



# **EMA-MOE**

# **Energy for Educators Forum**

Factsheet on the Power Sector in Singapore

31 July 2014

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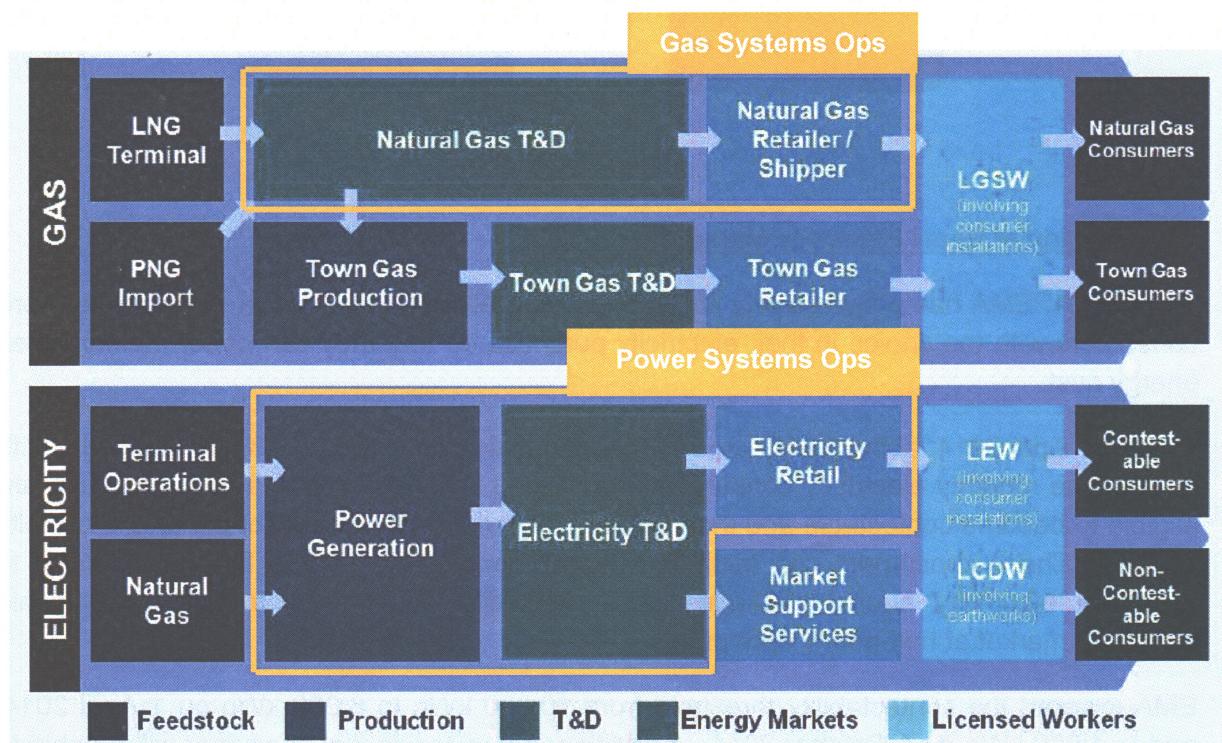
# PART 1: OVERVIEW OF SINGAPORE ENERGY LANDSCAPE AND CHALLENGES

## About the Power Sector

The Power sector, which comprises the electricity and gas sectors, plays a critical role in sustaining Singapore's economy, as it is responsible for the generation, transmission, and distribution of electricity and gas to businesses and homes. Business, residential and transport activities are made possible on the back of a robust and reliable electricity and gas system.

Figure A provides an overview of how electricity and gas are produced, transmitted/distributed and sold to consumers.

