is to increase the line limit of type 1 artificial lines by a small margin.

Mixed integer programming based regulation constraints

Prior to clearing the market, any Generation Registered Facility (GRF) that satisfies certain conditions would be qualified by the MCE to provide regulation. A series of regulation constraints would then be imposed upon it. These constraints confine the scheduled energy output of a GRF within a range (between regulation min and regulation max) in which it is able to provide regulation. As these constraints are applied on all qualified regulation providers, they inadvertently also bind those that are not subsequently scheduled to provide any regulation. When imposed on a GRF not scheduled to provide regulation, these regulation constraints become unnecessary. Uneconomical dispatch schedules may result if cheaper generation outside the regulation range of such a GRF cannot be made available for dispatch when they should have been made available.

The linear programming employed by the MCE was not able to overcome this shortcoming. The solution was to introduce mixed integer programming based regulation constraints on qualified regulation providers. These new constraints will allow a qualified regulation provider not scheduled to provide any regulation to be able to be scheduled for energy output outside its regulation min and regulation max. This solution allows the MCE to produce optimal dispatch schedules, thus improving economic efficiency.

Market participation

Removal of registration application fee

Removing the registration application fee was considered because:

- the fee was seen by some small producers as a barrier to participating in the NEMS,
- the fee is a negligible portion of the total fees EMC collects on a per megawatt hour (MWh) basis and
- waiving the fee is unlikely to encourage frivolous applications or other undesirable behaviour.

Renewable fuel source producers are typically small (<10MW). These small producers were of the view that the registration fee inhibits their participation in the NEMS. From the perspective of the NEMS, encouraging renewable fuel source participants to join the wholesale market enhances competition. Moreover, energy security can be improved with added fuel source diversity. Hence, to reduce the cost of participating in the wholesale electricity market, the \$5,000 registration application fee was removed.

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

An embedded generator is a power generation plant that generates electricity to its onsite load for self-consumption. In August 2006, the EMA reviewed its policy on reserve and non-reserve charges (EMC fees, PSO fees, Monthly Energy Uplift Charges [MEUC] and Market Support Services [MSS] fees) for embedded generators. The EMA decided that embedded generators should continue to bear reserve charges based on their gross generation. However, those that do not export power into the grid (i.e., do not compete with generation companies to sell electricity) can receive some form of net treatment for non-reserve charges. The Government's policy decision is in view of its

assessment that while the current arrangements for embedded generation in Singapore are broadly reasonable within the context of the NEMS, net treatment for embedded generators that do not export power and compete to sell electricity will not distort competition in the electricity market.

Consequently, a rule change to implement net treatment of non-reserve charges for embedded generators was implemented on 4 December 2007. This change was directed by the EMA to implement the government policy and applies only to embedded generators that do not export power into the grid. Under the new rules, non-reserve charges (EMC fees, PSO fees and MEUC) for these 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.

Prudential management

Discretion to revise/revoke margin call requirements in the presence of manifest error(s)

This change allows EMC to revise/revoke margin call requirements for a market participant (MP) or MSSL in exceptional cases in which the MP/MSSL has reasonable basis to believe that its estimated risk exposure determined by EMC contains manifest error. Such an error could be inherent in metering, human input or system calculation. Prior to this change, the Market Rules did not give EMC the discretion to reassess the estimated risk exposure of a MP/MSSL, and consequently to revise or revoke a margin call that has already been issued. This change provides a recourse mechanism that prevents an MP/MSSL from having to meet expensive margin calls that were issued based on erroneous input or calculation.

Equity related issues

Review of price revision regime

Price revision/MCE re-run currently applies to the following types of cases:

- **Type 1:** cases in which the MCE has failed to produce a real-time pricing schedule
- **Type 2:** cases in which the MCE has used the wrong input data in determining the real-time schedule
- **Type 3:** cases in which the MCE has used the adjusted nodal load forecasts which reflect energy shortfall specified by the PSO
- **Type 4:** cases in which the MCE has incurred a constraint violation penalty (CVP) for line constraints when there is no load shed in real-time
- **Type 5:** cases in which the MCE has produced prices that do not reflect the respective LSMP

Following the observation that the existence of price revision is inconsistent with an ex-ante pricing regime, the RCP undertook a comprehensive review of the current price revision regime. It sought to determine if price revision should be allowed and if so, whether the current arrangement was appropriate.

In its conclusion, the RCP considered equity and fairness to be the critical considerations in deciding whether or not there should be price revision. The RCP decided that price revision yields a fairer and more equitable outcome for the market in general. The RCP recommended refining the definition of wrong input data for Type 2 cases. It also recommended removing price revision for Type 4 cases because a CVP incurred for line constraints reflects genuine ex-ante system conditions and should be preserved. Whether a load shed subsequently took place in real-time should be irrelevant.

Equity between generators and IL in reserve provision

There were concerns that under the current regime, reserve payments to GRF and load registered facilities (LRF) were inequitable because LRFs have been activated for reserve considerably less often than GRFs have.

In the RCP's study, it noted that because GRFs and LRFs are different types of facilities, their responses differ in several aspects and different operational requirements apply to each type. Thus, the provision of reserve by these two types of facilities is not directly comparable.

Nonetheless, the RCP explored and evaluated three options to address the differences:

- (1) consider reserve from GRFs and LRFs as different services,
- (2) alter the reserve payment methodology and
- (3) adjust the primary and secondary reserve activation frequencies of LRFs to bring about more balanced response between GRFs and LRFs in reserve provision.

Overall, the RCP concluded that neither option 1 nor 2 is conceptually sound. It also did not support option 3 because (1) the current activation frequencies of LRFs are already high compared to other markets; (2) the PSO is concerned about its impact on system security; and (3) the level of IL participation is currently low. Hence, there is no present need to change the reserve regime.

Dear Industry Members,

In 2007, we continued to maintain and develop the Dispute Resolution and Compensation Panel in its support for the NEMS.

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. Comprised of a Mediation Panel and an Arbitration Panel, the DRCP is honoured to have among its members professionals with significant experience in mediation and arbitration practice.

At the end of 2007, the terms of office for our panel members came up for renewal. I invited each member to continue serving on the DRCP, and am pleased to say that all have agreed to do so. However, Mr L P Thean (a former judge of the Supreme Court) has since been asked to assume the chairmanship of the Market Surveillance and Compliance Panel; thus I would like to take this opportunity to thank Mr Thean for his support and contributions to the DRCP.

In my capacity as Dispute Resolution Counsellor, I will continue to seek qualified and experienced local and foreign panel members for the DRCP. In this way, we can ensure that the NEMS market players will always have access to a pool of capable professionals who are able to assist the industry when necessary.

Negotiation Workshop and DMS Contacts

On 16 October, a workshop on “Negotiation Strategies, Tactics & Counter-measures” was conducted for the Dispute Management System (DMS) contacts. Through role play, the DMS contacts had the opportunity to practise and fine-tune their negotiation skills. New DMS contacts were introduced to the NEMS dispute resolution process, while existing DMS contacts were given a forum to seek clarification. The workshop was also important in providing an opportunity for DMS contacts to meet and build rapport. Many participants said that they found the workshop helpful, and we will continue to organise such sessions.

