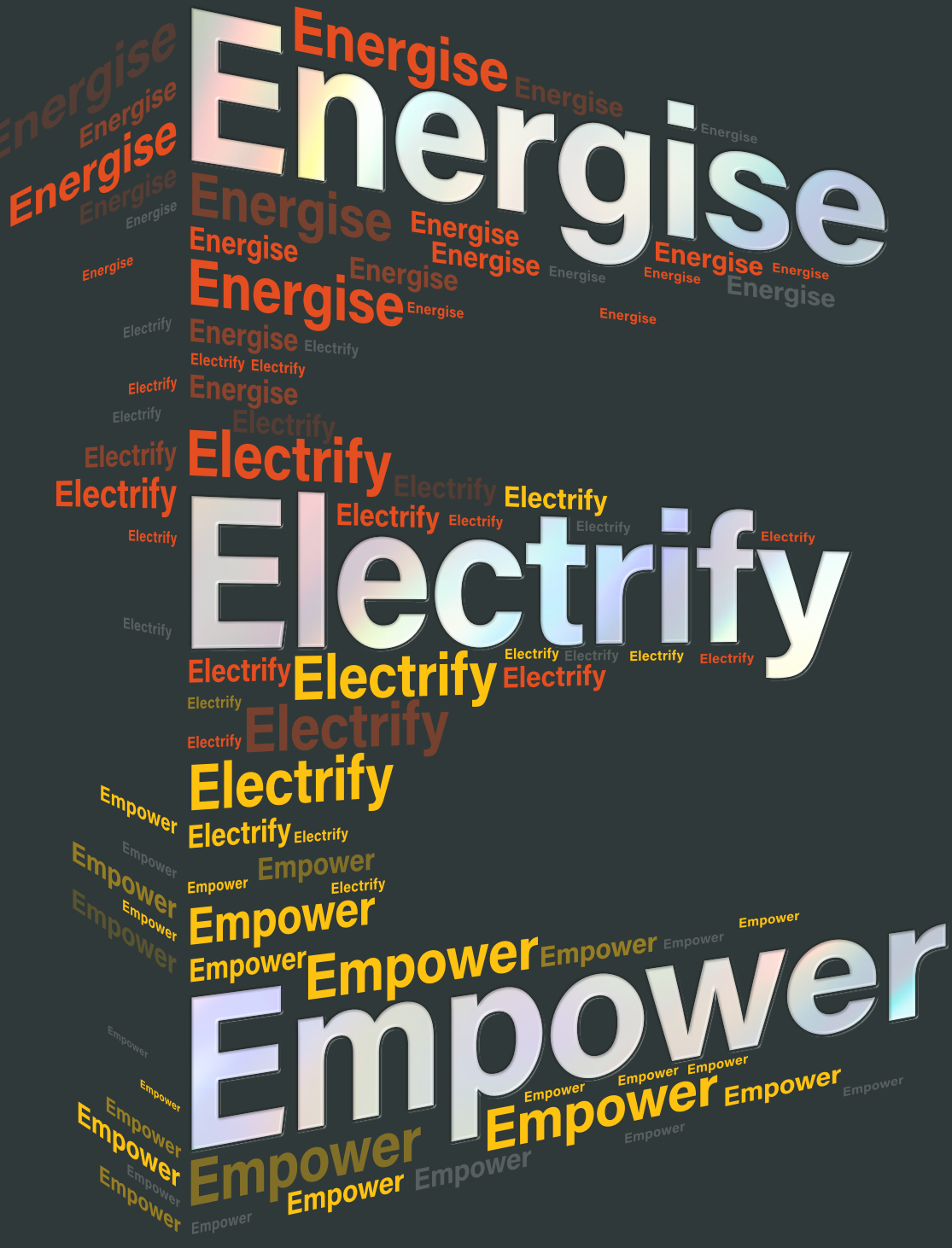

ENERGY MARKET AUTHORITY

20 YEARS AND BEYOND

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Electrify
Empower

20 YEARS AND BEYOND

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ENERGY MARKET AUTHORITY

Smart Energy, Sustainable Future

CONTENTS

FOREWORD

THE Energy Market Authority (EMA) was set up 20 years ago to ensure a reliable and secure energy supply, promote competition in the energy market, and develop a dynamic energy sector in Singapore.

Over the past two decades, EMA has helped guide the transition of Singapore's energy sector and enhance the competitiveness of the energy market. It saw through the deregulation of the power generation market in 2001, the commencement of the National Electricity Market of Singapore in 2003, and the liberalisation of the retail electricity market that culminated in the Open Electricity Market initiative in 2018. These moves have ensured the reliability and affordability of power supply, which benefitted consumers and businesses, supported our continued economic growth, and improved our standard of living.

EMA has also facilitated the shift from using fuel oil to natural gas, which is the cleanest fossil fuel, for power generation. The transition started in 2001, when we signed our first long-term piped natural gas agreement, and was strengthened in 2013 when we opened our first liquefied natural gas terminal to give us flexibility to source natural gas from around the world.

Going forward, EMA will need to reckon with a pressing global imperative — climate change. As part of Singapore's long-term low-emissions and development strategies and plans for sustainable development, we will need to accelerate our transition to low-carbon energy, through our four supply sources — natural gas, solar power, regional power grids, and emerging low-carbon solutions such as hydrogen and carbon capture, utilisation and storage.

This transition is challenging for Singapore, a small nation with no natural resources. We need to continuously balance the energy trilemma — energy security, cost-competitiveness and affordability, and environmental sustainability. We have been taking steps, including incentivising gas-fired plants, to improve energy efficiency, accelerating the deployment of solar generation capacity across Singapore, and investing in research and development on emerging low-carbon technologies. We are also piloting several low-carbon electricity imports projects. We will press on to enable our transition towards a cleaner and more sustainable energy future, while keeping energy reliable and affordable.

EMA has also been building new capabilities among Singaporeans, as well as enterprises under our Research, Innovation and Enterprise plans. As part of a larger global energy system, there is so much more we can learn from one another. EMA launched the inaugural Singapore International Energy Week in 2008, to provide a platform for global energy leaders to collectively discuss the challenges and opportunities in the global energy markets, and this has been successfully running for 13 years. EMA is also collaborating with like-minded regional and international partners to explore and develop low-carbon energy technologies.

EMA has made significant achievements in steering Singapore's energy sector, while ensuring that everyone in Singapore continues to enjoy reliable, sustainable, and affordable energy. I thank all past and present staff of EMA and members of the energy community in Singapore for their contributions. Let us continue to work together to develop Singapore's energy future.

Mr Gan Kim Yong
Minister for Trade and Industry

MESSAGE

THE Energy Market Authority (EMA) celebrates its 20th anniversary this year. We can reflect with pride on our achievements in delivering reliable, affordable, and increasingly sustainable energy for Singapore.

Singapore has one of the most reliable electricity systems in the world based on international benchmarking. We have an average interruption time of less than a minute per customer per year over the last decade.

EMA plays a critical role in charting the future of Singapore's energy system and market, underpinned by continuous innovation. With the shift of our key fuel source to natural gas — imported from over 10 countries all over the world — EMA has laid a strong foundation for a secure energy system. Singapore has continued to develop a more open, competitive, and sophisticated electricity market. Households and businesses have benefitted from the increased breadth of innovative and affordable plans that better meet their needs. More recently, good progress has also been made in our push towards creating a cleaner energy mix. Singapore is today one of the most solar-dense cities in the world, and we have set ourselves a target to achieve at least 2 gigawatt-peak of solar deployment by 2030.

Over the last decade, EMA and our industry partners have also awarded over $200 million in grants to support promising energy research, development, and pilot projects in areas such as energy storage, grid digitalisation, and energy efficiency. More recently, we are also exploring emerging low-carbon energy technologies such as hydrogen and carbon capture, utilisation and storage that could provide us with long-term options to further decarbonise Singapore's energy sector.

As we navigate the increasingly complex world of energy, collaborations between EMA and our stakeholders will continue to underpin our pursuit of a greener energy future. EMA has worked closely with the industry, research community as well as overseas organisations and counterparts to actively seek out new and game-changing technologies. We have also partnered with the unions, educational and training institutions, and the industry to build up new capabilities and prepare the sector's workforce for the challenges and opportunities ahead.

I wish to express my appreciation to past and present Board Members, management, and staff of EMA for their dedication and contributions to the evolution of the energy sector. While this book offers only a glimpse of EMA's milestones over the last two decades, I hope it will inspire current and future generations of the agency to build on these past efforts and take Singapore's energy sector to new heights.

Mr Richard Lim Cherng Yih
Chairman, Energy Market Authority

Before EMA was formed...

OUR MILESTONES

1901 – 2000

1906

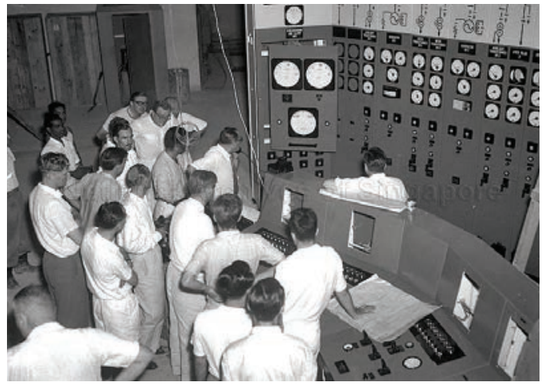
The opening of Mackenzie Road Power Station marked the "official turning on" of electricity here.

1924

Singapore started constructing its second power station, St James Power Station, to meet rising energy demand. It became the first power station to use fuel oil in 1940.

1939

Cathay Cinema became the first cinema to offer air-conditioning.



1952

After the war, Singapore commissioned Pasir Panjang A Power Station to meet post-war electricity demand.

1963

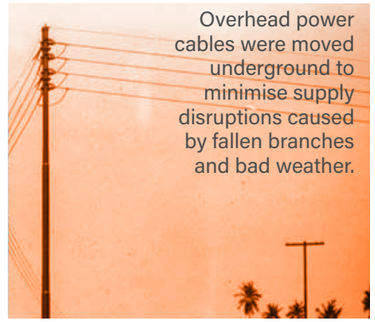
The Public Utilities Board (PUB) was formed to manage Singapore's electricity, water, and gas supplies. That same year, it started the 10-year Rural Electrification Programme to bring electricity to everyone in Singapore.

1965

The Pasir Panjang B Power Station was opened to generate more electricity to support our rapid industrialisation.

1979

Overhead power cables were moved underground to minimise supply disruptions caused by fallen branches and bad weather.



1985

All new homes were fitted with Residual Current Circuit Breakers to enhance electrical safety.

1992

Singapore started importing natural gas from Malaysia solely for power generation in Senoko Power Station.

1995

PUB's electricity and piped gas undertakings were corporatised, marking the first step towards liberalising the energy market.

1998

The first wholesale electricity market (Singapore Electricity Pool) commenced operations and lasted till 2003.

After EMA was formed...

OUR MILESTONES

2001 - 2021

2001

Singapore began importing piped natural gas from West Natuna of Indonesia.

2003

The National Electricity Market of Singapore (NEMS) opened for trading.

2008

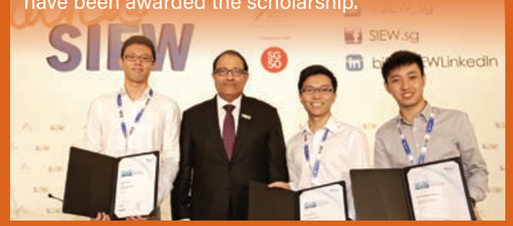
The Energy Market Authority (EMA) held its first Singapore International Energy Week (SIEW), which has become a flagship event for energy professionals and policymakers to share best practices and solutions in the global energy space.

2013

Our liquefied natural gas (LNG) terminal commenced operation, bringing in natural gas from all over the world.

2014

EMA introduced the Energy-Industry Scholarship to support polytechnic and ITE students in their pursuit of a career in the energy sector. To date, more than 30 students have been awarded the scholarship.



2014

To create a more diversified and secure energy market, EMA launched its first Request for Proposal to appoint up to two term LNG importers. Since then, the number of term importers has increased to four.

2015

The electricity futures market was launched to enhance competition in the wholesale and retail electricity markets, for the benefit of consumers.

2016

Singapore became an Association Country member of the International Energy Agency (IEA).

2018

EMA launched the Genco Energy Efficiency Grant Call to encourage power generation companies to improve their energy efficiency and reduce carbon emissions. Four companies have been awarded thus far.

2018

With the zonal rollout of the nationwide Open Electricity Market initiative, all consumers were able to buy electricity from different retailers.

2019

EMA unveiled the Singapore Energy Story, which paved the way for Singapore to accelerate its energy transition towards a cleaner, affordable, and reliable future.

2019

EMA partnered with Sembcorp Industries to develop our first Virtual Power Plant, which will allow for more clean and distributed energy resources to be integrated into Singapore's energy mix.

2020

Singapore achieved its 2020 solar target of 350 megawatt-peak. Moving forward, it targets to achieve at least 2 gigawatt-peak of solar deployment by 2030 and deploy at least 200 megawatts of energy storage systems beyond 2025.