Figure A: Value Chain across the Power Sector in Singapore

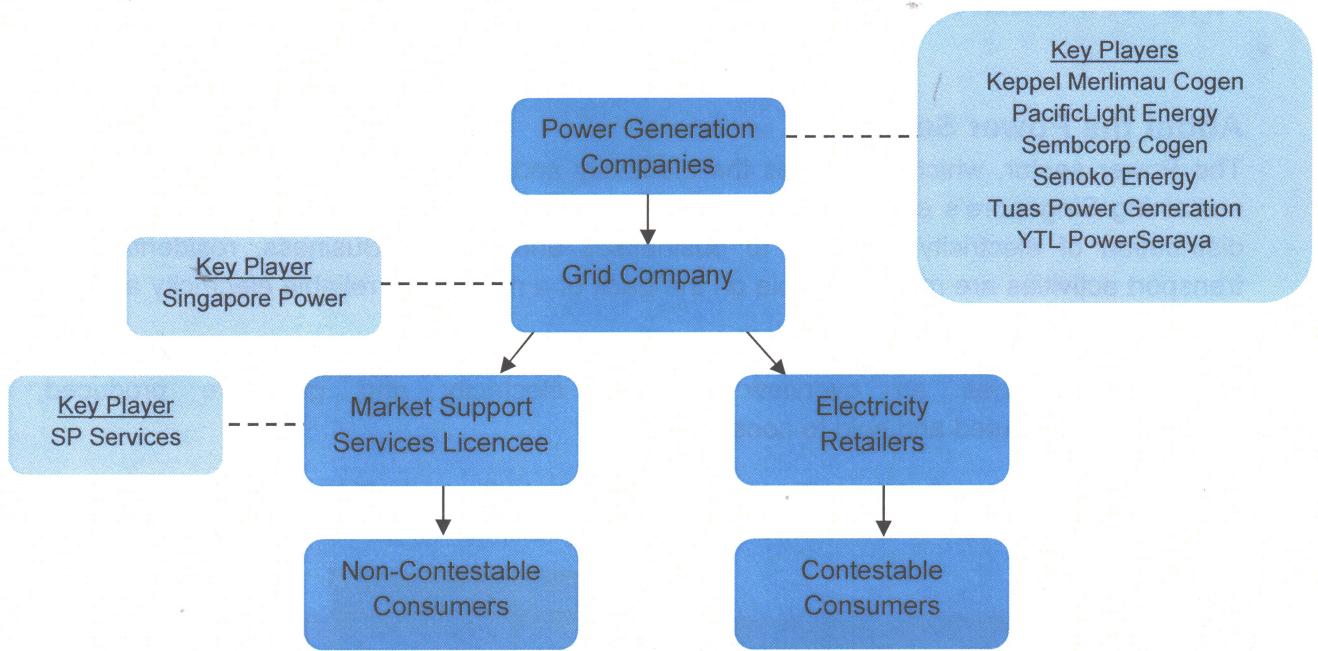


## Electricity Sector

Traditionally, the electricity sector in Singapore had been vertically integrated and Government-owned. Tremendous progress has been made since 1995 to liberalise the electricity industry for greater efficiency and innovation.

Figure B illustrates the current electricity market structure.

**Figure B: Electricity Market Structure**



#### Liberalisation of Retail Electricity Market

Since 2001, EMA has progressively liberalised the retail electricity market to empower more consumers with the choice in their electricity purchase so that they can better manage their energy cost.

Prior to 1 April 2014, about 8,000 large non-residential consumers (or 13,000 accounts) with an average monthly electricity consumption of 10,000 kWh or more at a single location are eligible to become contestable and they account for around 75 per cent of the total electricity demand. These consumers can apply to become contestable so that they can choose to purchase electricity supply packages from electricity retailers or from the wholesale electricity market at half-hourly spot prices.

EMA lowered the contestability threshold from 10,000 kWh to 8,000 kWh on 1 April 2014, and to 4,000 kWh on 1 October 2014. In addition, a non-residential consumer will be able to combine his electricity consumption at different locations to meet the contestability threshold. Together, these measures will allow about 23,000 consumers (or 77,000 accounts) to be eligible for retail contestability.

EMA aims to fully liberalise the retail electricity market over the next few years. This will allow the remaining 1.3 million small consumers, mainly households, to also have the option to choose whether they want to remain on the regulated tariff or buy electricity at market prices.

This means that consumers will soon have the choice to shop for their electricity packages, similar to how they shop for their mobile price plans today.

## Reliable Power Grid

The power grid in Singapore is operated by Singapore Power and it is one of the most reliable in the world. It has the fewest and shortest power outages worldwide, with a SAIDI rating of less than a minute per customer per year.

### **What is SAIDI (System Average Interruption Duration Index)?**

The SAIDI measures the average interruption time per customer in minutes in a year.

