



# Key Lessons from Singapore Power Market Liberalization

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# The Singapore Electricity Sector Reform – a decade long process

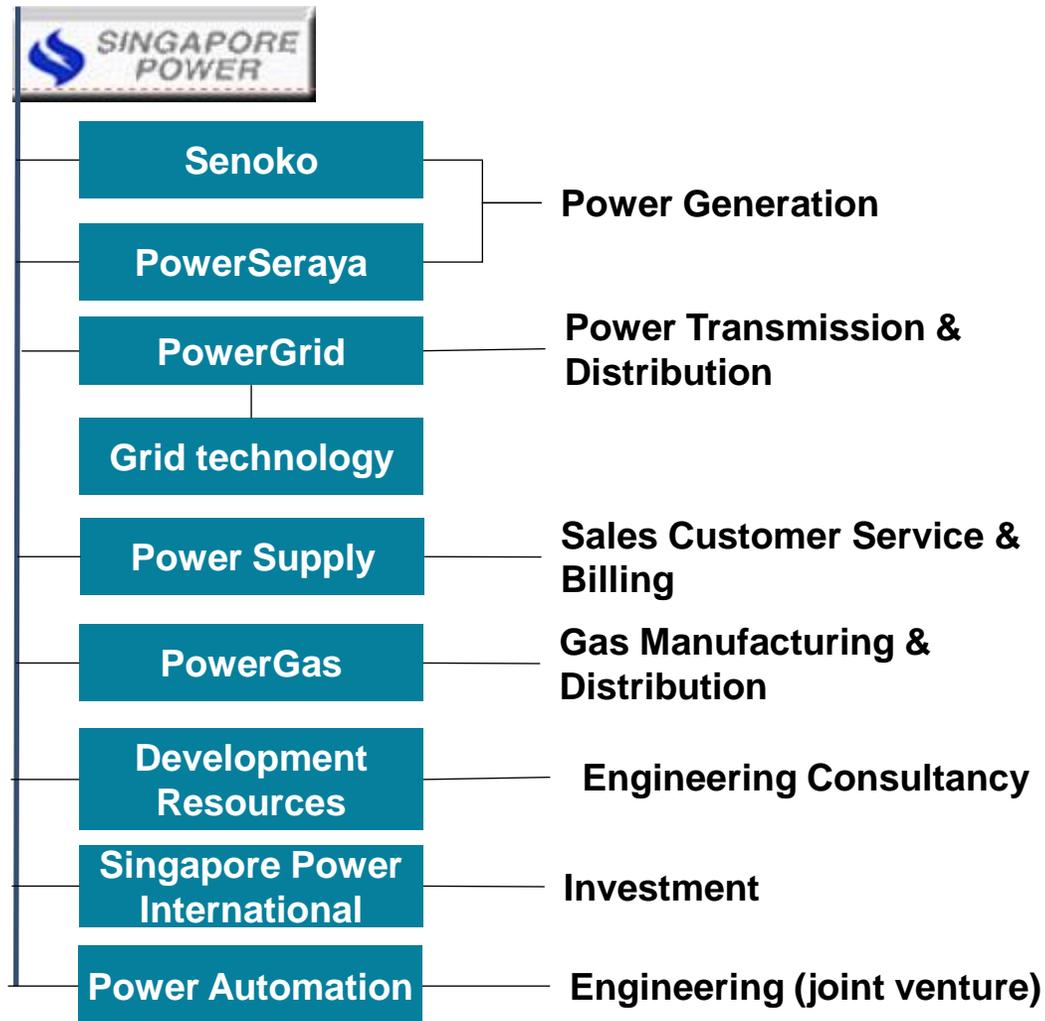
## Milestones of the Electricity Reform Process in Singapore

1995	←	<b>Mar 1995, Tuas Power was incorporated to own generation capacity under construction (directly owned by Temasek Holdings, a government investment fund)</b> <b>Oct 1995, the government separated the electricity and gas units out of the Public Utility Board (PUB) and incorporated under Singapore Power Group (100% owned by Temasek Holdings)</b>
1998	←	<b>Apr 1998, Day-ahead wholesale electricity pool with capacity payment commenced</b>
1999	←	<b>Sep 1999, Government reviewed electricity industry due to failure of Tuas privatisation</b>
2000	←	<b>Mar 2000, Government decided to further deregulate the electricity market</b>
2001	←	<b>Apr 2001, Energy Market Authority (EMA) formed</b> <b>Jun 2001, Energy Market Company (EMC) formed</b>
2003	←	<b>1 Jan 2003, New energy-only wholesale competitive electricity market, National Electricity Market of Singapore (NEMS), commenced operation</b>
2004	←	<b>Jan 2004, Vesting Contract was introduced</b>
2008	←	<b>Tuas, PowerSeraya and Senoko were sold by Temasek Holdings to foreign investors</b>
2019	←	<b>EMA is doing a study to introduce a forward capacity market to address long-term resource adequacy issue</b>

- Market reform is a decade-long process, and its design has to evolve over time.
- Value capture for privatization of government-owned generation assets can be more effective after building up track-record and confidence in the deregulated market framework
- Effective regulatory oversight from the government still plays important role in the market.

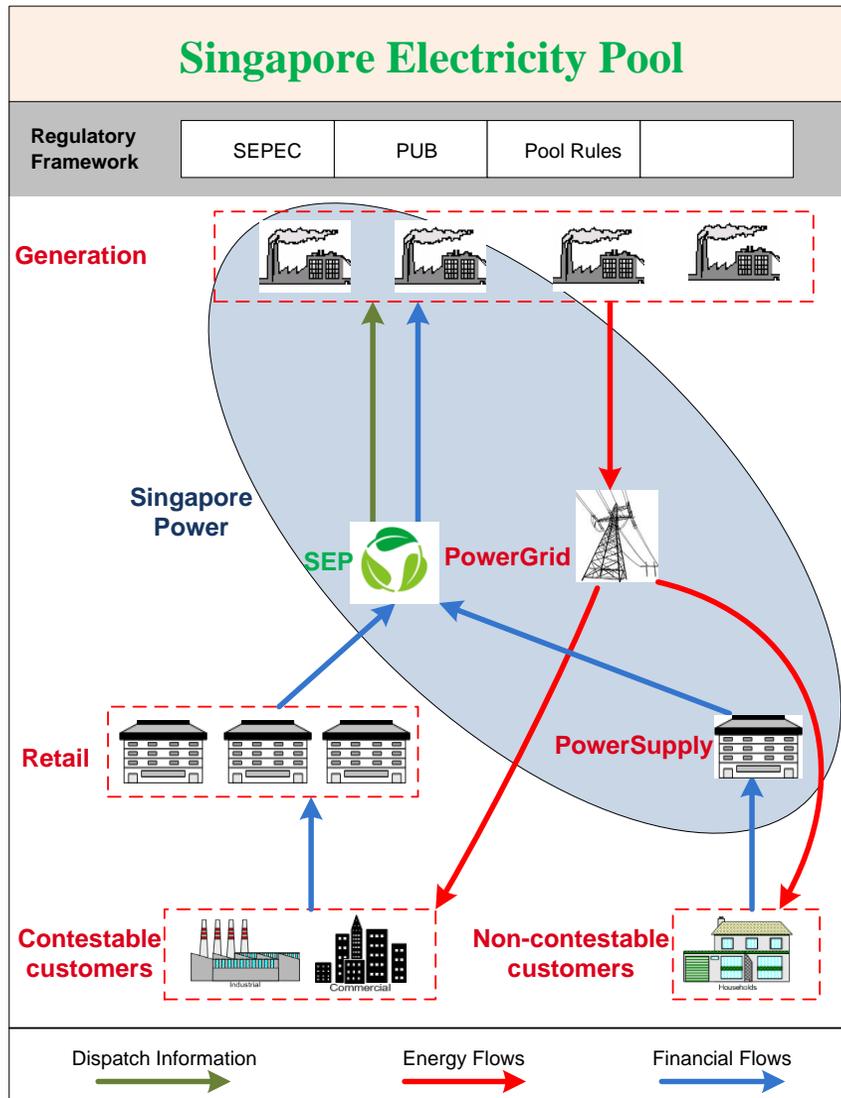
# 1995: Incorporated the electricity and gas functions in PUB to form Singapore Power

