

Planning Ahead for a Better Fuel Mix



Future Fuel Mix for **Electricity Generation** Consultation Document



Environment Bureau

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Foreword

As a well-developed economy, Hong Kong is one of the world's leading commercial, financial and logistics centres. Every minute of every day, moving people, goods, information and money efficiently is critical to Hong Kong's continuing success. Hong Kong is also a well-known "vertical city" showcasing quality urban living with high density of skyscrapers served by lifts and escalators. The safe and reliable electricity we have become so used to is key to our quality of life and crucial for our economic competitiveness.

For our city to thrive, we cannot do without safe and reliable electricity provided at an affordable price. Alongside these objectives, we also want a cleaner environment. We are considering how the fuel mix for electricity generation may be changed to better serve our population and economy in future having regard to the need to strike a balance among these competing policy objectives. The issue is important and imminent as our future fuel mix will help shape the contours of our electricity market in the long run.

Regardless of the fuel mix that we would collectively decide upon for Hong Kong, our electricity tariff will likely increase due to wider use of cleaner but more expensive fuel, and as existing electricity generation facilities are to be retired. Nevertheless, we believe Hong Kong can afford to pay more for cleaner electricity in order to further improve our environment.

These various factors underline the ever greater importance for all of us to conserve and use electricity efficiently so as not to waste valuable resources. We know there is a lot of interest in the community to achieve a higher level of energy efficiency. While this consultation document deals with the supply-side of electricity provision, we will continue to step up our efforts on the demand-side of the equation to achieve our common goal to conserve and save electricity.

I look forward to your views as we chart the way ahead on Hong Kong's future fuel mix for electricity generation.

KS Wong

Secretary for the Environment

March 2014

Background



Chapter 1: Background

1.1 Hong Kong does not have any indigenous resources for electricity generation and has been meeting its electricity demand through importing fuel for local electricity generation or importing electricity from the Mainland. The Government's energy policy is to ensure that the energy needs of the community are met safely, reliably, efficiently and at reasonable prices, while minimising the environmental impact of electricity generation.

Electricity supply by privately-owned power companies

1.2 Electricity supply in Hong Kong has all along been provided by the private sector. The Hongkong Electric Company, Limited (HKE) supplies electricity to customers on Hong Kong Island, Ap Lei Chau and Lamma Island, while CLP Power Hong Kong Limited and Castle Peak Power Company Limited (referred to collectively as CLP) supply electricity to customers in Kowloon, the New Territories and some outlying islands.

1.3 Both power companies are privately owned and vertically integrated. They own and operate their respective electricity supply chain, including generation plants, transmission and distribution networks, and supply electricity directly to customers and provide customer services within their respective service areas.

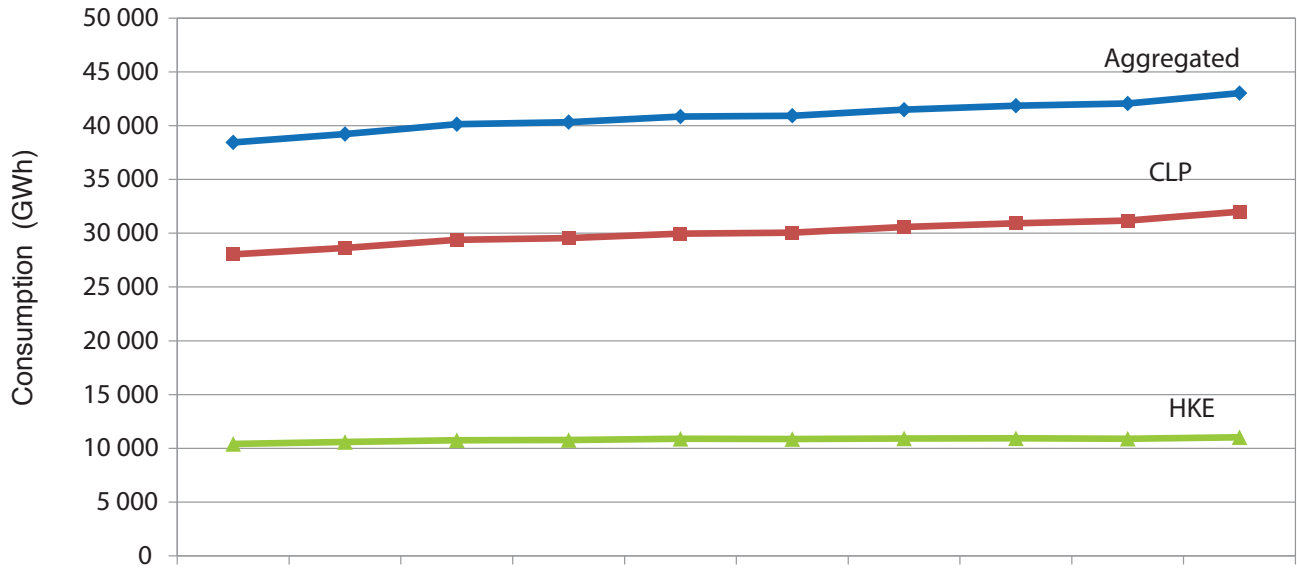
1.4 The two power companies have a total installed electricity generation capacity of 12 645 megawatts (MW) in 2012. About 77% of our electricity needs are met by local generation, with the remaining 23% imported through a dedicated transmission line from the Daya Bay Nuclear Power Station (DBNPS) in the Mainland.

Electricity consumption and maximum demand

1.5 Due to the energy efficiency measures implemented over the past few years and the concerted efforts of the community in conserving energy, the growth in electricity consumption in Hong Kong has slowed. Electricity consumption from 2008 to 2012 increased by about 5.1%, or by an average of about 1.3% on an annual basis. The gross domestic product (GDP) growth for the same period was 19.3%. On maximum electricity demand, it is the highest electricity requirement in a year, and an important parameter for assessing the adequacy of generation facilities and the need for new facilities. From 2008 to 2012, the aggregated¹ maximum electricity demand in Hong Kong decreased by about 0.8%. Figures 1 and 2 show the electricity consumption and maximum demand in Hong Kong during 2003-2012.

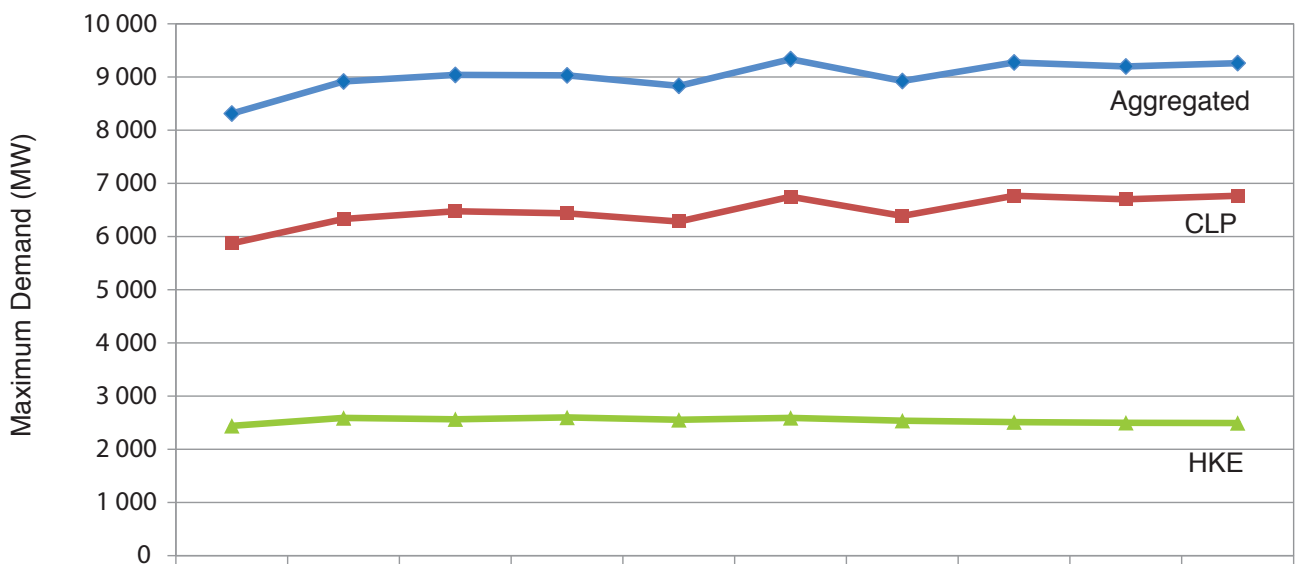
¹ Aggregated maximum electricity demand is the sum of the non-coincident maximum demands of CLP and HKE.

Figure 1 : Electricity consumption in Hong Kong during 2003-2012



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Aggregated	38 448	39 225	40 137	40 334	40 853	40 930	41 491	41 862	42 065	43 031
Growth Rate	0.2%	2.0%	2.3%	0.5%	1.3%	0.2%	1.4%	0.9%	0.5%	2.3%
CLP	28 035	28 632	29 382	29 561	29 962	30 065	30 570	30 929	31 168	31 995
Growth Rate	1.2%	2.1%	2.6%	0.6%	1.4%	0.3%	1.7%	1.2%	0.8%	2.7%
HKE	10 413	10 593	10 755	10 773	10 891	10 865	10 921	10 933	10 897	11 036
Growth Rate	-2.2%	1.7%	1.5%	0.2%	1.1%	-0.2%	0.5%	0.1%	-0.3%	1.3%

Figure 2 : Maximum electricity demand in Hong Kong during 2003-2012



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Aggregated	8 314	8 917	9 040	9 032	8 836	9 338	8 926	9 276	9 200	9 263
Growth Rate	0.6%	7.3%	1.4%	-0.1%	-2.2%	5.7%	-4.4%	3.9%	-0.8%	0.7%
CLP	5 874	6 329	6 475	6 435	6 284	6 749	6 389	6 766	6 702	6 769
Growth Rate	0.8%	7.7%	2.3%	-0.6%	-2.3%	7.4%	-5.3%	5.9%	-0.9%	1.0%
HKE	2 440	2 588	2 565	2 597	2 552	2 589	2 537	2 510	2 498	2 494
Growth Rate	0.2%	6.1%	-0.9%	1.2%	-1.7%	1.4%	-2.0%	-1.1%	-0.5%	-0.2%

Guiding energy policy objectives

(a) Safety

1.6 Safety is the top priority, and our objective is to ensure that electricity is generated, transmitted, distributed and used in a safe manner.