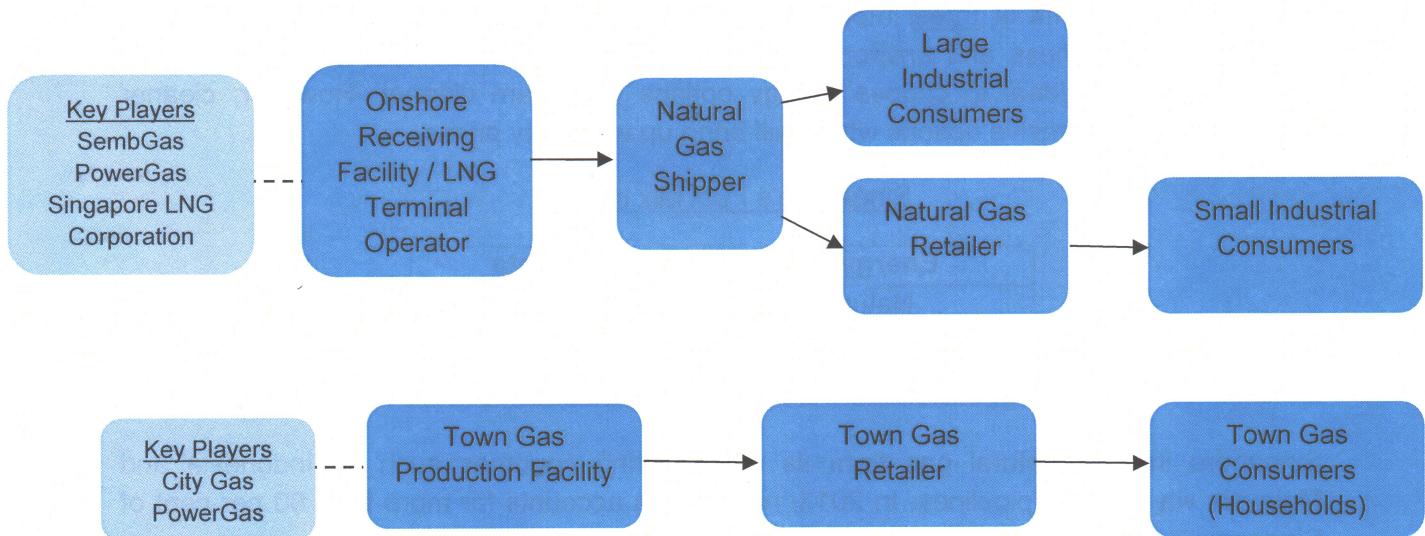
## **Gas Sector**

With natural gas being the dominant fuel for electricity generation in Singapore, the gas industry has been restructured with a competitive market framework to support the reform of the electricity industry.

The new gas industry structure has been put in place since 15 September 2008. As part of the restructuring, the gas transport business has been separated from the competitive business of gas import and retail.

The structure of the new gas industry is shown in Figure C.

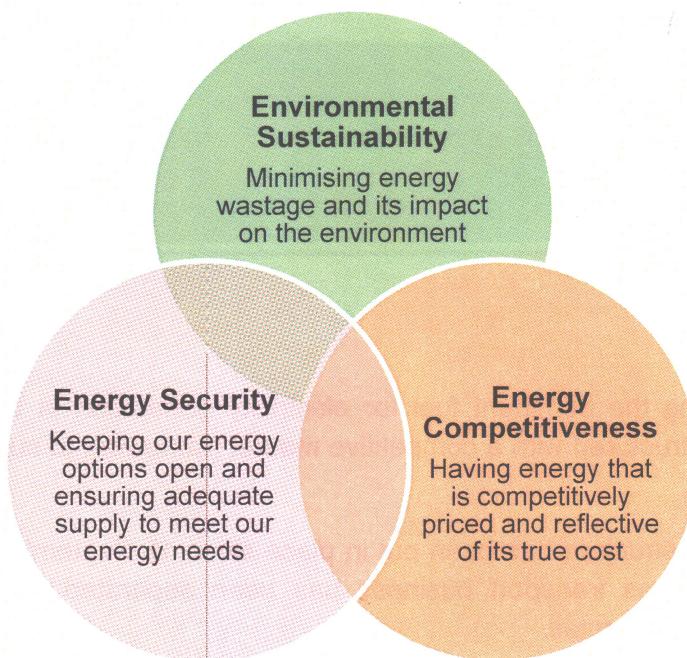
Figure C. Gas Market Structure



There are two separate gas networks in Singapore. Both the town gas network and the natural gas network are operated by PowerGas. The town gas network serves about 55 per cent of households in Singapore, who receive town gas produced by City Gas, while the natural gas network serves mostly industrial and commercial users. Large companies can buy directly from a gas transporter or shipper.

