# Strategic Energy Procurement : Your Key to Effective Energy Management in Single and Multi-Tenanted Premises

**Ken Jung** *Executive Director B.A.Sc (Univ. of Toronto, EE), C. Eng (UK), P. Eng (Singapore, Ontario, Canada), Quality Power Management Pte Ltd*

**Martin Lim** *Chief Operating Officer, Quality Power Management Pte Ltd, B. Eng (National University of Singapore)*

**Ben Lau** *Senior Manager, B. Eng (Hons), MSc, MBA, P. Eng, Tuas Power Supply Pte Ltd*

**Neo Poh Hua** *Manager, B. Eng (Hons), P. Eng, Tuas Power Supply Pte Ltd*

**Nicholas Neo Tiong Tian** *B. Eng (Elect), P.Eng, MIES, MIEEE, MSNAMES, Licensed 22 KV engineer, Electrical Engineer, Singapore Turf Club*

URL: http://www.qpower.com.sg
E-mail: martin@qpower.com.sg

URL: http://www.tpsupply.com.sg
E-mail: customer@tuaspower.com.sg

URL: http://www.turfclub.com.sg
E-mail: nicholas_neo@turfclub.com.sg

## Abstract

*This paper is the valuable result of a joint effort amongst Tuas Power Supply Pte Ltd, one of the leading retailers in the new electricity market, Singapore Turf Club and Quality Power Management Pte Ltd (QPM), a service provider in the power and electrical sectors. It highlights the important reasons for implementing Strategic Energy Procurement (SEP) as an effective means of energy management in a rapidly de-regulating electricity market. The Singapore Turf Club through its experience will highlight a case study that underlines the usefulness and effectiveness of SEP in creating savings.*

## Keywords

Strategic Energy Procurement, New Electricity Market, energy retailers, multi-tenanted, de-regulation

## Introduction

Liberalisation of the Singapore electricity market is finally taking shape. For over 30 years, the Singapore electricity industry had been vertically integrated and Government owned. In 1995, despite being one of the smallest markets in terms of demand size, Singapore became the first country in Asia to kick-off de-regulation of the electricity market. The nation is now into the final phases of implementing the New Electricity Market or NEM.

Under the NEM, electricity will be traded between generator companies and retailers through a "real time" wholesale electricity market, a computer-based wholesale auction market set up and administered by the market operator - Energy Market Company (EMC).

Generator companies submit bids to the wholesale electricity market to sell electricity for each of their generator sets. Retailers procure electricity from the wholesale electricity market to serve end consumers. The wholesale market is subject to spot prices which can be volatile. A liberalized electricity market creates healthier competition among electricity suppliers allowing market forces to dictate pricing.

Consumers that have been declared contestable can procure energy independently from licensed electricity retailers. The process of achieving contestability and procuring energy from a licensed retailer is simply termed Strategic Energy Procurement or SEP.

SEP is a systematic, cost-effective and efficient method of energy procurement. It is rapidly gaining popularity among clients in the commercial and industrial sectors where energy consumption constitutes a significant amount of their operating expenditure. When applied correctly and with good management commitment, it is a highly efficient tool in turning a cost-centre into a revenue-generating centre.

## New Electricity Market (NEM)

As early as 1 October 1995, Singapore began the reform of its electricity and piped-gas industries by separating the regulator from the operational entity. Singapore Power was established to undertake the electricity and piped-gas operations of the Public Utilities Board (PUB). PUB was re-constituted as the regulator for the newly reformed electricity and piped-gas markets. Singapore Electricity Pool started operating on 1 April 1998 as the wholesale market for electricity.

