Implications of enhanced competition in electricity generation in selected places

RT01/2024
15 January 2024

1. Introduction

1.1 In Hong Kong, the two power companies have persistently maintained an ultra-high supply reliability ratio of 99.99% for decades, but the public perception of this remarkable record was tainted by three disruption incidents in recent years.[1] Meanwhile, the average net tariffs have escalated by a total of 46%-47% from 2013 to 2023, outpacing the overall consumer inflation rate of 25%, partly due to the cost associated with adopting a cleaner fuel mix. To enhance competition, there are suggestions to admit new power generating companies ("gencos"), either locally or from the Mainland.[2] In preparation for enhanced competition in the longer term, the Government has (a) approved a plan of CLP Power Hong Kong Limited ("CLP") to enhance power transmission system with the Mainland so that the share of import in the overall mix of electricity supply can be lifted from 27% to 35% in 2025; (b) earmarked newly reclaimed land in Tseung Kwan O for construction of inter-connected grid facilities so that the share of imported electricity can be further lifted to 60%-70% before 2035; and (c) requested the two power companies to conduct feasibility studies on interconnection with the Mainland and third-party access to grids.

1.2 At the request of Hon LUK Chung-hung, the Research Office has gathered major research documents on competitive implications arising from admission of new gencos in the world, focusing on Singapore and Australia which are hailed as places with "successful" power market reforms. As local policymakers are primarily concerned about implications arising from the segment of additional gencos only, this note will be very brief on reforms in other segments (e.g. transmission and retail).[3] Major findings are summarized below.

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1 A cable bridge caught fire in Yuen Long in June 2022 and a switching station at Cyberport triggered a power interruption accident in April 2023. These two incidents affected 175 000 and 44 000 customers respectively. Most recently in January 2024, there was electricity outage in a substation of Cheung On Estate in Tsing Yi, affecting 388 customers.

2 Between 1999 and 2015, the two consultancy studies commissioned by the Government proposed to introduce competition from the Mainland. Yet most respondents in a public consultation completed in June 2014 expressed "reservations on importing electricity from the Mainland". Some local scholars cautioned that it would be "risky" and "unwise" to abandon the existing model and switch to an "unproven competitive model".

3 The "textbook model" of power market reform usually covers (a) privatization of state-owned monopolies; (b) unbundling competitive segments in the supply chain; (c) restructuring those segments to ensure sufficient competitors; (d) creation of competitive markets for those segments; (e) adoption of open access regime for third-party connection to grid on fair and equal terms; and (f) establishment of independent regulatory agencies.

2. Global development of electricity market reform

2.1 Upon the spread of neoliberalism and Thatcherism, there were waves of power market reforms across the globe after the 1980s, believing that consumers could benefit from efficiency gains upon increased competition and resultant reduction in electricity tariffs. Chile and the United Kingdom were the early pioneers of such reforms in 1982 and 1989 respectively, followed by over 150 countries in the next few decades.

2.2 However, empirical studies of the power market reforms over the past four decades showed that their outcomes were "mixed", "at variance with the expectations" and "extremely risky", bringing "unpleasant consequences".[4] The disappointing results were attributable in part to (a) poor or idealistic design in reform; (b) huge capital investment required from new entrants; (c) global uptrend in fuel prices; and (d) regulatory failures. Moreover, there are inherent conflicts amongst the three reform objectives (i.e. tariff affordability, supply reliability and environmental sustainability), known as "energy trilemma". For instance, power companies may wish to reduce capital investment to keep the tariffs low, but this would adversely affect stability of the power system. As another indication, increased generation from renewable energy is environmentally friendly, but its intermittent nature could undermine supply reliability.

2.3 Turning to the **competitive mechanism amongst gencos** (which is a key focus of policymakers and stakeholders in Hong Kong), the common practice is to set up a wholesale market under which all participants need to offer supply bids in regular intervals (e.g. every 30 minutes), with the cheapest bids allowed to dispatch their power to the retail market. To protect new entrants for fostering competition in the longer term, some regulators may impose restrictions on existing gencos (e.g. market share caps and price restrictions). New gencos are also given the right to connect to existing transmission or distribution systems on fair terms.

3. Policy experience in Singapore

3.1 In **Singapore**, its electricity market used to be vertically integrated and operated by a monopoly – the Public Utilities Board ("PUB") before the mid-1990s. In the reform, PUB was turned into a corporate entity owned by Temasek Holdings in 1995, followed by unbundling of gencos from other segments in 2001 and further privatization of gencos in 2008. While a new regulator named the Energy Market Authority was set up in 2001, the competitive retail market phased in gradually from 2001 to 2018. The entire liberalization process in the power market took 23 years to complete in Singapore.

