Energy Market Authority
Our Clean Energy Future

Singapore's Energy Transition

TOH WEE KHIANG
DIRECTOR, HYDROGEN & SUSTAINABLE ENERGIES OFFICE

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Sharing by Mr Toh Wee Khiang
Director (Hydrogen & Sustainable Energies Office), Energy Market Authority

Singapore's climate ambitions

Climate change is an existential threat for all of us, especially for a small island state like Singapore.

We are taking a decisive move to achieve net-zero emissions.

2030

2030 Nationally Determined Contribution

Reduce emissions to around 60 $MtCO_2e$ in 2030 after peaking emissions earlier

2050

Long-Term Low-Emissions Development Strategy

Achieve net-zero emissions by 2050

With the **power sector** contributing to about 40% of Singapore's carbon emissions, the power sector will push ahead to provide **low-carbon electricity** to power our economy.

To enable decarbonisation efforts, decisive policies are in place to right-price carbon to shape business decisions and consumer behaviour.

Energy Trilemma

EMA balances trade-offs across the Energy Trilemma in our energy plans & policies.

- Even as we transition towards a low-carbon energy future, we need to manage competing demands of security and affordability.
- Singapore is a small city state with limited natural resources. Achieving sustainability while ensuring security and affordability is complex and challenging.

The energy transition will require **transformational changes** across the entire **energy value chain**, involving challenges and inevitable trade-offs.

SUPPLY

NATURAL GAS

Mainstay, continue to diversify our gas sources and improve efficiency of power generation

SOLAR

Maximise solar deployment and use ESS to manage solar intermittency

REGIONAL POWER GRIDS

Pursue electricity imports to access cleaner and cost-effective energy beyond Singapore's borders

LOW CARBON ALTERNATIVES

Pre-position Singapore for new low-carbon supply alternatives such as hydrogen, carbon capture, utilisation and storage, geothermal, and nuclear

GRID

SMART GRID

Create a multi-layered grid that leverages digital technologies to enhance grid planning and operations, and improve grid reliability.

DEMAND

DEMAND MANAGEMENT

Actively manage growth of energy demand and shape end-user consumption patterns.

2050 Net Zero Emissions

Natural Gas remains a mainstay to continue to diversify our gas sources and improve efficiency of power generation.

Singapore will need to depend on NG for the next few decades as it is a dependable, reliable fuel, even as we transition to cleaner sources.

EMA continues to work closely with the industry to:

- Improve efficiency of gas-fired generation plants
- Ensure security and reliability of gas supplies through long-term contracts and source diversification

The SLNG terminal can receive, store, and regasify LNG shipped in by tankers from all around the world.

In EMA, we work with industry to:

- Deploy best-in-class natural gas generation technology with the capability to run on other low-carbon alternative fuels (e.g. H2).
- Contract cost competitive, secure and reliable gas supplies.
- Deploy flexible LNG regasification solution (e.g. FSRU)
- Explore new power generation technologies that use natural gas and are carbon capture-ready

Maximise solar deployment as it remains Singapore's most viable renewable energy source.

By 2025

1.5 GWp of solar, which can power around 260,000 households

By 2030

At least **2 GWp of solar**, which can power around 350,000 households

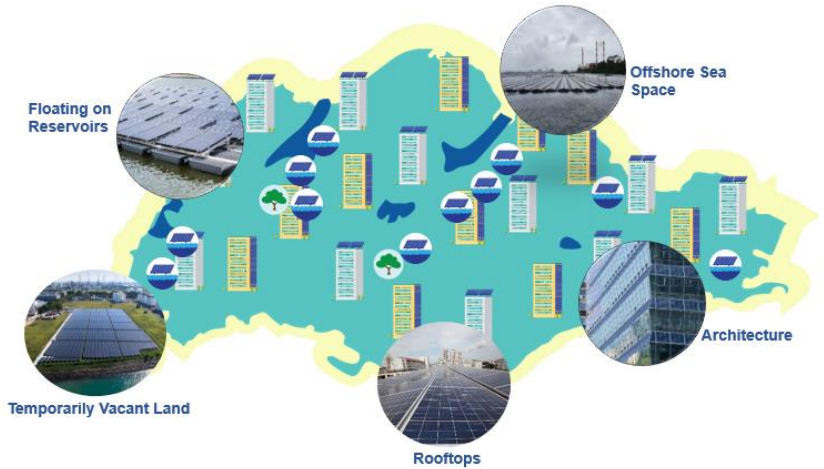
EMA has been working with agencies, research institutes, and industry on promising R&D projects to enable more solar deployment, such as high-efficiency solar technologies and innovative solar applications.

We also lead WOG efforts to deploy solar PV systems at public as well as private facilities, and address industry issues with existing rules and regulations.

Solar is Singapore's most promising renewable energy.

We are one of the most solar dense cities in the world and have creatively deployed solar in land-scarce Singapore. Today, 903 megawatt-peak^ (MWp) of solar has been installed and we are on track to meeting our 2025 target.

