



1. Introduction

1.1 Electricity is of particular importance to the economic and social development of society. It drives economic activities that are the engines of jobs and growth, and enables the provision of essential services such as lighting and heating that enhances people's quality of life. For some 100 years after electricity was commercialized in 1878, electricity industry around the world typically featured the dominance of a single company that generated, transported and sold electricity to end-consumers in a defined service area¹. This vertical integration was often accompanied by a legal monopoly within the service area – only one company could provide electricity to customers in that area.

1.2 The reason for vertical integration and the monopoly was due to the nature of the electricity industry at that time, which was characterized by the economies of scale in generation and the natural monopoly aspects of transmission and distribution networks. Then a technological advance in the 1980s, which allowed significant technological improvements to electricity generation, contributed to changes in the structure of the electricity industry. In particular, the new combined-cycle gas turbines are smaller scale generating units that can be built with lower investment cost. This new technology has effectively ended the economies of scale as an inevitable part of electricity production and opened the door to liberalization of the electricity market².

¹ See Hunt (2002).

² The terms "liberalization", "deregulation" and "restructuring" are used interchangeably in this information note to mean the transformation of an electricity sector dominated by vertically integrated power electric utilities into distinct generation, transmission, distribution and retail supply companies.

1.3 In Europe, the **United Kingdom** ("UK") has been at the forefront of liberalizing its electricity sector starting from the mid-1980s when the enactment of the Energy Act 1983 permitted small scale private electricity generation to operate, to the late 1980s and 1990s when the privatization of the electricity industry took place. Other **member states of the European Union** joined the UK in the 1990s to deregulate their electricity markets, involving the liberalization of the whole supply chain and introduction of competition to the wholesale and retail markets.

1.4 In the Asia-Pacific region, **Singapore** is the first place to liberalize its electricity industry with the first reform measure coming into place as early as in 1995. Over the years, Singapore has gradually deregulated its electricity market from a vertically integrated monopoly to a fully divested generation sector with competition at the wholesale and retail levels. **Australia** and **Japan** also liberalized their electricity markets in 1998 and 2000 respectively.^{3, 4}

1.5 In contrast, electricity in Hong Kong has all along been provided by two privately-owned power companies, viz. (a) the CLP Power Hong Kong Limited and the Castle Peak Power Company Limited (referred to collectively as **CLP**); and (b) The Hongkong Electric Company Limited ("**HEC**"). Both power companies are vertically integrated in that they own and operate their respective electricity supply chains, including generation plants and transmission/distribution networks. They also supply electricity directly to customers and provide customer services within their respective service areas.

1.6 At the request of Dr Hon KWOK Ka-ki, the Research Office has prepared this information note on the liberalization of electricity markets in the UK and Singapore. The information note will first briefly describe the four core activities of the electricity supply chain, i.e. generation, transmission, distribution and retail. It will then discuss the landscape of local electricity industry, including the market environment, price setting mechanism, and issues of concern over the existing regulatory framework. The information note is followed by a study of the electricity liberalization in the UK and Singapore and its implications for future restructuring of Hong Kong's electricity industry.

³ In Australia, a key milestone of electricity reform came in 1998 when the federal government unbundled the vertically integrated state-owned electricity authorities in each state/territory. See Electrical and Mechanical Services Department (2015).

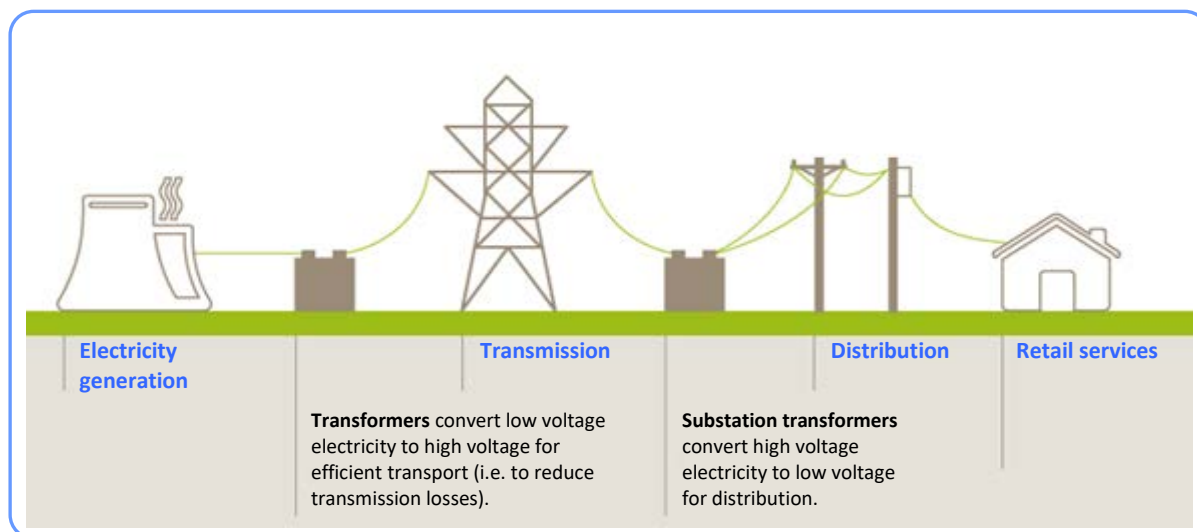
⁴ Japan restructured its electricity market in 2000 to allow large factories, department stores and office buildings in the "extra-high voltage category" to choose their own electricity suppliers. See Agency for Natural Resources and Energy (2013).

2. Electricity supply chain

2.1 The electricity industry can generally be thought of as consisting of the following four separate but vertically connected core activities (**Figure 1**):

- (a) **electricity generation** refers to the production of electricity at power plants using primary sources of energy, e.g. coal, natural gas, nuclear fuel and renewable energy;
- (b) **transmission** refers to the bulk delivery of electricity on high voltage networks from the power plants where it is generated to the local distribution networks;⁵
- (c) **distribution** refers to the transmission of electricity for the "last mile" from distribution substations into customers' premises by way of local networks of low voltage power cables;⁶ and
- (d) **retail services** refer to the sale of electricity to consumers, including the customer-end services such as metering and billing.

Figure 1 — Layout of electricity supply chain



Source: Queensland Competition Authority (2019).

⁵ The voltage of electricity coming from the power plant is "stepped up" using transformers at transmission substations for long-distance transmission. Electricity generation companies use high voltage in long-distance transmission as less energy is lost if the voltage is very high.