## Singapore's Energy Challenge

### Energy Trilemma



Policy makers in Singapore grapple with the “Energy Trilemma”. This refers to the need to balance the trade-offs of three important yet competing considerations – energy security, energy competitiveness and environmental sustainability. For instance, for environmental sustainability, it is ideal to choose energy options which are cleaner. However, cleaner energy may be expensive options which will bring up electricity prices.

### Singapore's Fuel Mix in 2013

Energy Source	Data
Natural Gas	91.8%
Petroleum products	3.9%
Others	4.3%

Singapore imports natural gas from its neighbouring countries such as Indonesia and Malaysia via offshore pipelines. In 2013, natural gas accounts for more than 90 per cent of Singapore's fuel mix.

To enhance its energy security, Singapore built its first liquefied natural gas (LNG) terminal on Jurong Island in 2013. The Terminal allows Singapore to import LNG from around the world. In other words, we are able to import natural gas from more sources than before.

### Singapore Energy Sources

Singapore does not have any indigenous energy resources. Its natural geography limits the types of renewable energy that the country can deploy. For instance, it is unable to reap the

benefit of hydroelectric power due to the lack of running water bodies such as rivers or waterfalls and our flat geography. In addition, the country's average wind speeds are too low for the economic use of large wind turbines. Lastly, there will be limited opportunities to harness tidal energy given its busy sea space that is used for ports and shipping lanes.

#### Greater Potential for Solar Energy

Currently, of all the renewable energy options, solar energy presents the highest potential for Singapore. EMA is supportive of solar energy as it is a clean energy source. It can also help to lower electricity prices by reducing peak demand during the day.

However, there are existing issues that need to be resolved. Solar energy output is intermittent in nature as it is dependent on weather conditions (e.g. cloud cover). Taller buildings may also cast shadow on solar PV panels installed on other buildings. These can lead to power disruptions if not properly managed.

To address these issues, Singapore is making efforts to facilitate the large-scale entry of solar energy into its power grid. For instance, it is looking to build up internal capabilities such as solar forecasting, trying to gain a better understanding of the differences in solar output in different parts of the island and ensuring that there is sufficient reserve capacity – either through the use of batteries or storage systems, to manage the intermittency issues.

Singapore remains open to its energy options should they be commercially viable as future technological developments may make previously “unfeasible” options workable one day.

## PART 2: ENABLING THE EFFICIENT USE OF ENERGY

Energy efficiency is a way of managing and restraining the growth in energy consumption. Something is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input. For example, when a compact fluorescent light (CFL) bulb uses less energy (one-third to one-fifth) than an incandescent bulb to produce the same amount of light, the CFL is considered to be more energy efficient.

### Do you know?

Around USD 80 billion is wasted each year because of inefficient technology.

*Source: International Energy Agency, July 2014*

Everyone has a role to play in ensuring the efficient use of energy. There are various efforts undertaken by the Singapore Government/industry to promote energy efficiency.

### Pilot Initiative to Redesign Electricity Bills

This pilot involves users of SP Services' (SPS) 'My Utilities Portal', which currently numbers around 260,000. These consumers, who have e-billing accounts, are able to compare their electricity consumption in the last six months against the national average consumption and the average consumption of their neighbours living in similar housing types. This initiative aims to raise consumer awareness of their own consumption patterns and encourage better energy-saving habits.

After gathering feedback on this pilot, EMA is working with SPS to redesign hardcopies of the utilities bill that reach out to all 1.3 million households in Singapore.

### Singapore Power Electricity Efficiency Centre

Singapore Power operates the Electricity Efficiency Centre (EEC) to enhance public awareness on electricity efficiency. Open to the public, the EEC employs interactive displays and courses to share tips on electricity efficiency. Educators, like you, may also leverage this as a platform to impart knowledge on energy efficiency to students through an experiential learning journey. For more information, email [eec@singaporepower.com.sg](mailto:eec@singaporepower.com.sg).