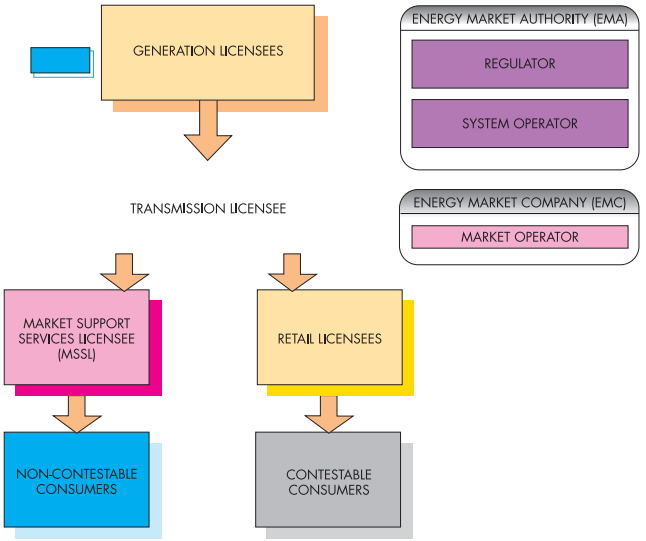



**Figure 1 : Singapore electricity industry structure**
**Source: EMA 2002**

This vertically integrated monopoly held by Singapore Power (SP) created an unlevelled playing field as SP was both market operator and power system operator through its subsidiary Power Supply Ltd and PowerGrid Ltd respectively. In 2000, the government decided to fully open the electricity market. In April 2001, SP divested its two generation companies and confined its undertakings to the electricity and gas grids. Energy Market Authority (EMA) was formed on 1 April 2001 to take over the regulatory functions of PUB whilst functioning as the power system operator for the electricity and piped-gas markets.

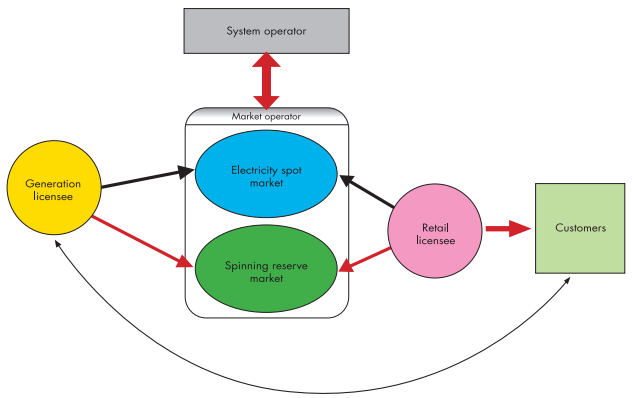



**Figure 2 : Singapore wholesale electricity market**
**Source: EMA 2002**

Power Supply Ltd (PSL), a subsidiary of Singapore Power Ltd, will continue to supply to non-contestable consumers but will cease to be an electricity retailer when the market is fully liberalized. Instead, PSL will be the Market Support Services Licensee (MSSL) to provide market support services such as consumer registration, meter reading, billing and bill collection. MSSL will also be the retailer of last resort.

The Energy Market Company (EMC) was formed as the market operator of the new wholesale electricity market. On 24 June 2002, the EMA commenced the eight-week trial for new software to manage dynamic energy trading in the New Electricity Market (NEM).

The software comprises two distinct areas – energy market clearing engine and market settlement system (managed by the Energy Market Company or EMC and the electronic business transaction and retail settlement system managed by Power Supply Ltd. Several changes including check and balance mechanisms as well as co-optimisation for energy, regulation and reserve have been made to the revised electricity pool in the NEM.

Currently, the licensed retailers in Singapore are: Tuas Power Supply Pte Ltd, SembCorp Power Pte Ltd, Keppel Electric Pte Ltd, Senoko Energy Supply Pte Ltd, Tractebel Asia Pte Ltd, Marubeni Petroleum and Seraya Energy Pte Ltd.

### Managing price risk

To manage price risk in the NEM, power generating companies employ a variety of tools to hedge against price volatility. Short or long-term financial hedge contracts can reduce exposure to volatile spot prices. These contracts may be based upon an agreed price for a defined quantity of electricity (or reserves) at specific times. The most common types of bilateral financial contracts for a power generating company are Contracts for Differences (CfDs).

CfDs are bilateral contracts between power generating companies and retailers entered at the discretion of the participants based on agreement to a CfD hedge strike price and the volume of energy covered.

### Vesting contracts

Vesting contracts are a form of CfD vested on the incumbent power generating companies by EMA for a specified transitional period. The objectives of vesting contracts are to limit the potential misuse of market power by the larger power generating companies and reduce price volatility. When spot price exceeds contract price, the Market Support Service Licensees (MSSL) pays the generators the difference and vice versa when spot prices fall below contract price.

### Divestment strategy

The next stage of de-regulation is the 100 percent divestment of the three generation companies owned by Temasek Holdings – Tuas Power, Power Seraya and Senoko Power.

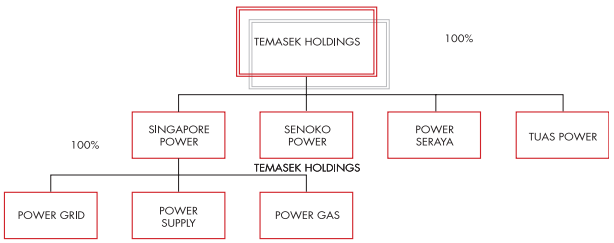



**Figure 3 : Current ownership structure**

The authorities will ensure that market equilibrium and reliability of supply are maintained while simultaneously fine-tuning the deregulation process so that prices are market driven and not influenced by regulatory or market power forces.