SERIS assessed that Singapore's technical potential of solar energy is ~8 GWp in 2050.



^ As of Q1 2023

Deploy Energy Storage Systems to support solar adoption and enhance grid resilience

Intermittency poses a key challenge of using solar energy – due to rain and cloud cover in our tropical climate. Harvesting solar energy is also limited to the daytime hours.

Energy Storage Systems (ESS) play an important role in overcoming this constraint:
- Maintain grid reliability by actively managing mismatches in electricity demand and supply; and
- Provide regulation services to address second-by-second fluctuations in our power grid.

EMA has partnered with the industry on various ESS deployments and R&D testbeds:
- Sembcorp – 285MWh ESS on Jurong Island (operational since Dec 2022)
- PSA Corporation – First ESS in Singapore to enable more energy efficient port operations
- Keppel Offshore & Marine (KOM) – First Floating & Stacked ESS on KOM's Floating Living Lab
- EDPR Sunseap/SP Group - First utility-scale ESS at a substation in Woodlands
- SP Group –Thermal ESS at George Street Substation

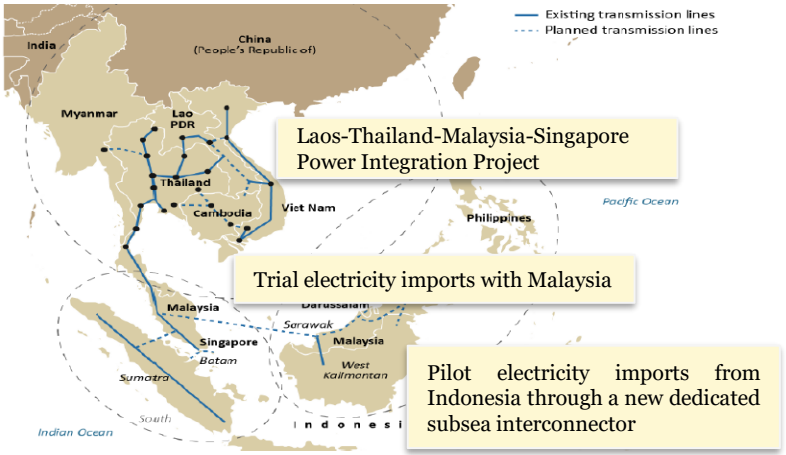
Sembcorp developed a 285MWh ESS, which has been operational since Dec 2022. It is the largest ESS deployment in Southeast Asia, and one of the fastest of its size to be deployed.

<u>Target:</u>
At least 200MWh of energy storage systems (ESS) beyond 2025:
The completion of the Sembcorp ESS marks the achievement of Singapore's 200 MWh energy storage target ahead of time.

Pursue adoption of electricity imports to access cleaner and cost-effective energy options beyond Singapore's borders.

Singapore is bringing in large-scale imports of **4 GW by 2035**, ~30% of Singapore's energy supply. In Mar and Sep this year respectively, EMA announced the granting of conditional approval to Keppel Energy for 1GW of electricity imports from Cambodia, and to five other projects to import a total of 2 GW of low carbon electricity from Indonesia.

To pave the way for these electricity imports, EMA has also been working with partners on small-scale import trials to gain insights on operationalizing the imports.



As Singapore scales up electricity imports, there are opportunities for companies to develop renewable sources in the region and work with regional partners to meet both overseas and local demand.

Significant infrastructure will also be needed in the form of new generation capacity, HVDC, cables

Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP) commenced flow in June 2022. This provides up to 100MW of hydropower.

The Singapore-Malaysia interconnector has provided mutual energy transfer between both countries. It has been recently upgraded to accommodate bidirectional electricity flows of around 1,000MW between Malaysia and Singapore.

Pre-position Singapore for new low-carbon supply alternatives for the power sector to undergo deep decarbonization (1/3).

As an alternative energy-disadvantaged country, we are investing early in low-carbon energy technologies so as to tap on them when they become commercially viable in the longer term.

Low- carbon hydrogen (H2)

Identified as a high potential decarbonisation pathway, it is a versatile energy carrier that can be used to store and transport energy for use in multiple end-use sectors. H2 could meet up to 50% of our projected electricity demand by 2050, after maximizing solar deployment and regional electricity imports.

Singapore's National Hydrogen Strategy was launched at SIEW 2022 which provides a roadmap for low carbon H2 adoption in Singapore.

- Experiment with the use of advanced hydrogen technologies at the cusp of commercial readiness through pathfinder projects
- Redouble efforts in R&D to unlock key technological bottlenecks
- Pursue international collaborations to enable low-carbon hydrogen supply chains
- Undertake long-term land and infrastructure planning
- Support workforce training and development of broader hydrogen economy

EMA and MPA jointly launched an **Expression of Interest (EOI)** for a small-scale commercial project to establish an end-to-end ammonia supply chain for power generation and marine bunkering

- Covering import, distribution, and use in power generation and marine bunkering
- EOI closed on 30 April 2023; Project targeted for commencement by ~2027/2028

This will allow us to better understand infrastructural/regulatory requirements & catalyse hydrogen supply chains and activities.