2021

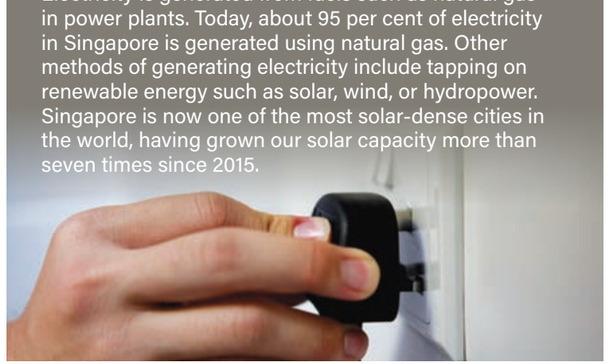
EMA outlined its strategies to advance Singapore's energy transition efforts.

WHAT IS ELECTRICITY?

Electricity is the flow of electrical charge that is essential for many tasks in our daily lives, from lighting and cooling our homes to powering electrical appliances such as mobile phones, refrigerators, and computers.

HOW IS ELECTRICITY GENERATED?

Electricity is generated from fuels such as natural gas in power plants. Today, about 95 per cent of electricity in Singapore is generated using natural gas. Other methods of generating electricity include tapping on renewable energy such as solar, wind, or hydropower. Singapore is now one of the most solar-dense cities in the world, having grown our solar capacity more than seven times since 2015.



HOW DO WE MEASURE ELECTRICITY GENERATING CAPACITY?

The generating capacity of a power plant is usually measured in kilowatts (kW) or megawatts (MW), which quantifies the amount of electrical power converted from energy stored in fuel sources. One kilowatt is equal to 1,000 watts and one megawatt is equal to 1,000 kilowatts.

HOW IS ELECTRICITY TRANSMITTED AND DISTRIBUTED?

Electricity is transmitted via an interconnected group of power lines and electrical equipment between power plants and distribution networks. The voltage at which electricity is transmitted is measured in kilovolts, kV (equal to 1,000 volts).

A distribution network, which consists of substations and cables, transports electricity from transmission networks to end users. At the substations, electricity of high voltage is stepped down to a lower voltage so that it is suitable for use by households.

HOW DO WE MEASURE THE RELIABILITY OF A POWER SYSTEM?

The System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI) provide an indication of a power system's reliability.

The SAIFI measures the average number of electricity interruptions per customer, while the SAIDI measures the average interruption time per customer in minutes. Today, Singapore has one of the most reliable electricity systems in the world.

CAN WE STORE ENERGY FOR LATER USE?

Electricity itself cannot be stored and has to be consumed when it is generated. To avoid wasting excess electricity that is generated, we can convert it into other forms of energy that can be stored. This is where energy storage technologies come in. An energy storage system (ESS) acts like a large battery that can store significant amounts of energy for later use. ESS can help to manage the output of solar which is not continuously available across the day. It can also enhance our grid resilience by actively managing mismatches between electricity supply and demand.

HOW DO WE MEASURE ELECTRICITY USAGE?

Electricity use is measured in watt-hour (Wh) or kilowatt-hour (kWh). This is calculated by multiplying the electrical power used by the time period of its usage.

For example, a 2.5 kilowatt electrical appliance that is switched on for an hour will use up 2.5 kilowatt-hours of electricity.

WHAT ARE ADVANCED ELECTRICITY METERS?

Advanced electricity meters are digital meters that allow electricity consumption to be measured at half-hourly intervals. Compared to cumulative meters where consumers are informed of their actual electricity usage only once every two months, those with advanced electricity meters can easily view and monitor their electricity usage throughout the day via a mobile app.

HOW CAN WE LOWER OUR ELECTRICITY USAGE AT HOME?

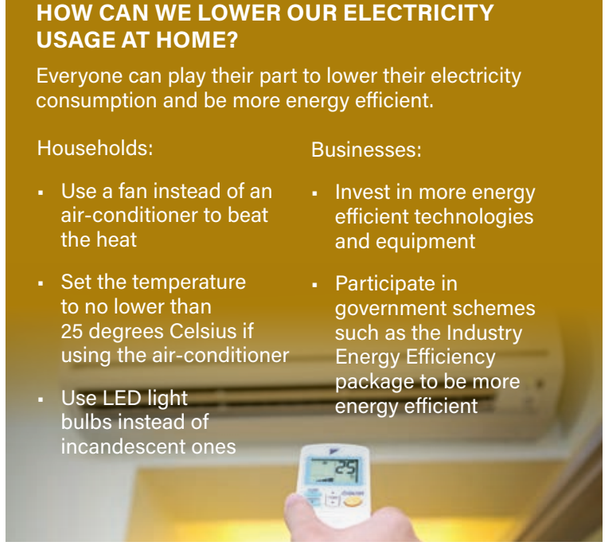
Everyone can play their part to lower their electricity consumption and be more energy efficient.

Households:

- Use a fan instead of an air-conditioner to beat the heat
- Set the temperature to no lower than 25 degrees Celsius if using the air-conditioner
- Use LED light bulbs instead of incandescent ones

Businesses:

- Invest in more energy efficient technologies and equipment
- Participate in government schemes such as the Industry Energy Efficiency package to be more energy efficient



HOW CAN WE USE ELECTRICITY IN A SAFE MANNER?

To use electricity safely, we should regularly check the Residual Current Circuit Breaker (RCCB) found in the electrical distribution board box in our homes and offices. The RCCB is a safety device that cuts off electricity supply upon detecting any electricity leakage.

CHAPTER ONE

HIT THE SWITCH: Singapore Electrified

More than a hundred years ago, Singapore gained a new way to remain bright in the night — lighting up with electricity instead of candles and kerosene lamps. It was a modest but important step towards modernisation.

However, as post-war demand in electricity grew across the island, the Public Utilities Board (PUB) faced the challenge of providing electricity and maintaining the supply to all homes. More power stations were built in quick succession to handle the growth in electricity demand.

While the use of electricity had made life more convenient, Singaporeans also learnt about its dangers. That was when the government came in and acted swiftly to tighten regulations to enhance safety, reliability, and quality.

As the 21st century beckoned, Singapore was on a quest to improve the efficiency in its electricity and gas industries. A new government agency, the Energy Market Authority (EMA), was formed to oversee the further liberalisation of the energy market. It ushered in a new era with various initiatives that electrified Singapore's energy sector.

DAWN OF A NEW ERA

LOW rumbles echoed through the streets of Singapore as bullock carts and steam-powered traction engines carrying various machinery lumbered along the uneven roads. The year was 1906.

The island's first power station – the Mackenzie Road Power Station — was officially in business. Built by the government agency Tanjong Pagar Dock Board, the power station was a sight to behold with its red brick walls and tall smokestack. This marked the first spark of electricity in Singapore.

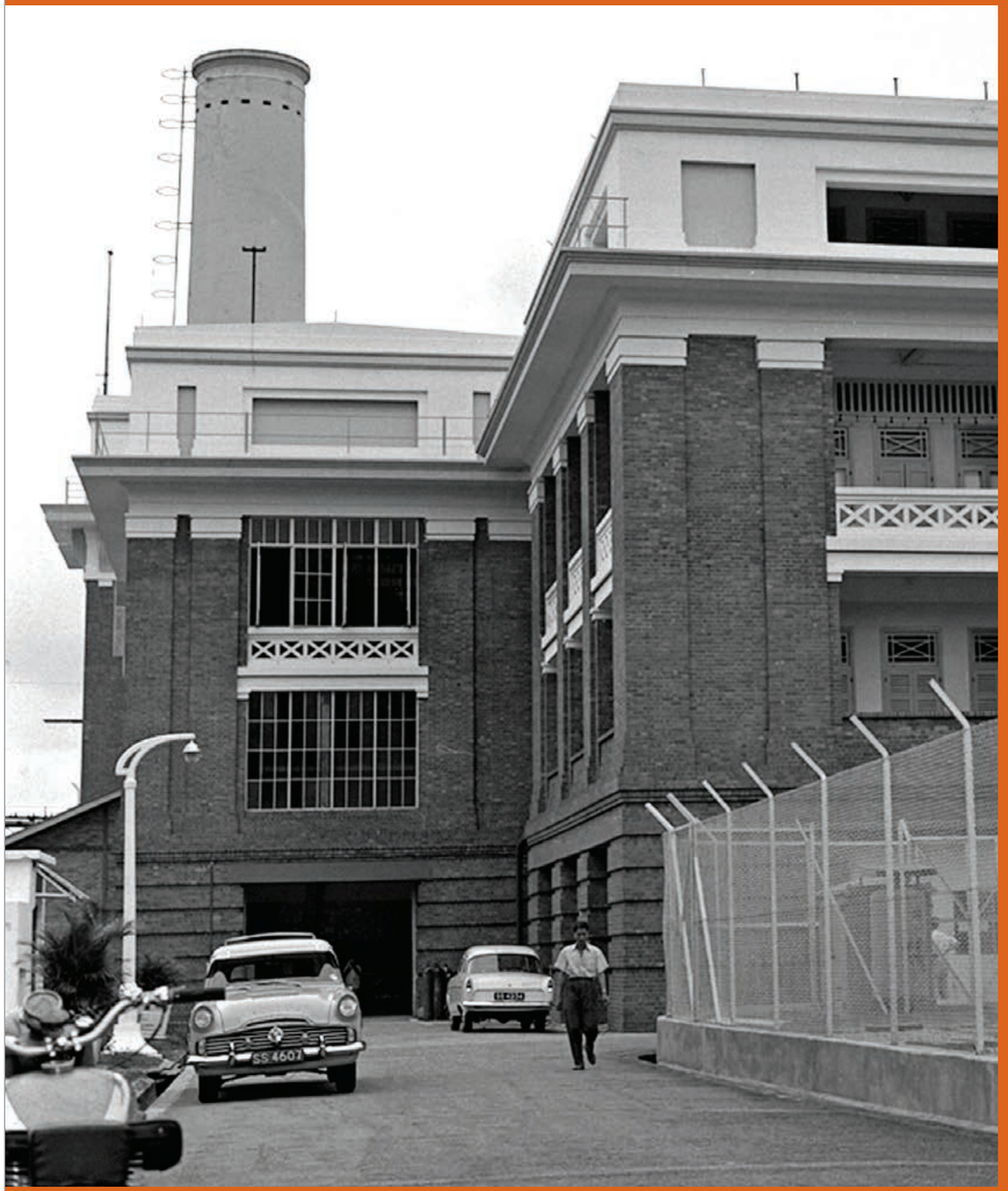
That year, the Municipality, or the local government administration under the British, also laid down a distribution system in central areas and purchased electricity in bulk from the Singapore Tramway Company. With its first public electricity supply secured, areas such as Raffles Place, North Bridge Road, and Boat Quay were lit for the first time with electric lamps.

TURBO-CHARGING THE CITY

AS Singapore's entrepot trade took off, electricity demand soon skyrocketed with new big private consumers in need of lighting as well as a rising demand for public lighting.

It was time to build a second power station. Construction of St James Power Station — located near the sea at Cape St James — began in 1924, after the 65,000 square foot land was bought for $375,000. The power station also became the first on the island to use fuel oil in 1940.

St James Power Station served Singapore well until it was decommissioned in 1976, before becoming a warehouse in the 1980s. Prior to its closure in 2018, the power station had been better known as an entertainment hub. Just like how it energised the nightlife in its later years, it was crucial in boosting electricity supply early on.



St James Power Station before it was decommissioned in 1976.

THREE UTILITIES, ONE PUB

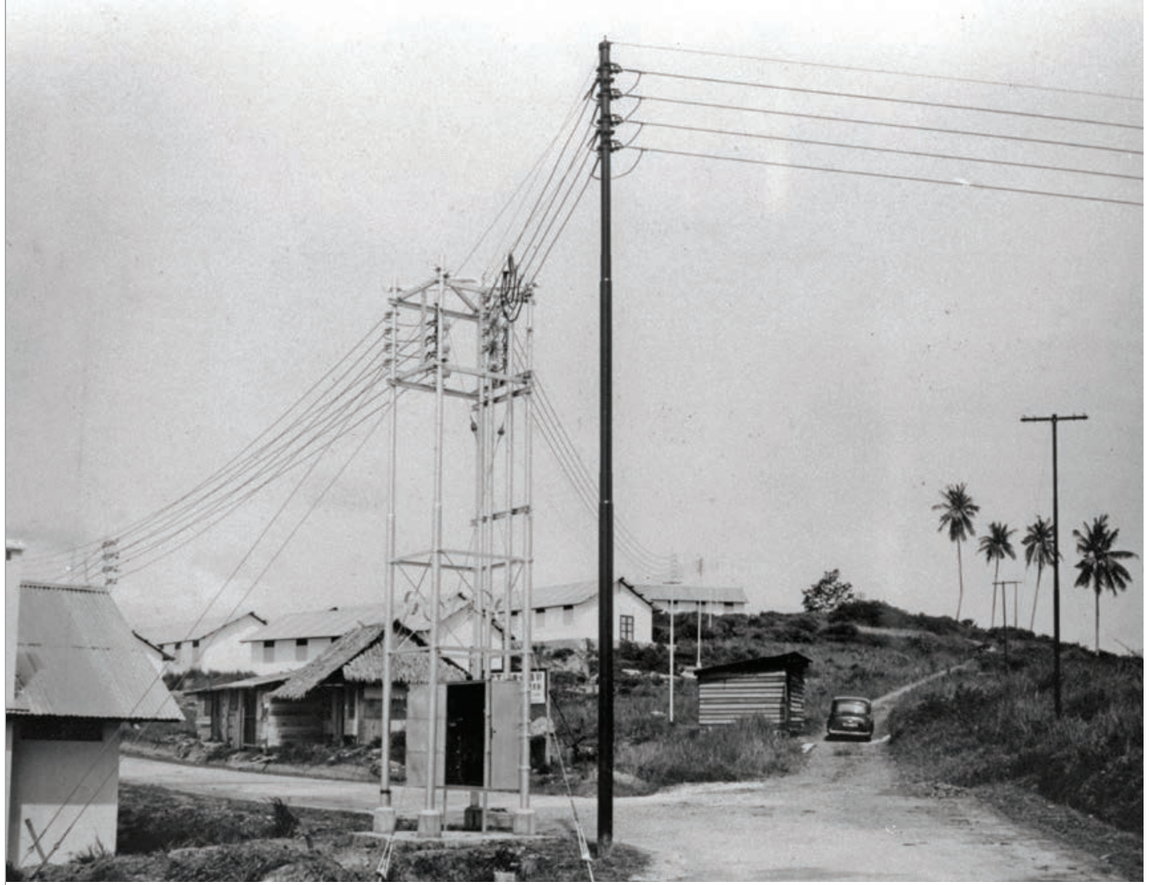
THE period between the 1960s and 1970s was marked by rapid urbanisation and infrastructure construction. These came as the newly-elected government sought to create more jobs and improve the quality of life for Singaporeans. This led to an unprecedented growth in demand for electricity, which in turn called for an accessible, efficient, and reliable electricity supply.