(b) Reliability

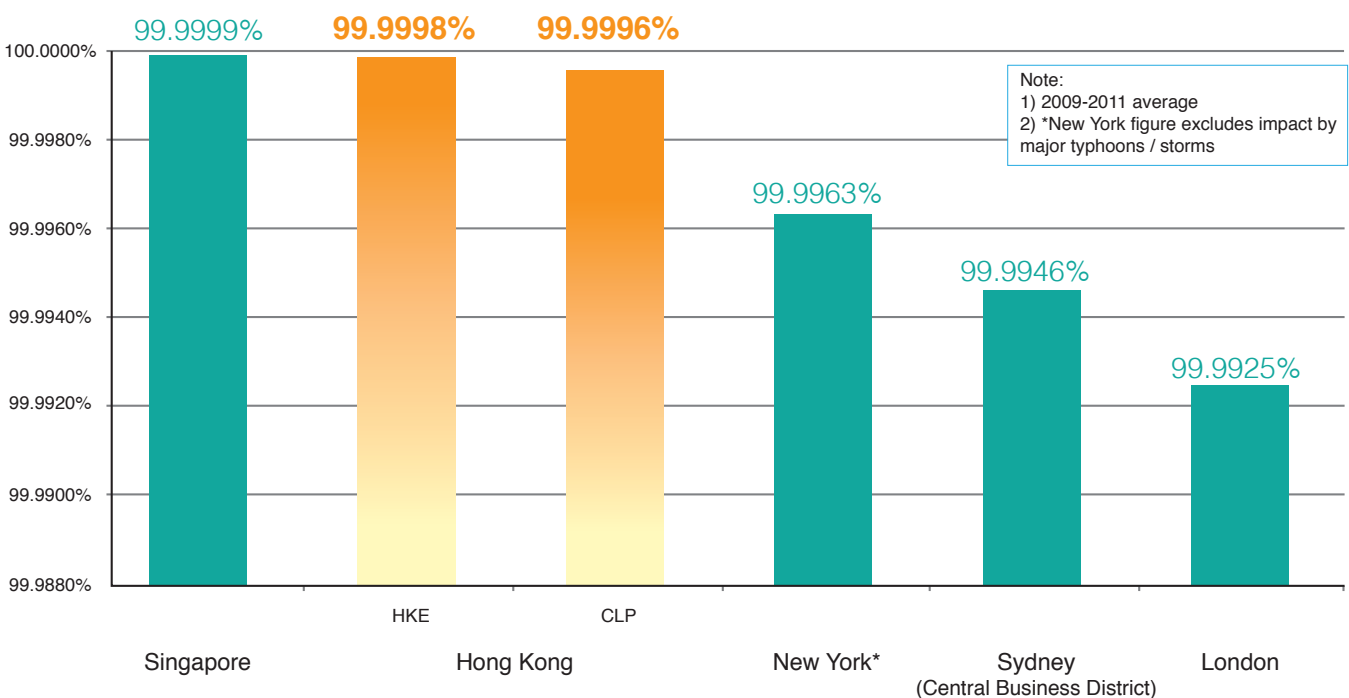
1.7 As an international financial and commercial centre operating in a densely populated environment with a significant concentration of high-rise buildings (domestic and non-domestic), Hong Kong cannot afford any instability in electricity supply. A reliable energy supply is essential not only to support and drive economic activities and development but also to ensure safety of the general public.

1.8 Hong Kong enjoys a highly reliable electricity supply. Reliability exceeds 99.999%, which surpasses those of many other large cosmopolitan cities. The average, unplanned electricity interruption from 2009

to 2011 for a typical customer in Hong Kong was less than 3 minutes per year. The last major blackout was in the mid-1980s.

1.9 The high degree of electricity supply reliability in Hong Kong should not be taken for granted. To maintain it requires constant monitoring and capital investments, both of which have cost implications. Apart from the generation capacity required to satisfy the maximum demand of the year, which usually happens in summer, the power companies need to have sufficient reserve capacity to cater for any loss of generating units in order to maintain stability. The required total installed capacity is determined by the maximum demand and the reserve capacity. In 2012, the reserve margins for CLP and HKE are about 30% and 50% respectively, which are expected to decline in the coming five years as maximum demand grows and as some existing generating units would be retired.

Figure 3 : Supply reliability



Sources: information provided by HKE and CLP.

(c) Affordability

1.10 As electricity is an essential utility for all walks of life, we must strive to ensure that it is provided at a reasonable price. Tariff paid by Hong Kong electricity users is made up by two major components: the basic tariff and fuel clause charge. Certain adjustments may be made from time to time through returning rebates to customers.

1.11 The basic tariff covers operating expenses, standard fuel charges and return to the power companies, and has been maintained at a relatively stable level in the last decade. Fuel clause charge reflects the changing price of fuels and is borne by electricity users and payable to the power companies on a cost-pass-through basis.

1.12 According to the “2009/10 Household Expenditure Survey and the Rebasing of the Consumer Price Indices” published by the Census & Statistics Department, households in Hong Kong on average spent less than 2% of their expenditure on electricity supply.

1.13 Figure 5 sets out electricity tariffs in some cosmopolitan cities. It shows that Hong Kong compares favourably with other cities in this aspect. For a customer with monthly consumption of 275 kilowatt hour (kWh), which accounts for around 50% of CLP’s domestic customers and 40% of HKE’s, the domestic electricity tariffs are lower than Singapore, London, New York and Sydney.

(d) Environmental performance

1.14 Electricity generation is a major source of air pollution and carbon emissions in Hong Kong. Extensive efforts have been made to minimise its environmental impacts, as further set out in Chapter 2.

Figure 4: Trend of average net tariff in Hong Kong from 2004 to 2014

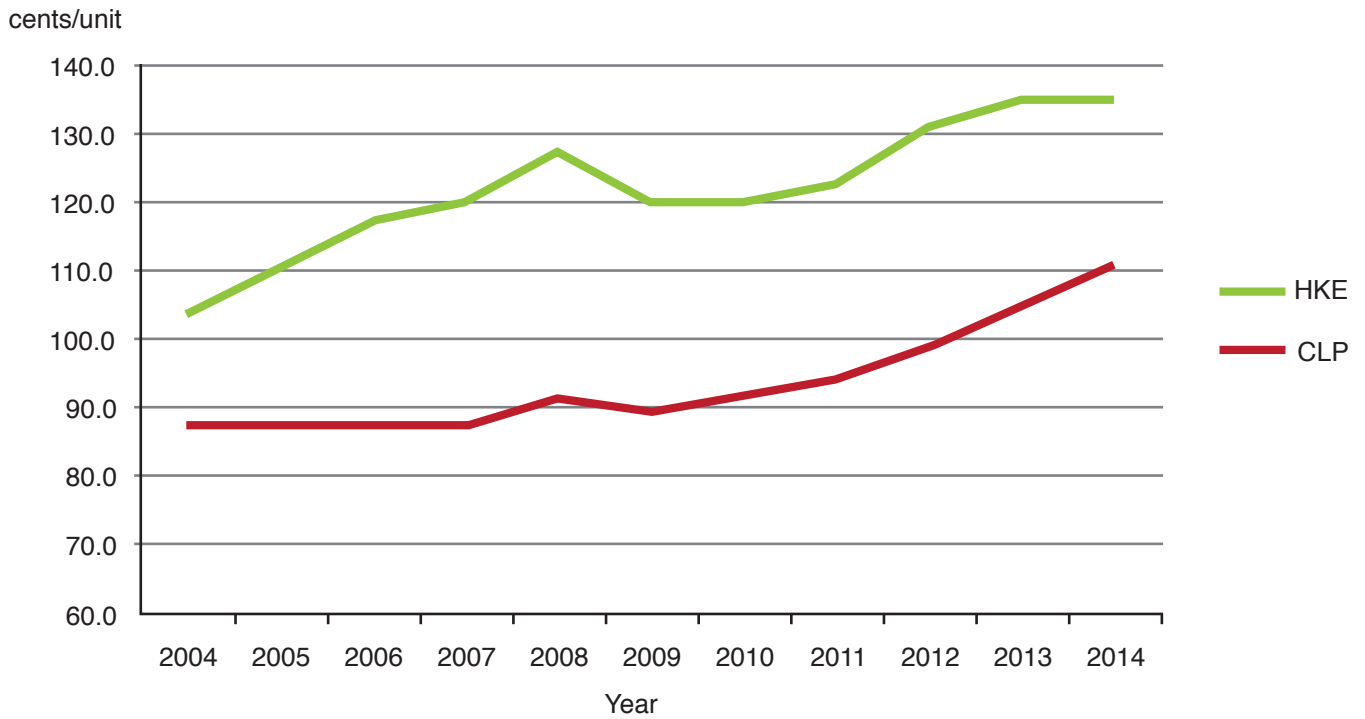


Figure 5: Comparison of electricity tariff in Hong Kong and other major cities



Remarks:

- Comparison based on average monthly domestic consumption of 275 kWh.
- For Hong Kong, net tariff for 2014 is adopted.
- For other countries, tariff and exchange rate at November 2013 are adopted.