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[4] For example, power market reforms resulted in surging tariffs instead of reduced electricity bills as envisaged (e.g. Estonia and the UK), episodes of widespread blackouts (e.g. Italy and California State in the United States), more carbon emissions (e.g. the Philippines and Alberta Province in Canada) and regulatory loopholes (e.g. Israel).

3.2 In the **wholesale market**, two restrictions were imposed on existing players to protect new entrants. First, the top three existing players were required to sell pre-set amount of power at a specified price under vesting contract regime between 2004 and mid-2023, thereby preventing them from capacity withholding and predatory pricing.[5] Secondly, the market share of individual gencos was capped at 25% in 2016. As such, the combined market share of the top three gencos fell from 83% in 2005 to 53% in 2022. As at end-2022, there were 18 large-scale gencos with generation licences in Singapore. It is further noted that (a) a number of corporations concurrently own multiple gencos; and (b) some gencos are focused on renewable energy such as solar and waste-to-energy.

3.3 On **competitive implications for electricity tariff**, the electricity price in the Singaporean wholesale market mostly mirrors global oil prices. From 2012 to 2020, the wholesale price in local currency had fallen by a total of 69%, versus the 62% plunge in crude oil price in US dollar terms. Regression analyses showed that the liberalization process till 2020 had resulted in efficiency gain and lower electricity tariffs in Singapore, holding other variables constant. Yet the wholesale price rebounded steeply by 317% in the next two years, outpacing the 141% rise in global oil prices. In response to public concerns, the Singaporean government intervened and imposed a temporary cap on wholesale prices in July 2023.

3.4 On **supply reliability**, the annual average interruption time per customer stayed at a very low level at only 0.16 minute in 2022, compared with 0.5 minute for Hongkong Electric Company, Limited ("HEC") and 5.7 minutes for CLP, thanks to its extremely high level of reserve margin at 50% in 2021. Yet such margin is projected to halve to 25% by 2025, upon surging power demand and retirement of older generation units. Prima facie, system uncertainties could be in part related to hesitant investment decisions of new gencos in Singapore, as revealed in the "energy trilemma" discussed above.

3.5 On **environmental sustainability**, there was increased usage of cleaner natural gas amongst gencos, resulting in a 21% fall in average carbon emission per unit of net electricity generation from 2005 to 2022. However, renewable power like solar and waste-to-energy took up just 4% of the fuel mix in Singapore in 2022, primarily due to geographical constraints. The Singaporean government thus plans to import low-carbon electricity (e.g. hydropower) from neighbouring countries (e.g. Cambodia, Indonesia and Vietnam), aiming to raise the ratio of imported electricity from 0.8% right now to 30% by 2035, thereby diversifying supply in the market.

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[5] Vesting quantity was first set at 65% of total electricity demand in 2004. It was gradually reduced to 25% in 2017 and completely phased out in mid-2023. Vesting price is adjusted biennially based on the long-run marginal cost of the most efficient technology that serves at least 25% of the power system demand in Singapore.

4. Policy experience in Australia

4.1 In **Australia**, electricity market used to be vertically integrated and operated by the government-owned utilities in individual states before the 1990s, causing inefficiency, over-capacity and excessive costs. The reform included (a) establishment of the National Grid Management Council in 1991; (b) corporatization and unbundling of the generation segment till the mid-2000s; (c) setting up several regulatory bodies in the late 2000s; and (d) full competition in the retail segment in 2014. The entire reform process also lasted for 23 years in Australia.

4.2 In the **wholesale market**[6], regulators set up both price ceiling and price floor for all gencos to address concerns of price volatility and market power. Moreover, large gencos with market share of over 20% were not allowed to make acquisitions from 2017 onwards. There are over 100 Australian gencos now, up from 15 in 1998. Yet the market share of the top three gencos remained noticeable at 44% in 2022-2023, about the same as 43% a decade ago.

4.3 On **competitive implications for electricity tariff**, the average wholesale price held broadly stable before 2006-2007. However, it surged by a cumulative 148% in the ensuing years till 2022-2023 (in local currency), significantly outpacing the 64% rise in global oil price (in US dollar terms). This could be attributable to many contextual and transitory factors, including drought, carbon tax[7] and volatility in the natural gas market. "Energy poverty" has become a concern in Australia.

4.4 On **supply reliability**, unplanned interruptions of electricity supply mainly happened in the distribution network. For example, based on an outage analysis for the period from 2009 to 2019, 98% of outages in Australia happened in the distribution network, whereas transmission network (0.7%) and generation plant (0.1%) only took up small shares. Excluding the distribution network, the supply reliability ratio for the wholesale market stayed above 99.998% over the past decade.[8]

4.5 On **environmental sustainability**, as Australia is a global leader in development of renewable energy, the share of renewable fuels used in generation tripled from 11% to 31% within a decade till 2021-2022. In the wholesale market, renewable energy took up 57% of generation capacity in mid-2023, also up significantly from 22% in mid-2013. Greenhouse gas emissions from power generation peaked in 2009, before falling by 28% in the next 14 years till 2022-2023.