Contact particulars of the industry’s network of DMS contacts are now published on the EMC website. This information will enable market participants to know whom to contact in the event of a dispute.

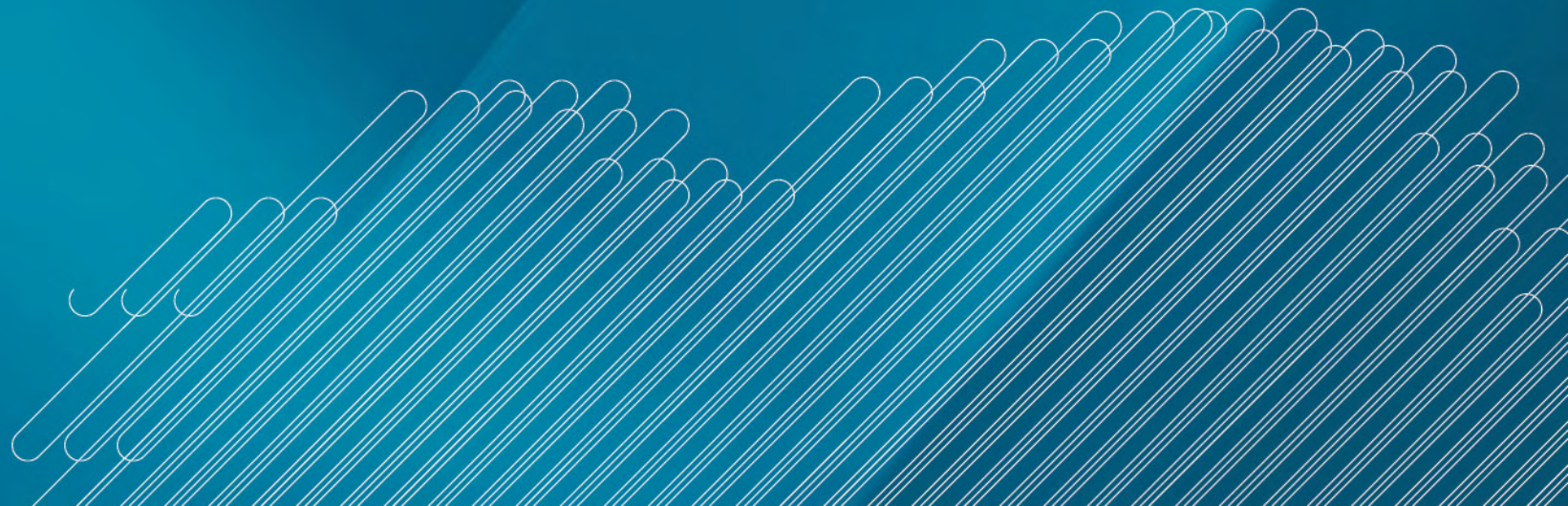
Conclusion

In conclusion, I would like to thank all market participants, DMS contacts and the Market Assessment Unit for supporting the work of the DRC.



George Lim
Dispute Resolution Counsellor

Market Performance



Definition of Peak, Shoulder and Off-Peak Period

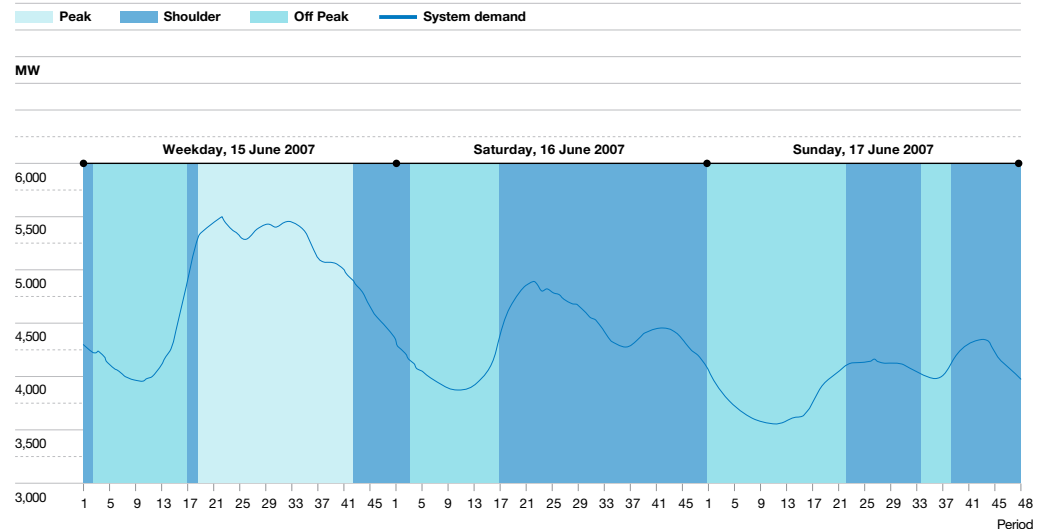
	Sunday/ Public Holidays	Weekday	Saturday
Peak	-	0830 to 2029	-
Shoulder	1030 to 1629 1830 to 2329	0000 to 0029 0730 to 0829 2030 to 2359	0000 to 0059 0800 to 2359
Off-Peak	0000 to 1029 1630 to 1829 2330 to 2359	0030 to 0729	0100 to 0759

Source: MSSL

In the National Electricity Market of Singapore (NEMS), generators compete to supply the forecast system demand for the next half-hour trading period.

On a daily basis, demand profile varies substantially according to the day-type, i.e., weekday, Saturday, Sunday and public holiday. There are some observed seasonal demand trends, with March to October as peak months. Over the longer term, economic growth is the main determinant of system demand.

System Demand Trend

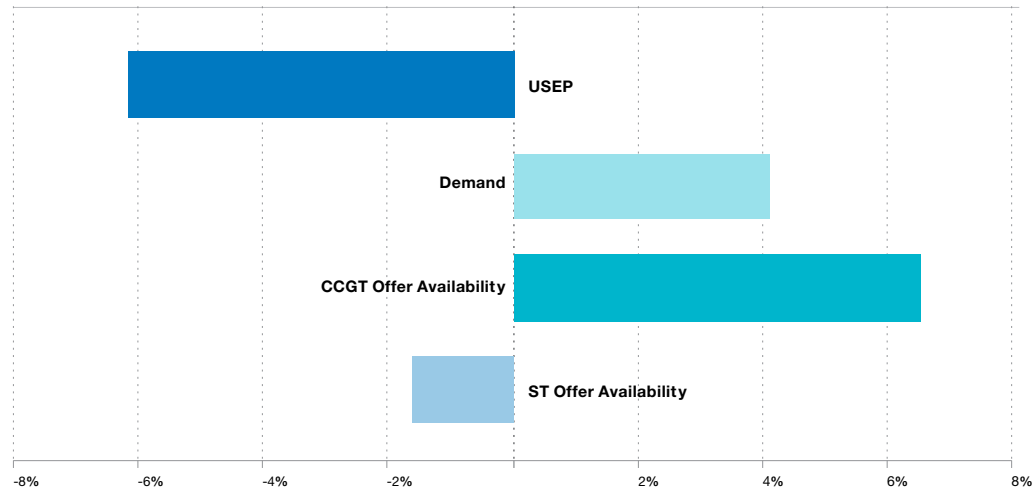


Period 1 = 0000 to 0029
Period 48 = 2330 to 2359

The amount of generation capacity available to the market in any trading period depends upon a mixture of operational and economic factors. A generating unit may not be operationally capable to bring capacity online to serve the market if it is undergoing maintenance or is otherwise not prepared for operation: such units are called cold units. Further, a generator may choose not to offer capacity into the market if it is not economically viable to operate at the prevailing market price.