Table 1: Average net tariff in Hong Kong from 2004 to 2014

CLP

	2004 ¢/unit	2005 ¢/unit	2006 ¢/unit	2007 ¢/unit	2008 ¢/unit	2009 ¢/unit	2010 ¢/unit	2011 ¢/unit	2012 ¢/unit	2013 ¢/unit	2014 ¢/unit
Basic Tariff	88.1	88.2	88.0	88.1	88.1	77.4	80.1	80.1	84.2	84.2	88.4
Fuel Clause Charge	(0.3)	0.2	2.0	2.0	5.9	11.8	11.5	14.1	17.8	22.4	22.4
Rebates	(0.6)	(1.1)	(2.9)	(2.9)	(2.9)	0	0	0	(3.3)	(2.1)	0
Average Net Tariff	87.2	87.3	87.1	87.2	91.1	89.2	91.6	94.2	98.7	104.5	110.8

HKE

	2004 ¢/unit	2005 ¢/unit	2006 ¢/unit	2007 ¢/unit	2008 ¢/unit	2009 ¢/unit	2010 ¢/unit	2011 ¢/unit	2012 ¢/unit	2013 ¢/unit	2014 ¢/unit
Basic Tariff	108.5	114.9	114.4	114.3	116.9	94.5	94.5	93.0	93.9	94.7	101.8
Fuel Clause Charge	(4.1)	2.2	4.9	5.9	10.5	25.4	25.4	30.2	37.0	40.2	33.1
Rebates	(1.1)	(7.1)	(1.9)	0	0	0	(0.1)	(0.1)	0	0	0
Average Net Tariff	103.3	110.0	117.4	120.2	127.4	119.9	119.8	123.1	130.9	134.9	134.9

Competing policy objectives

1.15 Each of the four policy objectives is important on its own. While we cannot compromise on safety, there is no room for lower reliability. We also attach much importance to air quality but at the same time have to strive to ensure the affordability of electricity supply. These four policy objectives are competing objectives in that the achievement of one may come at the expense of another. For instance, maintaining a high degree of reliability calls for more infrastructural investments; and cleaner energy, such as natural gas, is more expensive than coal and its greater use will cost more.



Current regulation of electricity supply

1.16 The electricity market in Hong Kong has until now been regulated through the Scheme of Control Agreements (SCAs) signed between the Government and the two power companies. The SCAs set out the obligations of the power companies, the returns for shareholders and the arrangements by which the Government monitors the power companies' financial affairs. The current SCAs run for a term of ten years and will expire in 2018, with an option exercisable by the Government to extend for five years until 2023. The Government has undertaken to carry out preparatory work, including studying the feasibility to open up the market, within the current regulatory period, before implementing any changes to the post-2018 electricity supply regulatory framework. The outcome of the present consultation on future fuel mix would set the scene for the review of the post-2018 regulatory framework for the electricity market.



Chapter 2

Revamping Hong Kong's Fuel Mix



Chapter 2: Revamping Hong Kong's Fuel Mix

Current fuel mix

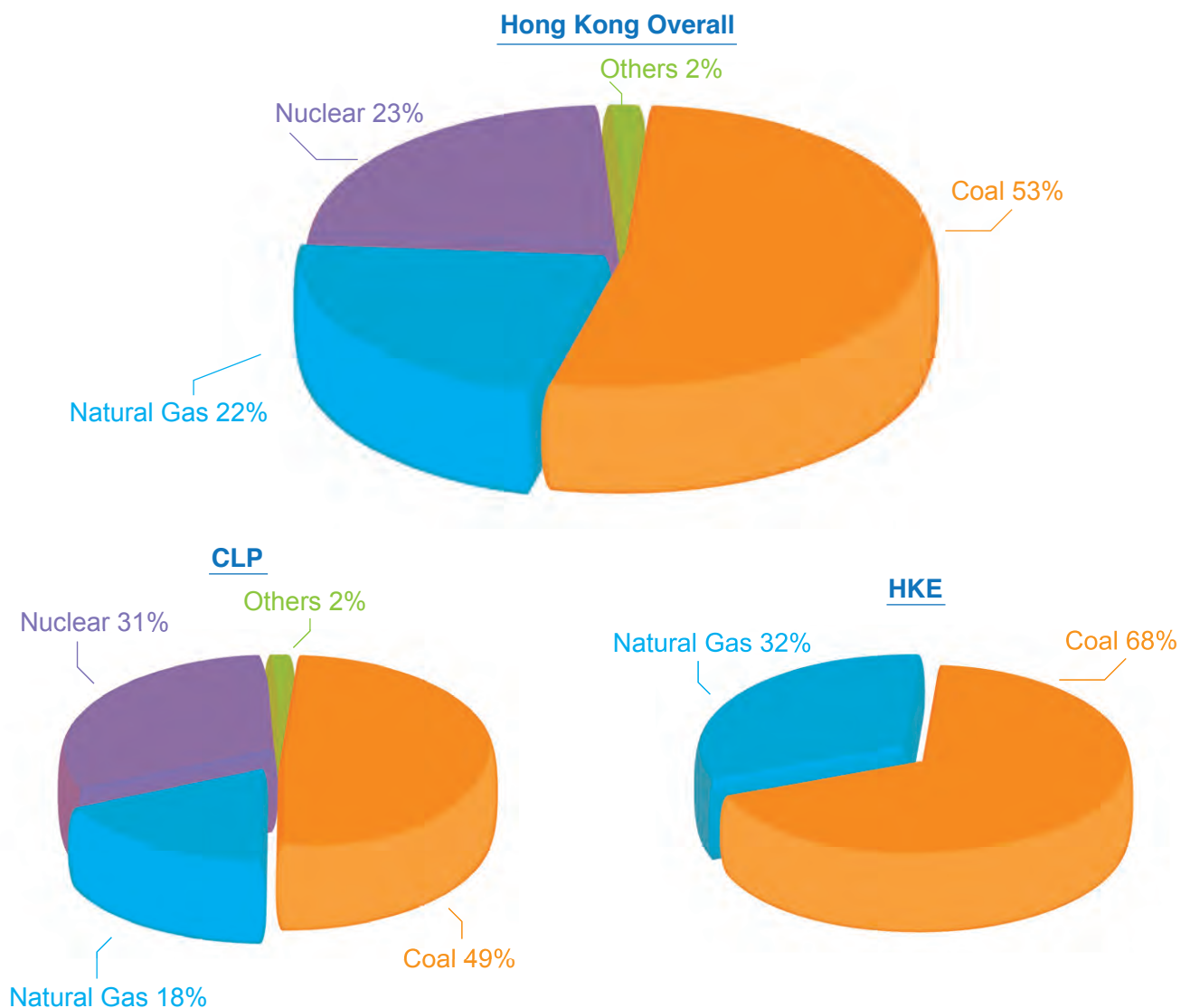
2.1 The “fuel mix” for electricity generation means the mix of energy sources used to generate electricity.

2.2 In 2012, HKE has a total installed capacity of 3 757 MW for electricity generation at the Lamma Power Station and its extension, with coal-fired, gas-fired and oil-fired units as well as some renewable energy (RE) technologies. CLP has an

installed capacity of 8 888 MW in total in four local power stations at Black Point (gas-fired), Castle Peak (coal-fired) and Penny's Bay (oil-fired), as well as from import from DBNPS and Guangzhou Pumped Storage Power Station.

2.3 Figure 6 shows that in 2012 coal dominated the overall fuel mix (53%), followed by nuclear electricity imported from DBNPS in the Mainland (23%), natural gas (22%), and oil and RE (2%).

Figure 6 : Fuel mix of Hong Kong in 2012



Major considerations

2.4 There are several key reasons why we need to review and plan ahead the future fuel mix for Hong Kong -

- some of the power generating units will start to be retired in the coming few years. This presents an opportunity to explore how they should be replaced, and calls for a reassessment of the overall fuel mix and early planning of necessary new generation and/or transmission infrastructure;
- we have to satisfy rising demand for electricity notwithstanding the small growth projected;
- we have to meet the air pollutant emission reduction targets already set to improve our air quality, both locally and regionally; and
- we remain committed to the carbon intensity² reduction target proposed during the public consultation on Hong Kong's climate change strategy and action agenda in 2010. This helps to reduce Hong Kong's greenhouse gas (GHG) emissions so that we can articulate a path forward in contributing to the global fight against climate change.

² Carbon intensity is the amount of GHG or carbon emissions per unit of GDP.

Replacing local generating units

2.5 Amongst the various fuel types being used for electricity generation, coal has the highest emissions. For environmental reasons, we have not allowed power companies to build new coal-fired electricity generating units since 1997. The majority of the existing local coal-fired units came into operation in the 1980s and they are scheduled to retire from 2017. Subject to their actual operating conditions, some of the existing units can be extended beyond their current book lives of about 35 years. However, even with such extension, they will be phased out eventually in the foreseeable future. As it takes considerable time to plan, design and construct new and cleaner facilities or to put in place cross-boundary electricity transmission infrastructure to import electricity from the Mainland, there is an imminent need for us to look and plan ahead now.

Meeting projected demand for electricity

2.6 Based on the latest trend of an average growth rate of about 1%-2% per annum in recent years, our latest estimation is that the total electricity consumption may increase from about 43 billion kWh in 2012 to about 48 billion kWh in 2020 and about 50 billion kWh in 2023. Despite the slower growth of electricity consumption, given the long lead time required for development of electricity infrastructure, we need to plan ahead early. The planning for generation capacity has to be done on the basis of maximum demand for electricity, rather than the overall consumption, with a reasonable reserve capacity to ensure supply reliability.

Improving air quality

2.7 Electricity generation is one of the major sources of air pollutant emissions in Hong Kong, accounting for 47% of sulphur dioxide (SO₂), 28% of nitrogen oxide (NO_x) and 16% of respirable suspended particulates (RSP) in 2012. On the supply side, as we have already done as much as practicable in applying technical improvements to the current coal-fired plants, changing our fuel mix is an important way to reduce emissions further.