## Current Electricity Market

According to statistics released by the Energy Market Authority (EMA), electricity sales for the first quarter 2002 was 7,220 GWh which is 2.4% higher than the same quarter last year. This increase was due to a 4.6% rise in domestic sales. Non-domestic customers increased by a further 1.9%. Currently, non-domestic customers comprise 80% of the total sales.

In the NEM, a contestable consumer will no longer be subjected to regulated tariffs. Instead, consumers will have the choice to buy electricity in one of the following ways:

- From the wholesale spot market directly as a wholesale market participant;
- From the wholesale spot market through Market Support Services Company; or
- From a licensed electricity retailer through an agreed electricity purchase contract

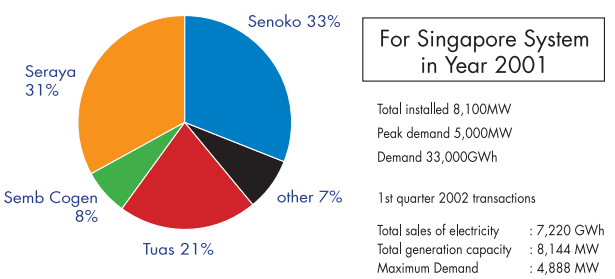


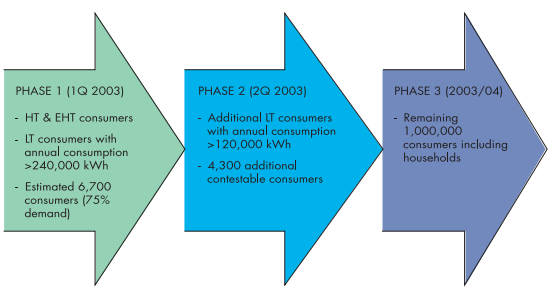

**Figure 4 : Market Share by Installed Capacity**

## Consumer Choices in the NEM

EMA has taken a phased approach in liberalizing the electricity retail market. Consumers with High Tension (HT) or Extra High Tension (EHT) and a maximum power requirement of 2 MW and above have attained contestability statutes on a case-by-case basis since July 2001. Further liberalisation of the retail market is expected to take place after introduction of the NEM around first quarter 2003.

Currently, around 200 contestable consumers with a contracted capacity of 2 MW and above can opt to procure energy from an independent retailer.

**Table 1: Time table for retail competition**




By 2003, another 6,000 consumers with an annual energy consumption of at least 240,000 kWh will be able to participate in the NEM.

This will be followed by a further 5,000 consumers subsequently. Retail contestability will progressively cascade to the remaining 1 million consumers including households.

## Dynamics of SEP in Multi-Tenanted Premises

Seventy percent of the current pool of large consumers have already switched supplier helped to a large extent by value-added packages offering meter reading and bill management services and greater savings on electricity costs.

Most commercial buildings in Singapore are multi-tenanted premises. Electricity consumption is measured using master and sub-metering. Electricity consumption for the whole premise is measured by Time-of-Day (TOD) interval meter (Master meter) in half hourly intervals.

In contrast, most tenants' meters (sub meters) are conventional electro-mechanical meters providing manual reading according to the monthly schedule. The landlord's monthly electricity consumption is computed by subtracting the sum of the sub-metered usage from the master-metered usage.

Landlords who meet the contestability threshold and wish to participate in a deregulated market have discovered technical limitations arising from their master and sub-metering arrangement. The solution is to allow the landlord to buy electricity en bloc on behalf of his tenants.

Contestability in commercial and industrial property owners requires two key considerations: a contracted capacity in excess of 2 mega-watts (MW) and if multi-tenanted, all its tenants must agree en bloc to allow the owner to procure energy on their behalf.

The appointed retailer will also lease the tenants' meters from Power Grid Ltd on behalf of the landlords. However, the private retailer is not allowed to enter into supply agreements directly with the tenants as they are not contestable until Phase 3 when the market is fully liberalized. All terms and conditions for the en bloc purchase of electricity shall be construed as commercial contractual obligations between the landlord and tenants.