⁶ As electricity is transmitted through the transmission network and arrives at the distribution network, voltage is "stepped down" by transformers at distribution substations and finally lowered further for use by domestic households and businesses.

Candidates for competition

2.2 As mentioned above, competition has been introduced into the electricity markets of developed economies since the mid-1980s. While the objectives behind the market liberalization varied, it was generally believed that increased competition could promote efficiency of electricity supply and bring down electricity tariffs. In addition, market competition could result in more suppliers and more choices for consumers.

2.3 In general, the core activities of the electricity supply chain that can be opened for competition or remain as natural monopolies are:

- (a) generation – the generation function is the major candidate for being made competitive. The arguments from economies of scale no longer hold; and the benefits of introducing competition are potentially the greatest as generation is the largest element of an electricity bill.⁷ With competition in power generation, all generation companies ("Gencos") will compete with one another in the wholesale market to sell electricity to distributors and/or large consumers (i.e. wholesale competition);
- (b) transmission and distribution – these two core activities are generally regarded as natural monopolies as it would not be practical or economical to have more than one set of transmission and distribution network in the same geographical area; and
- (c) retail – the retail function can be competitive with respect to procuring, pricing and selling electricity. Under a competitive retail market, Gencos compete to sell their electricity to retailers, which in turn compete to sell electricity to customers (i.e. retail competition). Customers can switch to a different retailer when the competing retailer delivers better and cheaper services.

⁷ According to Consumer Council (2014), the cost of generation accounts for more than half of the price of electricity.

Need for unbundling of the electricity market

2.4 Transmission and distribution networks, or the so-called power grid, are essential facilities that remain natural monopolies because no one could economically provide competing services. Problems arise when the operator of such essential facilities is also active in the contestable generation and retail sectors and competes there against other entities. Such operator might have the incentive to advantage its own Gencos or retailers (and disadvantage its rivals) in the operation of the natural monopoly infrastructure elements.

2.5 To eliminate as far as possible any conflict of interest, it is typical to place a form of access regulation on the natural monopoly infrastructure elements. Access regulation mandates non-discriminatory access to the transmission and distribution networks by all Gencos/retailers to reach their customers. In order to create a more level playing field for all market participants, regulators might also require a vertically integrated power company to segregate its generation business from transmission and distribution businesses, thereby avoiding any discriminatory access arrangement against the new players. The broad options for unbundling integrated functions, in order of severity, are accounting separation⁸, functional separation⁹ and corporate separation¹⁰.

3. Hong Kong

3.1 Hong Kong is probably one of the few jurisdictions in the world where the electricity companies have never been under majority public ownership. Local electricity supply has, instead, all along been provided by two private vertically integrated electricity companies, HEC and CLP, which were incorporated in 1889 and 1901 respectively. HEC supplies electricity to customers on the Hong Kong Island, Ap Lei Chau and Lamma Island, while CLP

⁸ Accounting separation requires a vertically integrated operator to unbundle the accounts of different functions and price them separately. The network operator must charge its Gencos/retailers the same fees for using the network as it charges third parties, thereby preventing any cross-subsidies between the generation/retail and network businesses.

⁹ Under functional separation, separately operating divisions of the same firm are responsible for the network and generation/retail businesses. This is to eliminate any free flow of sensitive commercial information between divisions.

¹⁰ Under corporate separation, the company that owns and operates the transmission/distribution network is legally separated from any Gencos/retail companies and will have no incentive to favour one company over another.

serves customers in Kowloon, the New Territories and some outlying islands. Though operating as separate businesses, HEC and CLP are interconnected by a cross harbour cable with a 720-MVA capacity, thereby providing emergency mutual back-up in the event of generator failure and hence reducing potential loss of supply to customers.

3.2 HEC has a total installed capacity of 3 237 MW for electricity generation at its Lamma Power Station. Meanwhile, CLP receives its electricity supply from three power stations, namely Castle Peak (4 108 MW), Black Point (2 525 MW) and Penny's Bay (300 MW),¹¹ as well as importing power from Guangdong Daya Bay Nuclear Power Station and Guangzhou Pumped Storage Power Station. In 2018, the total number of electricity consumers in Hong Kong was about 3.1 million, of which about 20% being served by HEC and 80% by CLP.

Regulatory regime

3.3 There is no legislation that expressly creates rights or obligations to supply electricity in Hong Kong. Electricity supply is regulated through the Scheme of Control Agreements ("SCAs") signed by the Government with HEC and CLP respectively. SCAs set out the rights and obligations of HEC and CLP, as well as providing a framework for the Government to monitor the operating and financial performance of the two power companies in providing electricity.¹²

3.4 The Government signed new SCAs with each of the two power companies in April 2017. The new agreements took effect upon the expiry of the previous ones on 30 September 2018 and 31 December 2018 for CLP and HEC respectively. The term of both SCAs will last until 31 December 2033. Key terms of new agreements include:

¹¹ CLP is building a new gas-fired unit of 550 MW at its Black Point Power Station and developing the landfill gas power generation project at the West New Territories Landfill site (10 MW).

¹² Operating performance covers supply reliability, operational efficiency, customer services and energy efficiency, whereas financial performance covers power companies' capital investment, operating expenditure, rate of permitted return and tariff adjustment.

- (a) reducing the permitted rates of return of HEC and CLP on their average net fixed assets from 9.99% to 8%;
- (b) introducing Feed-in Tariff Scheme to encourage the renewable energy development in the community; and
- (c) raising the incentive/penalty levels and thresholds in relation to supply reliability, operational efficiency and customer services where appropriate.

Price setting mechanism

3.5 Electricity tariff charged by HEC and CLP is made up of two components, namely the Basic Tariff and Fuel Cost Adjustment. The Basic Tariff covers operating expenses, standard fuel charges and the permitted return to the power companies. Meanwhile, Fuel Cost Adjustment is either a surcharge or rebate to cover any fuel costs above or below the standard fuel charges already included in the basic tariff.¹³ In this connection, fuel cost is fully borne by consumers and payable to the power companies on a cost-pass-through basis.

Areas of concern

3.6 Electricity is currently provided by two privately-owned power companies, and there is no competition in the local electricity industry. Over the years, there have been suggestions that competition should be introduced to the local electricity market to allow more suppliers, as well as to allow consumer to have choices.¹⁴ There is a general belief in the local community that promoting competition in the electricity market would help drive down electricity tariff.

¹³ In the annual tariff review, Fuel Cost Adjustment is set using a projection of fuel prices for the following year. This, together with the standard fuel cost, constitutes the "forecast fuel cost". The difference between "forecast fuel cost" and actual cost of fuel is charged or credited to a Fuel Clause Recovery Account. See CLP (2017).