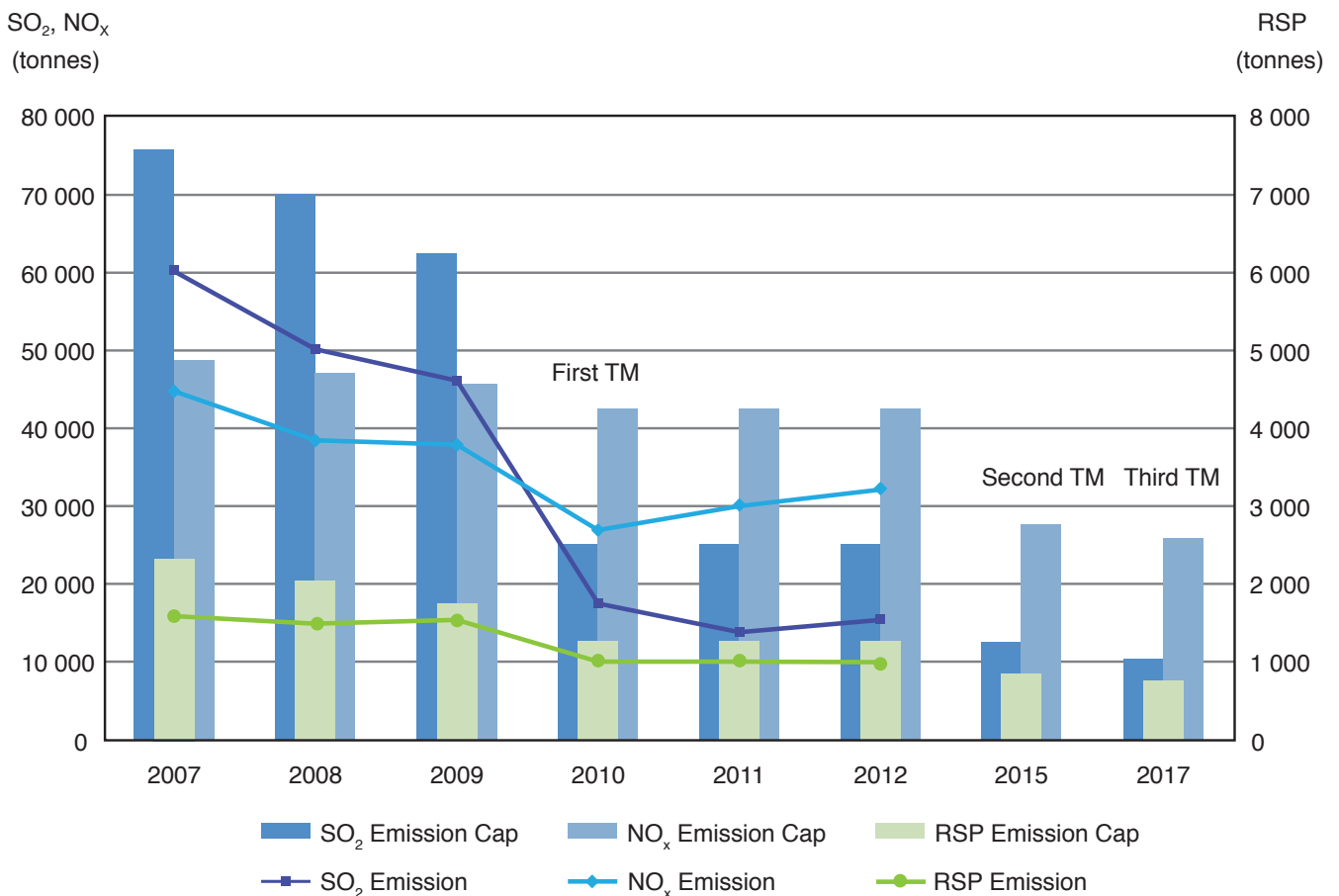
(a) Statutory control over air pollutant emissions

2.8 To reduce air pollutant emissions from the power plants, we have been progressively tightening up the statutory emission caps for SO₂, NO_x and RSP among local power plants as well as encouraging the power companies to use cleaner fuels and to retrofit their major coal-fired electricity generating units with advanced emission reduction devices. Further to the promulgation of the First and Second Technical Memoranda (TM) under the Air Pollution Control Ordinance (Cap. 311) in 2008 and 2010 respectively, we issued the Third TM in November 2012 to further tighten the emission caps for the power sector from 2017 onwards by 39%-59% as compared with the 2010 levels.

2.9 The First TM came into effect from 2010. The Second TM will come into effect from 2015 and the third from 2017. Figure 7 shows the required emission reduction levels for the power sector, as well as the achieved levels with respect to the First TM.

2.10 In order to meet the emission caps, the power companies have added flue gas desulphurisation and NO_x control systems to their major coal-fired generating units in phases between 2009 and 2011, at a total cost of about \$10 billion, which has significantly reduced emissions of SO₂ and NO_x. They are also using low-emission coal whenever possible. On the supply side, further emissions reduction from electricity generation can be achieved only through reducing the reliance on coal and switching to cleaner fuels.

Figure 7 : Emission caps of air pollutants for local power plants



(b) 2020 air pollutant emission reduction targets

2.11 Other than the promulgation of TMs, as part of our continuous effort to improve air quality, the Government also announced in November 2012 new air pollutant emission reduction targets for 2020. As shown in Table 2, SO₂ emissions in Hong Kong would be reduced by 35%-75%, NO_x by 20%-30% and RSP by 15%-40% by 2020 when compared to 2010. With this, we expect that by 2020 the ambient air quality of Hong Kong would meet broadly the new Air Quality Objectives, which came into effect from 1 January 2014 to further protect public health.

2.12 The air pollutant emission reduction targets are to be achieved through implementation of a package of ongoing initiatives, including phasing out highly polluting commercial diesel vehicles, requiring ocean-going vessels to switch to cleaner fuel while berthing at Hong Kong waters, tightening of the standard of local marine diesel, etc. Beyond these measures, revamping the fuel mix for electricity generation would be one of the major contributors towards the achievement of the 2020 air pollutant emission reduction targets.

Table 2: Emission reduction targets for major air pollutants

Air Pollutant	Actual Emission Level in 2010 (tonnes)		Emission Caps for Power Sector in 2017 (tonnes) [% reduction vs. 2010]	Emission Reduction Targets for Hong Kong in 2020 (% reduction vs. 2010)
	Hong Kong Overall	Power sector only		
Sulphur dioxide (SO ₂)	35 500	17 800	10 399 [↓ 42%]	↓ 35% – 75%
Nitrogen oxides (NO _x)	108 600	27 000	25 950 [↓ 4%]	↓ 20% – 30%
Respirable suspended particulates (RSP)	6 340	1 010	750 [↓ 26%]	↓ 15% – 40%

Combating climate change

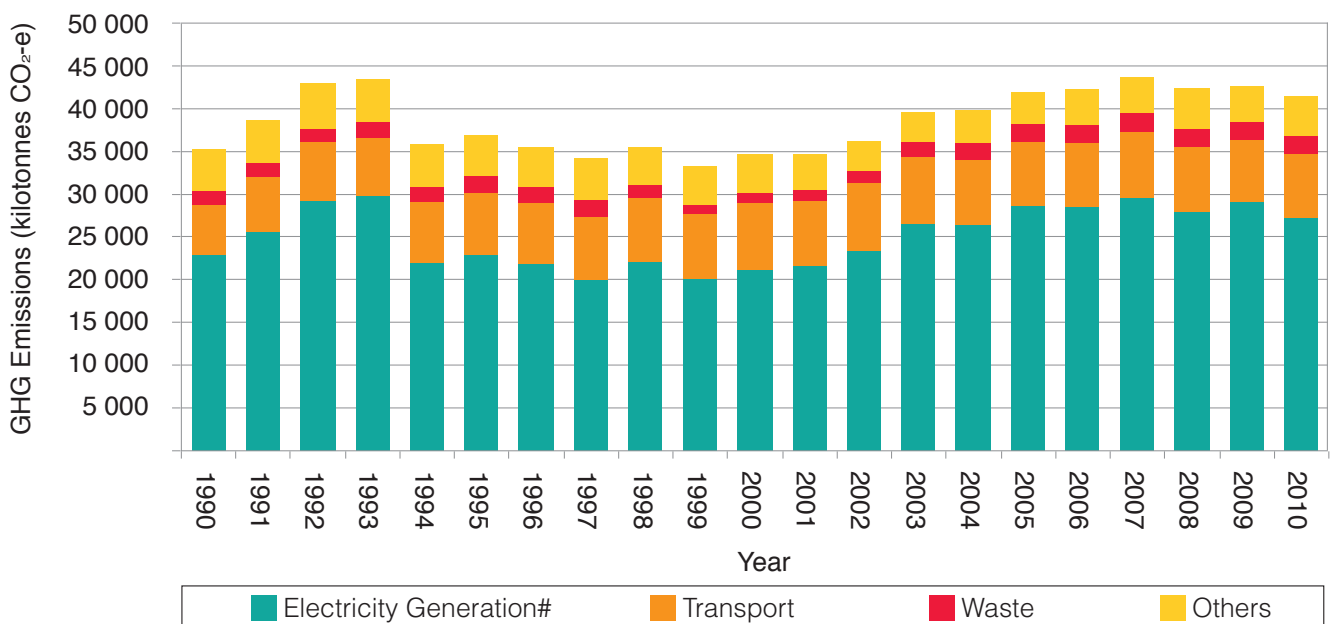
2.13 In 2010, Hong Kong's total GHG emissions were about 41.5 million tonnes of carbon dioxide equivalent (CO₂-e), or around 5.9 tonnes on a per capita basis, accounting for about 0.1% of global emissions or slightly less than that of Hong Kong's population as a share of the world's total. In terms of sectoral contribution, electricity generation is the largest source of local GHG emissions, accounting for about 66%.

2.14 Revamping the fuel mix for local electricity generation is an essential step to maximise the scope for suppressing Hong Kong's GHG emissions and carbon intensity. The Government proposed in a public consultation on combating climate change in September 2010 to revamp Hong Kong's fuel mix for electricity generation in 2020, as part of a package of proposals to reduce the carbon intensity by 50%-60% by 2020 when compared to 2005³. The achievement

of this target would result in an absolute reduction of carbon emissions by 19%-33% or from 42 million tonnes in 2005 to 28-34 million tonnes in 2020. Per-capita emissions would correspondingly be reduced from 6.2 tonnes to 3.6-4.5 tonnes.