In May 1963, PUB was established as a public statutory board to manage Singapore's electricity, water, and gas supplies. It took over the reins from the City Council, with Dr Fong Kim Heng at the helm as PUB Chairman.

At PUB's inaugural meeting, he said: "It is also the intention of the board to bring amenities of water and light to the rural areas as soon as possible."

Indeed, the government saw the need to improve the living conditions of those living in the villages and initiated one of its most extensive projects in history — the Rural Electrification Programme, which brought electricity to all of Singapore.

Works being carried out under the Rural Electrification Programme.



Overhead electrical distribution cables at Ulu Pandan.

LIGHTING UP THE *KAMPONGS*

OVERHEAD wires stretched high above the *kampongs*, or villages, as far as the eye could see. They were strung from towering metal poles, hung metres away from each other. The Rural Electrification Programme was an extensive and expensive project that was initially met with apprehension.

As Mr Soh Siew Cheong, former Chief Transmission and Distribution Engineer in PUB's Electricity Department, recounted: "At that time, people were at first suspicious, then later on, they realised that it was for their own good that we were bringing in the supply."

It was no straightforward task, however. While *kampongs* clustered near the power grid were "electrified" without much issue, those that were located farther away and more dispersed were deemed too costly. Eventually, the government decided to fork out $1 million in late 1969 to subsidise work on these *kampongs* so that they could enjoy electricity.

Bringing light to the villages proved to be challenging from a technical perspective as well. Falling tree branches during thunderstorms could cause blackouts, and engineers were at risk of being struck by lightning. "Working with electricity was very dangerous. (It's) much safer nowadays... Last time, we learnt everything on the job. There were no instructions," former PUB engineer Chow Futt Yew told The Straits Times in a 2019 interview. He was involved in planning the installation of the power lines for the programme.

The Rural Electrification Programme, which benefitted more than 200,000 people at a cost of nearly $20 million, was eventually completed in 1973.

As everyone gradually gained access to electricity and usage increased, a new challenge on electrical safety emerged.

SAFETY FIRST

IN 1967, PUB formed an Inspectorate Division to study and adopt the best practices used by industrialised countries on electrical safety.

However, mishaps were still unavoidable. Between 1966 and 1987, there were 250 fatal electrical accidents.

One such event occurred on the morning of 21 November 1972. A fire had broken out at the Robinsons Department Store. The blaze, which was caused by a short circuit, claimed nine lives.

The Robinsons fire triggered a tightening of licensing regulations, with the Electrical Workers and Contractors Licensing Act and Electrical Workers and Contractors Licensing Regulations introduced in 1975, among others. Since December 2002, these have been subsumed under the Electricity Act, Electricity (Electrical Installations) and Electricity (Electrical Workers) Regulations.

Separately, there was the mandatory installation of Residual Current Circuit Breakers, formerly known as Earth Leakage Circuit Breakers, in all new homes from 1985. Mr Ng Nam Wah, head of the Inspectorate Division at the time, said: "The move is to protect the consumer."

The Robinsons Department Store fire in 1972 triggered a tightening of licensing regulations.

PUB Board Members at a visit to Pasir Panjang Power Station.

Engineers monitoring Singapore's electrical supply at Pasir Panjang Power Station.

ALWAYS PLANNING AHEAD

PLANNING ahead to ensure sufficient supply has always been the cornerstone of Singapore's electricity infrastructure development. Mr Lee Ek Tieng, who was PUB Chairman from 1978 to 2000, said the key to PUB's work was to always aim to "stay ahead of the curve".

Previously, PUB's corporate planning department would prepare annual rolling 10-year demand forecasts to determine when new power stations had to be built to meet future electricity needs, said Mr Wong Siew Kwong, who previously worked in the department and is now Senior Director of EMA's Industry Regulation Division (IRD). The department would consult agencies such as the Singapore Economic Development Board and JTC Corporation on upcoming major projects that required large amounts of electricity.

Mr Wong said: "For instance, in the mid-1980s, it was apparent that (the existing) power stations might not be sufficient to cater to our long-term electricity demand, and that triggered the process to build Tuas Power Station. The challenge then was to be able to convince PUB's management and the ministry that a new power station was needed based on the long-term electricity demand forecasts."

Between the post-war and post-independence years, a slew of power stations was constructed – Pasir Panjang A in 1952, Pasir Panjang B in 1965, and Jurong in 1970 – to meet the rapidly rising demand. And tucked in the northern part of Singapore was one of the largest power plants in the region, Senoko Power Station. Built in 1977, Senoko had a generation capacity of 1,610 megawatts — enough to supply 60 per cent of the island's electricity needs back then.

By 1991, Senoko became the first power plant to generate electricity using natural gas – an effort to "go green", said Mr Thia Chye Seng, Director of IRD at EMA. He had also spent 35 years prior in the power generation industry. "(Senoko) led the way with the first Combined Cycle Gas Turbine (CCGT). When new plants were built by gencos (power generation companies), they followed suit with CCGTs and used natural gas," he added.

The gas was channelled through a 730-kilometre-long pipeline in Malaysia, stretching from Terengganu to Singapore. It marked the start of the nation's transition to natural gas as its main fuel source for electricity generation.

At the same time, PUB was heading for a turning point that would change its role in nation-building.

Mr Kng is currently the Deputy Chief Executive heading the Industry Regulation Division in EMA.

"I was navigating the displays for the Chief Engineer and his deputies to explain what was happening and the options available to the Minister. It was quite exciting to be in the middle of the massive power restoration efforts."

Mr Kng Meng Hwee
Then-Senior Engineer at PUB

ALL IN A DAY'S WORK: MEETING LEE HSIEN LOONG, CHILDBIRTH AND FIXING SINGAPORE'S LONGEST BLACKOUT

ATTEND a routine talk at the PUB headquarters, then return home to care for his heavily pregnant wife expecting their fourth child. What could go wrong? As then-Senior Engineer Kng Meng Hwee discovered on 29 September 1992, nothing went according to plan.

The talk was halted just after 10am as Mr Kng received news of a major fire that had broken out at Senoko Power Station. He was stationed at the crisis management room to ensure timely updates on the power system condition.

The major fire at one of the two 230 kilovolt switchhouses at Senoko Power Station had damaged the equipment which was connected to three 120 megawatt (MW) and four 250MW generating plants. As a result, these generating plants supplying about 45 per cent of the island's total electricity demand had to be shut down within 30 minutes to prevent further damage.

The rapid shutdown resulted in an islandwide blackout as 27 transmission substations were automatically disconnected to quickly balance the supply and demand of electricity. All available fast-start generating plants were run-up to help in the partial restoration of electricity supply. The gravity of the situation soon came into focus.

"The event was so serious that (then) Minister for Trade and Industry Lee Hsien Loong entered the room with my Chief Engineer and PUB's senior management," recalled Mr Kng.

"I was navigating the displays for the Chief Engineer and his deputies to explain what was happening and the options available to the Minister. It was quite exciting to be in the middle of the massive power restoration efforts."

As the control equipment in the switchhouses was soaked with water from the fire-fighting efforts, the Chief Engineer and his officers had to use hairdryers to blow-dry the control equipment overnight before the three 120MW and one of the 250MW generating plants could be restarted the next day.

Engineers in Jurong Power Station also rushed to restart the two smaller 60MW generating plants which had been mothballed. It was a near miracle that these very old and retired generating plants could work and also commence operations in the next two days.

The blackout was the longest in Singapore's history to date, lasting for 13 hours and affecting several parts of the island – including Mr Kng's home where his pregnant wife went into labour at the most inopportune time, about noon on that fateful day.

She managed to wait for him to return home after 4pm, but the lifts were still not working. "She walked down 16 floors with an overnight bag on her own and I took her to the hospital, where she delivered just after 7pm," he said, smiling at the memory of how a precious life was born when the lights went out.

The next morning, after settling childcare arrangements for his three other children — then aged three, two and one — he went back to the Power System Control Centre to assist his colleagues in the electricity supply restoration and reporting efforts.

HELLO, COMPETITION

AS the century waned, the electricity and gas markets' sole player was feeling the heat. PUB had to meet the growing electricity demand and keep costs down. It was time to progressively liberalise the energy sector. With more players in a liberalised energy market, the power generation companies had to improve productivity and lower costs.

Work to deregulate the electricity and piped gas markets in Singapore started on 1 October 1995. PUB corporatised its electricity and piped gas functions under Singapore Power Ltd, known today as SP Group, to introduce competition in the energy market.

A NEW BEGINNING

AT the dawn of the new millennium, Singapore pressed on with its efforts to open up the energy sector. To oversee further liberalisation and inject competition into the electricity and gas markets, EMA was set up on 1 April 2001. Mr Chiang Chie Foo, the chairman at the time, said: "EMA would provide the necessary focus to the regulation of the liberalised electricity and gas industries, enhancing competition and maintaining a level playing field."

Two decades on, EMA continues to strive for fair and effective competition, ensure a reliable and secure energy supply, and develop a dynamic energy sector for Singapore. These efforts have forged a progressive energy landscape ripe for sustained growth.

Scan to watch a video on Singapore's energy history.

Singapore's iconic skyline in the early 2000s.

Singapore's underground transmission cable tunnels deliver electricity islandwide.

CHAPTER TWO

POWER UP: Strengthening Our Energy Resilience

Singapore entered the new millennium with the aim of bolstering its energy resilience.

Deals were struck to import piped natural gas in the early 2000s. Singapore broke new ground again with its first liquefied natural gas (LNG) terminal in 2013, which further enhanced its energy security.

The Energy Market Authority (EMA) kept a tight watch on the energy supply to ensure system reliability and prevent disruptions. It relied on state-of-the-art computer systems to keep the lights on and natural gas flowing.

EMA has also overseen improvements to Singapore's power infrastructure and network to maintain a robust power system. It also continues to harness the latest technology to keep cyber threats at bay.

A NATURAL (GAS) SOLUTION

THE transition from fuel oil to natural gas began as Singapore went in search for a cleaner, more cost-effective, and efficient way of generating electricity.

Singapore first imported gas from Malaysia in 1992 to generate power in Senoko Power Station. But what drove the shift to natural gas in a big way were developments in the chemical industry.

Back then, Singapore was developing Jurong Island as a hub for the multinational chemical and petrochemical companies. These companies were using natural gas as a primary feedstock for their operations. The growth of these industries led to a surge in demand for natural gas.

To meet this growth in demand, Singapore inked a US$8 billion, 22-year agreement with Indonesia to import natural gas from West Natuna in 2001. Two years later, in 2003, the Republic signed a US$9 billion, 20-year agreement to import more piped natural gas from South Sumatra, Indonesia.

FORTIFYING SINGAPORE'S ENERGY SECURITY

BESIDES meeting the nation's rapid energy demand growth, energy supply was an area of concern as well.

Singapore's sole reliance on piped natural gas meant it was vulnerable to supply disruptions. There was a need to find other ways to bring natural gas into Singapore.

A solution soon became apparent: to build a terminal to gain access to natural gas imports from all over the world. Construction of the first LNG terminal in Singapore thus began in 2010 and operations started in May 2013.

Today, the LNG terminal on Jurong Island operates with two jetties and four storage tanks. While the terminal currently supplies about 25 to 30 per cent of Singapore's total natural gas demand, the terminal has sufficient capacity to supply all of Singapore's total natural gas demand.

Singapore receives its supply of natural gas from Indonesia's West Natuna Sea via Sembcorp Gas Pte Ltd.

Scan to view a 3D visualisation of the process starting from the berthing of a LNG tanker to the send-out of LNG for power generation.

LNG from around the world is imported via the LNG terminal for industrial use and power generation.