However, the most difficult task is to educate consumers to look beyond the cost of generating electrons vis-à-vis the tariff structure. They have to learn to evaluate proposals on a common platform and benchmark the tariff structure with other value-added packages offered. The roles of retailers will involve packaging of the electricity rates in various time tiers and enhanced customer service especially in working closely with SEP consultants.

Some considerations include the recovery strategies in the event of power failure, legal implication of the service level agreement between landlord and tenants and landlord with retailer, contractual liabilities, and financial risk based on the entry position of spot prices and the appropriate pricing model to use.

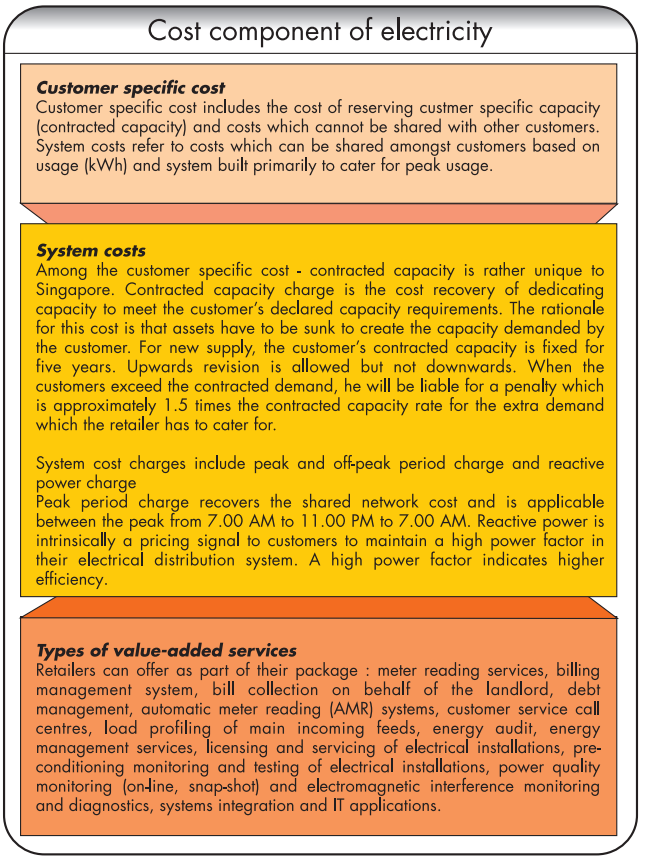



**Figure 5 : Cost components of Grid Charges**
**Source: QPM 2002**

SEP covers many fields encompassing administrative, financial engineering, legal and contractual interpretation and documentation, project management and facilitation. The pre-sales period often involves market education and awareness of the new electricity market. SEP consultants work closely with its potential customers advising them and helping them understand the mechanics and dynamics of the NEM.

SEP consultants must not only be techno-savvy, but they have to be able to help the client navigate through a minefield of legal jargon, interpret legal issues correctly and be able to evaluate proposals from retailers onto a common benchmark that the client can comprehend.

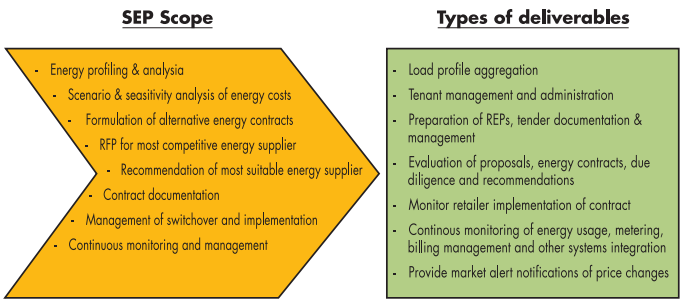



**Figure 6 : SEP scope of services and deliverables**
**Source: QPM 2002**

Clients appreciate the tangible savings generated through the savings analysis and modelling exercise. However, the financial exercise has to be intricately balanced with the right dose of technical competence.

The ability to work closely with the landlord's Licensed Electrical Worker (LEW) forms a critical part of SEP. The role of the LEW in the NEM has been further expanded to conducting compliance checks and installation turn-on.

## SEP Methodology

To expedite complex SEP projects, a systematic approach was conceived by QPM. Termed the QPM 3-step methodology, it provides a systematic framework to attain contestability in a multi-tenanted environment.

The entire exercise of getting contestability for the landlord can be between 21 days to two months depending on the pro-activity of the tenants. Thereafter, the SEP consultant has to follow through with EMA for an official approval before he can proceed with the energy tender.