2.15 While we were consolidating the comments received, the earthquake that took place in northeastern Japan in March 2011 and the tsunami that followed caused the nuclear incident in Fukushima. We had therefore temporized our assessment at that stage. In further reviewing the fuel mix and mapping out the fuel mix options set out in Chapter 4, we remain committed to achieving the proposed target of reducing carbon intensity by 50%-60% by 2020 when compared to 2005. Apart from this important measure on the supply side, we will review separately the progress taken so far in implementing other mitigation measures on the demand side as well as adaptation measures in articulating our path forward in combating climate change.

Figure 8 : GHG emission trends of Hong Kong from 1990 – 2010



Including Towngas production which accounts for about 1% of GHG emissions caused by energy production.

³ As a non-Annex I Party under the Kyoto Protocol, China (including Hong Kong SAR) is not required to meet any mandatory GHG emissions limits or reduction targets. This notwithstanding, the Central People's Government announced in November 2009 a voluntary national target to reduce its carbon intensity by 40% - 45% by 2020 as compared with the 2005 level. Hong Kong proposed in 2010 a higher target for itself in combating climate change with regard to its state of economic development.



Impacts of Climate Change

The latest United Nations Intergovernmental Panel on Climate Change Summary for Policymakers of the Fifth Assessment Report reaffirmed the observed and unequivocal warming of the Earth's climate, highlighting various unprecedented changes, including the atmospheric concentration of carbon dioxide (CO₂) having increased by 40% since pre-industrial times. The increase is primarily due to burning of fossil fuels. Human influence is believed to be the dominant cause of the observed warming since the mid-20th century. Scientists projected that in the high greenhouse gas concentration scenario, global mean surface temperature by the end of this century would likely rise by 2.6°C-4.8°C as compared with that in the end of last century. There will be more extreme weather events, causing flooding and droughts in various locations. Further uptake of CO₂ by ocean will increase ocean acidification.

Impacts on Hong Kong

There are already observable changes in local weather patterns. The rising trend in temperature in Hong Kong is likely to continue in the future, and depending on the level of greenhouse gas concentration in the atmosphere, the rise is expected to be in the range of 1.5°C - 6°C by the end of this century as compared with that in the end of last century. The number of very hot days is projected to increase in the 21st century, and conversely the number of cold days is going to fall. In addition, there is likely to be greater variability in yearly rainfall patterns with a higher frequency of extreme conditions, i.e., extremely wet years and extremely dry years are expected to become more frequent in the 21st century. The number of heavy rain days is likely to increase. It is expected that the mean sea level rise in the South China Sea, including Hong Kong waters, would increase in line with the global trend in the late 21st century.

Considering the Fuel Mix Revamp



Chapter 3: Considering the Fuel Mix Revamp

3.1 This chapter sets out the benefits and drawbacks of various fuel types available to Hong Kong, and highlights the related developments that should be taken into account in mapping out the future fuel mix for electricity generation.

Fuel Types

(a) Coal

3.2 Globally, coal currently supplies more than 40% of the world electricity consumption. It is relatively cheap, abundant, accessible, widely distributed and easy to transport, store and use⁴. However, coal combustion is a major source of air pollutant and GHG emissions.

3.3 In Hong Kong, electricity generation by coal-fired units accounted for 50% of total SO₂ emissions, 22% of NO_x, 14% of RSP and 50% of GHG in 2010. On generation cost, it is determined not just by coal price but also investment made to the coal-fired plants to reduce emissions.

(b) Natural gas

3.4 Natural gas is meeting more than 20% of the world's electricity demand and the share may continue to rise. Its clear advantage over coal is that it burns more cleanly and produces less air pollutants and CO₂. The emissions of SO₂, NO_x and RSP per unit of electricity generation from using natural gas are about 98%, 77% and 79% less than those from burning coal respectively⁵. For an equivalent amount of heat input, burning natural gas produces about 45% less CO₂ than coal⁶.

3.5 As compared to coal, natural gas is more costly. Its price has been very volatile and generally on a rising trend in recent years as a result of the increasing demand globally for cleaner energy. As an illustration, Japan LNG prices surged in recent years from around USD 7 per million British Thermal Units (mmBtu) in 2006 to around USD 16 per mmBtu in 2013⁷. Natural gas price delivered to Asia in the foreseeable future is difficult to predict at this stage. Even as large-scale shale gas production in the United States (the US) has brought prices down there, with long-distance transportation and strong global market demand, its prices in the Asia market are not expected to be as low as they are in North America.

3.6 In Hong Kong, natural gas has been used for electricity generation since the 1990s. The natural gas supply contracts that the two power companies entered into then are very competitive when compared to today's prices. However, with the gradual depletion of a major existing gas source and the increasing use of gas at prevailing market price, the cost of natural gas electricity generation will likely increase in the foreseeable future.

(c) Renewable energy (RE)

3.7 RE generally refers to energy sources that are sustainable or capable to be naturally replenished. These include solar energy, hydropower, wind and biomass. As compared to fossil fuels, RE does not create air pollutant or GHG emissions during the electricity generation process. The viability of most RE types is, however,

⁴ Source: International Energy Agency (www.iea.org)

⁵ Based on the overall emission performance of the power sector in 2012.

⁶ Source: www.naturalgas.org

⁷ Source: World Bank

determined by locations. This is particularly true for solar, hydro and wind power, where the availability and adequacy of energy sources in the vicinity of generation essentially determines the scale of electricity generation and economic viability.

3.8 Given its intermittent nature, electricity generation using RE is not as reliable as that using fossil fuels and nuclear power. In the case of Hong Kong, given our natural constraints

and geographical limitations, there are limited opportunities in using RE as a major fuel source economically under the current state of technology. That said, the Government has been encouraging the development and wider adoption of RE in Hong Kong with regard to technical and economic viability.



Memorandum of Understanding (MoU) on Energy Co-operation with the Mainland

The Government of the Hong Kong Special Administrative Region signed a MoU on energy co-operation with the National Energy Administration in August 2008 to ensure a continuous supply of natural gas and nuclear electricity to Hong Kong for the next two decades. Under the MoU, the Central People's Government provides a guarantee on the supply of natural gas from three sources, i.e. offshore gas, piped

gas and via a liquefied natural gas terminal to be jointly built on the Mainland. The implementation of the MoU ensures the provision of cleaner energy to Hong Kong for electricity generation. Through the MoU, the Hong Kong Branch Line of the Mainland's Second West-East Natural Gas Pipeline has been constructed, which provides Hong Kong with a new source of natural gas from Turkmenistan via the Mainland. Besides, energy enterprises of the two sides also renewed the agreement on the supply of nuclear electricity from DBNPS for a further term of 20 years from 2014 up until 2034.

Wind energy

3.9 The wind energy sector has experienced significant growth worldwide in recent years. The wider adoption of wind power as a source of electricity supply would hinge on various factors, including the availability and reliable supply of wind resource, space for setting up the requisite facilities, commercial viability, etc. In Hong Kong, the two power companies have explored the feasibility of offshore wind farm projects. However, it is doubtful as to whether there is an economic case to develop and use off-shore wind farms. Because of lack of wind resources in the vicinity and the scattered nature of supply, import from the Mainland through dedicated lines is not currently viable either.

Solar energy

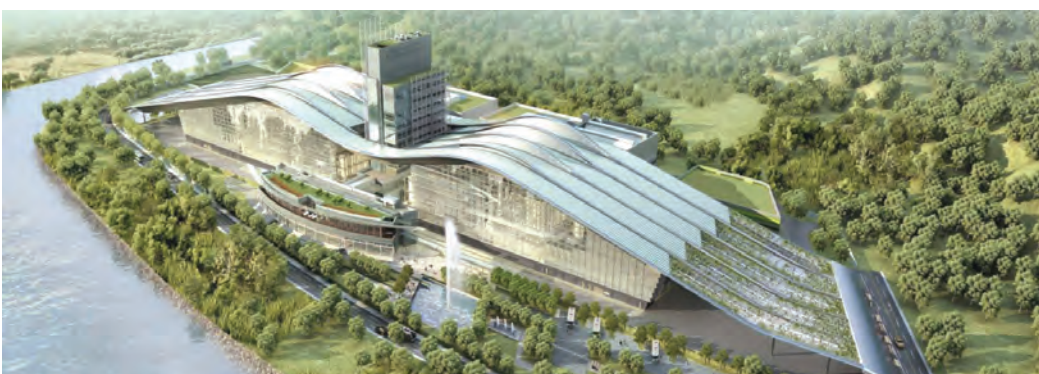
3.10 The global harnessing of the solar resource has made considerable progress in recent years. The Government has adopted solar technologies in a number of government projects. The two power companies have also started to apply such technologies, although the scale is very limited. It cannot be relied upon as a major source of power

for electricity generation notwithstanding our policy to continue to promote its adoption.

Waste-to-energy

3.11 The adoption of waste-to-energy in Hong Kong as a source of electricity supply would depend on the potential of developing waste-to-energy facilities. The substantial amount of municipal waste generated as a result of urban life in Hong Kong can be used for electricity generation. As promulgated in the “Hong Kong Blueprint for Sustainable Use of Resources 2013-2022” and “A Food Waste & Yard Waste Plan for Hong Kong 2014-2022”, specific measures to promote waste-to-energy include the operation of a sludge treatment facility (STF), an integrated waste management facility (IWMF), and a number of organic waste treatment facilities (OWTFs).

3.12 With regard to the projects already completed and being planned, the share of RE from waste is unlikely to be significant and may at the most make up about 1% of total electricity demand by the early 2020s.



Waste-to-energy facilities

Sludge Treatment Facility

The new STF is coming into operation in 2014, which will have a total daily treatment capacity of 2 000 tonnes of sewage sludge. The RE generated from the incineration process will be utilized to meet the power demand of the daily operation of the STF. About 18 million kWh of surplus electricity, at a maximum output of 2 MW, can be supplied to the electricity grid per year, which is expected to reduce GHG emissions by about 260 000 tonnes per year.