Address: 460 Alexandra Road, #08-01/02 & #08-06 PSA Building Singapore 119963

Tel: 6378 8293

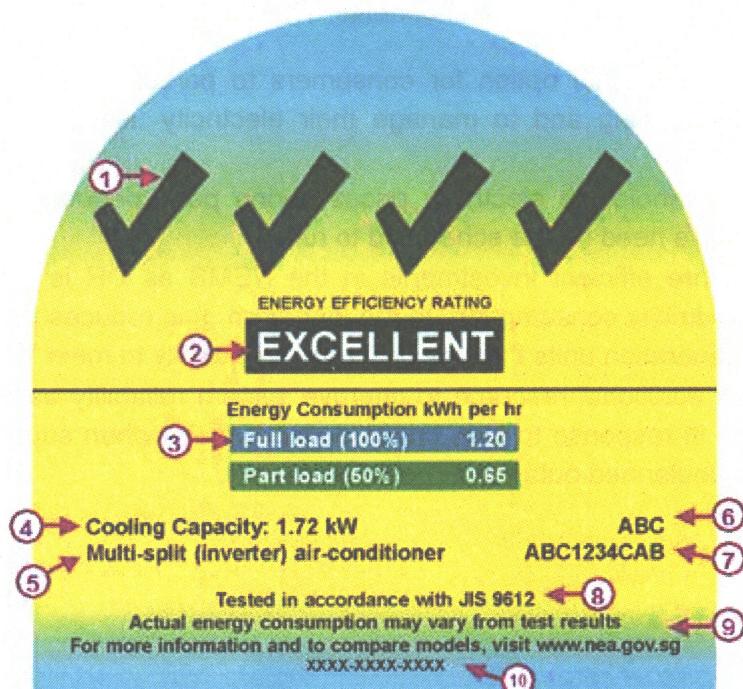
Operating Hours: Mon-Fri: 8am to 5.30pm

## Energy Conservation Act (ECA)

The ECA aims to promote energy conservation, improve energy efficiency and reduce the negative environmental impact of carbon emissions. Large energy consumers, companies that consume more than 15 gigawatt hours (GWh) of energy, will be required to appoint an energy manager. They will also need to submit a report on their energy usage and an energy efficiency improvement plan.

## Mandatory Energy Labelling Scheme (MELS)

The MELS requires retailers to affix the Energy Label on household appliances, so as to enable consumers to choose products that are more energy efficient.



### Features of an Energy Label

1. Ticks on a scale of one to four, with one representing the lowest rating
2. Energy efficiency rating
3. Energy consumption
4. Capacity
5. Type
6. Brand
7. Model number
8. Test standards
9. Disclaimer
10. Registration number

## **Demand Response**

EMA is introducing a Demand Response (DR) programme to enhance competition in the National Electricity Market of Singapore (NEMS). DR enables contestable consumers to reduce their electricity demand voluntarily, in exchange for a share in the system-wide benefits as a result of their actions. Such reductions typically take place when wholesale prices in the NEMS are high or when additional resources can improve system reliability.

While DR is a new feature in Singapore's electricity market, it has been successfully implemented in various forms in jurisdictions such as Australia, New Zealand and the United States.

### Benefits of Demand Response

The DR programme brings about several benefits. These include:

- Providing an additional option for consumers to participate in the NEMS through demand side bidding and to manage their electricity usage in response to price signals;
- Reducing the wholesale electricity prices during peak periods as more expensive generation units need not be scheduled to run;
- Promoting more efficient investments in the NEMS as DR is expected to reduce 'peaks' in electricity consumption. In the long term, this reduces the need to invest in expensive generation units that are only run infrequently to meet 'peak' demand; and
- Providing an additional resource to improve system reliability as consumers reduce consumption in response to high prices during periods when supply capacity is tight (e.g. due to unplanned outages or gas disruptions).

## PART 3: EMERGING DEVELOPMENTS WITHIN THE POWER SECTOR

There are exciting developments within the Power sector ranging from the commissioning of the first Liquefied Natural Gas Terminal in Singapore to new generation planting.

### Singapore's 1<sup>st</sup> Liquefied Natural Gas (LNG) Terminal on Jurong Island



The LNG Terminal allows Singapore to import LNG from around the world, instead of relying on piped natural gas from Indonesia and Malaysia. The LNG terminal has a throughput capacity of 6 million tonnes per annum (Mtpa), with room for an increase of up to 15Mtpa. There are plans to build a second LNG terminal, with the government studying a few potential sites in the east of Singapore.