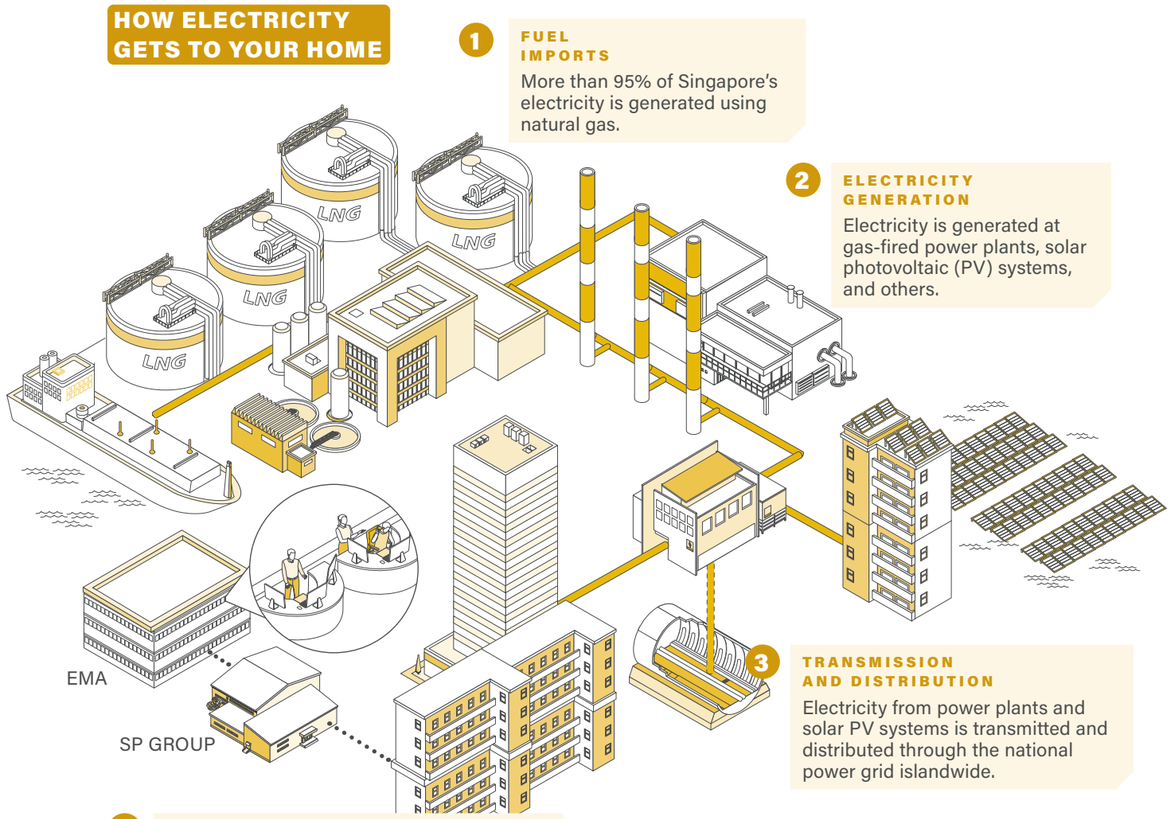
25 February 2014 marks the official opening of the Singapore LNG Terminal.

"The Terminal has an important responsibility to ensure uninterrupted send-out of natural gas for domestic use, particularly for power generation. This has been our mandate and primary focus since we began commercial operations and it will always remain so," said Mr Tan Soo Koong, Chief Executive Officer of Singapore LNG (SLNG) Corporation.

SLNG is also exploring ways to tap into the terminal's capabilities to promote the use of cold energy for applications such as cooling systems, and to study alternative clean energy sources such as hydrogen.

Mr Tan added: "SLNG is stepping up to be a catalyst for the development of a vibrant, coherent, and progressive LNG ecosystem. We are prepared to go beyond the physical boundaries of our terminal to find new and innovative ways of using LNG and explore new possibilities in the energy transition."

As the country presses on with its energy diversification efforts, ensuring that consumers have a reliable supply of electricity remains crucial. This is where the nerve centre of the power system comes in.



THE CENTRE THAT NEVER SLEEPS

A myriad of numbers and graphs blinks continuously across a massive screen in EMA's Power System Control Centre (PSCC). On one side is the map of Singapore, reflecting the status of the electricity supply across the island. The other side shows an overview of the power system and gas network.

EMA monitors this information round the clock to ensure that electricity supply remains stable from source to switch. Each day, three groups of six officers work eight-hour shifts to make sure that any detected anomalies are immediately attended to.

"What is important to us is to always keep the lights on," said Mr Chew Gim Wah, Senior Specialist in the Power System Operation Division (PSOD).

Yet, ensuring uninterrupted power supply goes beyond the daily monitoring and operations of the power system. "Like all other infrastructural projects, there needs to be forward planning to ensure resilience and to meet Singapore's future energy needs," said Mr Yeo Lai Hin, Senior Director of EMA's Industry Regulation Division.

Mr Yeo's team works closely with SP Group, which manages and operates the national power grid. Together, they draw up long-term plans to develop and strengthen Singapore's grid infrastructure and network.

"The task of safeguarding the reliability of the power grid against the backdrop of a rapidly changing landscape is something my team and I devote a lot of our time to," added Mr Yeo.

EMA officers manning the Power System Control Centre, the nerve centre of Singapore's electricity generation and transmission system.

Automatic inspection vehicles and smart sensors are used to monitor and detect any abnormalities in the electricity cable tunnels.

OUT WITH THE OLD, IN WITH THE NEW

LYING 60 metres underground are three cavernous cable tunnels that are critical to Singapore's electricity supply. Touted as the country's deepest tunnel system, the tunnels span about 40 kilometres across Singapore.

The $2.4 billion underground cable tunnel system is part of a network to facilitate installation of electricity transmission cables from major power stations to electricity transmission substations islandwide.

"The completion of the cross-island underground transmission cable tunnels in 2018 was a major engineering achievement. These underground cable tunnels cater to future network requirements, and enable the timely renewal of ageing assets more efficiently, with minimal disruption to the public," said Mr Jimmy Khoo, Chief Executive Officer of SP PowerGrid. "Customers can be assured that they continue to enjoy safe and reliable supply as Singapore maintains its position as having one of the best-performing electricity networks in the world," Mr Khoo added.

Officers from the PSCC also work closely with SP Group to monitor critical systems that track the condition of the cable tunnels.

UNDERGROUND FOR THE FIRST TIME

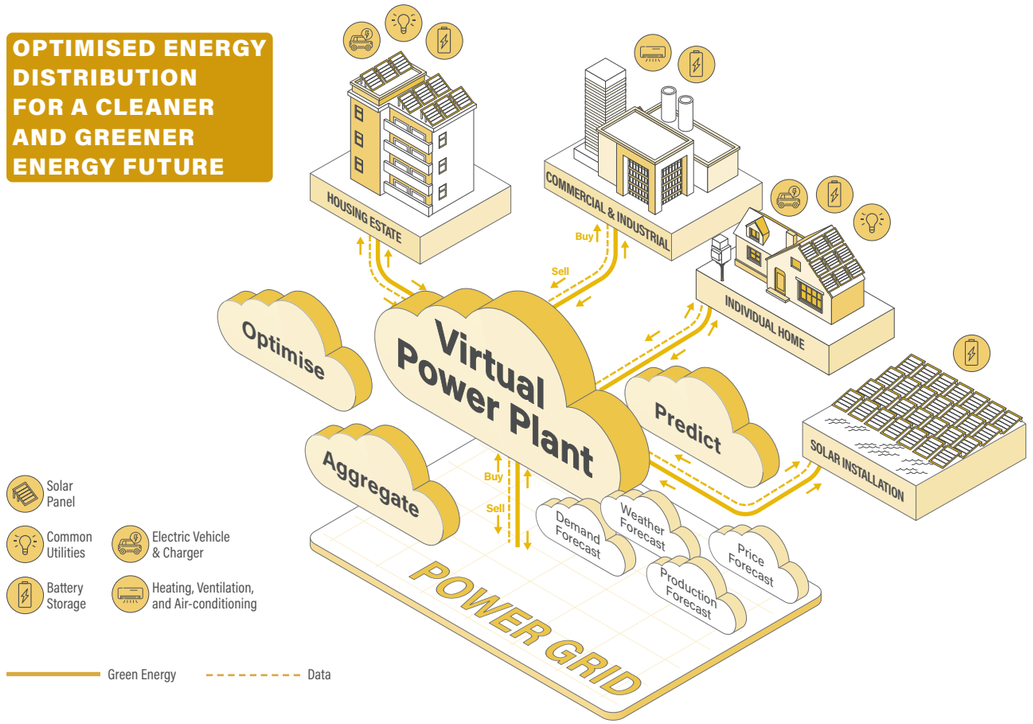
ELECTRICAL substations help link up the various components of a power grid from power generation plants to cables. They serve the vital role of stepping down high-voltage electricity so that consumers can safely power their homes and offices.

Occupying a space of around four football fields, the 230 kilovolt Labrador underground substation is part of the nation's commitment to build sustainable power infrastructure. Mr Ryan Wong, General Manager (Special Projects) of SP PowerGrid said: "Leveraging our (SP PowerGrid) extensive experience in constructing the underground electricity cable tunnels that span across Singapore, we are able to deal with the complexities of building Southeast Asia's first mega underground substation."

He added: "By freeing up prime land space for residential, commercial, or recreational purposes, land use and resources can be optimised in land-scarce Singapore. In addition, an underground substation has a lower risk of being exposed and damaged, therefore enhancing asset and network security."

Site of Singapore's first large-scale underground substation at Labrador, which is scheduled for completion in 2024.

OPTIMISED ENERGY DISTRIBUTION FOR A CLEANER AND GREENER ENERGY FUTURE



THE POWER OF TECHNOLOGY

AS EMA continues to strengthen Singapore's power infrastructure, it also harnesses smart technology to future-proof the power system.

In 2019, EMA and Sembcorp Industries jointly awarded a grant to Nanyang Technological University to develop Singapore's first Virtual Power Plant (VPP). The digital platform will optimise the power output of distributed energy sources such as solar and energy storage to automatically manage any energy fluctuations. The VPP is also equipped with advanced forecasting and optimisation algorithms that aim to improve grid reliability and resilience.

"A big challenge that the project team faced was uncertainties in user behaviour and the different types of distributed energy resources involved. So the team came up with a novel algorithm that accounts for these scenarios and generates dispatch plans to improve efficiency and robustness," shared Mr Karan M Sabnani, who is a Technology Associate leading digital transformation projects at Sembcorp Industries.

A grid digital twin is another project that EMA is developing to future-proof the power system. By mirroring the real-world system, the digital twin allows for optimisation of network expansion and renewal planning, operations, and maintenance. For example, it is able to monitor the health of the different grid assets and also perform scenario analysis to guide EMA on when to renew these assets.

SAFETY IN THE CYBERSPACE

IN today's digital age, power generation and distribution are far more complex and interconnected than before.

To keep cyber threats at bay, EMA uses the Cyber Threat Detection System to monitor baseline communications with the Energy Management System for any malicious activities. Any deviations are then reported through the system in real time.

Another system that EMA uses is the Power Sector Sectorial Detection & Early Warning System. It allows the agency to monitor and uncover cybersecurity threats in the Operational Technology environment within the power sector's critical information infrastructure.

Being able to respond to potential cyber attacks is equally important as having cyber defence systems in place. To keep abreast of the latest skills and evolving threats, cyber engineers in EMA undergo regular security awareness training. They also take part in industry-wide tabletop exercises organised by the Cyber Security Agency of Singapore.

Today, EMA continues to diversify Singapore's energy sources for greater reliability and security. At the same time, it remains focused on driving a competitive market for the benefit of the industry and consumers.

The digital twin project uses simulation techniques to optimise and enhance the resilience of our power grid.

A new regulatory agency has to lay down the rules to achieve the desired operating environment. EMA is no exception — its desired outcome is a vibrant, competitive electricity sector for the benefit of consumers. In its inaugural years, EMA achieved significant milestones that laid the foundation for Singapore's energy sector today.

To transition to a competitive market, EMA introduced vesting contracts to manage the market power of generation companies, which were operating in a different landscape. EMA also had a key role in developing the energy market. Indeed, we had a lot to learn in the early years. We worked closely with international experts to establish the Energy Market Company, which was tasked with operating the National Electricity Market of Singapore. In addition to importing piped natural gas, we also advocated the development of Singapore's first liquefied natural gas (LNG) terminal to diversify supply.

Over the years, EMA has made its presence felt in the global energy space, especially since the inaugural Singapore International Energy Week in 2008. Today, EMA not only has strong cooperation with local partners, but international partners as well.

Congratulations on EMA's 20th anniversary. You have done well in "keeping the lights on" for all your consumers. Wishing you continued success even as you meet new challenges in the ever-evolving energy landscape.

Mr Chiang Chie Foo
EMA Chairman
2001 – 2009

Singapore's energy security cannot be taken for granted. In this regard, EMA has been steadfast in safeguarding Singapore's energy reliability and security, and developing a competitive energy sector.

As the energy landscape evolved, EMA's role also expanded in the late 2000s to include the development and promotion of the industry. This paved the way for various initiatives, notably in developing R&D capabilities to support the burgeoning industry.

From rolling out an electric vehicle test-bed programme to piloting a micro-grid at Pulau Ubin, these efforts marked the agency's early foray into R&D by collaborating closely with industry players.