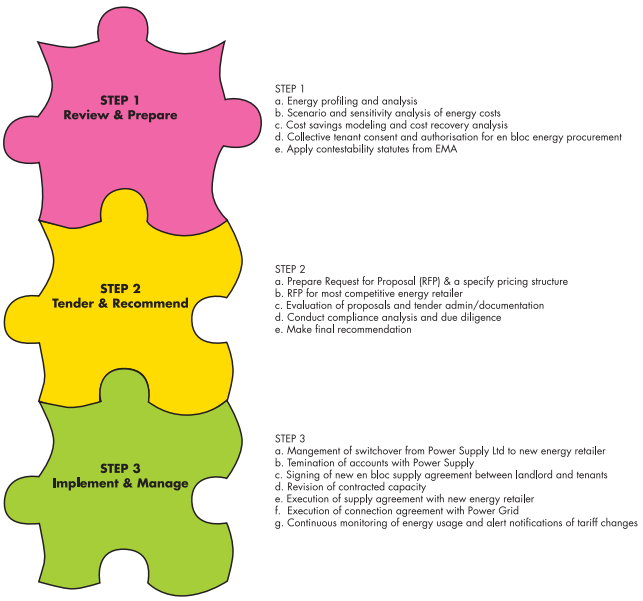



**Figure 7 : QPM 3-step methodology**
**Source: QPM 2002**

## Application of SEP

In May 2002, QPM furnished SEP services to Allgreen Properties Limited for Great World City, a commercial development located at the fringe of Orchard Road and bounded by Kim Seng, River Valley and Zion Roads and Kim Seng Promenade.

Great World City is a commercial complex with a mix of retail and office space occupying over 400,000 square feet of shopping space. The mixed development comprises retail, office, service apartments and Tiara Condominium. There are more than 1,000 car park lots to meet shoppers' needs. Altogether, there are 140 retail outlets and 46 offices in the 18 storey complex.

From initial modelling of various savings scenario, it was determined that indicative savings of between 5 to 10% of the total energy cost per month could potentially be achieved through switching to a new energy supplier. The savings was modelled on the landlord's existing charges comprising reactive power, contracted and uncontracted capacity and internal losses. In the modelling exercise, a reduced tariff to its tenants was factored in.

The experience of the Singapore Turf Club, a world-class horse racing venue with a monthly consumption of 2.2 GWh (see attached story) yielded savings of 15% per month after implementation of SEP.

## Derivatives of SEP

Competition has spawned the need for quality, value-added services and level of service as the differentiating factors. In the near future, energy retailers are likely to differentiate themselves by offering innovative packages like:

a. Energy billing management system
b. Power quality monitoring and analysis
c. Systems integration and IT application services
d. Automatic meter reading (AMR) interface systems
e. Maintenance and technical support services

**Energy billing management system**

The benefits of an in-house billing system includes better management, efficient deployment of resources, integration of energy billing into monthly rental and no vendor lock-in. The salient features of a comprehensive billing system should include customizable client-specified formats that can be integrated seamlessly into the accounting system to generate energy billing together with the monthly rental invoices. In the near future, it is envisaged that billings will be web-enabled and made accessible via internet browser, a useful feature for clients with multiple buildings who wish to centralize operations into one location.

**Power quality (PQ) monitoring and analysis**

Prime-movers like QPM have been pioneering IT applications and internet-enabled energy meters and softwares to support real-time energy monitoring of power generation and distribution. Using this cutting edge technology, building operators in consultation with PQ specialists will learn to make rational decisions on how to improve the performance of electronic equipment in a well-informed and cost-effective manner.

PQ analysis in essence allows early detection through:

- Listing and explaining the main causes of PQ problems
- Detecting the sensitivity of electronic equipment to PQ events
- Monitoring PQ at source
- Prediction of the performance of electronic equipment
- Allows circuit analysis techniques to be performed to predict PQ levels for specific circuits
- Applying a holistic approach to solving PQ problems

Through a comprehensive PQ analysis, consultants are able to improve:

- Sags in voltage
- Interruptions in supplied power
- Distortion of supplied voltage due to harmonic currents

**Systems integration and IT application services**

In the next few years, as more and more internet-based applications are being built, there will be a need to either outsource the systems integration portion of the services or to develop and maintain an in-house IT team. In the interim period, it is envisaged that more of such services will be utilized to "jump-start" the deployment of IT services. The increasing use of Customer relationship management (CRM) tools to improve customer loyalty will result in more firms integrating CRM modules to their enterprise systems.