## Structure of Singapore Power in 1995



- In Mar 1995, the government set up Tuas Power to own generation capacity that was under construction/plan.
- In Oct 1995, the Singapore Government corporatised the electricity and gas functions in the Public Utility Board (PUB) by establishing a holding company, Singapore Power Limited
  - Created separate subsidiaries for generation, transmission & distribution, and supply
  - The PUB was reconstituted to take on the new role of regulating the electricity and gas sector.
  - This is a necessary intermediate step for the subsequent market reform and then asset privatization
    - Allow for an evaluation of the effects of competition on prices, asset values and security of supply
    - Allow time to prepare the sector for the move to competition
    - Implement the appropriate measures to protect value, resolve contractual issues and address security of supply prior to the sale process and the introduction of full competition.

# 1998: Singapore Electricity Pool was established



- Singapore Electricity Pool (SEP) was formed and commenced operation on 1 April 1998
- The Pool operated as a wholesale electricity market to facilitate the trading of electricity between generators (i.e. Tuas\*, and Singapore Power subsidiaries Senoko and PowerSeraya, as well as SembCorp which was constructing co-gens) and the retailer (i.e. Singapore Power subsidiary, PowerSupply)
  - Generation companies in Singapore Power competed for the dispatch of electricity. They submit supply curves each day for delivering electricity next day.
  - The retail company (i.e. PowerSupply) submit a bid (i.e. totally inelastic “demand curves”) for the aggregate electric energy they agree to take the next day.
- Singapore Power subsidiary, PowerGrid, took on the role of the Pool Administrator. It operated the power system and administered the settlement system.
- It was a simple day-ahead market where generators offered price and capacity for 48 trading periods per day
- The SEP effectively acted a single buyer using an internal pool mechanism.

Note: \*Singapore government specifically created Tuas Power to own new capacity under construction in 1995, and the new capacity was commissioned in 1999 and it helped to enhance competition.

# Even though the first round of reform arguably had shortcomings, it still provided valuable lessons and a good starting point for further reform

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- **Regulatory and commercial unbundling** by separate the power and gas business from PUB to form Singapore Power.
- **Functional unbundling** by forming different subsidiaries under Singapore Power and creating Tuas Power to own power projects under construction/plan.
- Valuable lessons were learned from the Singapore Electricity Pool
  - Shift from a single individual that manually determined the generation dispatch to a more structured process – new process documented, and the dispatch outcomes could be mathematically validated
  - New knowledge learned by the industry stakeholders, in particular, the pool administrator about market bidding, market modelling and optimization, price discovery methodologies and market settlements. The industry players and system operator progressively became conversant in market design lingo and jargons
  - New systems, technologies, tools and operational processes were developed to facilitate better communication and reporting of generation schedules
  - Identified modelling improvements for the power system requirements and constraints and putting in model refinement plans to achieve better generation dispatch feasibility outcomes
  - Established a means for measuring the total generation cost and **created a focus for further improvement on this objective.**

# Early 1999: Government decided to do further reform after the failure to privatize Tuas

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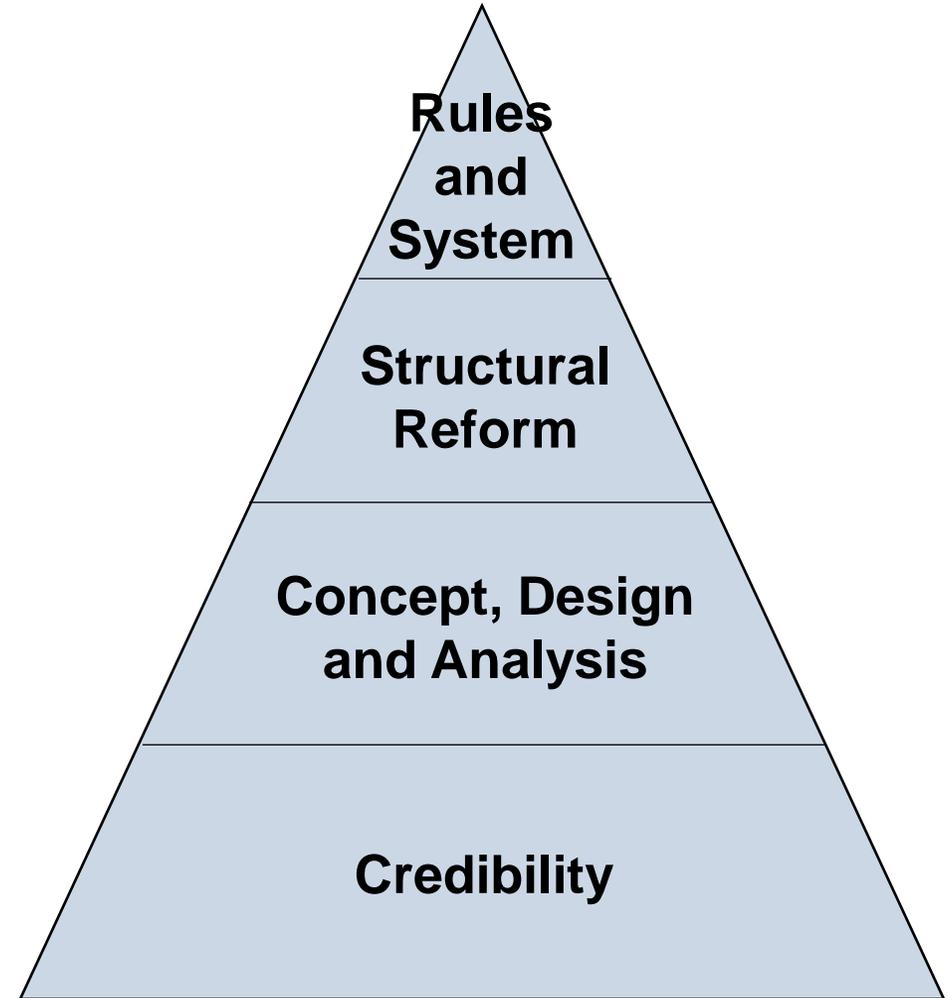
- In early 1999, during the process by which Tuas was to be privatised, potential investors indicated that the market design, structure and rules/governance framework did not provide sufficient certainty for a satisfactory valuation for Tuas. It is believed that the market structure does not provide a level playing field for private investors. The sales process for Tuas was subsequently stopped.
- The Government wants to take the next most important step towards competition - to separate transmission and generation.
- This leads naturally to:
  - privatization of existing generation assets [Temasek would like to maximize financial return from privatization]
  - addressing market power
  - ensuring an open-access regime, and
  - establishing competitive parity.
- Three phases for the market reform were envisioned with privatization representing the cornerstone component of the market reform process.