EMA has come a long way on many fronts and I am honoured to have been part of the journey. My heartiest congratulations to EMA on its 20th anniversary.

Ms Chan Lai Fung
EMA Chairman
2009 – 2013

I am privileged to have had the opportunity to witness the opening of Singapore's liquefied natural gas (LNG) terminal on Jurong Island. Building the terminal was a strategic move to diversify our natural gas sources, with the goal of strengthening our overall energy security and resilience. It also reflected our tenacity in fortifying our energy security as we pressed on with the project despite initial challenges posed by the 2008 global financial crisis.

EMA also rolled out the electricity futures market to enhance market competition, and the National Energy Competency Framework (now known as the Skills Framework for Energy and Power) to boost manpower capabilities for the power sector.

The years that I spent working with the EMA team were most rewarding. And I am confident that EMA will continue to scale greater heights for many more years to come.

Mr Loh Khum Yean
EMA Chairman
2013 – 2016

One highlight for me was the launch of the Open Electricity Market in 2018, which marked the final phase of our 20 years of liberalising the electricity market. In addition to bringing more choices and benefits to consumers, I am heartened that greater competition has spurred the industry to continually innovate and refresh their offerings to meet consumers' needs.

On the international front, Singapore hosted the 36th ASEAN Ministers on Energy Meeting in 2018. This event holds special meaning for me as it coincided with the Singapore International Energy Week. Energy ministers from ASEAN countries and eminent energy leaders convened in Singapore to discuss ways to deepen our collaboration for sustained economic growth for the region.

In recent years, the existential threat of climate change has amplified the role that energy plays in Singapore's sustainable development. It was therefore opportune that EMA unveiled in 2019 the pathways to transforming the energy supply through natural gas, solar, regional power grids, and emerging low-carbon technologies. This will be underpinned by efforts to lower our energy demand and increase energy efficiency.

As we move towards a more sustainable future, I applaud EMA for the efforts made so far. I wish the agency a happy 20th anniversary, with many more fulfilling years to come.

Mr Ng How Yue
EMA Chairman
2016 – 2020

CHAPTER THREE

COMPETITION ENHANCED: Reaping the Benefits

At the turn of the 21st century, energy supply was stable, and disruptions were few and far between. Singapore's focus shifted to promoting competition in the energy market — giving consumers more choices and greater benefits.

To this end, the Energy Market Authority (EMA) embarked on restructuring Singapore's energy market. From deregulating the power generation market to opening up the wholesale and retail electricity markets — it was one breakthrough after another as competition intensified.

THE TWO-DECADE JOURNEY

FROM the 1960s through to the 1990s, Singapore's rapid industrialisation led to a rise in energy demand. Therefore, the Public Utilities Board (PUB), as the sole utilities provider, had to upgrade the energy infrastructure to meet this demand growth and support Singapore's burgeoning economy.

At first, these capital-intensive investments were mostly financed by the sale of electricity to consumers. Subsequently, the government had to find a way to mitigate the impact of rising electricity prices on consumers as well as maintain the nation's attractiveness to prospective global investors.

This prompted the progressive liberalisation of the energy market — a journey that spanned nearly two decades. By introducing competition and bringing in more market players, the energy sector was able to meet the energy demand, while ensuring reasonable electricity prices. The intensified competition also prompted the power generation companies to improve productivity and lower costs.

DEREGULATING THE POWER GENERATION MARKET

THE first step of the liberalisation journey was taken in 1995, when PUB corporatised its electricity and gas operations under a newly-formed Singapore Power Ltd (now known as SP Group). Meanwhile, PUB continued with its role as the regulator of the electricity and gas sectors.

The subsidiary companies under Singapore Power Ltd in 1995

1
PowerGen (Seraya) Ltd and PowerGen (Senoko) Ltd — power generation companies

2
PowerGrid Ltd — electricity transmission and distribution

3
Power Supply Ltd — electricity supply and customer services

4
PowerGas Limited — gas transmission and distribution networks

To introduce more competition in the market, independent power producers and co-generators were also allowed to enter the power generation market.

The 800 megawatt Combined Cycle Gas Turbine power plant by PacificLight Power Pte Ltd.

A major milestone was reached in 2001 when Singapore Power divested its two power generation companies — PowerGen (Seraya) Ltd and PowerGen (Senoko) Ltd — to became wholly-owned subsidiaries of Temasek Holdings. This levelled the playing field in the power generation market, leading to the official separation of the competitive sectors of electricity generation and retailing from the operations of the national power grid.

That same year, EMA was formed by merging the regulatory role of PUB and the power system operations of PowerGrid Ltd. As Mr Khoo Chin Hean, EMA's first Chief Executive, shared in its first annual report: "There's new excitement and pride as we bring the Singapore energy market into an era driven by competition and efficiency."

The 66kV Changi Business Park substation delivers electricity to consumers in the area.

A tanker unloading LNG at the LNG terminal, where term importers bring in LNG to supply to their customers.

OPENING OF THE GAS MARKET

CHANGES were also afoot in the gas market, which underwent restructuring due to the growth in the use of natural gas.

The restructuring process started in 2000, with the separation of gas transportation from the competitive businesses of gas imports, shipping, and retail. PowerGas, which used to perform all these functions, became regulated by EMA and was allowed to undertake only the transportation of both town gas and natural gas through its pipelines to consumers. This ensured an open and level playing field in the gas market.

In February 2014, Singapore introduced a Competitive Licensing Framework, which awards liquefied natural gas (LNG) import licences on a tranche-by-tranche basis. Today, businesses have the option to purchase natural gas from four term importers — ExxonMobil LNG Asia Pacific, Pavilion Energy Singapore, Sembcorp Fuels (Singapore), and Shell Eastern Trading.

REVAMP OF WHOLESALE ELECTRICITY MARKET

AROUND the same time, the wholesale electricity market was also revamped. The Energy Market Company (EMC) was incorporated to operate the market. It plays an instrumental role in keeping wholesale electricity prices competitive and sending accurate price signals to optimise production and consumption decisions.

As EMC's Chief Executive Officer, Mr Toh Seong Wah put it: "Market mechanisms guide the production, trade, and consumption of electricity in Singapore's liberalised electricity sector. The orderly and rule-based environment makes the sector attractive to investors, which in turn drives competition that benefits consumers."

The Singapore Electricity Pool (SEP) also made way for the National Electricity Market of Singapore (NEMS). Unlike the SEP where electricity was traded before each operating day, power generation companies competed to sell electricity on a half-hourly basis in the NEMS.

Subsequently, the electricity futures market — a first in Asia — was launched in 2015. It was a move welcomed by many. Not only did it spur competition in the wholesale and retail electricity markets, but it also limited the market influence of the bigger players. "It (electricity futures market) is a must for independent retailers to participate," said Mr Jomar Eldoy, Managing Director of Ohm Energy.

With that, only one segment remained in the journey towards a fully liberalised energy market.

Liberalising the wholesale electricity market brought greater transparency and competitive trading among industry players for the benefit businesses and consumers.

Scan to learn more about the Open Electricity Market.

Since May 2019, all households in Singapore have been able to buy electricity from more retailers.

MORE CHOICES, SAME RELIABILITY

FROM the outset, EMA knew it had to open up the retail electricity market in phases. "Although we could learn from other jurisdictions, we still had to design and implement frameworks and features that are fit for purpose," explained Mr Soh Sai Bor, EMA's Assistant Chief Executive of the Economic Regulation Division.

In 2001, large commercial and industrial (C&I) consumers, which had electricity demand of 2 megawatts and above, could choose to buy electricity from a retailer. Over time, more C&I consumers were given the option as well.

With this consumer segment checked off the list, EMA focused its efforts on extending the power of choice to the remaining 1.4 million households and small businesses, that made up the remaining 25 per cent of electricity demand.

THE "TOUGHEST" CONSUMER: HOUSEHOLDS

THOUGH households and small businesses made up a comparatively small part of Singapore's energy demand, their sheer number called for careful consideration and deliberation of the steps to be taken.

Hence, when then-Minister for Trade and Industry (Industry) S. Iswaran announced in 2015 the decision to fully liberalise the retail electricity market in the second half of 2018, the government did not take a big-bang approach. A soft launch of the Open Electricity Market (OEM) involving only households in Jurong was first set for April 2018. The nationwide launch followed only seven months later in November, after EMA, SP Group, and electricity retailers had gathered feedback to fine-tune processes where needed.

Roadshow held at Westgate during the Jurong soft launch.

Raising public awareness on the Open Electricity Market through outdoor advertising.

GETTING A SENSE OF THE GROUND

THE Jurong soft launch yielded useful insights into consumer behaviour that helped EMA to improve the design of the OEM. For instance, households were reportedly overwhelmed by the wide array of choices as electricity retailers pulled out all the stops to entice them to switch.

The insights gained led to several key changes to enhance the consumer experience, including streamlining of the standard price plans and enhancement of EMA's online price comparison tool. EMA also partnered agencies such as People's Association and Housing and Development Board on events to deepen residents' understanding of the initiative. In addition, it held roadshows that brought electricity retailers together so that consumers could easily shop for a suitable price plan.

Protecting consumer interests also played a vital role in the smooth implementation of the OEM. "With the launch of the Open Electricity Market, Consumers Association of Singapore (CASE) worked closely with EMA to strengthen consumer safeguards and to educate consumers on things they should look out for when they switch to an electricity retailer. This was an important step due to the number of retailers and the different bundles and price plans that were offered," said Mr Melvin Yong, CASE President.

Electricity retailers, on their end, prepared extensively for the change. For Ohm Energy, work started as early as two years before the OEM soft launch. Its goal was to develop systems with a high degree of automation that would allow consumers to switch between retailers seamlessly. This would free up the Ohm team to spend more time in explaining the initiative and addressing consumers' questions, explained its Managing Director, Mr Jomar Eldoy.

Another retailer, Keppel Electric, took pride in being able to contribute to the growth and vibrancy of the OEM. "Through the liberalisation of the retail electricity market, consumers today have a wide range of plans to choose from. This has spurred Keppel Electric to innovate to stay ahead of the competition," said Ms Janice Bong, Executive Director (Power & Gas) of Keppel Infrastructure.

Bringing all the various stakeholders together to work towards a common goal was not easy but these efforts eventually paid off. Nearly three years later, more than half of Singapore's 1.4 million households have benefitted with energy savings and innovative offers.

As the energy landscape evolves, EMA continues to take steps to transform the sector through research, innovation, enterprise development, and collaborations with stakeholders and partners.

Scan to learn about EMA's partnerships with the industry and research community to test-bed innovative Energy Storage Systems (ESS) solutions.

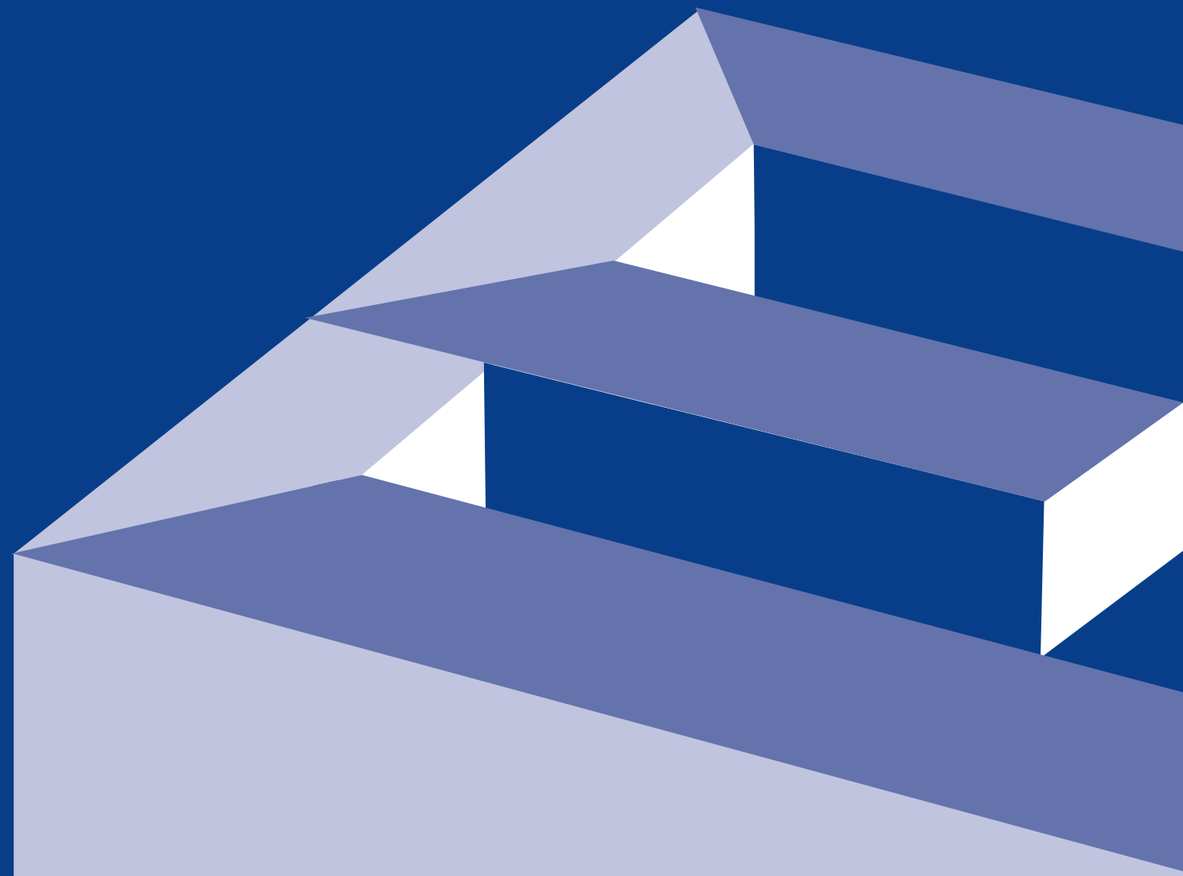
ESS deployed by one of EMA's industry partners, Durapower Group, at Jurong Port.