¹⁴ For example, a motion on "Creating a sustainable and open electricity market" was passed at the Council meeting of 18 January 2012.

3.7 One possible option of introducing competition in the local electricity market is to allow HEC and CLP to sell electricity into the other's defined service area, thereby enabling consumers to choose their own supplier and narrowing the tariff differential between the two power companies¹⁵. This option will require expanding the capacity of existing interconnection between HEC and CLP, as the link is not suitable for routine transfers of bulk electricity between the two.¹⁶

3.8 At end-March 2015, the Government launched a public consultation on the future development of Hong Kong's local electricity market in view of the expiry of SCAs in 2018. In the consultation document¹⁷, the Government states that "the requisite conditions are not present for us to introduce competition on a sizable scale to the electricity market in 2018". These requisite conditions included a framework to establish the terms and conditions of access for new entrants to use the transmission and distribution grids, as well as a means for electricity to be bought and sold between different suppliers and buyers (e.g. a wholesale electricity market).¹⁸

3.9 On the regulatory framework, there have been criticisms over the present contractual agreement by SCAs that pegs the permitted rates of return of HEC and CLP with their average net fixed asset.¹⁹ While the guaranteed return provides the necessary incentive to ensure continued investment by the two power companies for electricity provision, some reckon that this has encouraged over-investment.²⁰ Another criticism is that SCAs allow HEC and CLP to pass the fuel cost for electricity generation to consumers, which does not provide sufficient incentive for them to source the cheapest fuel available.

¹⁵ According to the 2018-2023 Development Plans of the two power companies, HEC would charge higher net tariff rates than those of CLP during 2018-2023. Allowing CLP to sell to HEC's customers might put pressure on HEC to lower tariffs to CLP's level. See GovHK (2018).

¹⁶ According to Cheng & Lin (2014), it has been argued that a capacity to transfer up to 1 000 MW regularly would be sufficient to allow competition between CLP and HEC.

¹⁷ See Environment Bureau (2015a).

¹⁸ See Competition Commission (2015a).

¹⁹ At the Council meetings of the Fifth LegCo and Sixth LegCo, Members had raised a number of questions about SCAs, in particular the terms relating to the permitted rate of return.

²⁰ The new SCAs signed in 2017 have revised the mechanism for calculating excessive generating capacity. If there is excessive capacity when an additional generating unit is commissioned, 100% instead of the formerly 50% of the net asset value of the mechanical and electrical equipment of the said unit will be deducted from the fixed assets and the permitted return calculation.

4. The United Kingdom

4.1 The UK is a pioneer country in the European Union in the drive towards liberalization, starting with enactment of the Energy Act 1983 to encourage private generation of electricity. The liberalization was later bolstered by an ambitious privatization programme in the late 1980s and 1990s, which led to the creation of a wholesale market where Gencos could sell electricity in a power pool. At present, the electricity market is fully liberalized. The UK experience demonstrates the feasibility of replacing a state-owned vertically integrated monopoly with privately-owned, unbundled and regulated companies.

Development of local electricity industry

4.2 In the UK from 1947 when the electricity supply industry was nationalized, generation and transmission facilities were owned by the public Central Electricity Generating Board ("CEGB"). CEGB sold electricity to 12 Area Boards that were in charge of distribution and supply of electricity to end-customers in their respective regions. A first attempt to introduce more competition into the electricity supply was made with the enactment of the Energy Act 1983, which allowed private generators to sell electricity to the Area Boards and use the public transmission and distribution systems.

4.3 The subsequent adoption of the Electricity Act in 1989 laid the legislative foundations for the privatization of the electricity industry, with legal provisions governing the transfer of the property, rights and liabilities of CEGB to independent successor companies and then to private hands through floatation. The thermal generation assets of CEGB were split into two new generation companies, **PowerGen** and **National Power**, while the nuclear assets were vested in a new company, **Nuclear Electric**. CEGB's transmission system was separated from the generation system and transferred to the **National Grid Company**. On 31 March 1990, these four companies were created as public limited companies suitable for floatation. On the distribution side, the 12 Areas Boards were renamed Regional Electricity Companies and jointly owned the National Grid Company.

4.4 Privatization began in 1990 with sale of the Regional Electricity Companies to the public. In 1991, the public were offered 60% of PowerGen (now E.ON) and National Power (now RWE Npower). The remaining shares were sold to the public in 1995. The Regional Electricity Companies floated the National Grid Company as an independent concern in late 1995, which was renamed the National Grid Electricity Transmission ("NGET") in 2005. Subsequently, Nuclear Electric was listed as British Energy (now EDF Energy) on the London Stock Exchange in 1996.

Regulatory framework

4.5 In the UK, the electricity market is regulated by the Gas and Electricity Markets Authority ("GEMA") pursuant to the power granted under the relevant legislation such as the Electricity Act 1989, the Competition Act 1998 and the Utilities Act 2000. GEMA has established the Office of Gas and Electricity Markets ("Ofgem") as its executive arm to perform day-to-day regulatory duties.

4.6 The regulatory system in the UK is administered through a licensing regime, in combination with a comprehensive set of industry codes that set out detailed rules and terms for connection and access to the electricity networks. Currently, there are four licensable activities in the UK's electricity market, namely generation, transmission, distribution and supply, and operators can engage in one or more of these licensable activities.

4.7 Ofgem has put in place unbundling requirements ensuring the separation of various stages of electricity supply chain. For example, the Utilities Act 2000 provides for separate licensing of supply and distribution activities and requires these businesses to be held by separate legal entities (although the entities could be held under common ownership). In addition, the Electricity and Gas (Internal Markets) Regulation 2011 requires the holders of electricity transmission licenses to be certified by GEMA as complying with ownership unbundling, i.e. separation of ownership and operation of transmission systems from generation and supply activities.

Operation of local electricity market

4.8 Deregulation of the UK electricity market in the late 1980s and 1990s has the effect of opening the market up to private ownership and competition, transforming the once vertically integrated process into separate generation, transmission, distribution and supply segments.

Generation

4.9 Since privatization of the generation industry in the early 1990s to form three Gencos (i.e. National Power, PowerGen and Nuclear Electric), the highly concentrated market has become more diverse with the entry of a growing number of small power producers. The wholesale electricity market is now shared between the "Big Six"²¹ and a number of independent generators.