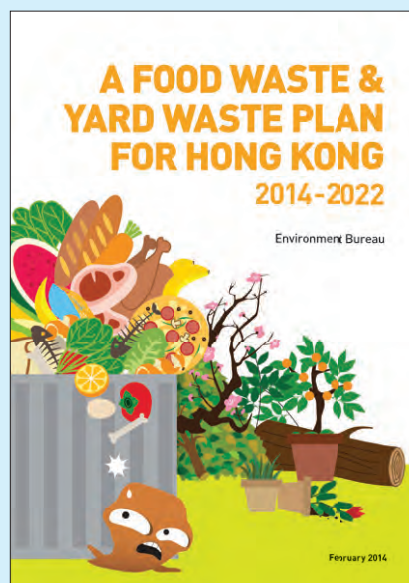
Integrated Waste Management Facility

We plan to develop an IWMF off Shek Kwu Chau by adopting advanced incineration with energy recovery as the core waste treatment technology. It will have a daily treatment capacity of 3 000 tonnes of municipal solid waste and can supply about 480 million kWh

of surplus electricity to the electricity grid per year. This is equivalent to 440 000 tonnes of GHG emission reduction. We plan to commission the IWMF by 2022.

Organic Waste Treatment Facilities

We plan to develop a number of OWTFs with the first one to commence operation by 2016-2017, the second one tentatively by 2018-2019 and the third by 2021-2022. On completion of these facilities, Hong Kong will have a total daily treatment capacity of 800 tonnes organic waste. The biogas generated in the treatment process can be used for electricity generation or other purposes. If used for electricity generation, it is estimated that at least about 14 million kWh of surplus electricity can be supplied to the power grid per year from each plant, which is expected to reduce GHG emissions by about 25 000 tonnes per year.



(d) Nuclear energy

3.13 Nuclear energy generates more than 11% of the world's electricity⁸. Around 30 countries are operating about 440 nuclear power generating units.

3.14 Following the Fukushima nuclear incident, various countries have reviewed the safe use of nuclear energy. In the Mainland, the State Council conducted comprehensive and extensive safety checks on all nuclear facilities and strengthened China's nuclear safety plan. In October 2012, the State Council announced plans to enhance nuclear safety and to further develop nuclear electricity. All new reactors shall meet the highest international safety requirements.

3.15 In Hong Kong, CLP meets about 30% of its power needs by importing nuclear electricity from DBNPS under a 20-year contract expiring in 2014, which had been extended in 2009 for another 20 years up to May 2034. This constitutes around 23% of the overall fuel mix in Hong Kong in 2012, and the percentage will reduce to around 20% by early 2020s as overall electricity consumption is expected to gradually increase. Some 70% of the total output of the two nuclear reactors in DBNPS is exported to Hong Kong while the remaining 30% is provided to Guangdong province. CLP is also making arrangements for additional import of about 10% of electricity from DBNPS as part of the measures to mitigate the tariff impact over the next couple of years.



Nuclear development in the Mainland⁹

There are currently 17 nuclear power generating units in operation in the Mainland. A relatively late start of the nuclear industry has enabled China to assimilate mature experience of other members of the international community in imposing stringent requirements on par with international standards regarding the regulation, planning and technology, nuclear waste treatment, manpower training, etc., and regulating the industry by strictly adhering to these standards.

On regulation, the National Nuclear Safety Administration (NNSA) is an authority independent of the nuclear development department to enforce independent monitoring and control on the safety of all nuclear facilities at various stages from site selection, design, construction, operation to decommissioning, and to ensure strict compliance of relevant requirements by operators. The NNSA has set up six regional nuclear and radiation safety monitoring stations in the Mainland and deployed staff to nuclear plants for on-site monitoring.

⁸ Sources: World Nuclear Association, Nuclear Energy Institute

⁹ Sources: National Nuclear Safety Administration

On planning and technology, the NNSA has adopted the safety standards published by the International Atomic Energy Agency (IAEA) as the basis, and has been cooperating with the IAEA in areas such as nuclear safety, nuclear technology and human resources, etc. The NNSA has also participated in IAEA's Commission of Safety Standards and its professional committees and engaged in the formulation of international nuclear safety standards. After the Fukushima nuclear incident, the Mainland conducted comprehensive security and safety checks and confirmed the safety of its nuclear plants under operation. The NNSA and other relevant organisations have seen to the completion of improvement works for the nuclear plants as recommended in the inspection reports. As for new nuclear projects, only those fully vetted stations will be considered by the Mainland authorities during the "12-5" period in accordance with the highest international safety standards, and their generating units must meet the highest international safety requirements. The nuclear plants should commence operation only after obtaining relevant permissions throughout the stages from site selection, construction, charging, operation to decommissioning.

On nuclear waste treatment, attaching great importance to the decommissioning of nuclear facilities, reprocessing of spent fuel, handling and disposal of radioactive waste, etc., the Mainland has adopted a management approach of "regional shallow ground disposal of low and mid-level radioactive wastes, deep geological disposal of high radioactive and transuranium wastes". Efforts are also being made to reduce the total quantity of radioactive waste to ensure environmental safety.

On manpower training, through government support and concerted efforts of universities and enterprises, the Mainland has set up a nuclear technology manpower training system with focus on basic university education and complemented by on-the-job training provided by enterprises, so as to enhance the quality of nuclear professionals.

(e) Direct purchase of electricity from power grid

3.16 Electricity imports and exports have been practised in many other countries, such as the US, the United Kingdom, and within the European Union (EU). Within a country, it involves the transfer of electricity from one region where generation is based to consumers in other regions. Electricity import also takes place between countries as in the cases of Switzerland and Germany importing electricity from France. In the case of the Macao Special Administrative Region, it imports about 90% of its electricity from the Mainland power grid.

3.17 In the case of Hong Kong, if we are to import electricity from the Mainland, this may be done through importing electricity directly from the China Southern Power Grid Co. Limited (CSG), which is already connected to CLP's power grid.



Electricity import in Macao

Macao meets about 90% of its electricity demand by importing electricity from Zhuhai, Guangdong, and the balance by local generation with oil/natural gas and incineration (waste-to-energy). In 2008, Macao's electricity company signed a 10-year agreement with the China Southern Power Grid Co. Limited to import electricity from the Mainland. The import is implemented mainly through interconnection between the power grids in Macao and Zhuhai, without specifying dedicated generation sources or fuel mix.

Electricity import in EU

Electricity trading among the EU countries takes place mainly through competitive market mechanism, including bilateral contracts, trading within power exchanges and balancing market. It helps meet the economic requirements of cities, nations and regions, and is primarily driven by differences in generation costs across countries during different periods. Taking the United Kingdom as an example, it has interconnections with France, the Netherlands and Ireland. In 2012, its total electricity imports from France and the Netherlands were 7 620GWh and 6 073GWh respectively, while the total electricity exports to France and the Netherlands from the United Kingdom were 1 191GWh and 254GWh respectively.

Electricity import in North America

Interconnections exist between the three major North American markets of Canada, Mexico and the United States. Canada typically exports between 6%-10% of its electricity production to the United States. A number of new grid connections between Canada and the United States have been established in the past five to ten years, including the Montana Alberta Tie Line project with a transmission line directly connecting Alberta and Montana electricity markets for transportation of primarily wind-generated power across the border.

China Southern Power Grid Co. Limited (CSG)

CSG is a state-owned enterprise established in 2002 after the Mainland reformed its power sector. CSG invests, constructs and operates power networks in Guangdong, Guangxi, Yunnan, Guizhou and Hainan provinces and regions. Featuring long-distance, large capacity, ultra high voltage and hybrid operation of alternating current (AC) and direct current (DC) systems, CSG is serving an area of up to 1 million square kilometers and a population of about 230 million. CSG's generation in 2012 stood at about 825 billion kWh and its total installed capacity was about 202 000 MW, of which non-fossil fuels accounted for about 44%, and fossil fuels about 56%. The generation fuel mix was about 62% thermal, 31% hydro, 6% nuclear and 1% wind.

Comparison of fuel types

3.18 The table below summarises the comparison of various fuel sources for future electricity generation for Hong Kong with regard to our four energy policy objectives.

Table 3 : Comparison of fuel types for future electricity generation for Hong Kong

Fuel Types	Availability	Reliability	Costs	Life-cycle GHG Emissions/ Air Pollutant Emissions
Coal	Adequate supply	High	Low	High
Natural Gas	Adequate supply	High	High and volatile	Medium
RE	Constrained locally	Low	Very high	Low
Nuclear	Available	High	Medium price plus extra costs for transmission, and possibly load management and local back-up	Low
Grid purchase	Available	High with suitable local back-up	Medium price plus extra costs for transmission, and possibly load management and local back-up	Low (in respect of local emissions)

Fuel Mix Options for Hong Kong



Chapter 4: Fuel Mix Options for Hong Kong

4.1 Having regard to the pros and cons of various fuel types and Hong Kong's local situation, we propose two specific fuel mix options as follows –

- Importing more electricity through purchase from the Mainland power grid; or
- Using more natural gas for local generation.

Planning horizon: a decade from now

4.2 Electricity supply requires long-term planning. For instance, it will take about four to five years to build new gas-fired electricity generating units in Hong Kong, and about eight to ten years to put in place new cross-boundary transmission infrastructure. We would also need to dovetail as far as possible the retirement schedule of the existing coal-fired generation facilities in Hong Kong with any decision to change the fuel mix.

The preferred fuel mix option will provide us with a basis to plan for our electricity infrastructure in the next decade. With a decision to be made in 2014 and depending on the fuel mix option we finally opt for, some of the infrastructure required could only be fully completed in around 2023. Under both options, appropriate measures will be adopted to achieve the pledged environmental targets in respect of air pollutant emission and carbon intensity reduction for 2020.