CHAPTER FOUR

FORGING AHEAD: Innovating for Growth

As Singapore advances towards a low-carbon energy future, the Energy Market Authority (EMA) is accelerating its efforts to catalyse research and innovation, facilitate the deployment of promising solutions, and develop local enterprises and their capabilities. Building a future-ready workforce is also key to supporting the energy sector that is ever evolving.

The transition to a greener energy ecosystem would not be possible without the close collaboration and sharing of best practices with the wider energy community. To achieve this, EMA actively engages in global dialogues on energy issues and exchanges with like-minded partners.



CREATING NEW ENERGY FRONTIERS

RIGHT up to the early 2000s, power engineering capabilities in the energy sector were limited as companies were focused on operations instead of research and development. Similarly, the Institutes of Higher Learning (IHLs) faced constraints in research competencies when it came to power-related areas.

As the energy landscape evolved with new challenges such as climate change, it became clear that the sector needed to build up its capabilities to respond to these challenges and seize new opportunities.

The annual Energy Innovation event, which EMA organises to foster collaboration and knowledge-sharing among the industry and research community.

ENERGISING THE SECTOR

EMA thus took on an active role in developing the energy ecosystem while remaining focused on maintaining energy reliability and security, as well as enhancing the sector's competitiveness.

First on the agenda was to quickly build up capabilities to better understand the challenges that the sector faced and the technology options available to overcome them. Companies and the research community were invited to come forward with new technologies and services.

In 2011, EMA secured funding under the Research, Innovation and Enterprise (RIE) 2015 plan to catalyse innovation in the areas of power utilities, smart grids, and energy storage to address key industry-relevant challenges.

EMA is working with the industry and research community to understand the potential of micro-grids, such as assessing the reliability of electricity supply within a micro-grid infrastructure using solar photovoltaic technology with the Pulau Ubin micro-grid test-bed.

Partnerships with industry partners play a vital role in developing the energy sector Singapore has today.

Funds were also set aside in the RIE 2020 plan. Instead of the previous "market-driven approach", top-down initiatives were developed in this round to achieve system-wide outcomes. EMA also made a stronger push to better capture value from its efforts in research and development, and test-beds by partnering multinational companies and large local enterprises, building a vibrant local energy ecosystem and forging overseas collaborations.

Ms Jeanette Lim, who heads EMA's Industry Development Department, said: "Our efforts were initially focused more on working with the research community to develop new solutions for the sector. Gradually, we started to rope in industry players in a more deliberate manner through collaborations to turn ideas into solutions."

To foster greater collaboration between the industry and research community, EMA launched the Singapore Energy Grand Challenge to co-develop solutions that could improve energy efficiency and business competitiveness. "The Challenge provided us with an opportunity to apply our technological assets in collaboration with institutions such as the National University of Singapore (NUS)," said Mr Katsumi Fujisaki, General Manager for Environmental Strategy at Mitsubishi Electric Asia Pte Ltd. He is working with NUS in one of the awarded projects that aims to improve the overall energy efficiency of air-conditioning systems.

Creating a conducive environment for continuous innovation, however, was not just about developing technological solutions. "As we work towards building a robust energy ecosystem, the sector will need the right people with the right skill sets. One cannot happen without the other," explained Ms Lim.

PREPARING THE WORKFORCE FOR FUTURE OF ENERGY

THE task of attracting, retaining, and developing talent for the sector was not an easy one though. In a manpower landscape study conducted in 2011, feedback gathered from young Singaporeans on their perception of the industry included "harsh working environment" and "little knowledge of the sector". Urgent action was needed to improve the ageing profile of the workforce.

An industry-led Power Sector Manpower Taskforce was then set up in 2012 to identify and recommend strategies to retain and build a strong Singaporean core in the sector. One of the key partners in the Taskforce was the Union of Power And Gas Employees (UPAGE).

"UPAGE has been working closely with the government and industry to curate and develop initiatives to upskill and reskill our energy workforce," said Mr Abdul Samad Abdul Wahab, Vice-President at NTUC Central Committee and General Secretary of UPAGE. "Amid technological disruptions and emerging opportunities, unions play a key role in identifying synergies across industries and training providers to develop relevant programmes to prepare our workers to be future-ready. This allows them to look forward to better pay, better welfare, and better career prospects."

Following the Taskforce's review, several key initiatives were implemented. One of them was the sector's first competency framework in 2015 (now known as the Skills Framework for Energy and Power). The framework defines the different pathways for career progression in traditional areas like power generation as well as emerging ones such as solar and energy storage.

Recipients of the 2019 Energy-Industry Scholarship, a dedicated scholarship for the energy sector offered in partnership with EMA and industry partners.

As part of EMA's Powering Lives Trail programme, students get the opportunity to visit the Power System Control Centre to find out what goes on at the nerve centre of Singapore's power system.

To draw youths to join the sector, the Powering Lives Trails programme, which takes participants out of the classroom and into the field, was launched in 2016. "Experiential learning journeys like these are important for students as we get to gain exposure to the sector in the real-world setting," said Ms Teo Chiaki, an electrical power engineering student at the Singapore Institute of Technology, who participated in one of the activities. She was also part of EMA's Energy Ambassadors Programme, a peer-to-peer advocacy initiative where youths who are passionate about the sector help to raise awareness among their peers at events such as Youth@SIEW.

Youth@SIEW encompasses a range of events held on the sidelines of the Singapore International Energy Week (SIEW). They include Ministerial dialogues and showcases of student energy projects to engage youths on energy issues. These aim to pique their interest and attract them to join the energy sector.

Students from the Institute of Technical Education (ITE) with their showcase at Youth@SIEW.

EMA has also been working with the Public Service Division Science & Technology Policy & Plans Office and relevant agencies to develop power engineering capabilities for the public service. This is crucial as power systems are needed for critical public infrastructure such as transportation.

ENGINEERED FOR SUCCESS

When Ms Teo Mei Fang had to decide on a diploma programme in polytechnic back in 2015, engineering was the last thing on her mind.

But life can be serendipitous. When the door closed on her first choice — life sciences — another door opened in Electrical & Electronic Engineering at Singapore Polytechnic.

She received the Energy-Industry Scholarship in 2017, which affirmed her belief that she had chosen the right career path. "Being awarded the scholarship really spurred me to be laser-focused on honing my engineering knowledge and skills," she recalled.

Today, as a Technical Officer at SP Group's Asset Planning & Strategy department, a key part of her job is to maintain long-term reliability of Singapore's power grid. When an asset requires renewal, she makes use of digital tools to generate data and simulation results, and works with engineers to derive the best possible solutions.

A recipient of the Energy-Industry Scholarship, Ms Teo has found a meaningful and exciting career in SP Group.

Scan to watch a video on past SIEW highlights.

Signing of a Memorandum of Understanding between ASEAN Energy Ministers and International Renewable Energy Agency to scale up renewable energy deployment for the region at SIEW 2018.

Second Minister for Trade and Industry Tan See Leng with ASEAN Energy Ministers, as well as the ASEAN Secretariat and the ASEAN Centre of Energy (ACE) Executive Director at the virtual Joint Opening Ceremony for the 39th ASEAN Ministers on Energy Meeting (AMEM) and Associated Meetings.

COLLABORATING FOR A BETTER ENERGY FUTURE

GIVEN Singapore's small size and lack of natural energy sources, it is vital to promote regular dialogue on shared issues and meaningful cooperation to further its energy interests.

"We hope that Singapore can be the catalyst to galvanise more collective actions and transformation towards a sustainable energy future and, at the same time, become a beacon of energy innovation and solutions for urbanised cities," said Mr Jonathan Goh, Director of EMA's External Relations Department.

To profile energy thought leadership, EMA launched SIEW as a leading platform for discussions on energy issues that impact Asia and facilitate collaboration between top players in the global energy industry. The first edition in 2008 attracted more than 2,800 participants. Since then, the annual event has become synonymous with the energy industry.

"As a melting pot of the national, regional, and global stakeholders on energy, the Singapore International Energy Week has played a significant role in pushing cooperation to escalate the energy transition in the region," said Dr Nuki Agya Utama, Executive Director of the ASEAN Centre for Energy, which regularly partners EMA to host roundtables on regional energy cooperation and initiatives at the event.

Dr Fatih Birol, Executive Director of the International Energy Agency, added: "SIEW is an extremely important event because it draws a unique mix of energy leaders and experts from governments, the private sector, and civil society with a focus on constructive dialogue and collaboration."

Besides holding its own events, Singapore also participates actively in platforms such as Association of the Southeast Asian Nations (ASEAN), G20, and Asia-Pacific Economic Cooperation. For instance, Singapore chaired the Drafting Committee of the ASEAN Plan of Action for Energy Cooperation (APAEC) Phase II, which serves as the regional blueprint for energy cooperation for 2021-2025. "We participate in various regional and global energy discussions to contribute to the global discourse on major issues like lowering energy intensity, facilitating deployment of renewables, and promoting low-carbon energy technologies and innovations, just to name a few," said Mr Goh.

Mr Francesco La Camera, Director-General of the International Renewable Energy Agency (IRENA), shared: "We believe Southeast Asia's rising energy demand can largely be met in a cost-effective way with renewable technologies. In this context, Singapore is an important gateway to the region and a facilitator of increasingly strong cooperation between IRENA and the ASEAN countries."

On the bilateral front, EMA has been building strong links with like-minded counterparts from countries such as the United States, United Kingdom, Hong Kong (China), and Malaysia to share knowledge and best practices. For example, in 2016, EMA and the US Department of Energy signed a Joint Statement on Clean Energy Cooperation that provides a framework to identify and achieve shared energy goals in three key areas: the future evolution of energy markets, energy technology and cooperation at the multilateral stage.

As EMA collaborates with partners — here and beyond — to build capabilities and develop innovative energy solutions, greater urgency has set in for the sector to accelerate its decarbonisation efforts.

In 2020, EMA and the Gas and Electricity Markets Authority (GEMA) of the United Kingdom signed a Joint Statement of Intent to Cooperate, which seeks to strengthen bilateral cooperation between the two regulators.

A behind-the-scene view of SIEW 2020's hybrid production.

AN UNPRECEDENTED EVENT IN A PANDEMIC

"We are back in business," said then-Minister for Trade and Industry Chan Chun Sing in his opening speech at the 13th Singapore International Energy Week (SIEW) in October 2020. As the first hybrid MICE event in Singapore since the COVID-19 pandemic broke out, SIEW 2020 signified a major step in the safe and gradual resumption of economic activities for the nation.

The execution of SIEW's unique hybrid format with onsite and online components required creativity and innovation, as many things were being done for the first time.

It was important to find ways to curate "different layers of experience and keep onsite and online audiences engaged", explained Mr Jonathan Goh, Director of EMA's External Relations Department.

Another major undertaking was the implementation of safe management measures to ensure the well-being of the onsite participants. The team had to develop protocols with other government agencies to conduct pre-event COVID-19 testing for all onsite attendees for the first time.

Digital technology was also central to safety measures. Delegates registered themselves and printed their own event passes at contactless registration kiosks.

Despite the challenges faced, Mr Goh and his team were delighted that the event went smoothly, and delegates enjoyed the SIEW discussions.

"Today marks the resumption of MICE events in Singapore. We are back in business. Thank you very much for being part of this hybrid event in a different format, but the same spirit."

Mr Chan Chun Sing
Then-Minister for Trade and Industry

Today, all of Singapore is served by electricity. It is reliable. It is competitively priced. These are the outcomes of the combined efforts of several generations of people. People who had provided stability in policy and strategic directions and people who had the technical knowledge and competence to implement these directions.

EMA moved the electricity system from one that is centrally planned to one that is driven to compete. The objective being to wring out efficiency gains to benefit all electricity consumers.

Security remained a key objective. This led to the building of the Singapore LNG terminal. The terminal enables Singapore to import natural gas from sources around the world. Should one source of gas fail, we can import LNG from other sources.

I remember the wonderful people I had to work with to introduce competition in the electricity market. At that time, the people in EMA and in the industry were still learning how to ensure reliable operations with natural gas. It was new to us. The work to bring together so many parties with different and often conflicting commercial interests was challenging.

I'm heartened to celebrate this 20th anniversary milestone with EMA. My hope is for the lights to stay on reliably and at a competitive price for many generations to come.

Mr Khoo Chin Hean
EMA Chief Executive
2001 – 2008

When I joined in 2009, EMA was in the process of expanding its roles – not just to continue with its traditional functions as an energy regulator and power system operator, but also to take on the new responsibility of being a developer for the entire energy ecosystem.