# Industry Review: Hierarchical approach – robust structural reform can reduce the scope and need for further reform.

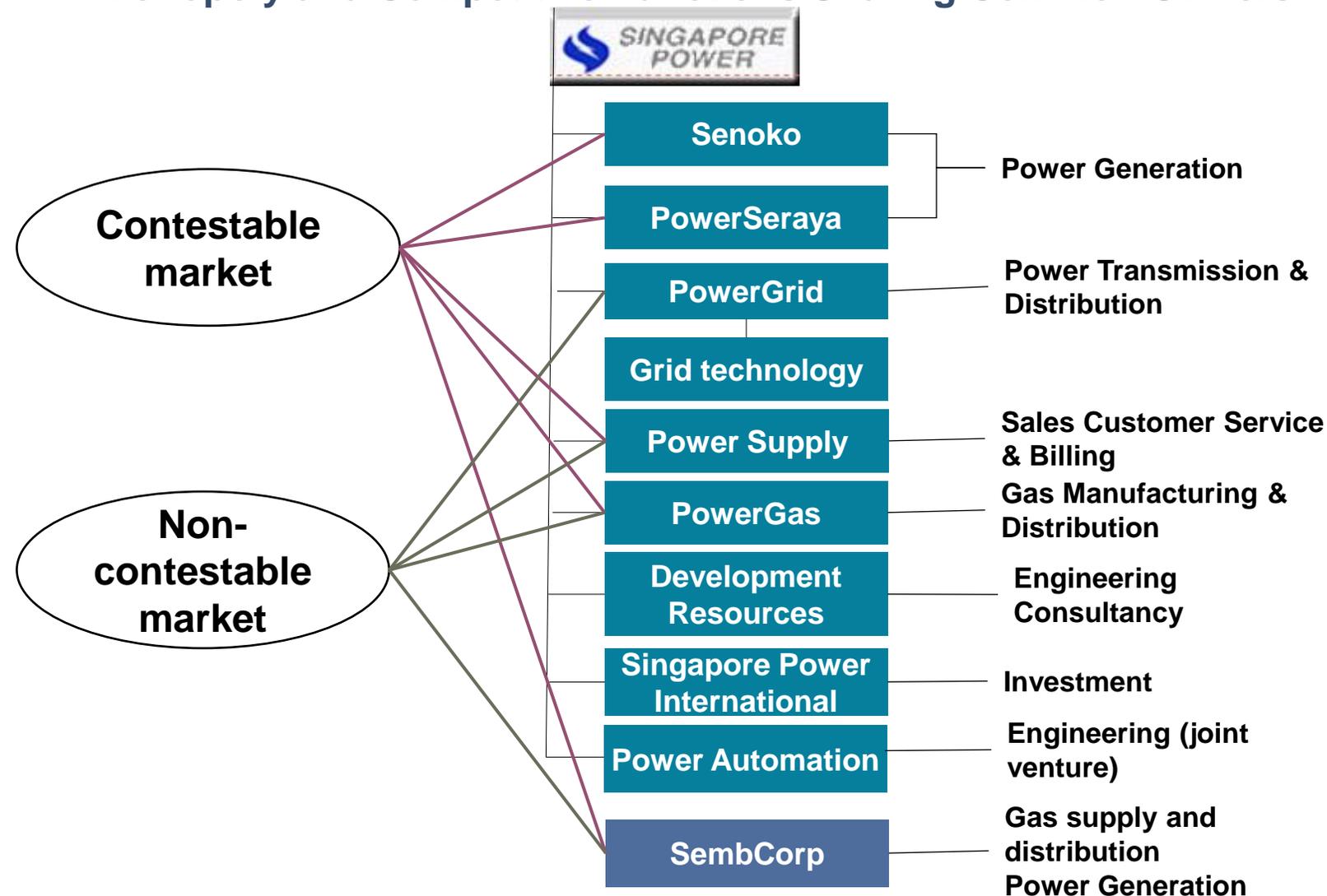
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- Credibility is the Foundation upon which reform is based.
- Economic reform in electricity and gas can best be achieved through **structural market reform** approaches
  - Structural market reform can reduce the scope and need for further reform.
- Transitional issues, including financial viability and residual market power remaining after structural reform, are best managed through appropriate commercial arrangements.
- The need for conduct regulation can, and should, be greatly reduced through appropriate use of structural reform and commercial arrangements thus enabling an increase in overall efficiency and transparency of the industry and a reduction in the overall regulatory burden.



# 1999: Electricity Industry Review by the government recommended that more structural reform is required to create an efficient competitive electricity market

## Monopoly and Competitive Functions Sharing Common Ownership



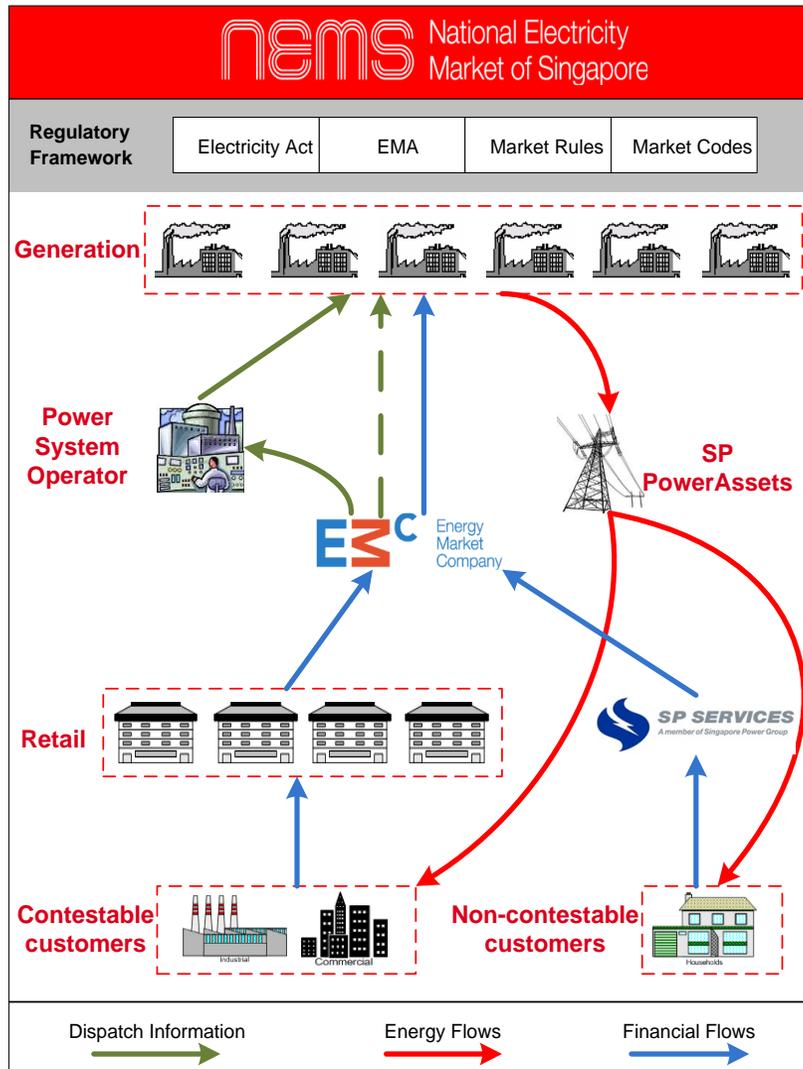
- Even though the electricity operations of the PUB were transformed into Singapore Power (SP), it has not gone far enough
- Monopoly and competitive activities are generally controlled by the same entity, SP, creating a number of inherent longer-term risks for future investors: (1) Cross-subsidization; (2) Self-dealing and (3) Unlevel playing field
- Management and oversight of the pool are not independent of market participants
- For power dispatch, it is recommended that: (1) Nodal pricing is used to reflect transmission constraint; (2) Real-time offer/bid should be used; and (3) Co-optimization of energy and spinning reserves can promote economic efficiency.