4.3 An important parameter to consider in planning the fuel mix is the estimated electricity consumption by 2023. In 2012, Hong Kong consumed 43 billion kWh of electricity. Based on the recent growth trend, we have assumed total electricity consumption of 50 billion kWh in 2023 and in respect of maximum demand, an annual average growth rate of 1%-2%, while continuing to promote energy efficiency and conservation.



Expected basic situation in 2023

(a) Imported nuclear energy

4.4 The present contract for importing nuclear electricity from DBNPS will last until May 2034. Hence, imported nuclear electricity will constitute about 20% of the total fuel mix in 2023, irrespective of the fuel mix option eventually pursued.

(b) Renewable Energy

4.5 Contribution from solar power will likely be small given the very little local potential to develop solar power generation in any massive scale. There is also limited prospect for wind power with the very high cost for constructing off-shore windfarms. Our waste-to-energy plans, if fully implemented, may at most contribute to about 1% of the fuel mix in 2023.

(c) Natural gas

4.6 Local gas-fired generation will play an increasingly larger role in meeting our electricity demand as we tighten the air pollutant emission caps in 2015 and 2017 through the TMs. Hence, the share of natural gas in the overall fuel mix will be larger than that of today under the two fuel mix options, albeit to varying extent.

(d) Coal

4.7 Our plan is for coal to be phased out completely in the longer term. Between now and 2023, we envisage coal usage to drop significantly. Coal in both fuel mix options proposed is more a “balancing” fuel type, with usage to be determined with regard to cost and environmental considerations.

Electricity import

4.8 Electricity import is not new to Hong Kong, as some 23% of our electricity demand is now met by imported electricity from DBNPS through a dedicated transmission line. In mapping out the future fuel mix for Hong Kong, a key issue that needs to be first addressed is whether we should meet the future electricity demand through importing more electricity from the Mainland or continuing to rely significantly on local generation.

For Hong Kong, electricity import from the Mainland can take the following two forms -

- (a) from a dedicated power source through dedicated transmission line. This is the model we have been adopting in importing nuclear electricity from DBNPS; and
- (b) from neighbouring power grids through strengthened interconnection¹⁰.

4.9 There are divergent views on which import arrangement can offer a higher degree of supply reliability. On (a) above, the designation of a dedicated plant for provision of electricity and the use of dedicated transmission line would enable Hong Kong to have direct control over the provision of electricity from the power plant and the quality of supply. The downside risk is that with increasingly heavy reliance on designated, external sources for meeting our electricity needs, any possible power disruption due to interruption to the designated power sources or breakdown of dedicated long-distance transmission network may undermine supply reliability.

4.10 On (b) above, while large-scale grid purchase is untested in Hong Kong, some are concerned about the adequacy of electricity supply in Guangdong and its reliability. However, experience in other places, including that of Macao, suggests that the concerns over supply reliability of imported electricity could largely be addressed through technical solutions, commercial agreements between the supplier and purchaser of electricity and commitments at government level.

4.11 As compared to importing more nuclear electricity through dedicated transmission line, we consider that purchase from the grid will allow Hong Kong to gain access to multiple sources of supply on a grid-to-grid basis, thereby enabling us to achieve a higher degree of fuel diversification. This option also allows Hong Kong to tap into clean fuel sources otherwise not available to us, e.g. hydro power. It also provides us with more flexibility in load management and meeting increase in future demand within a shorter planning lead time without having to identify specific new power sources. In respect of affordability, we estimate that the price differential of the two import options is not substantial having taken into account all necessary load management and grid access charges not currently applicable to import from DBNPS. For these reasons, we consider that purchasing electricity through the grid is preferable over importing electricity from dedicated sources through dedicated transmission lines.

¹⁰ Reference may be made to Macao importing from CSG to meet about 90% of its electricity needs.

Future fuel mix for Hong Kong

4.12 With a planning horizon of about a decade from now, it is important to diversify risks and to preserve maximum flexibility going forward given the uncertainties we are facing now in projecting the movement of fuel prices and the state of technological development. It would also be prudent to manage changes in the supply of an essential utility in a measured manner without affecting normal operation of the society.

OPTION 1 Importing more electricity through purchase from the Mainland power grid

A possible fuel mix ratio under this option is that Hong Kong would import electricity to meet about 50% of our demand, with about 20% being nuclear electricity currently imported from DBNPS and about 30% being new purchase from the Mainland power grid (i.e. CSG); while natural gas for local generation would account for about 40%, and coal and RE the remaining about 10%.

4.13 With the above considerations, we propose, for the purpose of planning necessary infrastructure, a mix of different fuel types for electricity generation towards 2023. Specifically, we propose two fuel mix options.

4.14 An assessment of these options against the energy policy objectives is set out below.

OPTION 2 Using more natural gas for local generation

A possible fuel mix ratio under this option is to increase the share of natural gas to about 60%, and to keep that for coal and RE within about 20% while continuing with import of nuclear electricity from DBNPS accounting for about 20% of the overall fuel mix.

Table 4 : Existing fuel mix ratio and possible ratios under the two proposed fuel mix options

FUEL MIX		IMPORT		NATURAL GAS	COAL (& RE)
		NUCLEAR (DBNPS)	GRID PURCHASE		
Existing (2012)		23%	-	22%	55% ¹¹
OPTION 1*	Importing more electricity through purchase from the Mainland power grid	20%	30%	40%	10%
		Total : 50%			
OPTION 2*	Using more natural gas for local generation	20%	-	60%	20%

* The above fuel mix ratios aim at providing a basis for planning the necessary infrastructure for electricity supply. Flexibility should apply to actual deployment of each fuel type, having regard to the circumstances happening on the ground. (See paragraph 4.43)

¹¹ Inclusive of a small percentage of oil.

Option 1: Importing more electricity through purchase from the Mainland power grid

4.15 Under this option, apart from the nuclear electricity imported from DBNPS which would account for about 20% of our projected electricity needs in 2023, Hong Kong will import from CSG electricity to meet about 30% of its needs (or about 15 billion kWh in absolute terms for 2023). The remaining 50% of electricity will be generated locally, with 40% using natural gas and 10% using coal and RE. The future fuel mix will therefore be roughly 50% imported electricity, 40% natural gas and 10% coal and RE for local generation.

Assessment

Environmental performance

4.16 This option offers a clear benefit of allowing Hong Kong to gain access to a more diversified fuel mix, and tap into low-carbon fuel sources not otherwise available to us. In 2012, for instance, generating units powered by non-fossil fuels accounted for about 44% of the installed capacity of CSG, being primarily hydro power from Yunnan.

4.17 This option will allow us to meet the upper bound of the air pollutant emission reduction targets, and help reduce carbon intensity by about 60% when compared to 2005 when the cross-boundary transmission infrastructure is fully completed in around 2023. Before then, appropriate measures will be taken to achieve the lower bound of the environmental targets in 2020. There may be

concerns as to whether importing electricity will lower Hong Kong's own emissions at the expense of the Mainland. The displacement effect, however, is expected to be minimal as the estimated amount of electricity to be purchased would only account for a small percentage of CSG's overall supply. As an illustration, CSG's generation in 2012 stood at about 825 billion kWh. Between now and 2030, CSG is planning to increase its generating capacity, which far exceeds the requirement of Hong Kong. Given the policy direction of the Mainland to increase the use of cleaner energy, importing electricity from the Mainland should not result in any significant rise in the overall emissions of the Pearl River Delta region.

Safety

4.18 This option poses no specific safety risks to Hong Kong.

Reliability

4.19 Importing electricity from the Mainland power grid for meeting some 30% of local electricity demand has not been tried before. While the Mainland is expanding its electricity generating capacity and transmission infrastructure, its electricity demand is also increasing due to population and economic growth and rapid urbanisation. The reliability of this option hinges on availability of electricity for supply to Hong Kong. We also need to ensure the quality of electricity import in terms of frequency and voltage. In considering this option, we should look beyond the immediate horizon with regard to –

- the relatively small demand of Hong Kong as compared to overall demand in the serving areas of CSG. The estimated

demand in 2023 would account for less than 2% of the total generation of CSG in 2012;

- the notable increase in the installed generation capacity in CSG, at an average rate of about 9% annually from 2009 to 2012; and
- further development in the Mainland electricity market and improvements that are being made to both supply quality and quantity in the next decade.

4.20 Subject to further feasibility studies of the detailed technical issues involved in importing more electricity from the Mainland, including the necessary arrangements to ensure reliable supply to Hong Kong in case of emergency, our assessment is that it is technically feasible for Hong Kong to import more electricity from the Mainland. In particular, Hong Kong should be able to benefit from the strong support provided by CSG's entire power grid with multiple sources of supply. Imports of electricity from neighbouring countries are not uncommon in many other overseas regimes. Experience outside Hong Kong, including the case of Macao, also suggests that supply reliability can be ensured through technical solutions, commercial contracts between the supplier and purchaser of electricity and commitments at government level. Locally, arrangements can also be made to provide back-up generation capacity to cater for emergency, through extending the useful life of existing power plants for instance.

Affordability

4.21 While more detailed cost assessment would be required, taking into account the cost of putting in place the necessary capital investment in new cross-boundary transmission infrastructure, a certain level of back-up generating capacity locally as may be required, and possible transportation and load management charges, a preliminary estimate is that the unit cost of imported grid electricity will roughly double the unit generation cost over the five years from 2008 to 2012. This includes the cost of electricity purchase and the cost of putting in place the necessary capital investment in new cross-boundary transmission infrastructure but excludes the cost of local transmission, distribution and customer and other supporting services.

4.22 There is a view that importing more electricity from the Mainland would increase the reliance of Hong Kong on imported power and may make Hong Kong a captive buyer in the longer run. It is worth pointing out that as some 20% of our electricity will continue to come from DBNPS in 2023, this option is only proposing to import electricity to meet another 30% of our electricity requirement. Local generation would still account for about 50% of our total demand. In any event, even if we are not to purchase electricity, we would still have to import substantial amount of natural gas for electricity generation from the Mainland.