4.10 Liberalization of the generation sector has helped created a platform, a wholesale market, where electricity is traded as a commodity. The initial wholesale electricity trading arrangement was based on a mandatory power pool. The Electricity Pool, which was established in 1990, facilitated a competitive bidding process between generators that (a) set the price paid for electricity each half hour of the day; and (b) established which generators would run to meet forecast demand based on the bids they submitted to the pool. However, there was no participation of buyers in price setting process.

4.11 In 2001, the Electricity Pool was abolished and replaced by the New Electricity Trading Arrangement ("NETA") based on bilateral trading between generators and suppliers²². NETA, operated by NGET, features generators and suppliers buying and selling electricity through forwards and futures markets, along a power exchange that allows fine-tuning of positions. After closure of the power exchange, a voluntary balancing market will open where

²¹ The Big Six is the shorthand name for the six largest power companies in the UK. They are E.ON, Centrica (British Gas), RWE Npower, Scottish Power, EDF Energy and SSE, which are involved in both the wholesale (generation) and retail (supply) markets.

²² The bilateral model is a more market-oriented design that encourages more interaction between Gencos and buyers through bilateral trading. This contrasts with the Electricity Pool which was a highly centralized market with the central scheduling and dispatch of generators. The Electricity Pool operator accepted bids from generators, starting with the cheapest, until the demand forecasts were met.

NGET can buy or sell additional electricity close to real-time to ensure it to balance the transmission system (see the [Appendix](#) for details).

Transmission and distribution

4.12 The electricity produced by Gencos goes to the national transmission network managed by NGET, which is tasked with overseeing and balancing the flow of electricity across the network. Meanwhile, there are 14 licensed distribution network operators (formerly known as Regional Electricity Companies) in the UK and each is responsible for a regional distribution services area.

4.13 In the UK, network operators must provide non-discriminatory third-party access to their transmission and distribution facilities. They are also subject to performance-based price control through which Ofgem sets the maximum amount of revenue that they can recover from network users. Until 2013, Ofgem regulated transmission and distribution companies' network cost pricing policies on a five-yearly basis. Charges were linked to inflation through a formula known as RPI-X, where RPI was the retail price index and X the expected efficiency gain set by Ofgem. In 2013, Ofgem replaced the RPI-X pricing regime with RIIO, which stands for (Revenue = Incentives + Innovation + Outputs). RIIO rewards network operators for innovation and meeting the changing expectations of consumers and society.

4.14 RIIO has six groups of outputs designed around the objectives of safety, reliability, customer service, environment, social obligations and connections. Transmission and distribution companies can gain bonuses or receive penalties based on their performance against these objectives. Moreover, the more innovative network operators will receive more financial rewards,²³ while those fail to innovate sufficiently will face financial penalties and further regulatory scrutiny. Ofgem also designs RIIO to attract more investment into the UK's energy infrastructure by increasing the price framework period from five years as under RPI-X to eight years, with the current period starting in 2013 and ending in 2021.

²³ As part of the RIIO framework, there are two funding mechanisms that encourage innovation across the energy industry that could make the energy networks smarter, accelerate the development of a low carbon energy sector, and deliver financial benefits to consumers.

Retail

4.15 The UK has phased in retail competition in three tranches. Customers with a maximum demand greater than 1 MW a year were free to choose their electricity supplier from 1990. In 1994, retail access was extended to customers with a maximum demand in excess of 100kW, and in 1999 to all customers. The introduction of full retail competition in 1999 has helped drive better customer services, as competition for consumers incentivizes the suppliers to create more innovative pricing plans to gain a competitive advantage.

Outcomes of market liberalization

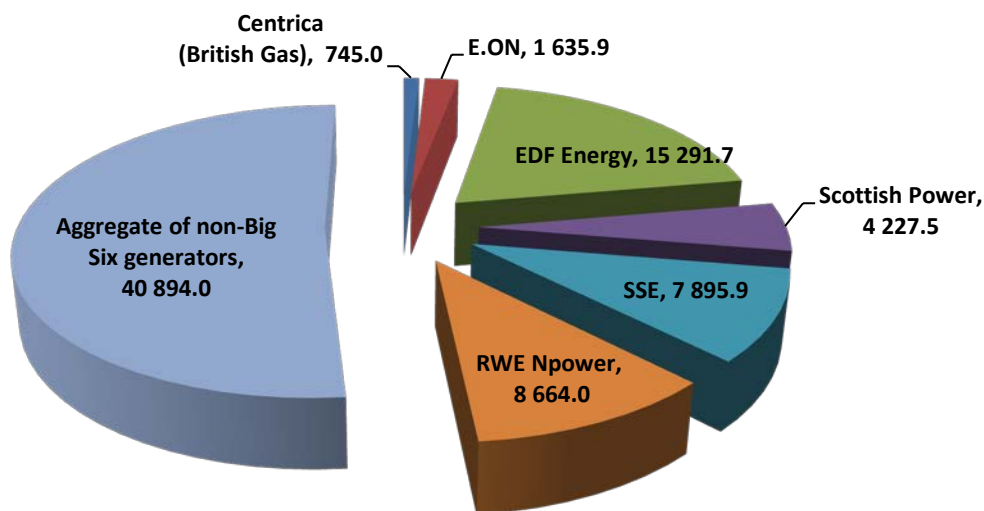
Market structure

4.16 At the initial stage of the reform, only three Gencos existed in the wholesale market. The number of Gencos has increased progressively to 57 at end-May 2018, reaching a total installed capacity of 79 354 MW. The surge has been fuelled by increased number of renewable generation stations consequential to the financial incentives offered by the UK government to generation processes based on renewable energy sources.²⁴ Indicative of this trend, renewable sources provided 29.3% of the electricity generated in the UK in 2017.

4.17 Notwithstanding the increase in the number of Gencos, the generating assets have been concentrated in a small number of companies. The Big Six companies together owned about half of the installed generating capacity at end-May 2018, with the remaining capacity being owned by independent power producers and a significant amount of which is renewable capacity (**Figure 2**).

²⁴ For example, Contract for Difference ("CfD") was introduced in the UK in October 2014 to support deployment of large scale renewable projects. CfD ensures that eligible project developers receive a fixed, pre-agreed price for the electricity produced for 15 years.

Figure 2 — Installed capacity by company (MW) at end-May 2018



Source: Department for Business, Energy & Industrial Strategy (2018).

4.18 The retail market has also seen substantial new entry in recent years.²⁵ There were 55 active licensed suppliers in the domestic retail market at end-2018, 41 more than at end-2011. They consisted of the vertically integrated Big Six and a large number of smaller independent suppliers. While the Big Six still dominates the retail market with a combined market share of 74% in Q4 2018, the percentage has been on the decline since 2012 (100% in Q3 2012).