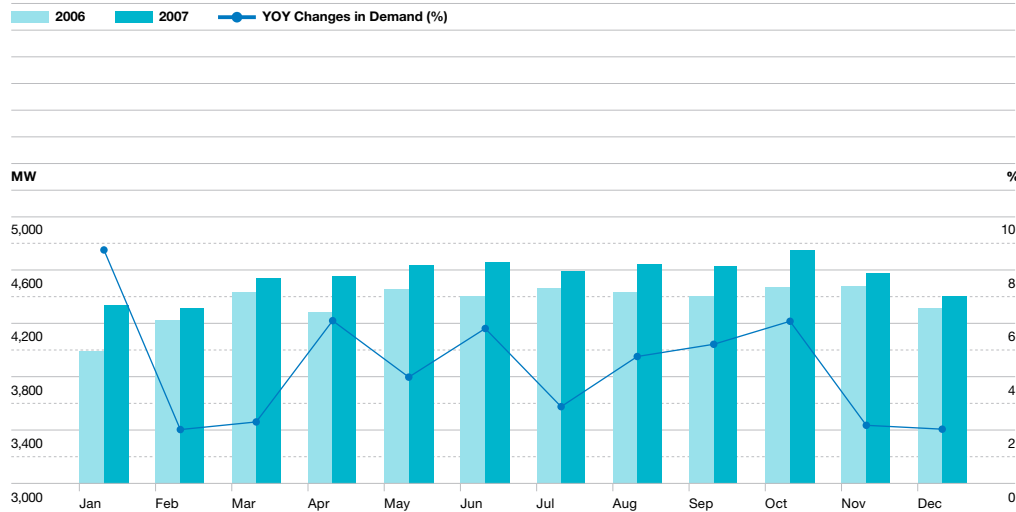
Retailers pay for electricity purchased from the wholesale market at a price known as the Uniform Singapore Energy Price (USEP). The USEP is calculated as the quantity-weighted average of all nodal prices in a particular trading period.

Major Market Indicators 2007 (% changes from 2006)



CCGT = combined-cycle gas turbine
ST = steam turbine

YOY Monthly Demand 2006/07

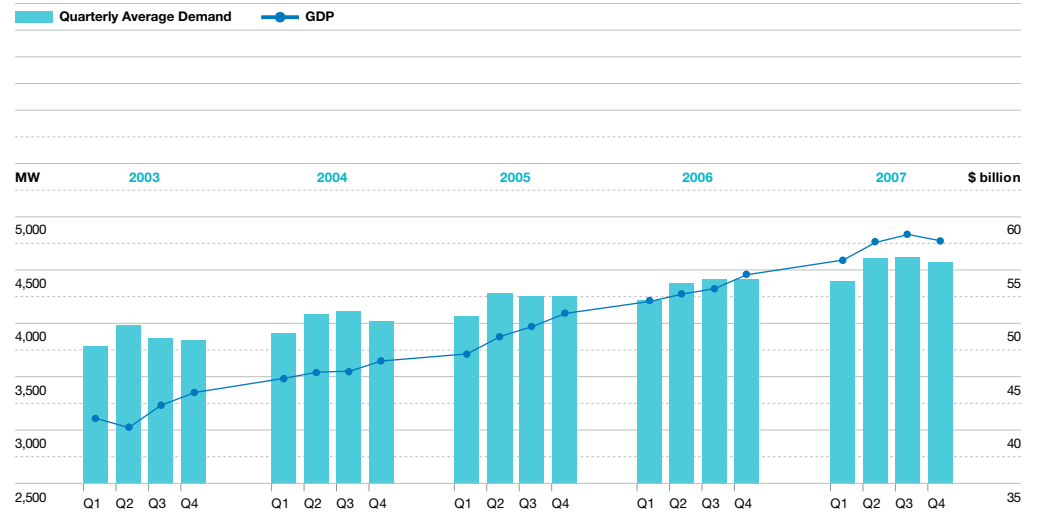


For 2007, electricity demand growth continued with higher monthly average demand for all twelve months when compared year on year (YOY).

January experienced the highest increase in monthly average demand with 8.7 percent YOY. This increase in demand was mainly due to the shift in occurrence of the Lunar New Year public holidays from January in 2006 to February during 2007. In addition, average monthly demand moved closer to the 4,800 megawatt (MW) mark, recording 4,744MW in October.

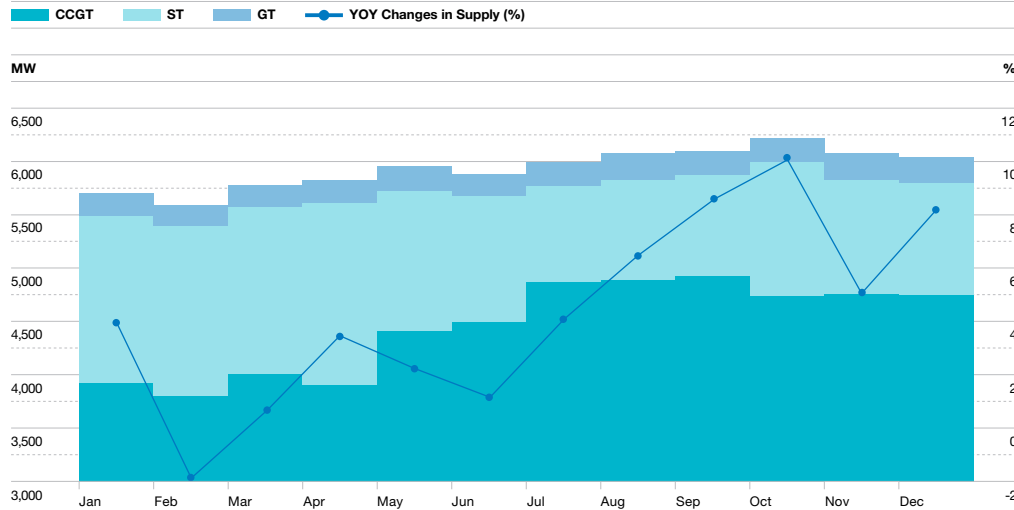
It was noteworthy that from 3 to 5 October demand climbed to 4,993MW, 5,022MW and 5,061MW respectively, which represent the top three daily average levels in 2007. Moreover, peak demand rose to 5,782MW in 2007 as compared to 5,452MW in 2006.

Quarterly Demand and Singapore GDP 2003/07



On a quarter-on-quarter basis, second quarter 2007 demand showed the highest increase, with 5.1 percent. With strong monthly average demand levels in both August and September, the third quarter 2007 demand advanced to 4,613MW, far surpassing the previous high of 4,425MW in the third quarter 2006. Overall, both electricity demand and Singapore GDP have displayed upward growth over the past five years.