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6 It connects networks in Queensland, New South Wales (including the Australian Capital Territory), South Australia, Victoria and Tasmania. Western Australia and the Northern Territory are not connected due to distance issues.

7 A think tank estimated that the introduction of carbon pricing scheme in Australia in 2012 had led to a 59% increase in wholesale electricity prices and a 10% rise in the retail household electricity tariff. See Blueprint Institute (2022).

8 In Australia, the reliability standard (i.e. unserved energy demand at 0.002%) was only breached once in 2008-2009 due to weather-driven surges in power demands in Victoria and South Australia.

5. Observations

5.1 Based on global experience (including Singapore and Australia), power market reforms in all segments require decades of careful planning and execution. However, empirical studies on such reform outcomes are far from conclusive, with mixed findings on tariff affordability and supply reliability.

5.2 In Hong Kong, it is believed that the introduction of new gencos could enhance competition in the local power market, but how far it could really improve consumer welfare can be subject to much uncertainty. Also, the mode of competition amongst gencos in the context of Hong Kong may be different from other places, such as the wholesale markets in Singapore and Australia. While some local scholars called for "further investigation", the Consumer Council also cautioned that such reforms should be "gradual", bearing in mind to maintain the strengths of the existing system.

Table – Implications of enhanced competition in electricity generation in selected places

		Hong Kong	Singapore	Australia
A.	**Basic facts of electricity reform**			
1.	Beginning year of reform	-	1995	1991
2.	Time taken for entire reform (years)	-	23	23
3.	Components of reform			
	- Corporatization	-	✓	✓
	- Unbundling	-	✓	✓
	- Privatization	-	✓	✓/×(1)
	- Retail competition	-	✓	✓
4.	Number of generating companies ("gencos") in 2023	2	18	>100
5.	Ownership of gencos	Private	Private	Private and public
6.	Market share of three largest gencos	100%	53% (2022)	44% (2022-2023)
7.	Market share cap for gencos	-	25%	20% (acquisition only)
8.	Mandated open access to transmission network	×	✓	✓
B.	**Details of wholesale electricity market**			
9.	Name of wholesale market	-	National Electricity Market of Singapore	National Electricity Market
10.	Year of establishment	-	2003	1998
11.	Frequency of market clearance (minute)		30	5
C.	**Indicators of enhanced competition in electricity generation**			
12.	Wholesale price per kWh			
	- 2012	-	S$0.2225 (HK$1.38)	A$0.031 (HK$0.25)(2)
	- 2022	-	S$0.2918 (HK$1.66)	A$0.128 (HK$0.70)
	- % change	-(3)	+31%(4)	+313%(4)
13.	Average duration of unplanned interruption (minute/customer) in 2022	<0.5 (HEC) 5.7 (CLP)(5)	0.16	262.1(6)
14.	Reserve margin	31% (2022)	50% (2021)	70% (2022-2023)
15.	Share of renewables in fuel mix			
	- 2012	-(7)	3%	11%(2)
	- 2022	<1%(8)	4%	31%
16.	Share of renewables in generation capacity			
	- 2012	<1%	2%	20%(2)
	- 2022	<1%	9%	52%

(-) Information not available/not specified.

(1) In all states except Victoria and South Australia, generation assets are still predominately government-owned.

(2) Figures for the financial years ending in June.

(3) For reference: residential electricity tariff rose 3% and 31% for HEC and CLP respectively between 2012 and 2022, though they are not comparable to the changes in wholesale prices in Singapore and Australia in this table.

(4) Changes calculated using local currency prices. For comparison, the annual average crude oil price in Organization of the Petroleum Exporting Countries (OPEC) decreased by 9% (in US dollar terms) over the same period.

(5) Annual average between 2020 and 2022.

(6) Figure in the distribution network only.

(7) The Government did not release the detailed breakdown. For reference, oil and renewable energy accounted for a total of 2% of fuel mix for electricity generation in 2012.

(8) Figure reported in the "Hong Kong's Climate Action Plan 2050" published in October 2021.

選定地方的加強發電競爭政策及其影響
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註：^本節所列互聯網資料是於2024年1月讀取。
Note: ^ Internet resources listed in this section were accessed in January 2024.
粗體的參考資料 ── 建議作深入研究的文件。
References in bold print - documents recommended for more in-depth study.