Electricity prices

4.19 The wholesale electricity prices varied considerably between £33.85 (HK\$341) and £67.69 (HK\$682) per megawatt hour ("MWh") without exhibiting a discernible trend during 2010-2018. Indeed, it is not easy to single out or isolate the impacts of electricity market liberalization on the wholesale electricity prices, which are also determined by other factors such as fuel price fluctuations in the international market, use of greener but more expensive fuel, and climatic conditions.

²⁵ A number of factors have contributed to the substantial new entry. These include exceptions of small suppliers from environmental and social policy obligations (e.g. providing energy efficiency improvements for low income households), which in turn lowers the barrier to entry. Also contributed is the increased number of Gencos in the wholesale market, as sourcing sufficient wholesale electricity to meet customer demand is essential to the operation of independent suppliers which do not involve in generation business.

Supply reliability

4.20 The UK has one of the most reliable electricity systems in the world, currently standing at 99.99%. Since the beginning of RIIO,²⁶ the number of customer interruptions has fallen by 11% and the duration of interruptions by around 9%. On average, in 2017-2018 each customer was off supply for around 36 minutes over the course of the year.

Switching rate

4.21 Competitive markets need a sufficient number of engaged consumers who will access, assess and act on information about offers in the market. For engaged consumers, Ofgem's analysis showed that between July and September 2017, internal switching (switching to another tariff within the same retailer) could lead to savings of up to £179 (HK\$1,804) while external switching (switching to another retailer) could lead to savings of £92-£311 (HK\$927-HK\$3,135).²⁷

4.22 Although there has been increase in the number of active consumers,²⁸ there remains a large proportion of consumers who are still disengaged. According to a consumer survey conducted by Ofgem in 2018, 34% of consumers reported that they had never switched to another supplier and 27% said they had switched only once²⁹. As a result of low switching rate, Ofgem introduced a price cap on default energy tariffs on 1 January 2019, bringing price protection to around 11 million energy customers who do not shop around for the best deals. Those customers are usually getting stuck on default deals provided by incumbent retailers, paying more than they need to.

5. Singapore

5.1 Singapore is the first liberalized electricity market in the Asia-Pacific region, characterized by a clear separation of the contestable market segments from the natural monopoly segments; open access to the transmission and distribution networks; and full retail competition where consumers have the choice to switch their electricity retailers.

²⁶ See paragraphs 4.13-4.14 for details of RIIO.

²⁷ See Ofgem (2017).

²⁸ The number of customers switched their electricity suppliers increased from 3.4 million in 2013 to 5.4 million in 2018.

²⁹ See Ofgem (2018).

5.2 Restructuring of Singapore's electricity industry began in 1995, and continued into the late 2010s when the government pressed on with further liberalization measures to reap full benefits of competition. The whole process features a detailed roadmap on how and when to introduce further layers of competition/reform in order to "ensure long-term diversity, reliability and security of its energy supply at competitive prices".³⁰

Development of local electricity market

5.3 The first reform of the local electricity market came in 1995 when the Singapore government corporatized the state-owned Public Utilities Board ("PUB"³¹), which had been responsible for the supply of electricity, piped gas and water for entire population of Singapore since 1963. The electricity sector function of PUB was transferred to Temasek Holdings, the investment arm of the Singapore government, as a result of the corporatization.

5.4 Within Temasek Holdings, Singapore Power was created as the holding company for several other new companies including: (a) two generation companies, Power Senoko and PowerSeraya; (b) a transmission and distribution company, PowerGrid; and (c) a retail electricity supply company, Power Supply Limited. A further generator, Tuas Power, was set up as an independent company directly under Temasek Holdings.³²

5.5 The second phase of the reform commenced on 1 April 1998 with the launch the Singapore Electricity Pool³³ to facilitate the trading of electricity under a competitive wholesale market. The Singapore government carried out a comprehensive review of the electricity sector in 1999, and it decided in 2000 to continue with further deregulation of the industry in the years ahead to obtain the benefits of full competition. The key milestones for Singapore's electricity market reform since 2000 are shown in the **Table** below:

³⁰ See Singapore Government (2002) and Electrical and Mechanical Services Department (2015).

³¹ Established in 1963, PUB was a statutory body responsible for the supply of water, electricity and gas for the entire population of Singapore. Today it is solely in charge of water supply in Singapore.

³² Tuas Power was set up in 1995 with core businesses in the generation, retailing and trading of electricity.

³³ Singapore Electricity Pool was a day-ahead electricity wholesale market, where contracts of electricity trading were made between sellers and buyers for delivery of power on the following day. Market players included two generation companies under Singapore Power (Power Senoko and PowerSeraya), Tuas Power, and the waste incineration plant of the former Ministry of Environment in the western part of Singapore.

Table — Market reform milestones since 2000

April 2001	<ul style="list-style-type: none"> • Energy Market Authority was created to replace PUB as the regulator of the electricity industry. • Energy Market Company was established as a subsidiary of Energy Market Authority to operate the Singapore Electricity Pool.
July 2001	<ul style="list-style-type: none"> • Commencement of the retail market liberalization. • Consumers with a maximum power requirement of 2 MW and above became contestable*.
January 2003	<ul style="list-style-type: none"> • National Electricity Market of Singapore was opened to replace the Singapore Electricity Pool. • Gencos were allowed to sell electricity in real-time into the National Electricity Market of Singapore.
June 2003	<ul style="list-style-type: none"> • Consumers with average monthly consumption of 20 000 kWh and above also became contestable.
February 2006	<ul style="list-style-type: none"> • Size threshold for consumers to be contestable was lowered to 10 000 kWh. Retail contestability was expanded to 75% of total electricity demand.
December 2008	<ul style="list-style-type: none"> • Divestment of Temasek's three Gencos (Power Senoko, PowerSeraya and Tuas Power) was completed.
April 2015	<ul style="list-style-type: none"> • Electricity futures trading commenced.
July 2015	<ul style="list-style-type: none"> • Size threshold for consumers to be contestable was lowered further to 2 000 kWh. Retail contestability was expanded to 80% of total electricity demand.
April 2018	<ul style="list-style-type: none"> • Soft launch of Open Electricity Market which allows all households and businesses in Jurong to choose their electricity retailers.
November 2018	<ul style="list-style-type: none"> • Open Electricity Market was extended progressively to all consumers across Singapore by zones.