Generation Offer Availability by Type 2007

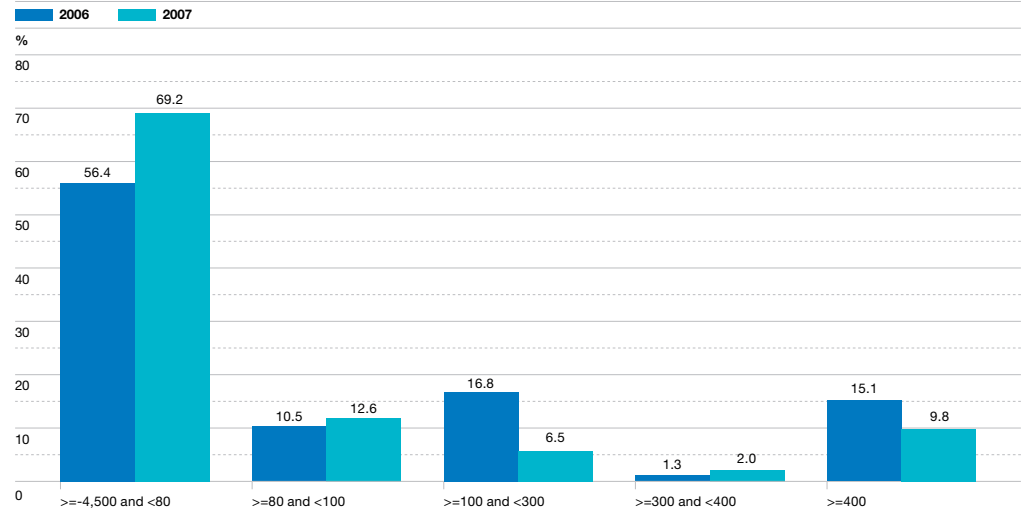


GT = open-cycle gas turbine.

The commissioning of two new combined-cycle gas turbine (CCGT) units (Keppel Merlimau) in the last quarter of 2006 allowed the CCGT offer availability to improve significantly in 2007. The CCGT offer availability rose steadily from May, peaking in September, with a level above the 4,900MW mark for the first time since market start. This increase in CCGT supply in May can primarily be attributed to the start of the commercial operation of Keppel Merlimau's CCGT units. The increased supply was further boosted by lower incidences of CCGT planned and ad-hoc generation outages in the second half of 2007 as compared to the first half. On the other hand, the steam turbine (ST) offer availability shrunk 1.4 percent in 2007 as compared to 2006.

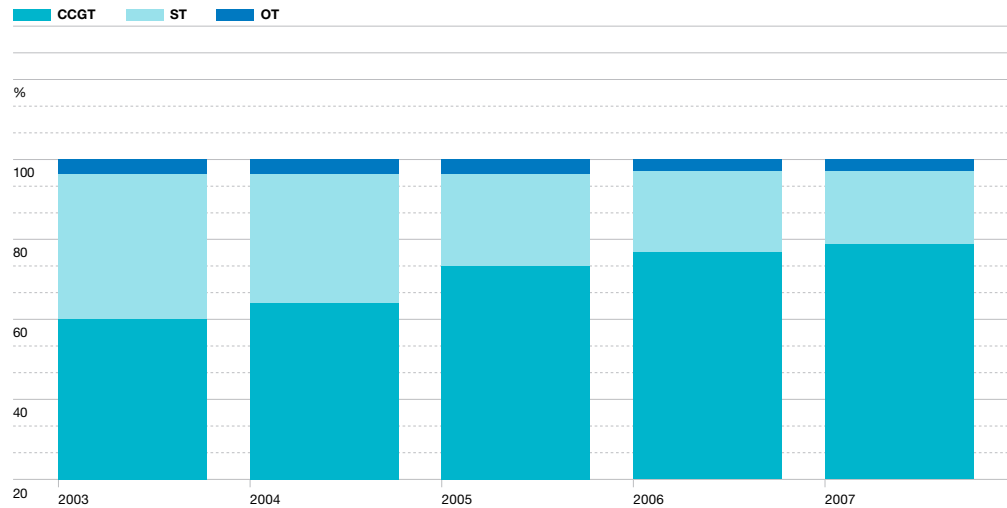
The MSCP report, the Market Monitoring/ The Energy Market/Market Structure section on page 8, shows why ST still plays a strategic role.

Energy Offer Price Bands 2006/07



The higher CCGT offer availability benefited the market, as the CCGT supply often acted as the base load. As such, under the marginal pricing mechanism, energy offer price bands below \$100 megawatt per hour (MWh) were 81.8 percent in 2007, compared to 66.9 percent in 2006.

Market Share by Plant Type 2003/07



Based on scheduled generation

OT = other facilities, i.e., incineration plants operated by the National Environment Agency that convert energy from incinerated refuse.

Note: The market share for GT units was 0.01 percent in 2007 and 2006, 0.03 percent in 2005 and 0.02 percent in 2004. GT units did not participate in the energy market in 2003.

However, owing to the higher incidences of CCGT planned and ad-hoc generation outages in the first half of 2007, the annual average CCGT market share only improved marginally to 79 percent for the year, up slightly from 78 percent in 2006.

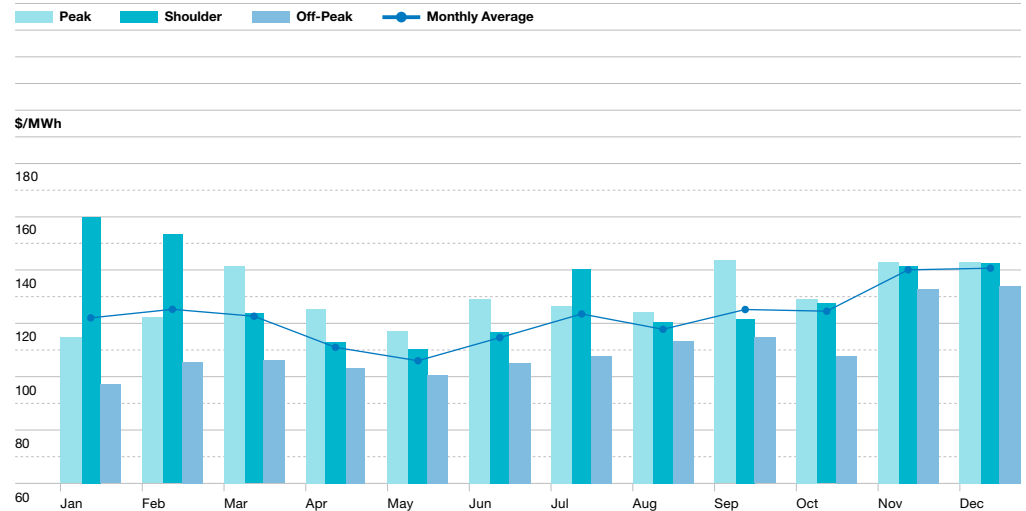
Five-Year USEP Overview

	USEP (\$/MWh)				
	2003	2004	2005	2006	2007
Yearly	92.35	82.35	109.90	132.42	124.57
Lowest Monthly	80.85	64.24	78.56	106.70	109.83
Highest Monthly	103.96	106.39	147.25	167.41	140.15

Despite higher demand, the changes in energy offer prices contributed to the declining USEP this year. In 2007, a total of forty-eight trading periods were recorded in which the USEP closed at or above \$500/MWh compared to eighty-five trading periods in 2006. Overall, the annual USEP dropped to \$125/MWh after climbing for two consecutive years.