We recognised then that Singapore, as an alternative energy-disadvantaged city-state, faced many constraints. But we decided to forge ahead, and developed the tagline "Smart Energy, Sustainable Future" to inspire us to seek smarter energy options and a greener, more sustainable future.

This goal remains at the heart of what EMA does today. For the past 20 years, EMA, together with its industry partners, has made significant contributions to transform Singapore's energy landscape, and to make it more competitive, reliable, and resilient. Not all of the work that EMA does is visible to the public. But we have an excellent team of capable and dedicated EMA officers, who take pride in their work, and who help to keep our lights on, and our nation powered up.

For the next phase of Singapore's energy development, we will need to keep pace with technological changes, and harness new innovative ideas to strengthen our energy competitiveness and security, and to significantly reduce our carbon emissions.

I am confident that EMA will continue to push the frontiers of this important work, and scale greater heights of excellence in the next 20 years!

Mr Lawrence Wong
EMA Chief Executive
2009 – 2011

EMA's dedication to create a skilled talent pipeline has elevated Singapore's energy sector by developing a workforce that is highly adaptable, nimble, and resilient.

The early foundations were laid in 2012 with the formation of the industry-led Power Sector Manpower Taskforce. This tripartite effort allowed us to identify and recommend key strategies to strengthen the manpower capabilities within the industry. With its sights set on training the energy industry's workforce, EMA went on to create a framework (now known as the Skills Framework for Energy and Power) that maps out clear career and progression pathways for the power sector professionals.

It also launched the first energy scholarship in 2014 – the Energy-Industry Scholarship – enabling young Singaporeans who have a keen interest in power engineering to gain real-life exposure to the sector.

People are Singapore's best natural resource, and I am heartened that EMA has continued to nurture our workforce. I am also happy to see EMA's emphasis over the years on developing its employees and looking after their well-being. Importantly, EMA has worked closely with our union leaders and employers to achieve these outcomes, demonstrating the significance of tripartism as a key enabler for industry transformation in Singapore.

My hope is that EMA's commitment to charting a new energy future, which is both pro-business and pro-worker, will remain steadfast amid the changing landscape. Happy 20th Anniversary, EMA!

Mr Chee Hong Tat
EMA Chief Executive
2011 – 2014

As the first in Asia to have a competitive wholesale electricity market, we had to create our own path. It required careful planning, numerous tests, and the determination to overcome obstacles. We pulled it off because we had an eye on the future, and believed that market competition could drive greater efficiencies.

Over the years, we progressively liberalised Singapore's electricity market to give consumers more choices and competitive prices. This is supported by the electricity futures market which has facilitated the entry of new retailers. We also empowered consumers to participate in the market through the Demand Response Programme, and by making it easy for them to sell the excess solar electricity that they generate to the grid.

Having the right policies, market designs and regulations is critical. But ultimately, it is the people that have made Singapore's energy system something that we can all be proud of. Responsible and committed licensees, skilful workers, and a progressive Union of Power and Gas Employees, a passionate and enterprising energy research community — they have all worked hand in hand with dedicated EMA staff to make Singapore's energy system reliable, resilient, and dynamic.

My hope is for Singapore to take advantage of the opportunities that lie ahead, and continue to work with all stakeholders to create a competitive and sustainable energy future.

Mr Ng Wai Choong
EMA Chief Executive
2015 – 2018

^ The 60 megawatt-peak Sembcorp Tengeh Floating Solar Farm.

CHAPTER FIVE

THE NEXT FRONTIER: Advancing the Energy Transition

The climate crisis is the greatest challenge facing the world. It transcends national borders and impacts current and future generations.

For Singapore, the urgency to move towards a low-carbon and climate-resilient future has never been greater. The energy sector plays a significant part in the nation's climate change efforts, and the Energy Market Authority (EMA) has set its sights on transitioning the sector through four energy supply switches. At the same time, work is also underway to address rising energy demand as electrification permeates through every aspect of the economy and the lives of Singaporeans.

IMPETUS FOR CHANGE

THE rapid pace of economic development in the last few decades has increasingly forced nations to reckon with a new challenge — sustainability.

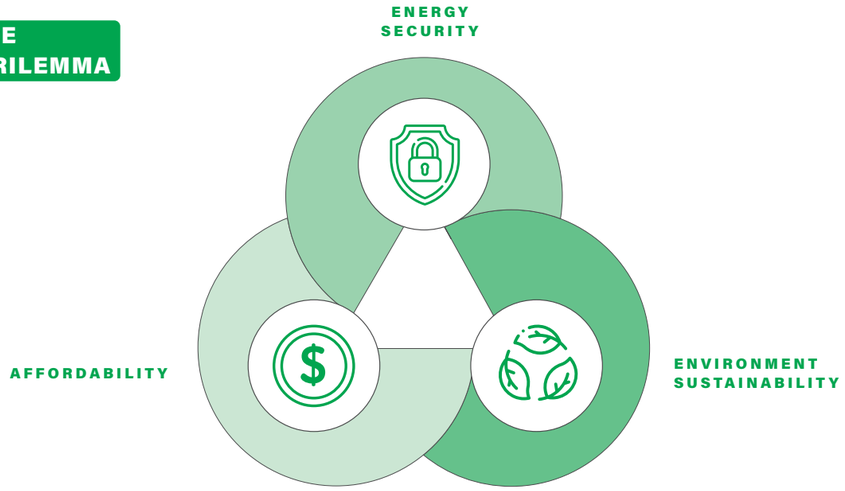
In 2015, representatives from 196 nations adopted the landmark Paris Agreement. The historical moment marked a global recognition that climate change has become ever more real and urgent, and collective action was required to put a halt to global warming.

To build a low-carbon and climate-resilient future, Singapore enhanced its Nationally Determined Contribution (NDC) with an absolute emissions target to peak emissions at 65MtCO_2e around 2030. It also submitted its Long-Term Low-Emissions Development Strategy (LEDS), which builds on the enhanced target to halve emissions from its peak by 2050 and achieve net-zero as soon as viable in the second half of the century.

With the power sector contributing 40 per cent of Singapore's carbon emissions, it is necessary to rethink and reimagine how energy is produced and consumed to meet the nation's climate goals.

Yet this is no easy task. Singapore's energy decisions are centred around the energy trilemma, which requires it to balance the trade-offs between energy security, affordability, and environmental sustainability. The transition towards a greener energy future also calls for concerted action from everyone.

SINGAPORE ENERGY TRILEMMA



Scan to view a 3D visualisation of how a solar panel works.

For Singapore to achieve its long-term net-zero emissions aspiration, the energy sector is pivoting towards more renewable energy sources.

Then-Minister for Trade and Industry Chan Chun Sing announced the Singapore Energy Story at SIEW 2019.

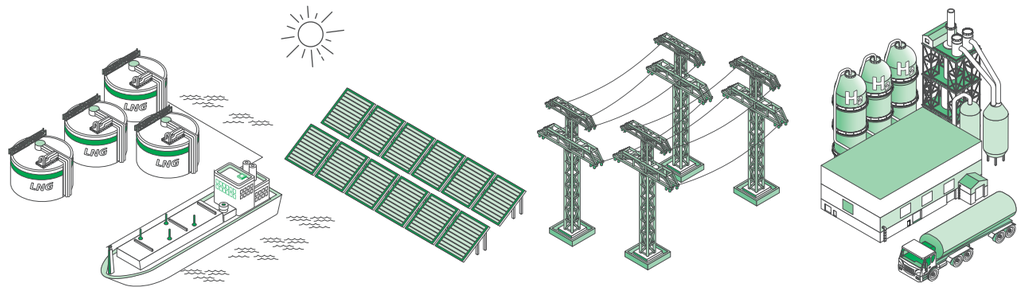
GREENING THE WAY FORWARD

SPEAKING to a ballroom full of delegates from both local and international organisations, then-Minister for Trade and Industry Chan Chun Sing recounted Singapore's water story at Singapore International Energy Week (SIEW) 2019, and emphasised how the city-state could do the same for energy.

"Now the question is, how will we build our energy supplies in a way that is sustainable, reliable, and affordable for the next 50 years?" he asked. Although Singapore's energy supply has evolved tremendously — from oil-powered plants to natural gas — it is still an alternative energy-disadvantaged country.

To overcome our challenges, he unveiled four pathways towards decarbonising the energy sector.

GUIDING SINGAPORE'S ENERGY TRANSFORMATION



Natural Gas

As a reliable fuel source, Singapore will continue to rely on natural gas as we scale up adoption of renewable energy such as solar.

Solar

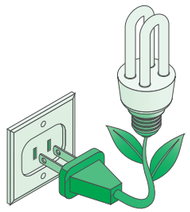
Accelerate deployment to 1.5 gigawatt-peak by 2025 and at least 2 gigawatt-peak by 2030, with energy storage deployment target of at least 200 megawatts beyond 2025.

Regional Power Grids

Access low-carbon energy sources that are either limited or unavailable in Singapore.

Emerging Low-Carbon Alternatives

These include carbon capture, utilisation and storage technologies and low-carbon hydrogen.



Energy Efficiency

Reducing energy demand through energy efficient technologies and materials, optimising design, and digitalisation.

CO-CREATION OF SINGAPORE'S ENERGY STORY

GOVERNMENT
Lead and support energy transformation

WORKFORCE
Upskill for a new energy future

RESEARCHERS
Research and develop innovative energy solutions

INDUSTRY
Develop and deploy energy efficient and clean technologies

INDIVIDUALS
Adopt energy efficient practices

The rooftop installation at Ascendas Real Estate Investment Trust-owned facility at 40 Penjuru Lane, which enabled Singapore to cross its 2020 solar deployment target of 350 megawatt-peak (MWp) in the first quarter of that year.

SOLAR, SO GOOD

THESE days, we often see rooftops of HDB flats, private houses, and commercial buildings installed with solar photovoltaic (PV) systems. But this did not occur overnight. Faced with disruptions in the energy landscape, the government needed to look at energy more holistically.

This resulted in the setting up of the National Energy Transformation Office (NETO) within EMA in 2017 to coordinate and synergise energy development efforts across different government agencies. Director of NETO, Mr Toh Wee Khiang, shared: "We knew that the energy sector was experiencing a seismic change. But what we did not know was how it would play out. You had to plan with multiple scenarios in mind. They (the agencies) had to take a leap of faith – agree to the targets and work out the specifics later."

By steering collective efforts across agencies, Singapore has taken steps towards achieving a low-carbon future by scaling up the use of its most promising renewable source — solar energy — across the island.

"In the absence of other renewable energy resources such as wind, hydropower, or biomass, harvesting the sun's energy is the most viable form of green electricity generation in Singapore," said Dr Thomas Reindl, Deputy Chief Executive Officer at the Solar Energy Research Institute of Singapore (SERIS) in the National University of Singapore (NUS).

Singapore's longest sheltered walkway fitted with solar panels at Singapore Discovery Centre.

"As a city-state with no hinterland and one of the highest population densities in the world, however, we will always face land constraints. Singapore has turned this challenge into an opportunity by opening the city as a living laboratory for novel deployment options such as floating solar or temporary land-based installations," he added.

One major initiative is the SolarNova programme, co-led by Housing & Development Board and Singapore Economic Development Board. Under this programme, demand for solar PV is aggregated across government agencies to achieve economies of scale and drive Singapore's solar industry. Technological advancements and greater efficiency of solar panels have also played a part in the proliferation of solar PV systems in Singapore.

The 60MWp solar PV farm at Tengeh Reservoir is a good example of how far Singapore's solarisation efforts have come. Other innovative ways include placing solar PV systems on offshore waters, temporary vacant land, and public spaces such as rooftops of walkways.

On the policy front, EMA has also enhanced its market rules and streamlined the regulatory framework to lower the cost of entry for smaller consumers. The initiatives include the Enhanced Central Intermediary Scheme and the Solar Generation Profile.

Aerial view of the SolarLand installation on Jurong Island. The system is modular and flexible, allowing JTC to maximise temporary vacant land and redeploy the panels when the land is needed.

These efforts have resulted in a wave of solar adoption that has allowed Singapore to exceed its 350MWp solar deployment target in 2020.

"Singapore is now one of the most solar-dense cities in the world, having grown our solar capacity more than seven times since 2015," said Prime Minister Lee Hsien Loong at the official opening of the Sembcorp Tengeh Floating Solar Farm in 2021.

Moving ahead, Singapore has set its sights to quadruple its solar capacity to 1.5 gigawatt-peak (GWp) by 2025 and achieve at least 2GWp by 2030 — a target that is enough to power some 350,000 households.

While this may seem like an ambitious target, a study by SERIS in the updated solar PV roadmap noted the readiness of Singapore's current power system to accommodate an even larger amount of solar energy by 2030.

However, the intermittent nature of solar means that we must improve grid resilience.

RAISING THE BAR FOR SOLAR

THIS is where Energy Storage Systems (ESS) come into play. This game-changing technology mitigates the variable output of solar and enhances grid resilience by managing mismatches between electricity supply and demand. In tandem with Singapore's solar ambition, a target has been set to deploy at least 200 megawatts of ESS beyond 2025.

To date, more than $30 million have been set aside to catalyse adoption by piloting ESS technologies through EMA's Accelerating Energy Storage for Singapore (ACCESS) programme. One such project is Singapore's first utility-scale ESS test-bed at a substation in Woodlands, that was implemented by a consortium led by Sunseap Group.