Note: (*) Contestable consumers have the right to choose to purchase electricity from a retail supplier, directly from the wholesale market, or indirectly from the wholesale market through Power Supply Limited at the regulated tariff.

Sources: Energy Market Authority (2011) and (2019).

Regulatory framework

5.6 The main legislation governing the electricity sector in Singapore is the Electricity Act (Cap. 89A). Under the Act, an entity may not engage in electricity-related activities such as generation, transmission and retailing, unless it has been issued an electricity license by the Energy Market Authority of Singapore ("EMA").

5.7 EMA, which was established in 2001 under the Energy Market Authority of Singapore Act (Cap. 92B), is the independent regulator overseeing the electricity industry in Singapore. As a statutory board under the Ministry of Trade and Industry, EMA is empowered to (a) revoke or modify an electricity license; (b) issue directions to electricity licensees; (c) fine a licensee for failing to comply with a lawful demand of EMA; and (d) investigate and sanction anti-competitive conduct.

Operation of local electricity market

5.8 Singapore's electricity market is structured to facilitate competitive wholesale and retail markets. Competition is achieved by separating the ownership of contestable generation and retail services from the non-contestable transmission and distribution services.

Generation

5.9 In Singapore, electricity is traded at the National Electricity Market ("NEMS") operated by the Energy Market Company ("EMC"), a subsidiary of EMA. NEMS is a "spot" market which determines the prices at which Gencos are paid through matching electricity supply and demand every half an hour³⁴. For each time period, Gencos bid to supply electricity to NEMS where those bids are ordered from the lowest price to highest price. EMC dispatches the least expensive Genco first then move on the next expensive Genco and so on. The price of the last generating unit needed to meet forecast demand set the market clearing price. Selected Gencos receive the market prices for electricity dispatched that are determined by the locations of their generating

³⁴ See Chen & Tan (2014).

units (i.e. nodal prices)³⁵. Retailers pay the Uniform Singapore Energy Price ("USEP"), which is the weighted average of the nodal prices.

5.10 Since the inception of NEMS in 2003, EMC has put in place various initiatives to enhance the competition and supply stability in the market. These include:

- (a) Interruptible Load Scheme – introduced in 2004 under which a contestable consumer participating in NEMS allows his or her supply of electricity to be interrupted and used for reserves during emergencies where capacity is insufficient. The consumer will receive reserve payment as compensation;
- (b) Embedded Generation – introduced in 2008 with the entry of new market participants with embedded generators³⁶ to start trading their excess generation in NEMS; and
- (c) Demand Response Programme – launched in 2016 which allows customers with flexible electricity demand to voluntarily reduce their demand in response to market conditions, in exchange of a reduction in the electricity prices as a result of their actions³⁷.

Transmission and distribution

5.11 Electricity is delivered to end-consumers via the transmission and distribution networks owned by SP PowerAssets ("SPPA"), formerly known as PowerGrid. In Singapore, the transmission and distribution segments are seen as non-contestable. As such, the Electricity Act prohibits SPPA from competing in the energy market, whether as a generator or retailer due to conflict of interest. In addition, SPPA is subject to access and economic

³⁵ The nearer the generating unit is to the load centre, the higher the nodal price the Genco will get because of lower transmission loss. Load centre is an area with a significant number of electricity customers such as an industrial zone or a large residential area.

³⁶ Embedded generators are generation units that produce electricity to their onsite load principally for self-consumption.

³⁷ Demand Response Programme is used by EMC as one of the options to balance energy demand and supply, particularly during periods of high wholesale market prices or when system reliability is adversely affected.

regulations by EMA.³⁸ On access regulation, SPPA is required to provide non-discriminatory access to its transmission and distribution systems for the supply and use of electricity in accordance with the Electricity Act, its license and the market rules. On economic regulation, SPPA's average grid charges are regulated by EMA and determined under its five-year regulatory framework.

5.12 For every five-year regulatory period, EMA reviews and sets the transmission and distribution charge based on CPI-X mechanism, where CPI is the consumer price index and X the efficiency gain target. EMA will, in consultation with SPPA, first calculate the allowed revenues or tariff based on factors such as the allowed rate-of-return on existing fixed assets and the return of capital for investment.³⁹ This tariff is then revised on an annual basis using a CPI-X mechanism to calculate the use-of-system charge payable to SPPA for the cost of transporting electricity through its networks.

Retail

5.13 In Singapore, EMA has progressively opened the retail electricity market to eligible consumers since 2001. Instead of buying electricity solely from SP Services (formerly Power Supply Limited) at the regulated tariff, the customers can choose to buy from a retailer at a price plan that best meets their needs or from the wholesale market at the half-hourly wholesale electricity prices. Those who exercise this choice are termed as contestable consumers.

5.14 Large-volume electricity consumers became contestable first and the consumption volume threshold for contestability has been lowered over time.⁴⁰ In 2018, EMA commenced the soft launch of the Open Electricity Market, where all households and businesses in Jurong can choose their suppliers.

³⁸ According to Wong, K. (2018), SPPA deals with both electricity transmission and distribution. In Singapore, the regulatory regime for transmission networks applies to distribution networks. The regulation of transmission charges is also applicable to distribution charges.

³⁹ Other factors include (a) projections of operation, maintenance and administration expenses; (b) forecast tax payments; and (c) sharing of capital and operating efficiency generated in the previous regulatory period. See IPA Advisory Limited (2015).

⁴⁰ See the Table on page 17 for details.

5.15 From 1 November 2018, the Open Electricity Market has been rolled out progressively to all consumers across Singapore by zones. This initiative allows about 1.4 million households and businesses to have more choices and flexibility when buying electricity, as they can buy electricity from a retailer at a price plan that best meets their needs, or remain on the regulated tariff with SP Services.