#### About LNG

LNG is primarily Methane condensed into liquid form by cooling it below its dew point to – 161 degree celsius at atmospheric pressure. When condensed, its volume is reduced by 600 times, which makes it more cost efficient to transport.

### Electricity Cable Tunnel Project

Singapore Power operates the country's grid network, ensuring that the 1.3 million industrial, commercial and residential customers benefit from a reliable electricity transmission and distribution system.

With rapid growth and urbanisation of Singapore's economy and society, demand for power supply has increased and there is a need to build a more sustainable solution through the ongoing upgrading and renewal of its grid infrastructure.

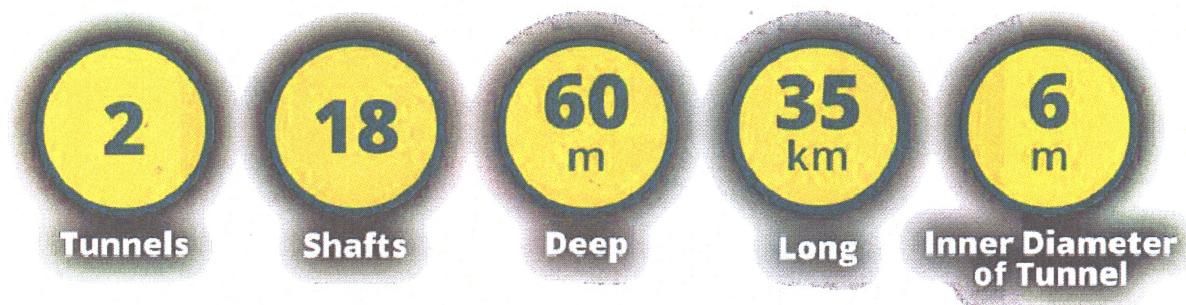
To meet future needs, Singapore Power is embarking on a \$2 billion project to build two cross-island transmission cable tunnels which are 60 metres underground to ensure the continued reliability and security of the network.

The construction of transmission cable tunnels is the long-term solution for the future of Singapore's power supply. It will allow the country to efficiently install and quickly replace underground cables and meet the increasing demand for power supply.

The construction of the cable tunnel infrastructure commenced in 2013 and is scheduled for completion in 2018.

Upon completion, the cable tunnels will ensure the reliability and security of Singapore's electricity network, maintaining the country's electricity grid as one of the best performing networks in the world.

#### Facts at a Glance



#### **Multi-Utilities Business**

The Power sector has evolved to adopt new technological developments that cater to new business opportunities riding on rising industrial demands and economic growth. Several state-of-the-art multi-utilities facilities on Jurong Island, such as the Tuas Power's Tembusu Multi-Utilities Complex (TMUC), offer a comprehensive range of energy, water and other on-site logistics.



The TMUC employs a mix of coal and biomass to produce steam and electricity for chemical companies on Jurong Island. For greater efficiency and environment sustainability, only the use of low ash and low sulphur coal are permitted. Biomass is also mixed with coal to lower greenhouse emissions to below that of an equivalent fuel oil plant. In addition, the cogeneration process adopted is more efficient than the separate production of steam and power through boilers and combined cycle gas turbines.

## **Manpower Development**

The Power sector currently employs about 4,600 people and is facing an ageing workforce with a median age of 48 years old. Of these, about two-thirds are technical professionals. Among this group, 63 per cent are above the age of 40, and more than 40 per cent are expected to retire in the next 10 to 15 years. Hence, there is an increased demand for fresh talent to work in the sector, which offers both a stable yet important career. By 2020, the Power sector will require about 2,400 technical professionals to replenish the workforce.

Some of the exciting job opportunities include power generation operations, network development and energy trading. Some examples of the job roles include technical officer, engineer and trading analyst.

### *Power Generation Operations*

- Power Plant Operations – Responsible for operating the power generating plants and units, and its associated auxiliaries and ancillaries equipment, ensuring compliance with all relevant safety and regulatory requirements.

### *Network Development*

- Transmission & Distribution (T&D) Network Projects – Responsible for coordinating, executing and implementing transmission and distribution projects.

### *Energy Trading*

- Energy Trading – Responsible for electricity or gas trading activities, ensuring compliance with market rules/regulations and risk guidelines, to maximise profits and increase shareholder value for the company.