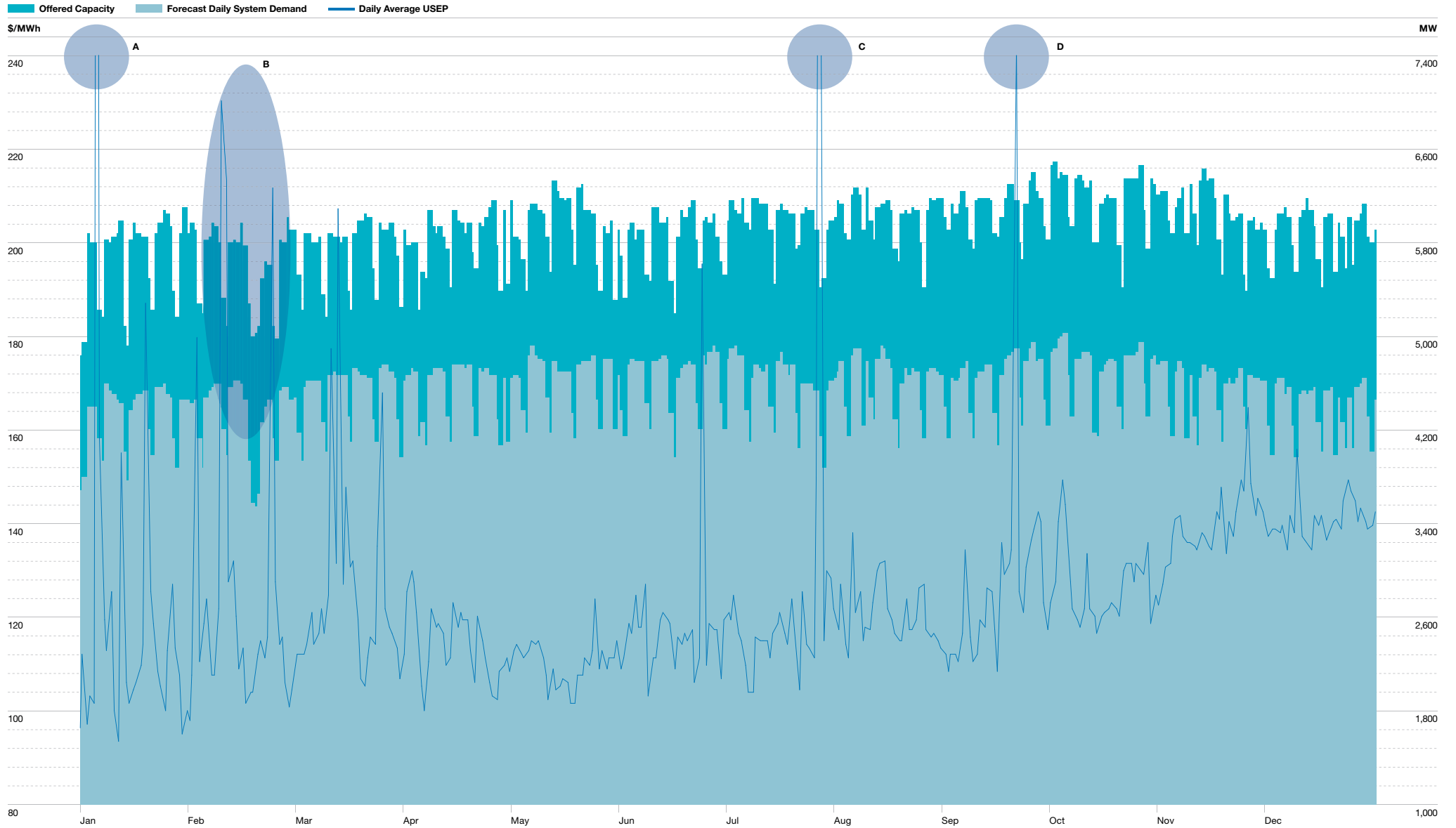
Over the first ten months of 2007, the USEP closed below \$128/MWh for the monthly average levels. Thereafter, the USEP rose and peaked at \$140/MWh in December. For the first time, the lowest monthly average USEP was recorded in May instead of in the months of January or February, as it was the case for the four previous years. This May-low was mainly attributed to the commencement of commercial operation of Keppel Merlimau's units.

USEP by Peak, Shoulder and Off-Peak 2007



During the months of January, February and July, the USEP during the shoulder period exceeded the peak. In January in particular, the shoulder USEP rose to \$160/MWh, while the peak and off-peak USEP stayed below \$120/MWh. The higher shoulder USEPs in January, February and July were mainly due to tight supply conditions, especially on Saturdays, when fewer generation units are deployed. In addition, in November, the off-peak USEP crossed the \$130/MWh for the first time since market start.

USEP, System Demand and Offered Capacity 2007



Prices above \$240/MWh are not displayed.

In 2007, the USEP was less volatile compared to the previous two years. However, USEP fluctuations were still observed, mainly in the first and third quarters of 2007. The key observations:

Point A:

On 6 January, a CCGT forced outage and offer changes caused the USEP to spike between \$827/MWh and \$4,330/MWh for six consecutive periods. Both available open-cycle gas turbine (GT) units ran for all six periods and the daily average USEP closed at its second highest level since market start with \$429/MWh. Primary reserve and contingency reserve experienced a deficit for one period, while regulation had deficits for three periods. These three ancillary markets hit their ceiling prices for the affected periods.

Point B:

The daily average USEP rose above \$170/MWh on four separate weekends: 3, 10, 11 and 24 February due to the lower CCGT offer availability, as units were out for maintenance or did not offer. GT units ran on all four trading days.

Point C:

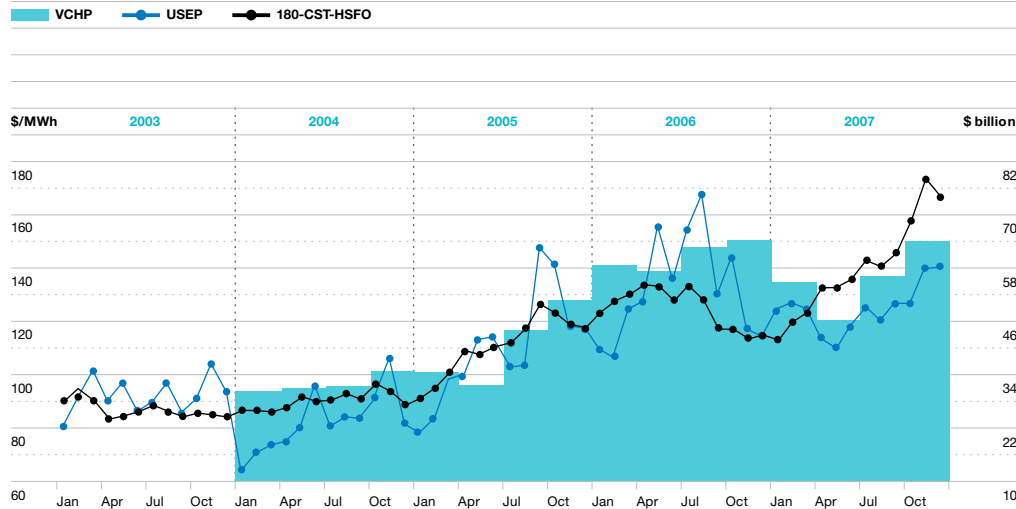
On 28 July, the USEP climbed to its ceiling price (\$4,500/MWh) after registering a deficit. The deficit was due to a series of supply crunches, the result of one CCGT forced outage, one CCGT unit on maintenance and two CCGT units remaining out (since their forced outages on the previous day). All GT units ran. Because of co-optimisation, the primary reserve, contingency reserve and regulation also hit their ceiling prices, and primary reserve and regulation recorded deficits for the same period.

Point D:

On 21 September, the USEP climbed above \$700/MWh for a total of three periods after the market experienced multiple forced outages by one CCGT unit amidst peak demand on that day. The GT units ran for a total of thirteen periods.

The MSCP report, the Market Monitoring/ Analysis of Outages and Prices section on page 24, covers points A and C in more detail. Table 2 on page 7 shows the statistical properties of the USEP, including standard deviations, which measure volatility.

Monthly USEP, VCHP and Oil Price 2003/07



Vesting contracts were imposed by the EMA from 1 January 2004.

180-CST HSFO (180-centistoke high sulphur fuel oil)

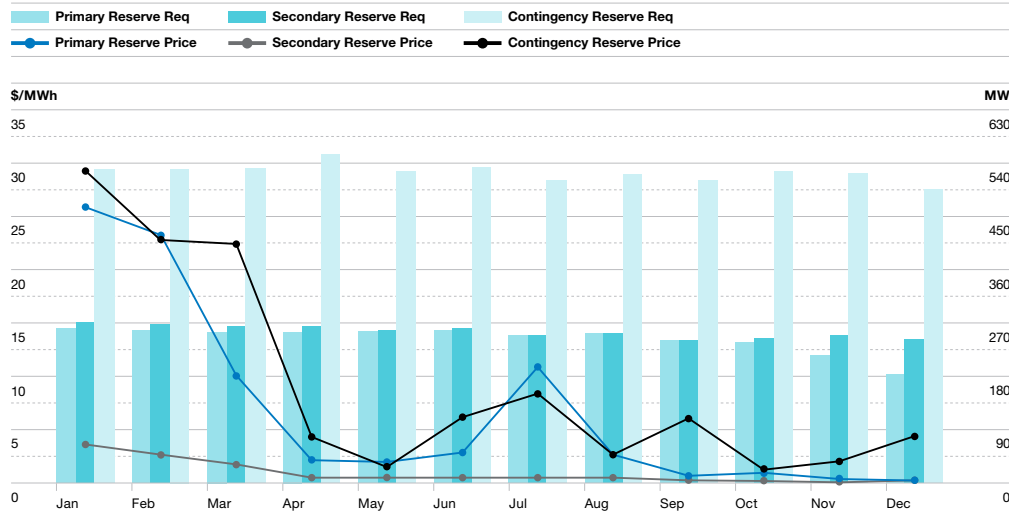
The USEP trend in 2007 was in line with the quarterly movements of the vesting contract hedge price (VCHP) over the year, which registered lower levels compared to 2006 in the first three quarters of the year before rising in the last quarter.

The Energy Market Authority (EMA) has imposed vesting contracts on generators since 1 January 2004, 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. The demand vested in mandatory contracts between the generators and SP Services (on behalf of consumers) was about 65 percent for the first half of 2007 and has been reduced to about 55 percent since July. In 2007, the VCHP averaged \$136/MWh, which is about 8.2 percent higher than the USEP of \$125/MWh.

Fuel costs make up a significant proportion of running costs for the thermal-fired generators that make up 97 percent of Singapore's generation capacity. This means that the bulk of production costs for Singapore's generation assets are either directly or indirectly (through the pegging of natural gas prices to an oil benchmark) determined by international oil prices. Hence, changes in fuel input costs, such as the price of fuel oil or natural gas, have a significant influence on electricity prices. The relevant oil benchmark for the Singapore electricity industry is 180-centistoke high sulphur fuel oil (180-CST HSFO). In 2007, the 180-CST HSFO price increased 18.7 percent over 2006.

See the MSCP report, the Market Monitoring/ The Energy Market/Contributing Factors in Price Fluctuations section on page 10, for further insights.

Reserve Prices and Requirements 2007



The ancillary markets play an important role in facilitating energy availability and reliability of the wholesale electricity market. In addition to supply, ancillary prices are also highly influenced by the energy market as a result of co-optimisation.

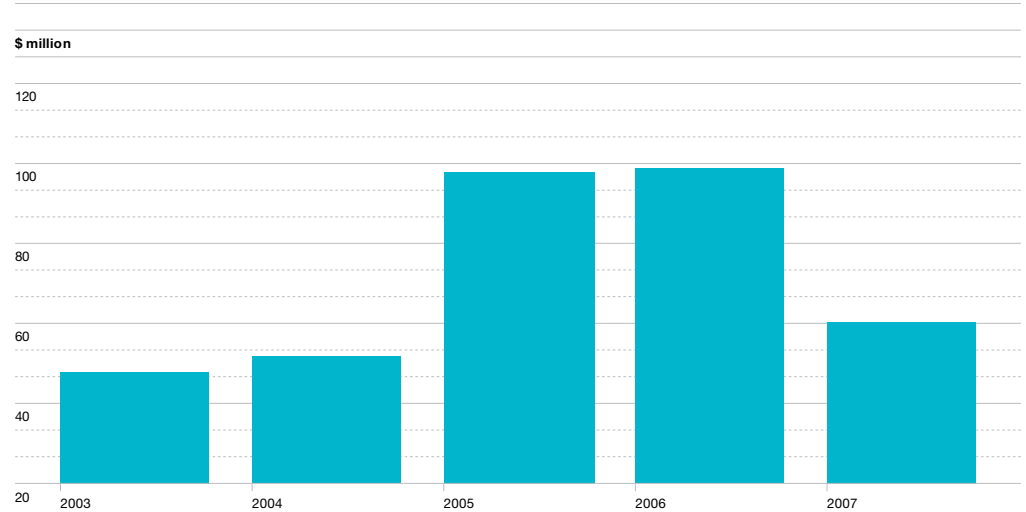
Reserve capacity is procured from the market to ensure that there is stand-by system capacity that can be drawn upon if there is an unforeseen disruption of supply, e.g., an equipment outage.

The primary, secondary and contingency reserve classes are used to procure reserve of 8-second, 30-second and 10-minute respectively.

During the first quarter, higher reserve prices were observed because of tight supply and the effects of co-optimisation, but they dropped thereafter as the reserve offer capacity increased. In 2007, primary, secondary and contingency reserve prices averaged \$6.57/MWh, \$0.65/MWh and \$8.99/MWh respectively.