**Automatic meter reading (AMR) interface systems**

Recently, Automated Meter Reading (AMR) interfaces are gaining public interest as an alternative means of meter reading management. Such considerations spring from the need to reduce labour-intensive activities by utilizing higher value-add and short-term Return on Investment (ROI) systems that help increase efficiency and accuracy of services.

**Maintenance and technical support**

These services will increase exponentially with the increasing use of more sophisticated softwares and hardwares in the power quality, AMR and billing management systems. As clients harness IT for enterprise efficiency and develop their operating environment, there will be a new class of service providers who will emerge to serve the needs of this market providing technical support, help desk services and customer services.

## Energy Management Strategies

There are typically three approaches to reshape the load profiles of commercial building for energy management.

***Strategic Energy Conservation Techniques***

Strategic energy conservation reduces the amount of energy consumed by a commercial building owner through reducing lighting loads or installing better efficient air-conditioning equipment. (Figure 8a)

The first step in the energy management programme is to reduce energy wastage in identified areas and to minimise energy usage in areas that will not cause disruptions to various functions or discomfort. Typical energy consuming areas include: building equipment operation; building envelope; air-conditioning and mechanical ventilation equipment and systems; lighting systems; power and electrical distribution systems, and other miscellaneous services.

This phase involves a detailed step-by-step analysis of the

building's energy usage factors and costs like: insulation valves, occupancy schedules, chiller efficiencies, lighting levels and records of utility and fuel expenditure. A summary of the Energy Conserving Opportunities (ECO) can be profiled along with the cost/benefit analysis.

The second step would be to improve efficiency of energy conversion equipment and reduce energy consumption by proper means of operation and maintenance. The third step can be investment-intensive requiring large-scale energy reducing measures including extensive repairs, replacement or retrofits.

***Peak Shaving Strategy***

Peak Shaving strategy reduces the building's power capacity (Maximum Demand) requirement during the peak periods and hence reduces the Use of System cost such as the Contracted Capacity, Uncontracted Capacity and the Network Utilisation charges. It also reduces the peak energy cost as well. Peak shaving strategy involves direct control of the building's non-critical equipment, which can be load shed during the peak periods. A different approach is utilise self-generation facility to produce electricity for self-consumption during daily peak periods at a cost less than the peak price of each day (future). (Figure 8b)

***Load Shifting Strategy***

Load Shifting reduces the load during the peak periods by shifting the peak load to the off peak periods. This is achieved either by shifting the operation in the peak periods to the off peak periods or by installing thermal energy storage system for the air-conditioning system and operating this during the off-peak period.

The electricity prices in peak periods are much higher than the prices in the off peak period. By load shifting, it would be cheaper to run the equipment during the off peak periods instead of peak periods without suffering of any discomfort.

Load shifting also reduces the building's maximum demand and hence reduces the Contracted Capacity and Network Utilisation cost. (Figure 8c)

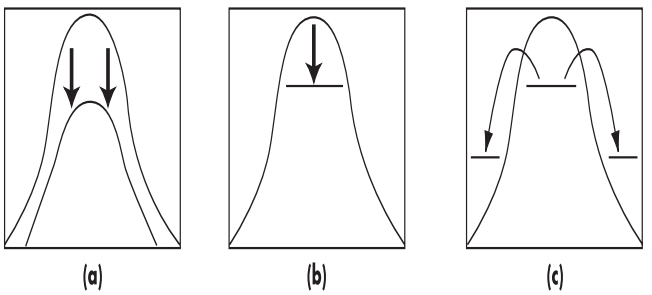



**Figure 8 : Energy management strategies**

Source: Tuas Power Supply Pte Ltd (adapted from HOSE, J.F. "Demand side planning; a practical perspective", IEEE Power Engineering Society)

The process of energy management program is illustrated in Figure 9.