To ensure that more will consider/have greater awareness of a career in the Power sector, EMA and the industry have collaborated on various initiatives which are listed below:

### Energy-Industry Scholarship (EIS)

Launched in January 2014, the EIS is a new industry scholarship for those pursuing relevant engineering courses at the local Institute of Technical Education (ITE), polytechnics and universities. It aims to develop and nurture talent for the Power sector.

The scholarship is open to Singapore Citizens and Permanent Residents who are entering their course of study and those who have already commenced their studies. They can apply for either the full-term scholarship or mid-term scholarship, depending on where they are in their academic path. Each EIS scholarship covers a student's tuition fees and hostel fees. It

also provides a monthly living allowance. There is also a one-time allowance to purchase items related to his or her studies, such as computers and books.

#### National Energy Competency Framework (NECF)

EMA is also working closely with the industry to develop the NECF. The objectives of the NECF are to (i) clearly articulate career progression pathways and opportunities in both management and technical specialist tracks to attract young Singaporeans into the sector as well as retain the existing technical workforce and (ii) identify core knowledge areas required by technical professionals in the sector.

Following the completion of the NECF, relevant information would be made available via an interactive web portal, which is targeted to be completed in 2015. This would enable youths/fresh graduates and mid-career switchers to easily locate information on career progression pathways and competencies required for the respective job roles that are available in the Power sector.

#### Powering Lives@Career Fairs

In February 2014, EMA and several key power companies came together again to set up booths at the annual career fairs at the National University of Singapore and Nanyang Technological University, which attracted approximately 18,000 students. The career fairs aim to generate greater awareness of the Power sector to student, who have little or no perception of the sector.

#### Energy Connect 2014

EMA organised the second edition of the Energy Connect to reach out to youths, in conjunction with the annual Energy Forum. The event comprised two key components – an energy competition, which saw the participation of 18 teams from the various IHLs, as well as a seminar where students had the opportunities to hear from industry professionals on their experiences in the Power sector.

#### Ensuring Relevance of Curriculum

To create greater awareness on energy related issues among youths, EMA worked with the Ministry of Education (MOE) to infuse energy related content into the Lower Secondary Geography curriculum. This complements earlier industry inputs to the design of the Singapore Institute of Technology-Newcastle University's degree course in electrical power engineering. EMA is also working with MOE and other IHLs to seek industry inputs on the curriculum for other levels.

#### Branding for the Power sector



Since 2013, EMA has been encouraging the industry to adopt the sector's branding message "Powering Lives", and have also ran a series of advertorial and sponsored series in

the local dailies, which featured young professionals and industry captains who shared how the sector can offer one a fulfilling career as well as the various interesting developments in the Power sector.

## Research and Development

### Grant Calls

As the agency for energy development, EMA rolls out competitive grant calls to catalyse applied R&D of innovative technologies and solutions that can address industry-relevant challenges and opportunities in the energy sector, and lead to long-term solutions that address Singapore's energy challenges. The key areas include smart grid, power generation, energy storage, and gas/LNG.

In response to the challenges and opportunities presented by new developments and trends such as increased renewables penetration and heightened risks of cyber-attacks on the grid, EMA sought R&D proposals for smart grid and gas through two competitive grant calls in May 2014. These were open to IHLs, public research organisations, agencies and companies. The (i) Smart Grid Grant Call focuses on improving our grid resilience, and the (ii) Gas Technology Grant Call focuses on enhancing the operational readiness and resilience of our gas network and LNG infrastructure.