# 2000-2001: Decisions were made on further reform to implement most recommendations in the Industry Review and legalize the process

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- On 11 Mar 2000, Government announced for further de-regulation.
- As part of the separation of the ownership of the contestable and non-contestable parts of the industry, Singapore Power divested its two generation companies, PowerSenoko and PowerSeraya, to Temasek Holdings. SP Services also became a Market Support Services Licensee (MSSL)
- A new act, the ***Energy Market Authority of Singapore Act***, created the Energy Market Authority (EMA) on 1 April 2001 to regulate the electricity and gas industries. Within the EMA, a division called the Power System Operator (PSO) undertakes the system operator function
- Another act, ***The Electricity Act***, provided the legal basis for creating the National Electricity Market of Singapore (NEMS). The NEMS, which commenced on 1 January 2003, is designed to
  - promote the efficient supply of competitively priced electricity
  - open up the retail market, eventually to full competition
  - allow certain government owned assets to be privatised
  - encourage private investment in Singapore's power system infrastructure
- A new entity, the Energy Market Company Pte Ltd (EMC), was established as the market operator to implement and then operate and administer the wholesale electricity market

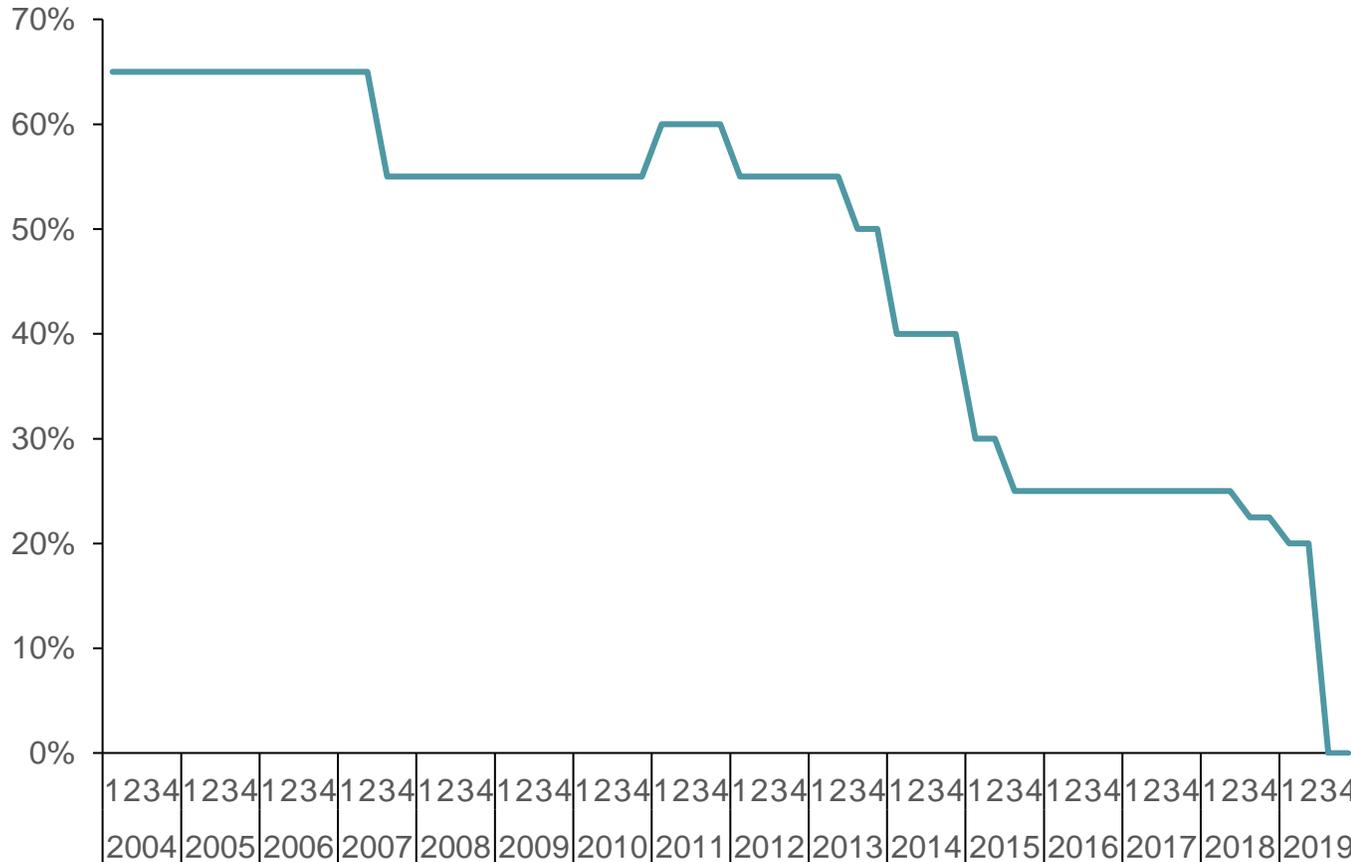
# 2003: The competitive electricity market (NEMS) is created for retail-time trading and co-optimization of energy and ancillary services



- On 1 January 2003, the National Electricity Market of Singapore (NEMS) commenced operations.
- It is a real-time electricity spot market, trading energy, three classes of reserves and regulation at each half hourly interval.
- The Market Rules describe how the electricity wholesale market functions covering areas of market registration, market rule change, market disputes, market surveillance and compliance, power system operator obligations, ancillary services contracting, market bid and offer submission, market price discovery and publications, settlements and market payments/charges.
- Key features of NEMS include
  - Real time security constrained dispatch
  - Self-commitment
  - Nodal pricing
  - Co-optimization of energy, reserves and regulation.
- Real-time market - prices determined by the market reflect the fundamental of demand and supply taking into consideration of the power system and market constraints. Prices send signals to the investors for generation planting and also influence consumers' consumption patterns.