Outcomes of market liberalization

Market structure

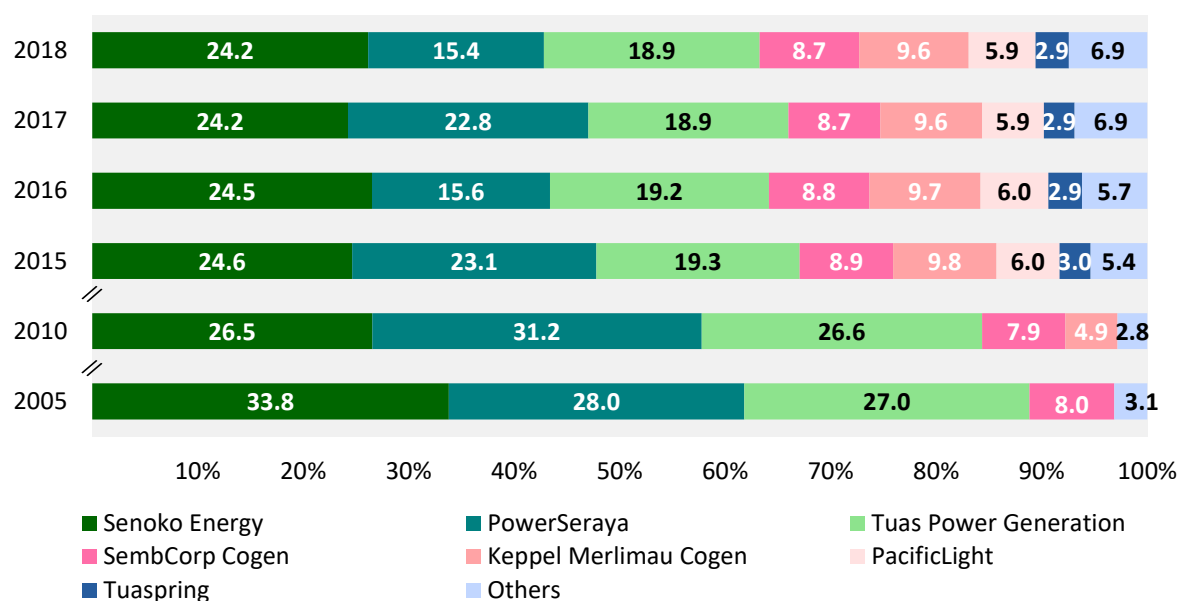
5.16 In the initial stage of electricity market reform, there were only three large-size Main Power Producers ("MPPs"⁴¹) – Power Senoko, PowerSeraya and Tuas Power – in Singapore. Over the years, the power generation market has seen the entry of new MPPs (e.g. PacificLight in 2014 and Tuaspring in 2015) and autoproducers⁴² into the market. At end-March 2018, the total electricity generation capacity in Singapore amounted to 13 614.4 MW, of which MPPs accounted for 95.0% or 12 930.7 MW and autoproducers the remaining 5.0% or 683.7 MW.

5.17 The entry of new MPPs and the expansion of smaller existing MPPs in recent years have resulted in reduced dominance of Senoko Energy (formerly Power Senoko), PowerSeraya and Tuas Power Generation (formerly Tuas Power). The generation capacity market share of these three decreased from 88.8% in 2005, to 84.3% in 2010, and subsequently to 58.5% as at end-March 2018 (**Figure 3**).

⁴¹ MPPs are defined as those companies that produce electricity as their principal activity.

⁴² An autoproducer is an industrial establishment which, in addition to its main activities, generates electricity for its own use.

Figure 3 — Electricity generation capacity by generator, 2005 to end-March 2018



Source: Energy Market Authority (2018d).

5.18 The introduction of contestability at the retail level has brought changes to the market shares of retail companies. This is particular the case for SP Services which has been providing electricity at regulated tariff. It lost its market share from 41.7% in 2005 to 27.7% in 2017. Keppel Electric, the second largest retailer after SP Services, won the most market share over the same period from 3.1% in 2005 to 13.8% in 2017.

Electricity prices

5.19 Competition in the generation sector has motivated Gencos to switch from oil-fired steam plants to more cost efficient gas-fired plants, leading to a reduction in costs. In 2017, natural gas accounted for 95.2% of fuel mix for electricity generation in Singapore. The use of cheaper fuel type has helped exerted downward pressure on wholesale electricity prices. Reflecting this, USEP decreased to a historical low of S\$63 (HK\$361) per MWh in 2016, compared with a peak of S\$215 (HK\$1,232) in 2011. However, it has recovered to S\$110 (HK\$630) in 2018, due to higher fuel oil prices and growth in energy consumption.

5.20 On the retail side, customers have benefitted through a greater choice of retailers and pricing plans. At present, there are 13 electricity retailers participating in the Open Electricity Market who offer a variety of

pricing plans. Consumers can choose a Fixed Price Plan and pay a constant rate for electricity through the contract period. However, the rate may be higher or lower than the regulated tariff during the contract duration as the regulated tariff is reviewed every quarter. This plan is suitable for consumers who prefer the surety of the same rate every month.

5.21 Alternatively, consumers can choose a Discount Off the Regulated Tariff Plan and enjoy a fixed discount off the prevailing regular tariff throughout the contract period. The discounts range from 15% to 25%, but most retailers offer 22% to 23% off. The Discount Off the Regulated Tariff Plan is suitable for consumers who do not mind that their electricity rate changes every quarter so long as it is lower than the regulated tariff.

Supply reliability

5.22 As part of its regulatory powers, EMA has imposed strict performance targets on SPPA to ensure that electricity is delivered reliably with a high quality of service. Tight performance targets have helped Singapore's electricity grid maintain its status as one of the most reliable in the world, as well as ensuring this has not been affected by the introduction of competition at the wholesale and retail levels. Reflecting this, Singapore's SAIDI and SAIFI⁴³ scores stood at a low of 0.26 minute and 0.008 interruptions per customer respectively in 2017.⁴⁴

6. Implications of the UK's and Singapore's experience for Hong Kong

6.1 In the UK and Singapore, the whole electricity supply chain has been unbundled into separate generation, transmission, distribution and supply segments, with competition introduced at the wholesale and retail levels. This results in the establishment of a competitive electricity market with transparent market-driven pricing mechanism that gives the consumers more options to choose from. The paragraphs below will highlight those areas

⁴³ SAIDI (System Average Interruption Duration Index) measures the average interruption time per customer in minutes, and SAIFI (System Average Interruption Frequency Index) measures the average number of interruptions per customer.

⁴⁴ See Energy Market Authority (2018a).

from which Hong Kong could draw reference for future liberalization of its vertically integrated electricity market.

Wholesale and retail competition

6.2 Generation and retail are competitive markets in the UK and Singapore, where all Gencos compete to sell electricity into the wholesale market or "power pool" and consumers can choose their electricity suppliers. This requires (a) a sufficient number of new players to enter the generation sector; and (b) the need for an operator to manage the wholesale market/power pool, i.e. NGET in the UK and EMC in Singapore.⁴⁵

6.3 In Hong Kong, electricity has all along been provided by HEC and CLP. Market liberalization would require more than mere competition between the two incumbents. It would require the entry of new power providers, and competition could be introduced in essentially three ways, namely:

- (a) allowing new entrants to set up new electric power stations in Hong Kong. There is no barrier to a new entrant entering local electricity market. Interested investors who meet the relevant reliability, safety and environmental performance requirement may enter the market;
- (b) new source of supply from distributed power generation. Distributed power generation is the installation and operation of small scale power-generating units at or near the end users, which can be based on a renewable energy source (e.g. solar energy or biofuel). This is similar to the case of the UK where the entry of renewable Gencos adds to the competitive landscape of the wholesale electricity market; and
- (c) importing additional electricity from the Mainland. According to the Environment Bureau,⁴⁶ it is technically feasible for Hong Kong to import electricity from the Mainland through the

⁴⁵ As mentioned in paragraphs 4.4 and 5.9 respectively, NGET is a private company in the UK and EMC is a subsidiary of EMA in Singapore.