In addition, the primary reserve requirement was revised downwards on 14 November in accordance with the fourth version of the Power System Operator (PSO) system operation manual.

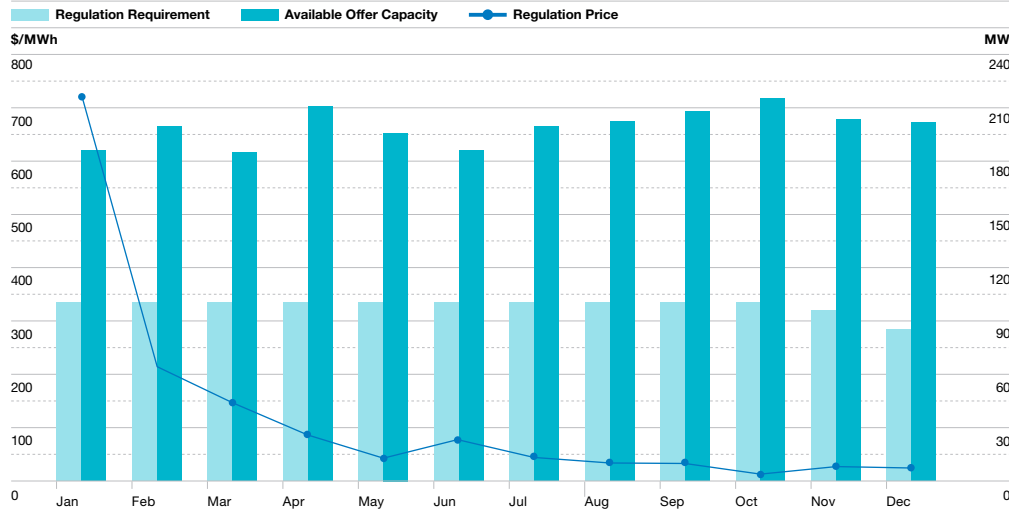
Total Reserve Cost 2003/07



Benefiting from an increase in the reserve offer capacity and lower energy price volatility, reserve cost eased down to about \$60 million in 2007.

Interruptible Load (IL) facilities participate in all three classes of reserve market within the NEMS — primary, secondary and contingency reserve. As of 31 December 2007, the total IL registered capacity was about 26MW for each class of reserve. This translates into a market share of about 5 percent each for primary and secondary reserves, and about 3 percent for contingency reserve.

Regulation Market Indicators 2007

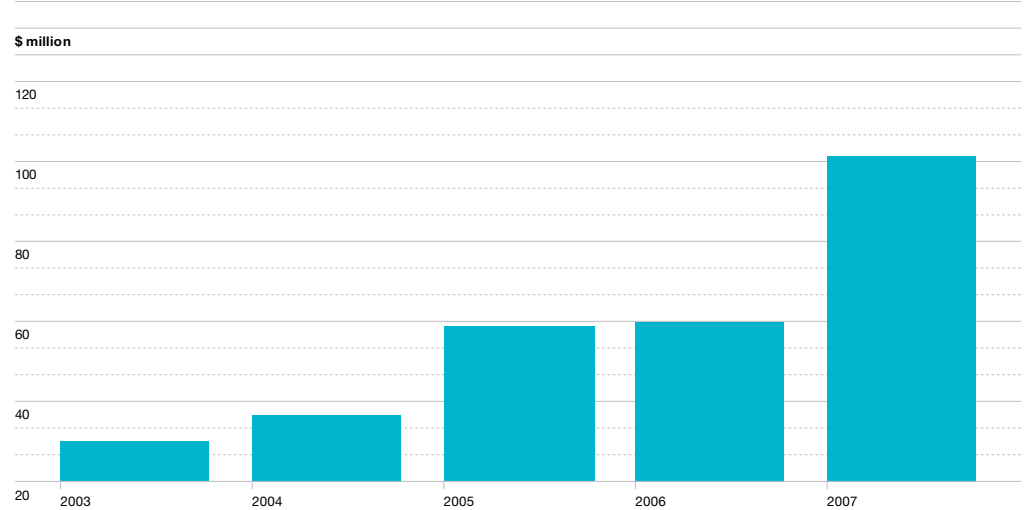


Regulation is generation capacity that is purchased from the market and used in real time to fine-tune the match between generation and load. The regulating generators ramp up and down in response to small fluctuations in demand and to the output of other generators.

Following a mid-2006 study by the PSO to re-model the regulation requirement, the PSO revised the regulation requirement from a fixed level of 100MW per day to a 48 period-based regulation requirement. This change took effect on 22 November 2007.

During 2007, the regulation price hit both a record high and a record low. In January, the monthly average regulation price rose to an all-time high of \$719/MWh, and in October fell to its lowest monthly average of \$11/MWh. Overall, the regulation price closed at \$118/MWh for 2007. The total regulation payment rose over the \$100 million mark in 2007.

Total Regulation Payment 2003/07



In view of record-high regulation prices experienced in late 2006 and early 2007, the Market Surveillance and Compliance Panel (MSCP) and the Energy Market Authority (EMA) examined the matter.

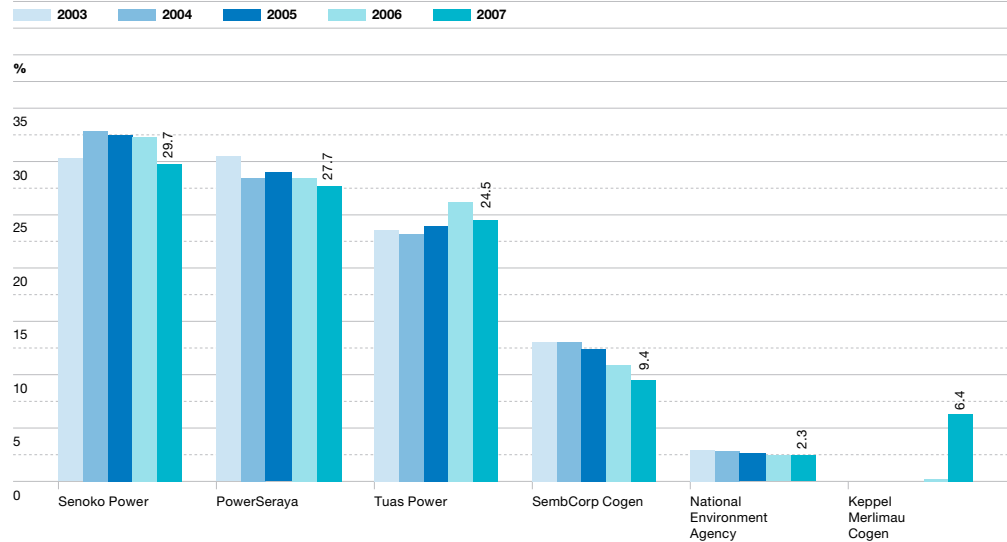
Based on studies conducted by the EMA, it was concluded that the period of high regulation prices was the result of a combination of factors:

- seasonal low demand and market concentration resulted in fewer generation units operating; thus units were more likely to fall outside their regulation band and become ineligible to provide for regulation,
- the planned maintenance of generation units,
- the increase in the regulation offer prices and
- the impact of commissioning units.