# 2004: Vesting contracts were introduced to address the potential market power concerns in the energy-only market

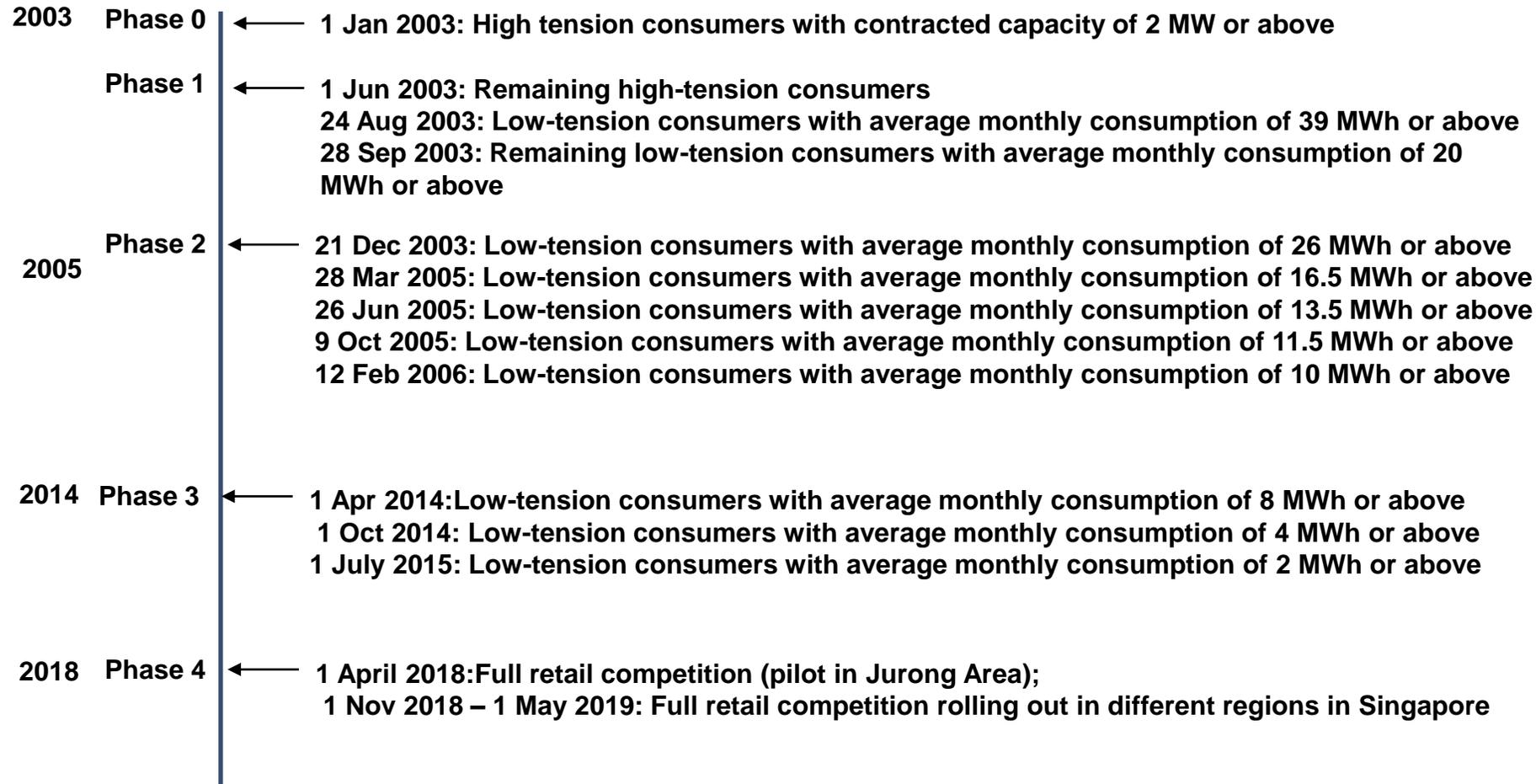
## Vesting Contract Level



- When NEMS was created, there were only four generators (Senoko, PowerSeraya, Tuas and SembCorp Co-gen) and it was believed that this could lead to undue exercise of market power.
- Since 1 Jan 2004, vesting contract (i.e. long-run marginal cost) has been used as a transition mechanism to curb the undue exercise of market power of the Gencos.
- The vesting contract level stays relatively high until 2013 as the market remains concentrated with only a few players in the first ten years.
- Its level has been reduced quickly in 2013-2015, as the market becomes more competitive with the entry of new players and expansion of capacity by small players.

# 2003 – 2018: Rolling out of retail competition is in phases and full retail competition is achieved in 2019

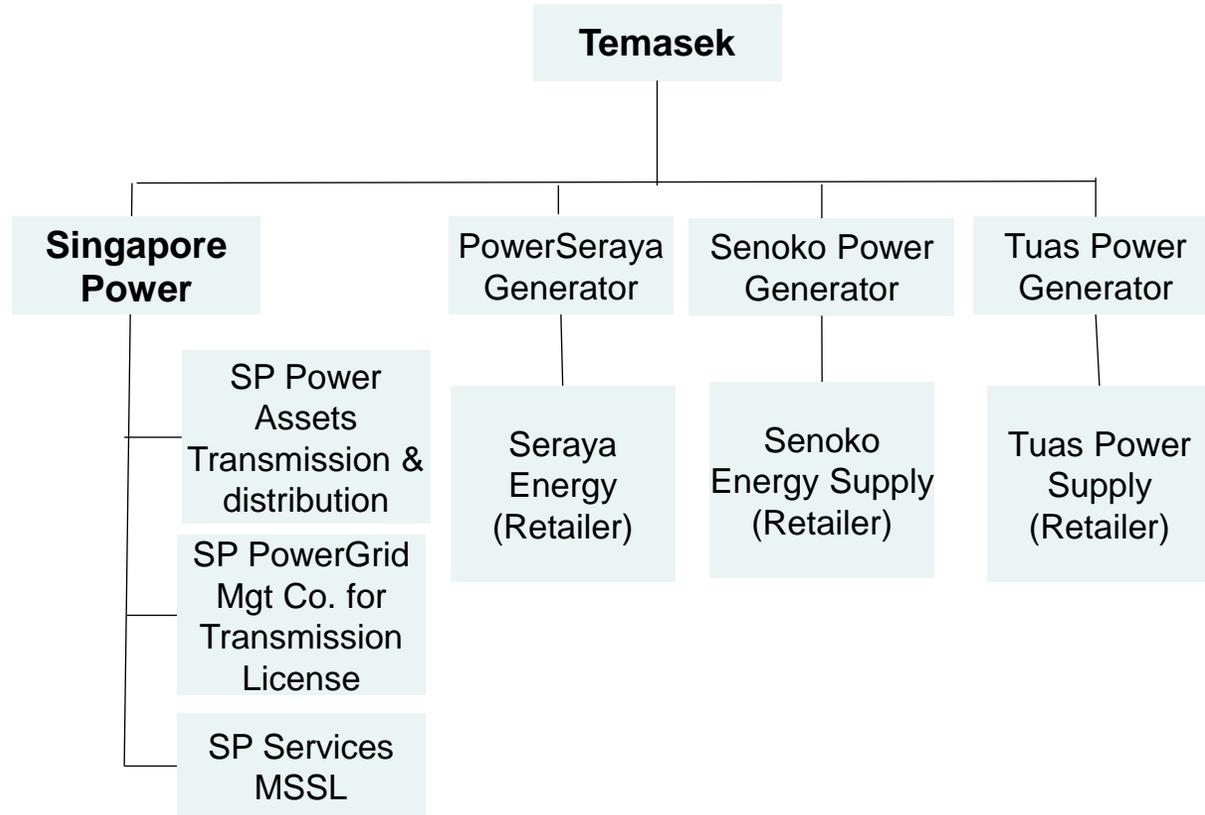
## Milestones of the Retail Competition in Singapore



- Retail competition is rolled out in phases
- It took a long time for SG government to decide to roll out retail competition for medium and small electricity consumers, probably because it prefers to wait until market structure is sufficiently competitive.