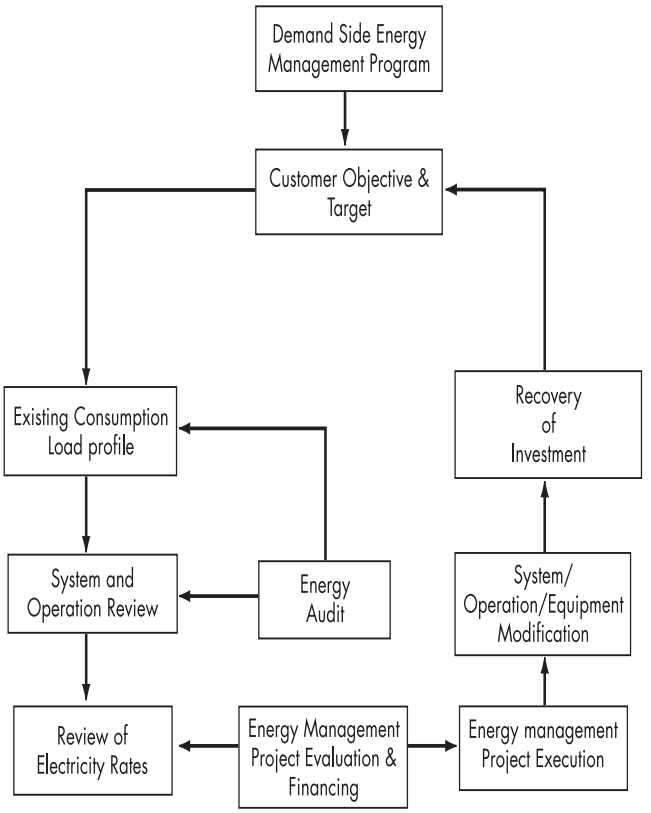



**Figure 9 : Process of energy management programme**

Source: Tuas Power Supply Pte Ltd (adapted from HOSE, J.F. "Demand side planning; a practical perspective", IEEE Power Engineering Society)

## Conclusion

Through implementation of various projects, SEP has proved to be an indispensable energy procurement system resulting in cost-effectiveness to the building operators and property owners. Its systematic process yields significant energy expenditure savings to the building operator.

Already bulk purchasing of electricity for grouped properties is being practiced whereby the property group, on behalf of its tenants negotiates directly with licensed retailers to procure energy at substantially lower rates.

With liberalisation of the electricity market expected in early 2003, one should not rule out the tangible benefits of SEP and its derivative services. In the near future, as retailers reach a state of maturity in a fully liberalized market, differentiating services will come into play as retailers package electricity rates in tandem with other value-added services.

At this present point in time, there is a need for more market education to create awareness of SEP services to property owners and building operators before the market fully liberalises.

***Case study: Experience of Singapore Turf Club in Electricity Purchasing***

*When Singapore Turf Club migrated from Bukit Timah in mid-1999 to the new racecourse at Kanji, its electricity cost doubled. This was further increased when night racing was introduced. In an effort to reduce cost, management set a directive to reduce the electricity cost by at least 10%.*

*Says Nicholas Neo, Electrical Engineer (Technical Services), Singapore Turf Club:*

*"Deploying internal expertise, an Energy Management Program was introduced with the objective of reducing energy consumption and thus the monthly electricity bill. The initial phase of this program was implemented with 'no cost' measures like:*

- *energy purchasing strategy, i.e. review fuel choices and tariff selection*
- *operating practices, i.e. review to ensure that existing systems and equipment are operating at maximum efficiency and wastage reduce to as low as possible*
- *motivation and training practices, i.e. review energy-awareness campaigns and tailor training programs to ensure adequate guidance is given to "good house keeping" practices for staff whose actions affect consumption*

*As of today, most of the initial phases of the program have been successfully implemented trimming down the monthly electricity bill at the racecourse from a historical high in April 2001 to the current low, saving more than 30% monthly. "*

Singapore Turf Club opted to buy electricity from a licensed retailer (in addition to Power Supply Ltd) after attending a Seminar for Contestable Consumer by the Energy Market Authority (EMA) on 27 April 2001.

The retailers were: Keppel Electric Pte Ltd, SembCorp Power Pte Ltd, Tuas Power Supply Pte Ltd, Senoko Energy Supply Pte Ltd and Tractebel Asia Pte Ltd.

Around mid 2001 when electricity retailing was still in its infancy, the Club solicited quotations from the five listed retailers. From this exercise, it was clear that neither the consumers nor retailers could be specific on the type of retail package best suited for the needs of the consumer. While it is useful educating the consumers on the liberalisation of the Singapore energy market and the procedures required to attain contestability, it is equally important to educate the Club's top management.

**Trial run**

For the first retail contract, the Club embarked on a six-month duration based on fixed 24-hour tariff. This tariff remained unchanged round the clock and was not subject to the fuel price index variation.

Notice of termination of supply contract with Power Supply Ltd (PSL) was served at end August 2001, fulfilling the one month notice requirement so that power by the new retailer could commence on 1 October 2001. Banker's guarantee to the new retailer was also processed with validity up to one month beyond the supply contract expiry date to cater to the end of month billing system.