Mr Frank Phuan, Chief Executive Officer and Executive Director of Sunseap Group, said: "This is an important step forward for Singapore's energy system. We expect this battery system in Singapore to enhance grid stability by providing the quick response and flexibility needed when integrating solar power into the grid. This project will also provide lessons for future ESS applications and pave the way for more solar power to generate more green energy in Singapore."

EMA is also working with SERIS to trial a solar forecasting model to accurately predict solar irradiance in Singapore's tropical climate. Using sensors installed across building rooftops and a dense network of weather stations, it will allow EMA to anticipate solar output and take pre-emptive actions to balance the grid.

Even as Singapore continues to introduce more solar into its energy mix, the amount of clean energy that can be harnessed is nonetheless limited — due to factors such as limited land area and the lack of natural energy sources.

To overcome these constraints, we have to look beyond our borders and initiate cross-border power trading in the region to access regional clean energy sources.

The utility-scale ESS test-bed funded by EMA and SP Group will evaluate the performance and safety of ESS in Singapore's hot and humid environment.

Under the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project, the four countries are exploring cross-border power trade of up to 100 megawatts of electricity from Lao PDR to Singapore via Thailand and Malaysia.

CONNECTING TO REGIONAL POWER GRIDS

AFTER a 2014 study on the technical viability of cross-border power trade from Lao PDR to Singapore, four ASEAN countries — Lao PDR, Thailand, Malaysia, and Singapore — have put in place a cross-border power trading scheme of up to 100MW using existing interconnectors.

On the bilateral front, Singapore will be piloting small-scale trials with countries like Malaysia. Professor Subodh Mhaisalkar, Executive Director of the Energy Research Institute @ NTU, said: "In addition to all the efforts in Singapore to reduce our emissions from power generation, industrial, and other sectors, we need to be open to partnering our neighbours to develop solutions that promote sustainable growth."

"The import trials help to establish the viability of electricity imports and is the first step towards setting up regional partnerships that would enable both private and governmental partnerships, and investments in renewable energy generation and the import of green electrons into Singapore," he added.

Spearheading the work on this front is the Energy Connections Office (ECO) at EMA. Mr Lee Seng Wai, Director of ECO, said: "Electricity imports will be a gamechanger for Singapore's energy system, providing us with access to competitive, reliable, and clean energy beyond our borders. It will also strengthen our economic relationships with our regional neighbours through win-win solutions.

"As we have zero electricity imports today, this marks the start of a challenging yet fruitful journey. The continued collaboration between governments and the private sector will be necessary to make this endeavour a success that we can be proud of."

Even as EMA turns to regional power grids to advance the energy sector's decarbonisation efforts, it is already in search of the next big breakthrough in low-carbon alternatives.

Laying of subsea cables interconnecting Singapore and Malaysia.

Pulling of subsea cables to Singapore's shoreline for them to be connected to the mainland grid.

LONG-TERM PATHWAY TO DECARBONISATION

SOME say the simplest element in nature — hydrogen — could be the solution to one of the world's most complex problems: an energy carrier that is not carbon-emitting. When burnt or put through a fuel cell, it produces only water while releasing energy.

Hydrogen is one of the emerging low-carbon alternatives that Singapore is exploring as a longer-term decarbonisation solution when it becomes commercially viable. The other technology is carbon capture, utilisation and storage (CCUS) that can be used to capture carbon emission from power plants.

The government has set aside $49 million to fund low-carbon energy research and test-bed efforts in hydrogen and CCUS technologies. The funding initiative is a multi-agency endeavour to develop cost-effective solutions to deliver carbon abatement for Singapore's power and industry sectors as early as 2025. Memoranda of Understanding were also inked with countries such as Australia, Chile, and New Zealand to collaborate on advancing low-emissions solutions.

Even as the nation ramps up efforts to green its energy mix, it is still imperative to maintain a secure and reliable energy supply.

Collaborations with other like-minded countries will go a long way to advancing Singapore's energy transition.

Natural gas is a reliable source for power generation.

THE RELIABLE FUEL SOURCE

NATURAL gas — which powers 95 per cent of the nation's electricity needs — will continue to be the dominant fuel source in the near future. Being a reliable energy source and the cleanest fossil fuel, natural gas provides a balance between energy security and environmental sustainability.

Power generation companies continue to play an integral role as Singapore transits and scales up the switches to solar, regional power grids, and low-carbon alternatives. To stay ahead of the curve, power generation companies will need to pivot towards more energy efficient technologies to generate electricity.

In 2020, a total of $37 million was awarded by EMA to four power generation companies to enhance the energy efficiency of their operations and lower their carbon emissions. The supported projects, when implemented, are expected to reduce carbon emissions by over 48 kilo tonnes per annum, equivalent to taking about 14,700 cars off the roads annually.

One of the power generation companies awarded is Senoko Energy. Its Executive Vice President, Operations & Maintenance, Mr Tan Cheng Teck, said: "Senoko Energy recognises that the focus on sustainability will positively impact the environment and the world we live in. We have acted to drive energy efficiency, which is our ongoing endeavour and commitment. With EMA's support through the award of the Genco Energy Efficiency Grant Call, Senoko Energy upgraded our power generating units to advanced Combined Cycle Gas Turbines, which significantly increased energy efficiency and reduced some 15 kilo tonnes of carbon emissions per year."

Besides the power generation companies, decarbonising the energy sector requires effort and action from consumers as well.

One of the gas turbines which Senoko Energy has upgraded with new cooling technologies and advanced materials, such as thickened thermal barrier coating on the turbine blades.

Providing consumers with information on their electricity consumption will allow them to better manage their electricity usage.

DRIVING ENERGY EFFICIENCY

IN the next decade or so, Singapore's annual electricity demand is projected to grow — spurred by emerging growth sectors such as data centres, 5G networks, and digitalisation.

Supporting the four supply switches are efforts in promoting energy efficiency among consumers. Work started as early as 2013 when EMA, along with SP Group, trialled the use of smart meters at some 1,900 Punggol households as part of the Intelligent Energy System Pilot. Along with a portable in-home display unit, participating households were able to view their electricity consumption in real time and find smarter ways of using electricity.

With enhancements made along the way, all households in Singapore will soon have advanced electricity meters where electricity consumption can be monitored on the go via the SP Utilities mobile app. The mobile app also dispenses energy-saving tips and features to help households make informed decisions about their electricity usage.

And reducing Singapore's carbon footprint and building a greener future will require a whole-of-nation effort.

By 2024, all households in Singapore will be installed with advanced electricity meters to track their half-hourly electricity usage.

The Energy Story exhibition is a net-zero energy showcase at Science Centre Singapore, and seeks to raise awareness of clean energy and promote energy efficient practices among Singaporeans.

CO-CREATING SINGAPORE'S ENERGY STORY

IN 2021, the government launched the Singapore Green Plan 2030 — a whole-of-nation sustainable development agenda for Singapore to achieve its long-term net-zero emissions aspiration. One of its key pillars is the Energy Reset, reaffirming the importance of cleaner energy and energy efficiency across all sectors in meeting Singapore's climate goals.

This long-term endeavour calls for open-mindedness, keen foresight in planning, and resolute execution — all while balancing the energy trilemma. The idea is for Singapore to be a living ecosystem that is ready to adopt cutting-edge energy solutions when they become suitable for the nation's needs.

With hydrogen having the potential to diversify Singapore's fuel mix towards low-carbon sources, EMA partnered the National Climate Change Secretariat and the Singapore Economic Development Board to commission a study that looked into the possible pathways to import hydrogen as well as the potential of deploying it in sectors including the power sector. Multiple pilot projects in collaboration with the industry are also currently underway — from Singapore's first floating energy storage system in partnership with Keppel Offshore & Marine to developing Singapore's first series of service stations integrated with smart energy management solutions with Shell.

Advancing the same sustainability agenda is the launch of the net-zero Energy Story exhibition at Science Centre Singapore. Jointly presented by EMA, Science Centre Singapore, and SP Group, the 400-square metre exhibition raises awareness of the critical role that energy plays in fighting climate change and inspires all Singaporeans to play a part in building a sustainable future.

Efforts such as the exhibition, among many others, signal the desire by all stakeholders — from the public sector to industry players, research communities, and the community at large — to work collectively to shape the future of the energy sector.

The hope is that one day soon, Singapore's solutions, ideas, and collaborations will serve as an inspiration for the world — that even a country without natural resources can have a green energy future.

"I am confident that EMA is well placed to lead the energy sector towards a more sustainable future."

Mr Ngiam Shih Chun
Chief Executive, Energy Market Authority

IN THE WORDS OF…

THE Energy Market Authority (EMA) turns 20 this year. We started with around 180 employees in three divisions, tasked with the roles of overseeing the power system and driving greater competition in the energy market. Over the years, the EMA pioneers have successfully balanced the energy trilemma — ensuring a secure, reliable supply of energy that is competitively priced and sustainable.

We have constantly transformed the energy sector in response to challenges amid a rapidly changing landscape. We completed our switch from fuel oil to natural gas for power generation about eight years ago. To enhance our energy security and resilience, we built the liquefied natural gas terminal in 2013 to further diversify our natural gas sources. In 2019, we completed the full liberalisation of the electricity market. The Open Electricity Market has allowed households and small businesses to buy electricity from a retailer of their choice.

Today, we are tackling one of the gravest challenges facing mankind — climate change. Our power sector contributes nearly 40 per cent of Singapore's carbon emissions. Energy demand will grow with the rise of electrification and the growth of new sectors such as the digital economy. It is imperative for the energy sector to transform and set itself on the path to decarbonisation.

What will be instrumental in our energy transition are the four switches — natural gas, solar, regional power grids, and low-carbon alternatives. In particular, electricity imports will enable us to tap on the abundant renewable energies in the region. Besides helping Singapore to achieve our climate change commitments, electricity imports will also help develop the regional green economy.

Technological innovation will be a critical enabler in our endeavour. In addition to helping us green our energy supply, it can bring about smarter grids and advanced energy demand management systems. Our goal is to develop a more flexible energy system which better facilitates the integration of renewables, meets future growing demand, as well as improves energy and cost efficiencies.

We could not have achieved so much without the close collaboration of stakeholders across the entire energy value chain. Many of them are featured in this book – industry players, research community, unions, Institutes of Higher Learning and international counterparts. EMA will continue to work closely with our stakeholders to co-create Singapore's energy future.

The heroes of our sector transformation efforts are the past and present EMA officers, especially the 49 who have been with EMA from the very beginning. They have successfully planned and executed the major pivots over the last two decades, while keeping our energy supply secure and reliable.

With a strong team in place, I am confident that EMA is well placed to lead the energy sector towards a more sustainable future.

Mr Ngiam Shih Chun
Chief Executive, Energy Market Authority

Smart Energy, Sustainable Future

CELEBRATING THE ENERGY MARKET AUTHORITY'S PIONEERS - POWERING SINGAPORE FOR 20 YEARS AND BEYOND


Kang Cheng Guan


Yeo Lai Hin


Kng Meng Hwee


Ear Chow Foo


Amy Teo


Khalid Mohd Aleh


Adaham Abdullah

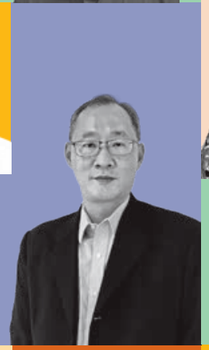

Chow Chin Choeng


Zuraidah Rohani


Mohd Adzlan Buang

CARING


Ho Chin Khong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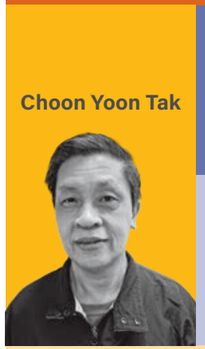
Lau Chee Keong


Lim Kea Chuan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Noraini Pani


Loh Mun Wah


Melvin Sng


Tan Yian Beng


Oh Chai Choo

TEAMWORK


Wong Siew Kwong


Chee Mei Ling


Gowri Kunasegaran


Soh Sai Bor


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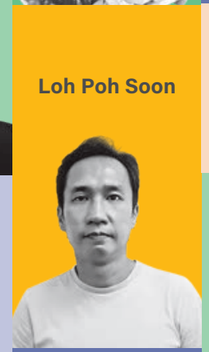
Mah Wai Khay


Lee Soon Yong


Muhammad Islahin Suriya


Soh Yap Choon


Lynn Wee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Popathi Uthirapadhi

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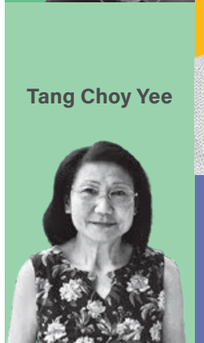
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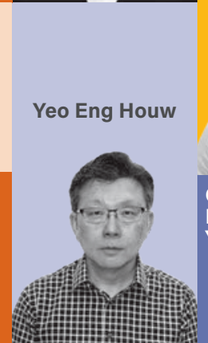
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Choy Weng Choong


Latha Ganesh

Lim Khoon Huat

Seah How Puey

Agnes Tan

Goh Kwang Yow

Salmiah Abdul Rahim

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SP Group Pages 32, 43, 89

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