# 2008 Privatization: Temasek successfully sold the three dominant Gencos to foreign investors at high prices in 2008

Ownership Structure in Singapore in 2000- 2008



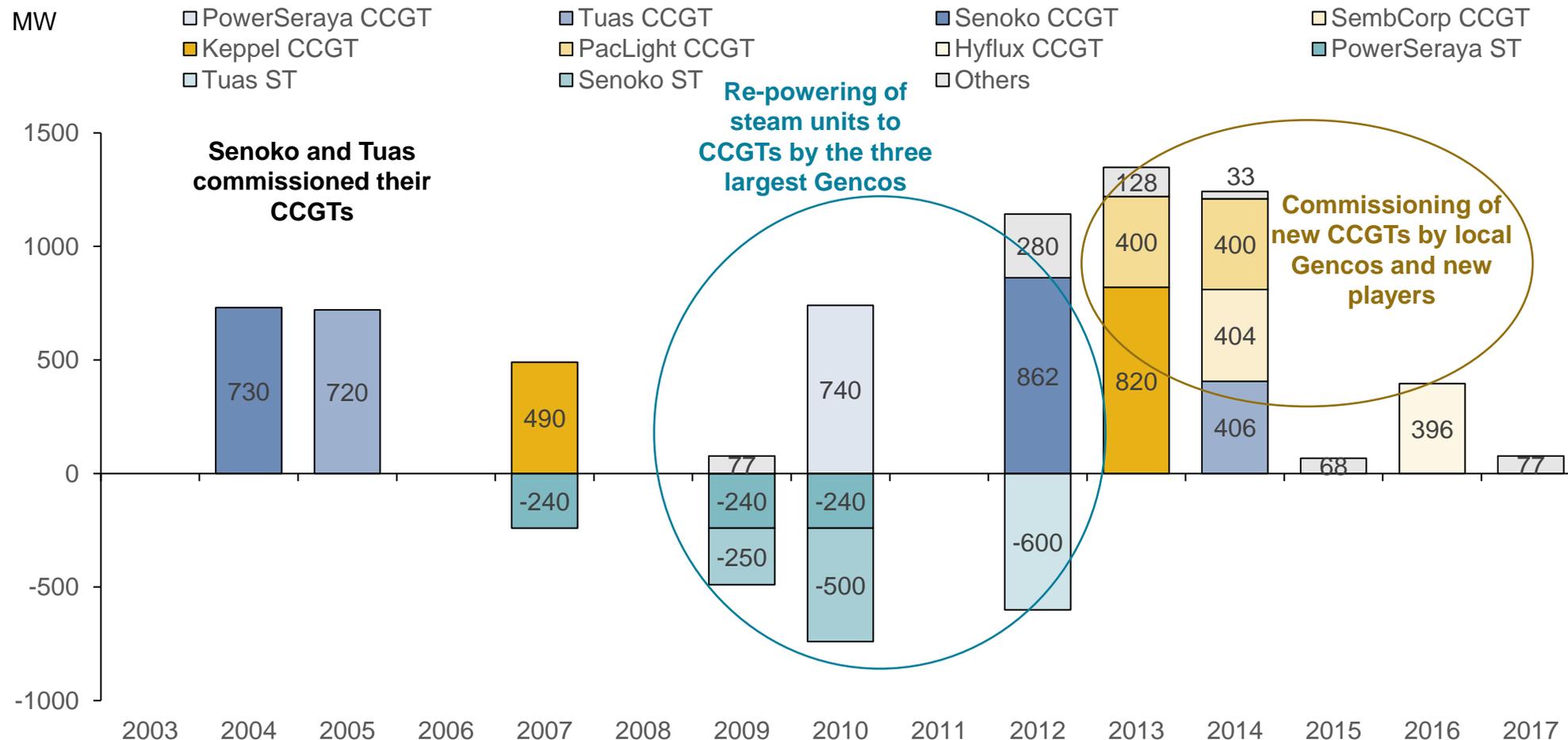
Privatisation of Temasek’s Power Assets in 2008

Date	Company	Buyer	Installed Capacity in 2008			Price (billion SGD)	Unit acquisition price (\$/kW)
			CCGT	Steam units	OCGT		
March 2008	Tuas	Huaneng International	1,470	1,200	0	4.235	1,586
Sep 2008	Senoko	GDF Suez (now Engie) and Japanese consortium Lion Power	1,945	1,250	105	3.973	1,204
Dec 2008	PowerSeraya)	YTL	728	1,970	210	3.801	1,307

- After 5 full years of operation of the wholesale electricity market NEMS, the Singapore government restarted the privatization process in 2008 and successfully sold all three of the generation companies to international players at high prices.
- After the privatization, Singapore has highest share of foreign investment in the power sector globally.

# After the creation of NEMS in 2003, massive investment is made in two waves – one is for re-powering of steam units to CCGTs and the other is the entry of new CCGTs incentivised by policies to make the LNG terminal bankable

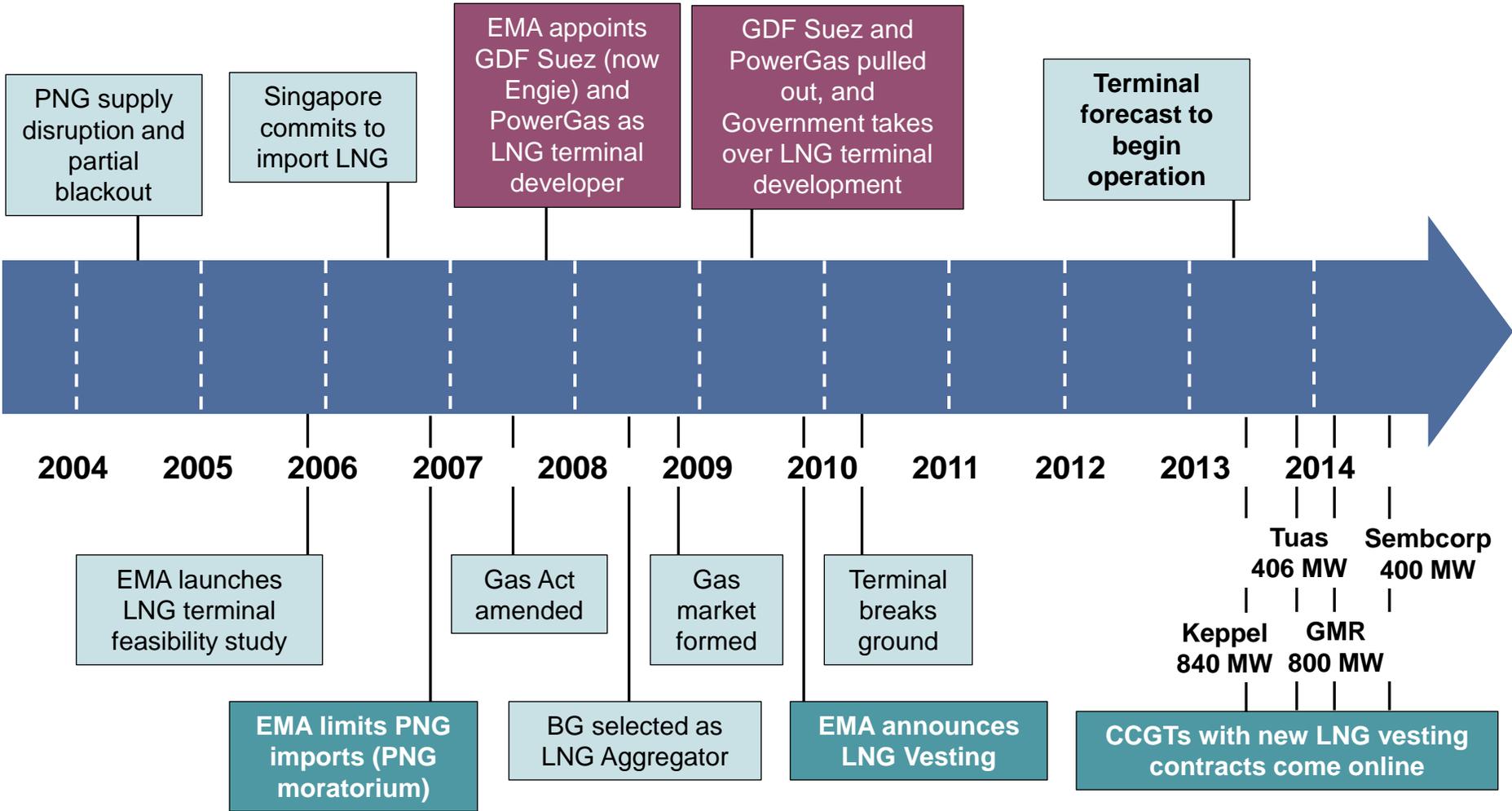
## Capacity Addition and Retirement since 2003