This guarantee was a very critical requirement before any retailer could supply power. The Club subsequently executed the PowerGrid Agreement to supersede the Power Supply Ltd Agreement. However, negotiations for better terms and conditions on the Supply Agreement inadvertently took longer than expected.

The Club exercised its contestable statute on 1st October 2001 with SembCorp Power, opting for an all-hours fixed tariff for a six-month period. Initially, the electricity bill for October 2001 was about 2% lower compared to Power Supply Ltd.

However, PSL published their new tariff effective from 1st November 2001 onwards which was 3.3% lower then their existing rate. This effectively eliminated the 2% saving previously enjoyed. Management had a tough time justifying their positions.

The Club then tried to bargain for a lower tariff. Although, the retailer had no obligation to reduce the tariff, it offered to do so with various schemes (some resulting in up to 20% savings) on the condition that the supply contract be extended. Being cautious, the six months contract was allowed to lapse and a new tender was called.

On 1st Jan 2002, PSL reduced their tariff unexpectedly by 9% for peak and 29% for off-peak. Inadvertently, the impact of the September 11 incident at the World Trade Centre, New York plunged the oil index to a historical low triggering off a recession and a massive reduction in the published electricity tariff (which is pegged closely to the oil price index).

The adjustment meant that buying power from the retailer based on previous secured supply contract was more expensive compared to PSL. Through this experience, various conditions were implemented for the subsequent tender document:

a. As long as Power Supply Ltd (PSL) remains a retailer for contestable customers, the successful Tenderer shall match PSL's high-tension tariff if PSL tariff becomes lower than that proposed by the Tenderer, and;

b. In the event that PSL revises their tariff upwards within the contractual period, the Tenderer shall revise their tariffs to match PSL tariffs or their tariffs proposed which ever is lower.

For the subsequent energy tender, seven licensed retailers including Seraya Energy and Marubeni International Petroleum were invited. Out of these, five retailers submitted their bids.

**Analysis and comparison**

All the retailers submitted different rates for peak and off-peak period. To determine the most competitive package, the submitted rates were analysed using the consumption figures for a typical month. The Club developed its own analysis tools using time and load weighted averages.

Time weighted average (TWA) is as follows:-

$TWA = {}^{2}/_{3} \times$ peak rate/kWh + $ {}^{1}/_{3} \times$ off-peak rate/kWh

Each installation has it own load demand pattern during peak and off-peak period. This load ratio (LR) is easily obtained using average energy data for these two periods to compute the ratio.

The load weighted average (LWA) is as follows:-

*LWA = peak LR x peak rate/kWh + off-peak LR x off-peak rate/kWh*

The retailer whose tariffs gave the lowest TWA & LWA is the most competitive. This exercise is advantages for comparison between various time dependent tariff packages.

SembCorp Power was awarded a two year contract to supply power to Singapore Turf Club starting in May 2002 based on the following criteria:

- lowest tariff calculated based on a typical month energy figures
- lowest time weighted average
- lowest load weighted average
- oil index was close to a historical low

**Savings achieved**

The SEP exercise yielded savings of about 15% per month since July 2002. The secured tariff was based on an oil index of about US$120/MT, i.e. monthly average price for 180cst HSFO (high sulphur fuel oil). This was close to historical low. However, with the impending tension of war in the Middle East region, the current oil index of about US$170/MT is expected to increase further and thus the published electricity tariffs will increase in tandem.

Furthermore, the traditional climatic change to winter in the Northern Hemisphere may drive energy demand for heating upwards. This may add extra upward pressure on electricity tariffs. Fortunately, with the good tariffs secured, Singapore Turf Club is expected to reap substantial energy savings for financial year 2002/03 ending on 31 March 2003.

## ACKNOWLEDGEMENTS

The authors would like to express their sincere thanks to Tuas Power Supply Pte Ltd and Singapore Turf Club for their invaluable contributions.

## REFERENCES

[1] HOSE, J. F. "Demand side planning; a practical perspective", IEEE Power Engineering Society

[2] IEEE STD 1159-1995: Recommended Practice for Monitoring Electric Power Quality

[3] Ferracci, Philippe, 2001, "Cahier Technique no.199 Power Quality", ECT 199(e) October 2001, Schneider Electric

[4] EMA, "Electric Industry and Singapore Electricity Market Rules", 6 July 2001, www.ema.gov.sg

[5] Ken Jung, Daniel Kwok, Martin Lim, Azmi Rahmat, "On-Line monitoring of a commercial building in Singapore", 24 October 2002, International Power Quality Conference 2002