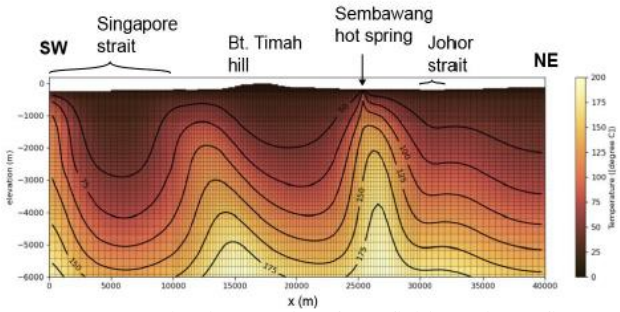
Pre-position Singapore for new low-carbon supply alternatives for the power sector to undergo deep decarbonization (2/3).

Geothermal

Singapore is sited within a region of high heat flow and there is a possibility of substantial heat at depths of 3-6km. However, conventional hydrothermal systems may not be suitable for Singapore due to the lack of quality resources (e.g. hot water and steam) at shallower depths. Nonetheless, recent developments in geothermal technology, such as enhanced or advanced geothermal systems (EGS/AGS), have opened up new possibilities for Singapore.

- As a first step, EMA is working closely with NTU to carry out exploratory studies to estimate the geothermal resource potential in northern and eastern Singapore. Promising results have come out from the Admiralty Lane borehole.
- EMA has also issued a Request for Proposal (RFP) in September this year for an island-wide non-invasive geophysical survey across Singapore to assess our deep geothermal resource potential at depths of up to 10km, for power generation purposes.

Ongoing efforts: Studies at northern and eastern SG



TOUGH2 simulates subsurface fluid & heat flow modelling (125°C at depth > 1.5km near Sembawang hot spring)

Pre-position Singapore for new low-carbon supply alternatives for the power sector to undergo deep decarbonization (3/3).

Other Decarbonization Pathways & R&D

As part of the **Low-Carbon Energy Research Funding Initiative** (LCER FI), we are also exploring other innovative H2 carriers, H2 production methods and **Carbon Capture Utilisation & Storage** (CCUS) technologies.

- **First tranche:** S$55mil was awarded to improve technoeconomic viability of low-carbon technologies. Projects funded include efficient catalyst and reactor system design for ammonia cracking, methane pyrolysis, hydrogenation of CO2 to useful fuels and innovative carbon capture technologies etc.

- **Second tranche:** S$129mil is set aside, which includes a **Directed H2 Program** to focus on translational H2 technologies that are aligned with our H2 strategy and an **Emerging technologies grant call** focusing on lower TRL technologies that could potentially help SG decarbonize.

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Create an **intelligent, flexible and multi-layered grid** that leverages on digital technologies to enhance grid planning and operations, and improve grid resilience and reliability.

EMA is supporting the development of solutions to manage our transition to our future grid:

Development of the **first Digital Twin** for the Singapore power grid in collaboration with SP Group and S&TPPO, which comprises a network and asset twin. It is a virtual representation of the physical power grid assets and 22kV distribution network which allows planners/operators to perform data analysis, modelling, simulation and machine learning to improve grid planning and decision making.

Deployment of innovative digital grid solutions through **partnerships with industry stakeholders.** For instance, EMA is working with PSA to develop a Smart Grid Management System to monitor and optimise energy consumption in PSA port. This enables real-time energy management to reduce overall energy costs and carbon footprint. Insights from this project may also validate the possibility for commercial and industrial users to adopt energy storage systems to perform demand management on-site and provide commercial ancillary services to support power systems.

Actively manage growth of energy demand and shape end user consumption patterns.

Besides transforming our energy supply, optimising energy demand is also key in decarbonising the power sector. Besides, energy conservation needs to be a way of life to reduce carbon emissions.

Work with key sectors to **manage the growth of electricity demand** in Singapore

Continue building on **energy efficiency** and **energy conservation** efforts.

Develop the **flexibility of demand** to optimise supply and grid capacities.

Enhance the market design to provide price signals and incentivise behaviour change among end users

EMA is undertaking a two-year **Demand Response/Interruptible Load sandbox** to help companies and industries optimise their energy demand and provide services back to the grid.

Navigating through the Energy Transition:

- Singapore has taken a decisive move to achieve net-zero emissions and the power sector has to decarbonise to support this ambition.
- Even as we transition towards a low-carbon energy future, we need to manage the competing demands of security and affordability to support Singapore's continued economic growth.
- The transition towards a net zero power sector requires transformational changes across the energy value chain with industry partnerships remaining as a key supporting pillar.

Thank you