Source: Company websites, news clips and WaterRock Energy Research and Analysis

# 2013: The supportive policies were implemented to increase bankability of the LNG terminal, which then have dramatic impact on the market outcome

## Singapore LNG Terminal Development History



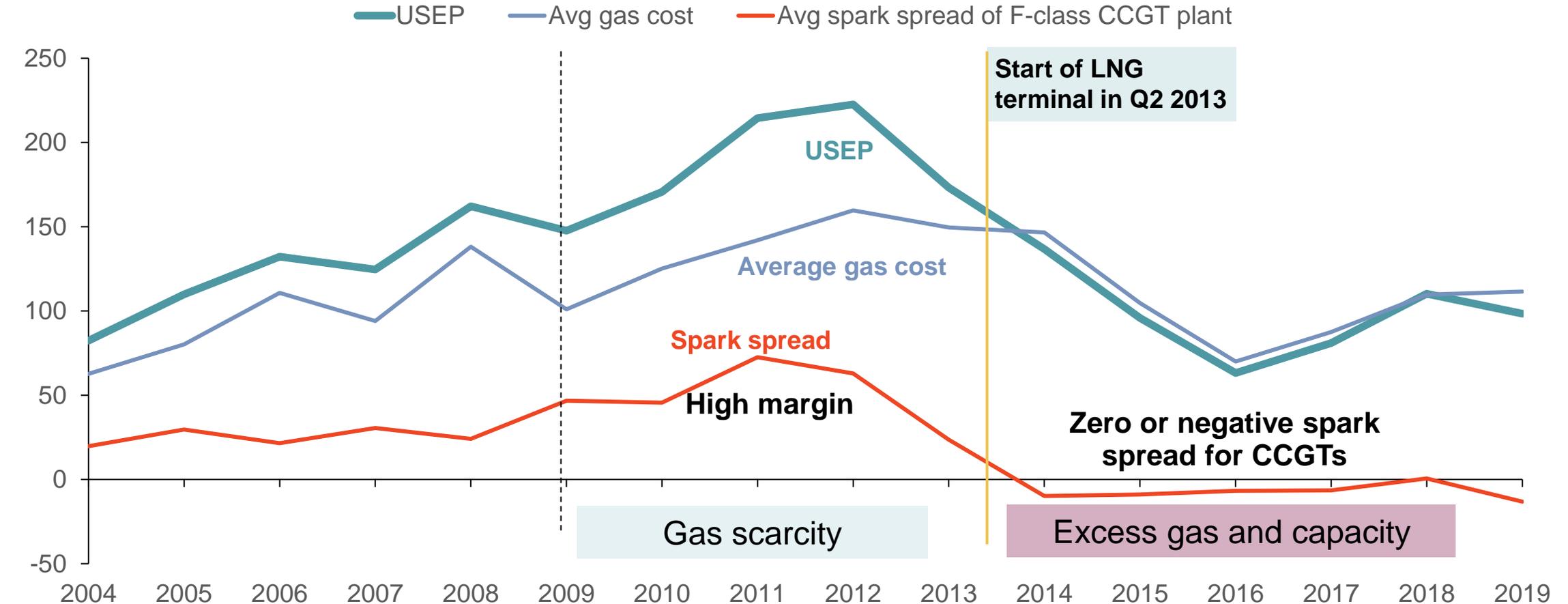
- The LNG terminal is built that increases energy security, but the supportive policies have indirectly lead to other issues.
  - The most important one is that the over-supplied in capacity and take-or-pay gas leads to the difficult financial situation for the power generators in the past 6 years.

\*Note: one unit, Tuaspring CCGT owned by Hyflux, also came online in 2016, without any LNG vesting contracts

# Spark spread has swung from high margin from 2009-2012 to very low/negative margin since 2013

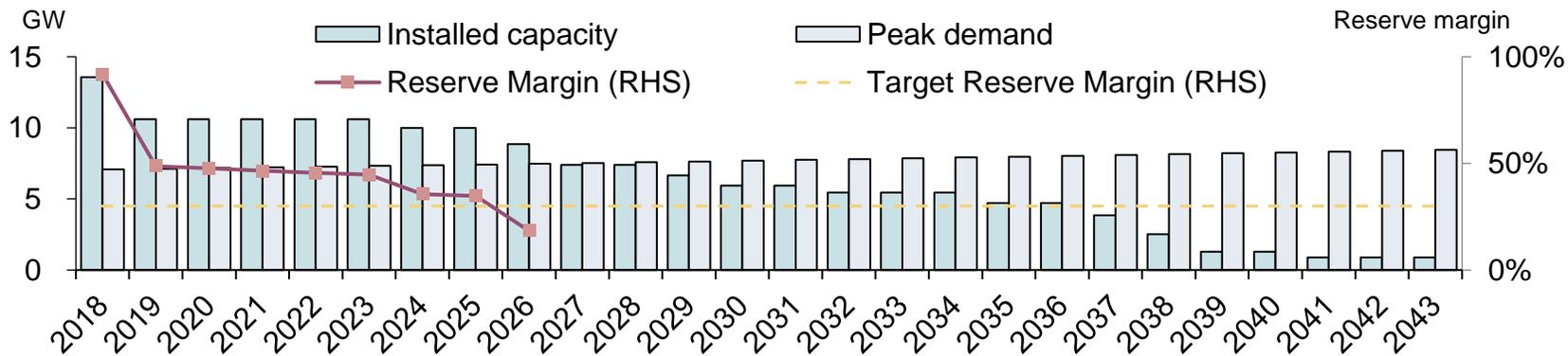
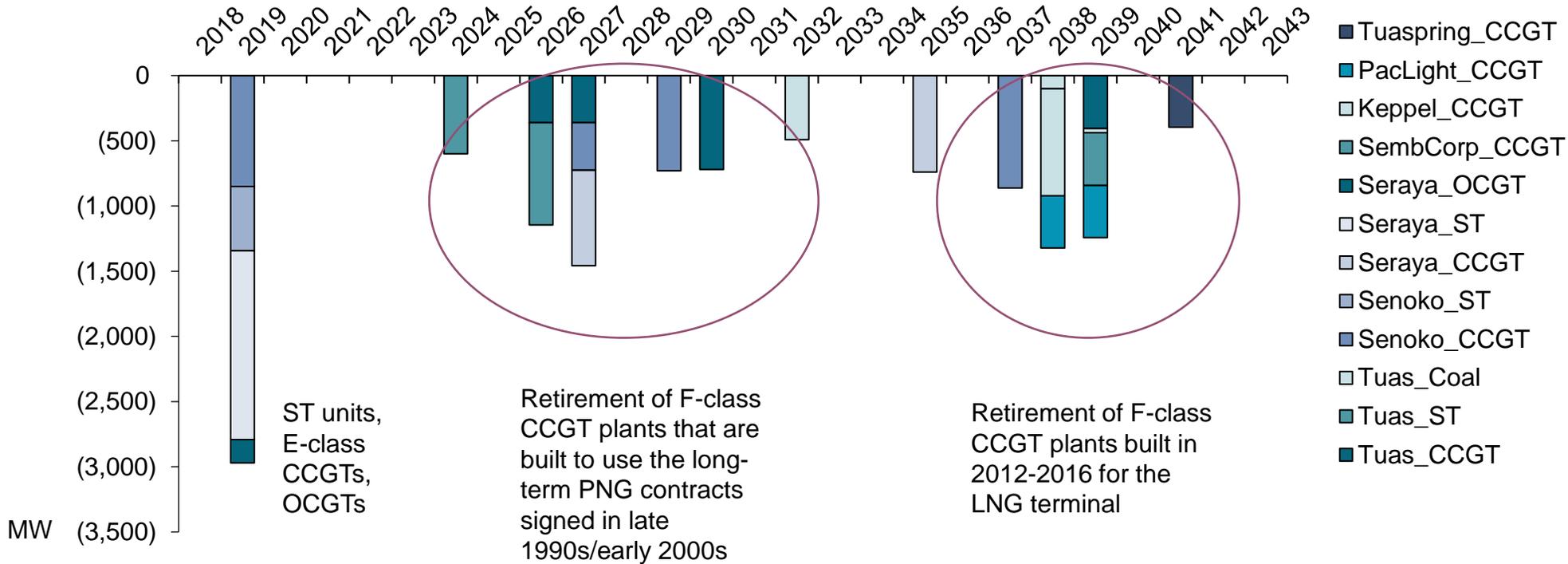
## Market Prices and Spark Spread