The EMA has announced that it is considering the implementation of regulation price caps.

See the MSCP report, [The Regulation Market/ The High Regulation Price Incident](#) section on page 17, for further details on the MSCP investigation of the high regulation prices in 2007.

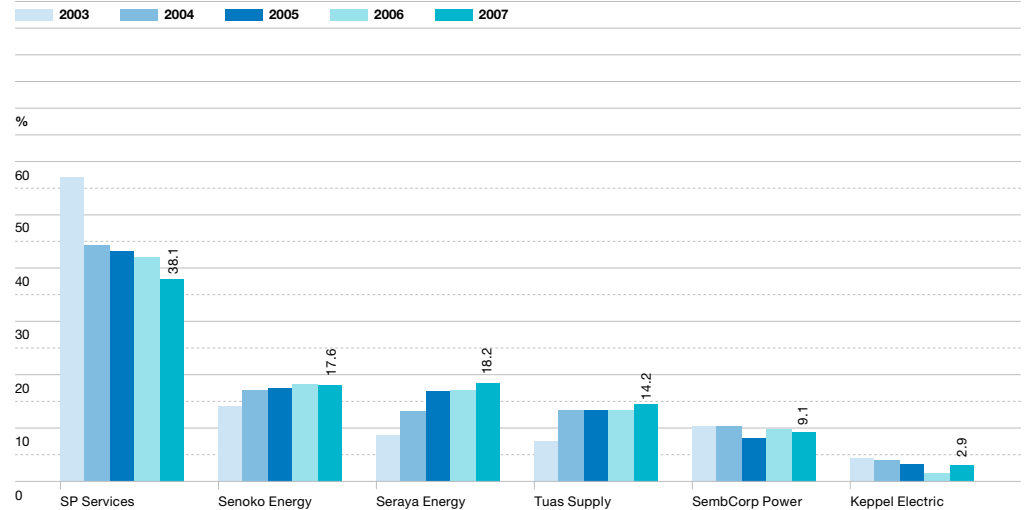
Market Share by Generator 2003/07 (based on scheduled generation)



2007 saw increased competition as Keppel Merlimau entered the market. Keppel Merlimau's market share rose as their commissioning process was completed. Its market share in the first half of 2007 was 4.11 percent, rising to 8.52 percent in the second half of the year, reducing the market shares of the incumbents.

While Senoko Power continued to claim the highest market share in 2007, its share was reduced by 2.49 percent compared with 2006. Tuas Power and SembCorp Cogen were similarly affected, with reductions of 1.6 percent and 1.4 percent respectively. The impact on PowerSeraya was more moderate, with a 0.62 percent decline in generation market share compared with 2006.

Market Share of SP Services and Retailers 2003/07



In the retail market, moderate changes continued to be observed in 2007. In particular, the market share for SP Services fell below the 40 percent mark as additional contestable consumers moved from SP Services to competitive retailers. This represents the continuation of retail competition in the Singapore electricity market.

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

- energy,
- three classes of reserve (primary, secondary and contingency),
- regulation,
- vesting contracts,
- uplift charges,
- fee recovery of EMC and the PSO administration costs and
- contracted ancillary services (black-start services).

Market participants may choose to have EMC settle bilateral contracts with other participants.

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 prudential cover protects EMC and other market participants from payment defaults. EMC reviews the adequacy of prudential cover daily.

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 prudential cover. In 2007, EMC issued 17 margin calls and these calls were met within the time frame of two business days.

For 2007, the value of total retail settlement payments (net of bilateral contracts) was \$3.514 billion and the value of credit support at 31 December 2007 was \$381.7 million.

EMC negotiates and enters into 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 January 2007 to 31 March 2008, 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 \$9.736 million. The capability was sourced from PowerSeraya, Senoko Power and Tuas Power.

**Contracted ancillary services
1 January 2007 to 31 March 2008**

	Cost incl. GST (million)	Quantity (MW)
Black-start Service	\$ 9.736	68.848

The costs associated with the wholesale functions of the NEMS are recovered directly from the wholesale market or from market participants and consumers.

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

EMC and PSO fees recovered directly from the NEMS 1 April 2007 to 31 March 2008

EMC	\$28.666 million	\$0.374/MWh*
PSO	\$14.413 million	\$0.188/MWh*
Total	\$43.079 million	\$0.562/MWh*

* Assumes energy trade of 7.664 terawatt hours (TWh) per month.

Fees recovered directly from market participants and consumers

Supplier	Service	Method of Assessment
SP Power Assets	Transmission charges	Levied based on actual usage
SP Services (MSSL)	Meter reading and data management	Levied on a per meter basis



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 fast-start ancillary service is procured by Energy Market Company (EMC) on contract based on regulated prices.

black-start ancillary service

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

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.

co-optimisation

The process used by the market clearing engine every half-hour to ensure that the cheapest mix of energy, reserve and regulation is purchased from the market to meet electricity demand in each dispatch period.

dispatch schedule

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

energy

The flow of electricity.

fast-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.

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.

market clearing engine (MCE)

The linear computer program used to calculate the spot market quantities and prices.

market participant (MP)

A person that has an electricity licence issued by the EMA and has been registered with EMC as a market participant.

megawatt (MW)

A measure of electrical power equal to one million watts. MWh represents the number of megawatts produced or consumed in an hour.

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 IL that can be drawn upon when there is an unforeseen disruption of supply.

retail market

The transactions made between retail companies and end consumers.

terawatt (TW)

A measure of electrical power equal to one million megawatts. TWh represents the number of terawatts produced or consumed in an hour.

USEP

The Uniform Singapore Energy Price is the weighted-average of the nodal prices at all off-take nodes.

vesting contract

A vesting contract is a regulatory instrument imposed on generators by the Energy Market Authority (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.

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 technology in the Singapore power system, i.e., the combined-cycle gas turbine (CCGT). The EMC's settlement system uses the VCHP to settle the vesting quantity between the MSSL and the generation companies.

wholesale market

The transactions made between generation companies and retail companies.

Active Generator Licensees	Keppel Merlimau Cogen National Environment Agency PowerSeraya SembCorp Cogen Senoko Power Tuas Power	www.keppelenergy.com www.nea.gov.sg www.powerseraya.com.sg www.sembutilities.com www.senokopower.com.sg www.tuaspower.com.sg
Active Retailer Licensees	Keppel Electric SembCorp Power Senoko Energy Supply Seraya Energy Tuas Power Supply	www.keppelenergy.com www.sembspower.com www.senokoenergy.com.sg www.serayaenergy.com.sg www.tpsupply.com.sg
Wholesale Market Traders	Air Products Diamond Energy Pfizer Asia Pacific	www.airproducts.com.sg www.diamond-energy.com.sg www.pfizer.com
Market Operator	Energy Market Company (EMC)	www.emcsg.com
Market Support Services Licensee (MSSL)	SP Services	www.spservices.com.sg
Power System Operator	Power System Operator (PSO)	www.ema.gov.sg
Transmission Licensee	SP PowerAssets	www.powergrid.com.sg