⁴⁶ See Environment Bureau (2015b).

China Southern Power Grid ("CSG"⁴⁷) which has a sufficient surplus of electricity to meet Hong Kong's requirements. CSG currently has a total installed capacity of 310 GW, some 25 times that of Hong Kong.

Transmission and distribution

6.4 In Hong Kong, as and when new electricity supply sources become available and acceptable to the public, the new entrants would need access to the power grids of HEC and CLP. In the UK, network operators are bound by the licensing conditions of providing non-discriminatory access to all market participants. Meanwhile, Singapore's Electricity Act requires SPPA to provide non-discriminatory access to its transmission and distribution systems for the supply of electricity in accordance with the Act, its license and the market rules.

6.5 In Hong Kong, there is no regulatory framework similar to that of the UK and Singapore for enabling third-party access to the existing transmission and distribution networks of HEC and CLP. According to a legal research⁴⁸, the Competition Ordinance (Cap. 619) is a useful strategic tool for proponents of liberalization. Under the Competition Ordinance, restricting access of new power providers to HEC's or CLP's power grids might constitute either (a) a general refusal to deal by a firm with substantial market power claim; or (b) a refusal to supply an essential facility claim⁴⁹. The Competition Commission might regard such refusal an abuse under the Second Conduct Rule of the Competition Ordinance.

⁴⁷ The power transmission and distribution sectors in the Mainland is controlled by the State Grid Corporation (國家電網公司) and the China Southern Power Grid (中國南方電網). State Grid operates power grids in 26 provinces, while Southern Grid is responsible for five provinces in Southern China (i.e. Guangdong, Guangxi, Hainan, Yunnan, and Guizhou).

⁴⁸ See Cheng & Lin (2014).

⁴⁹ According to the Guideline on the Second Conduct Rule, "refusal to deal" describes a situation where "an undertaking with a substantial degree of market power refuses to supply an input to another undertaking, or is willing to supply that input only on objectively unreasonable terms". The guideline further states that "[a] refusal to deal may harm competition in the downstream market by preventing the undertaking seeking access to the relevant input from: (a) operating in that market; or (b) operating in that market as an effective competitive constraint", and that "[c]oncerns may arise in particular when the refusal relates to an input that is indispensable for undertakings operating in the downstream market".

Retail

6.6 The retail segment is viewed as being contestable in the UK and Singapore, where competition was introduced progressively. Large-volume electricity consumers became contestable first and the consumption volume threshold for contestability had been lowered over the years. This has allowed further opening of the market to consumers to occur smoothly without undue technical demands being placed on the retail companies, while allowing smaller consumers the benefit of additional time to learn about and understand their options in the new retail market. Such approach might benefit Hong Kong if it moves towards electricity liberalization with the reform measures to be more prudently implemented over a period of time.

7. Concluding remarks

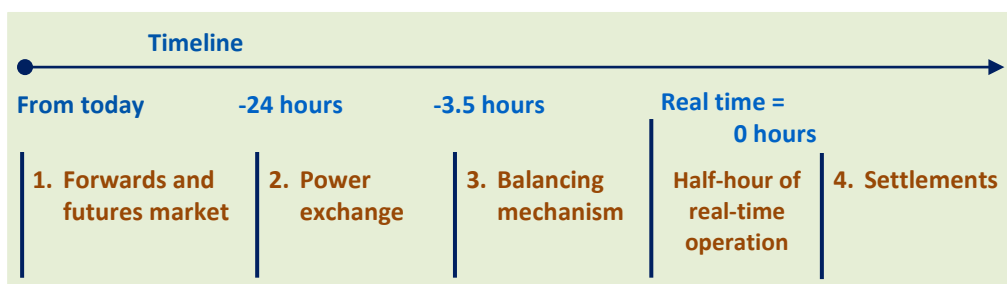
7.1 Experience from the UK and Singapore suggests that it is easier to start from a situation where the government owns the electricity industry, and also has the legal power to change the market structure, generally in the run-up to privatization. Yet, electricity supply in Hong Kong has all along been provided by the private sector. The Environment Bureau has iterated in the signing of the 2018 SCAs the need for setting out the necessary preparatory work to pave the way for introducing potential new suppliers when the requisite market conditions are present.

7.2 It is also observed from the UK and Singapore that there is no conclusive evidence that market liberalization would naturally lead to reduction in electricity prices. Nevertheless, it is evident that consumers stand to benefit from a liberalized market with more choices in terms of suppliers and pricing plans. Added to this, the supply reliability has not been affected by introduction of competition at the wholesale and retail levels.

New Electricity Trading Arrangement¹

The NETA market structure is based on bilateral trades with a balancing mechanism to maintain a continuous balance between supply and demand. This includes:

- (a) **Forwards and futures market.** Suppliers make estimates of their demand based upon contracted loads and sales expectation. They use this information to contract with Gencos to meet these basic requirements. "Bilateral" trades take place in the forwards and futures markets. Contracts can be drawn up to cover requirements several years into the future.



- (b) **Power exchange.** Suppliers fine-tune their positions from 24 hours before physical delivery. They are required to adjust the amount of electricity to be purchased to cover any excess or shortfall between their actual position and that covered by the contracts in the forwards and futures market. Suppliers then declare their positions by making a Final Physical Notifications, up to 3.5 hours before physical delivery. The power exchange closes 3.5 hours before real-time operation, known as "Gate Closure".
- (c) **Balancing mechanism.** At gate closure, a voluntary balancing market will open where NGET, the system operator, can accept offers of and bid for electricity to enable it to balance the transmission system.
- (d) **Settlements.** This is effectively an accounting process for making payments to and from those whose contracted positions do not match their actual electricity production or consumption.

¹ See Butler (2001).

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Prepared by Samantha LAU
Research Office
Information Services Division
Legislative Council Secretariat
23 August 2019
Tel: 3919 3548

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