SGD/MWh



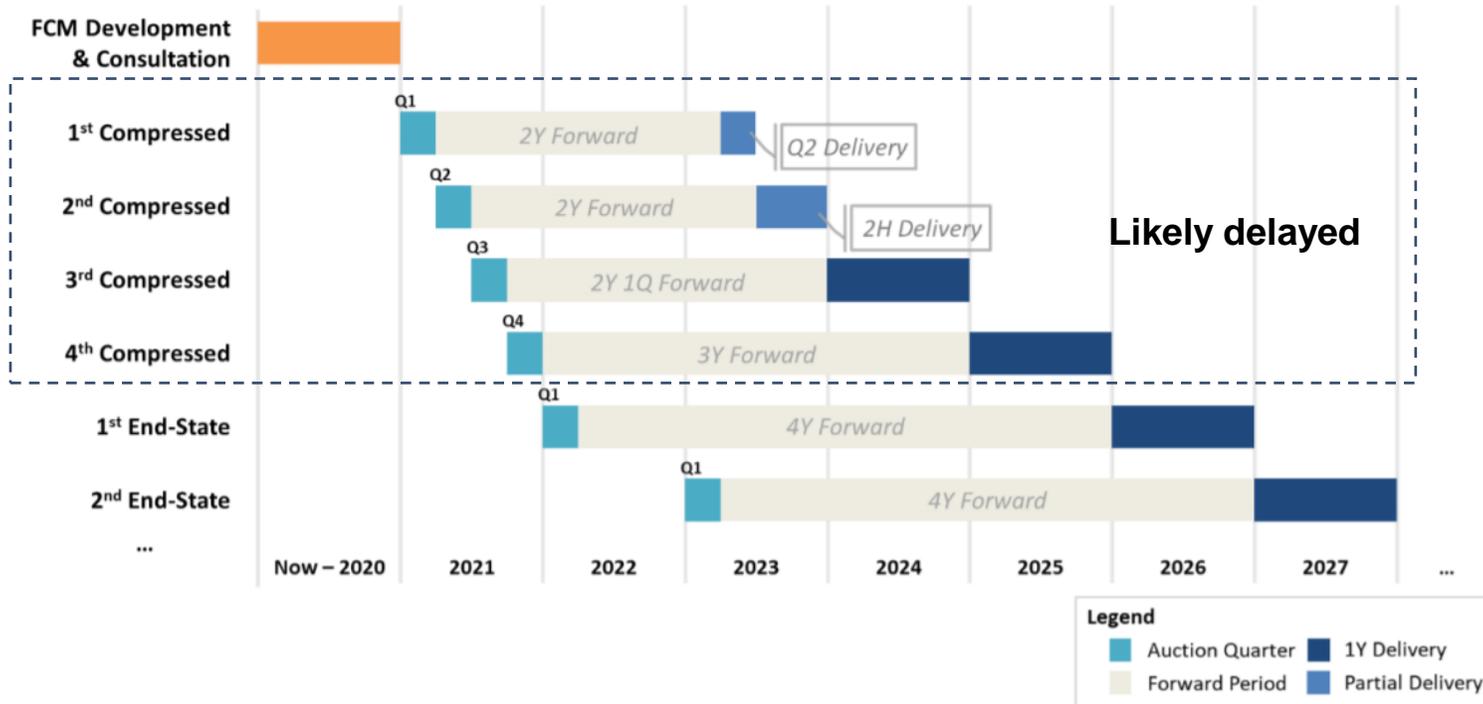
Note: Spark spread is based on the difference between USEP and average fuel cost of a F-class CCGT plant  
Source: EMC, WaterRock Energy Analysis

# The market may have reliability or long-term resource adequacy issue without any actions



# Singapore government has been doing a study to introduce a Forward Capacity Market since early 2019

## Indicative Timeline for Compressed and End-State FCM Auctions



### Key objective of introducing the Forward Capacity Market (FCM)

- Maintain resource adequacy to meet an expected LOLH (Loss of Load Hours) of 3 hours by providing adequate incentives to existing and new resources
- Use a market process to maximize economic efficiency and minimize long-run costs to consumers.

Source: EMA website, The Brattle Group, Second Consultation Paper – Developing a FCM to enhance the SWEM, <https://www.ema.gov.sg/cmsmedia/Second%20Consultation%20Paper%20-%20Developing%20a%20FCM%20to%20Enhance%20the%20SWEM.pdf>

# Summary: Lessons from the Singapore Market Reform Process for other markets

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- Market reform can take a long time to reach the end-state desirable design and a phase-wise approach (like Singapore) has many benefits.
- Even though the first round of reform in Singapore is imperfect, it still provides useful and necessary learning lessons for the market stakeholders and the government.
- Robust reform on the market structure is critical to create an efficient and effective competitive electricity market that provide confidence to the investors that a level-playing field is created for everyone. It can also reduce the scope and need for conduct regulation.
  - Structural unbundling of monopolistic segment (like T&D) and competitive segment (like generation and retail).
- Commercial arrangement, such as vesting contracts, can be created to successfully mitigate the potential undue exercise of market power of some of the Gencos in Singapore.
- Retail competition can be rolled out in phases.
- Flexibility has material values in a small market like Singapore.

# Thanks and Contact

## WaterRock Energy Economics

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# Who is WaterRock Energy Economics

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## Background:

- A boutique market and economic consulting firm for provision of advisory services related to the power and gas markets in ASEAN and East Asia regions
- Small, nimble and client-focused.
- Focus on the power and gas sector in the Philippines, Singapore, Taiwan, Hong Kong and mainland China
- Very analytical team
- Deep local knowledge and connection with local companies
- Flexibility to partner with other consulting firms for projects.

## Services:

- **Transaction Support:** Offer due diligence studies on power and gas assets in ASEAN and greater China region. To date, the team have supported the successful completion of >20 GW of renewable and thermal capacity with a transaction value of more than US\$30 billion
- **Market Analysis:** Provide independent and detailed fundamental market analysis on the power, gas and oil sector since 1990s. Key focused topics are opportunities and risks of investing in RE sector, economics of power plants and gas infrastructure projects (like LNG terminals) etc
- **Regulatory Support:** Provide analysis and support on regulatory issues related to fuel mix, market design, market power mitigation and long-term resource adequacy in competitive electricity markets such as Singapore and the Philippines
- **Modelling Support:** Create and provide power dispatch and optimization modelling support for power companies and consultancies.

**We focus on the power and gas sector in ASEAN and Greater China Region**