### Test-Beds

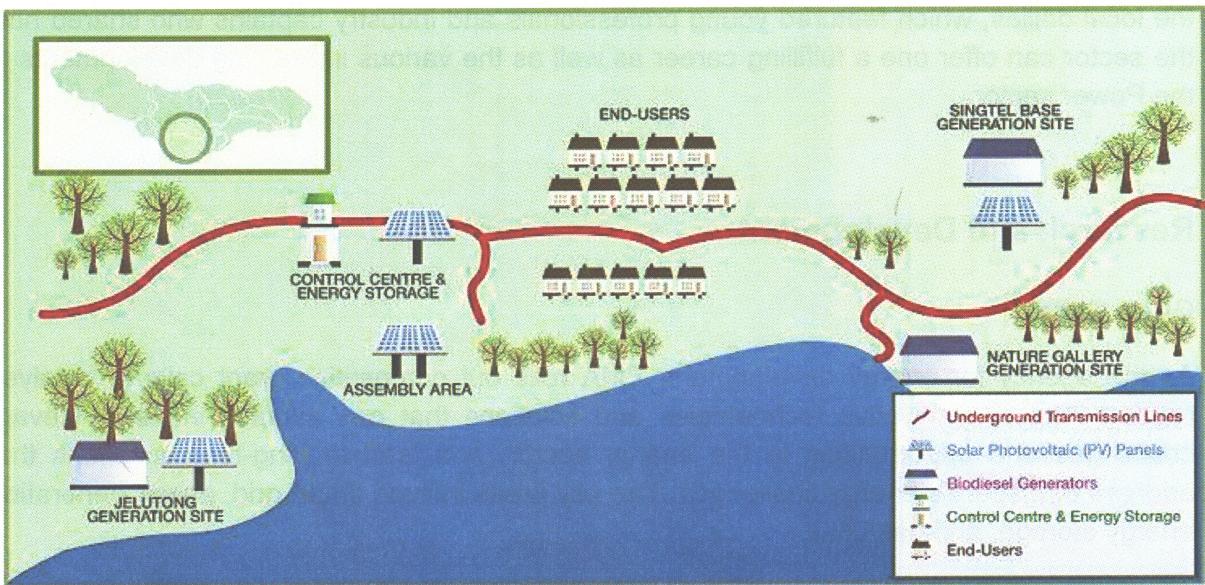
EMA is also participating in test-beds for energy-related solutions.

#### Pulau Ubin Micro-Grid Test-Bed

EMA embarked on a micro-grid test-bed at the jetty area of Pulau Ubin, an island north-east of Singapore.

This test-bed aims to assess the reliability of electricity supply within a micro-grid infrastructure using intermittent renewable energy sources. It will build local capabilities in the area of smart grid design, systems integration and energy management. The test-bed showcases how such micro-grid technologies and solutions could be adopted for off-grid communities in the region.

A Singapore-based consortium comprising Daily Life Renewable Energy Pte Ltd and OKH Holdings Pte Ltd had been appointed to design, build, own and operate the micro-grid infrastructure.



The micro-grid test-bed infrastructure will bring about cleaner and more cost-competitive electricity with improved scalability and reliability for both residents and businesses at Pulau Ubin. Following its launch, more than 30 residents and businesses have signed up for electricity from the micro-grid. Previously, residents and businesses had to rely solely on their own diesel generators which are pollutive, noisy and often break down.

#### Electric Vehicle Test-Bed

Launched in June 2011, the test-bed aims to assess different electric vehicle (EV) prototypes and charging technologies given Singapore's urbanised environment and road conditions, to determine the feasibility of using EVs in Singapore.

The test-bed aims to examine several issues relevant to policies regarding roll-out of EVs in the future including:

- The optimal way to operate and deploy charging infrastructure;
- Consumer behaviour on charging and range anxiety;
- Robustness of EV battery systems; and
- General performance of EVs on Singapore road conditions.

Data collection ended on 31 December 2013 and a review of collated data is currently underway.

In all, 89 EVs participated in the test-bed; involving 53 organisations. To cater to the charging needs of the EVs, 68 normal charging stations (full charge within 7-8 hours) and 3 quick charging stations (full charge within 30-45 minutes) have been deployed.

#### Intelligent Energy System Pilot

EMA, in partnership with Singapore Power, launched the "Intelligent Energy System" (IES) Pilot. The Pilot will bring the capabilities of our power grid to the next level and ensure that our electricity infrastructure is ready for the future.

Across the world, governments and companies are looking at ways to modernise their electricity transmission and distribution networks with new information, communication and sensor technologies. Singapore already has a high-quality power system, which is amongst the most reliable in the world. Nevertheless, there is scope to leverage new technologies to further improve the capabilities of the country's power grid. This would also encourage the development of applications that are enabled by a smart grid such as dynamic pricing plans and advanced energy management systems, which could help consumers to better manage their energy consumption and lower their energy costs.

The IES Pilot assessed new applications and technologies around a smart grid that would benefit Singapore's power system by enhancing its resilience, reducing wastage and shaving peak loads to optimise system efficiency.