Option 2: Using more natural gas for local generation

4.23 This option is to continue to rely on local generation to meet the long-term electricity demand of Hong Kong, using primarily natural gas, while keeping nuclear import from DBNPS at about 20%. The share of natural gas in the fuel mix would rise from the current 22% to 60% in around 2020, with the remaining 20% to be met by local coal-fired generation and RE. A higher proportion of coal is proposed in this option bearing affordability in mind. The fuel mix will be 20% imported nuclear energy, 60% natural gas, and 20% coal and RE.

Assessment

Environmental performance

4.24 We estimate that this option will allow us to meet the lower bound of the air pollutant emission reduction targets by 2020 and reduce the carbon intensity by about 50%. But barring major technological advancement, the prospect of any further significant improvement in environmental performance brought by the new generation facilities may be rather limited over their expected lifespan of about 30 years after commissioning.

Safety

4.25 As in option 1, this option poses no specific safety risks to Hong Kong.

Reliability

4.26 Local generation has been achieving a very high standard of reliability.

Affordability

4.27 A key drawback of this option is the high and volatile cost of natural gas and the heavy reliance on it. The overall affordability will also depend on other costs of production, e.g. capital investment, land cost, labour cost, etc., which are generally higher in Hong Kong than in the Mainland although costs are also rising in the latter too. Local generation, however, can obviate the need for constructing new cross-boundary transmission network, and avoid other related charges such as load management charge associated with the import option. Similar to the unit cost of imported grid purchase, we estimate that the unit cost of additional gas-fired electricity will roughly double the unit generation cost over the five years from 2008 to 2012. This includes fuel cost and cost of putting in place the necessary capital investment in generation facilities, but excludes the cost of local transmission, distribution, and customer and other supporting services.

Summary comparison

4.28 In terms of the four energy policy objectives, there is no major difference between the two options as far as **safety** is concerned. On **reliability**, local gas generation has a proven track record of strong and steady performance. While large-scale grid purchase is untested in Hong Kong, reliability of supply is expected to be secured through technical solutions, commercial contracts between the supplier and purchaser of electricity and commitments at government level. Hong Kong should be able to benefit from the strong support provided by CSG's entire power grid with multiple sources of supply. We can also retain local back-up generating capacity to cater for emergency.

4.29 On **affordability**, regardless of the option to be taken, it is certain that electricity will cost more than what we are currently paying as we are reducing our reliance on less expensive but more polluting coal. Either option involves substantial capital investment in new transmission or generation facilities. The rising trend has been set by the scheduled retirement of existing generation units, the decision to use more natural gas for electricity generation for better environmental performance and the expiry of the current natural gas contracts of lower price entered into some years ago. Our preliminary estimate is that the unit import/generation costs under both options will roughly double the unit generation cost over the five years from 2008 to 2012. Although the increase in unit import/generation cost will be passed through to electricity users ultimately in terms of electricity tariff, it is premature to make any meaningful assessment of the tariff implications for any particular year. This is because how the increase in unit cost will be reflected in electricity tariff would depend on a host of factors, including

the retirement schedule of existing generation units, the pace of capital injection, and the means of financing new infrastructure. More importantly, electricity tariff in a particular year is also affected by other factors including operation costs, sales volume, as well as movement in the Tariff Stabilisation Fund and the Fuel Clause Recovery Account.

4.30 As the price differential between the two options is not substantial, cost should not be a major consideration in assessing the two proposed fuel mix options. However, heavy reliance on natural gas under the option of local generation will increase the susceptibility of tariffs to price volatility of natural gas, especially as it is difficult to come to a definitive view today on the extent to which the eventual availability of large-scale commercial production of shale gas in other parts of the world would bring gas price down in Asia.

4.31 Grid purchase may be able to offer us electricity at lower price in the longer term because of the lower albeit rising production cost in the Mainland. However, it will incur substantial cost to put in place the necessary cross-boundary transmission infrastructure. There are also costs associated with load management and for maintaining a certain percentage of local backup, etc., all adding up to the final cost for importing electricity from the Mainland.

4.32 We must stress that the estimated unit import/generation costs for electricity are provided with regard to the best information available today. It should be taken as a reference only, and the actual unit costs and the tariff implications would depend on a host of intervening factors that could only be ascertained at a later stage. For instance, the cost of electricity import would depend to a large

extent on the cost of construction of cross-boundary transmission network, which in turn would be dictated by the exact physical alignment of the network after extensive research and site survey.

4.33 On **environmental performance**, under both options, we will implement measures to achieve the pledged environmental targets in respect of air pollutant emission and carbon intensity reduction for 2020. The import option would have a better local environmental performance in that it will help us achieve the upper bound of the air pollutant emission reduction target and help reduce carbon intensity by about 60% when compared to 2005, when the cross-boundary transmission infrastructure is fully completed in around 2023. By comparison, under the local generation option, barring major technological advancement, the prospect of any further significant improvement in environmental performance brought by the new generation facilities may be rather limited over their expected lifespan of about 30 years after commissioning.

Other considerations

4.34 Other than the four energy policy objectives, the proposed options may also be evaluated against some other relevant considerations with longer-term implications on Hong Kong's electricity landscape.

(a) Diversification

4.35 Among the two options, grid purchase allows us to tap into various types of cleaner fuels (such as hydro power) which would otherwise not be available to Hong Kong. As the Mainland is set to increase the use of non-fossil fuels, Hong Kong would stand to benefit from a greener and more diversified fuel mix. Local gas generation, on the other hand, will increase

the risk of heavy reliance on a particular fuel type.

(b) Flexibility in scaling up future supply

4.36 As compared to local generation, grid purchase offers a more viable and sustainable option in the longer run in meeting the electricity demand of Hong Kong, as it does not require any new land sites in Hong Kong to accommodate new generation facilities. A key constraint of local generation is that there may not be the flexibility to catch up with rising demand because of possible difficulty in identifying suitable sites for building new power plants, taking into account the environmental and visual impacts that may be caused to nearby residents. While there is room for further expansion in the existing power plants, there is a limit to the long-term sustainability of local electricity generation as a means to satisfy electricity needs, even after taking into consideration possible changes in demand as a result of energy efficiency measures.

(c) Other social implications

4.37 Importing more electricity from the Mainland would mean that the scale of local generation currently operated by the two power companies may be reduced. The impact on local employment by the two power companies would have to be carefully managed, with regard also to the outcome of the review of post-2018 electricity market.

(d) Implications for the post-2018 electricity market

4.38 The current SCAs with the two power companies will expire in 2018, with an option exercisable by the Government to extend them for five more years, i.e. until 2023. The Government has undertaken to carry out preparatory work,

including studying the feasibility to open up the market, within the regulatory period, before implementing any changes to the post-2018 electricity supply regulatory framework. According to the SCAs, the power companies may recover from the market any stranded costs, i.e. costs incurred by the power companies in relation to investments made or agreements entered into in respect of their electricity-related activities which become stranded as a result of a change in the electricity supply market structure, in line with the terms and conditions of the SCAs.

4.39 The future fuel mix for electricity generation will affect the mode of electricity supply in Hong Kong and, to a certain extent, the regulatory framework for the electricity market when the current SCAs expire in 2018. While the latter will be further studied and reviewed by the Government, the preferred fuel mix option will set the scene for the review of the post-2018 regulatory framework for the electricity market.

4.40 More specifically, the import option will involve the construction of new cross-boundary transmission network. This may enhance interconnection between the two local power grids, and hence provide more room to introduce competition at the generation level, although the detailed mode of operation between new and existing players and related issues, e.g. third-party access to the transmission network of the two existing power companies, will need to be further studied in the post-2018 market regulatory framework review.

4.41 On the other hand, more new gas generating units will need to be built if we choose to rely more on local generation by natural gas. The extent to which new suppliers may take part in local generation is affected by the availability of land for any new generation facilities, the opportunity cost foregone and, perhaps more importantly, social acceptability. Allowing existing power companies to construct new generating units, however, may add to the potential stranded costs that consumers will have to bear if we are to open up the electricity market in future. There will be more constraints in introducing competition to the electricity market if we decide to go for this fuel mix option.

4.42 We will launch a separate public consultation on the post-2018 regulatory framework for the electricity market later.

Actual deployment of fuel types

4.43 The proposed share of different fuel types or mode of supply under the two options essentially provides a basis for planning necessary infrastructure. Once the infrastructure is put in place under the preferred option, flexibility should apply to actual deployment of each fuel type, having regard to the latest projection of fuel prices and environmental performance of respective fuel types against the assumptions made now, provided that the environmental targets and other energy policy objectives are met. For instance, if natural gas prices are substantially lower than the current projections, we may be using as much natural gas as possible for electricity generation if this helps mitigate tariff increase while staying within the air pollutant emission caps and carbon intensity reduction targets.

Beyond 2023

4.44 Beyond 2023, coal-fired power plants would be completely phased out in a gradual manner. The exact retirement schedule would be worked out with regard to, for instance, their physical conditions and environmental performance, as well as cost considerations. Whether they should be replaced by electricity import or local gas generation would be ascertained at a later stage in the light of overall electricity consumption, technological development as well as public views.

Summary



Chapter 5: Summary

Planning horizon

5.1 Electricity supply requires long-term planning. The preferred fuel mix option will provide us with a basis to plan for our electricity infrastructure in the next decade. With a decision to be made in 2014 and depending on the fuel mix option we finally go for, some of the infrastructure required could only be fully completed in around 2023. Meanwhile, under both options, appropriate measures will be adopted to achieve the pledged environmental targets in respect of air pollutant emission and carbon intensity reduction for 2020.

Fuel mix options and comparison

5.2 As a basis for planning the necessary infrastructure, the possible percentages of various fuel types under the two proposed fuel mix options, and a comparison of these options against some major considerations, are summarized in the following tables.

Table 5: Proposed fuel mix options

FUEL MIX		IMPORT		NATURAL GAS	COAL (& RE)
		NUCLEAR (DBNPS)	GRID PURCHASE		
Existing (2012)		23%	-	22%	55% ¹²
OPTION 1*	Importing more electricity through purchase from the Mainland power grid	20%	30%	40%	10%
		Total : 50%			
OPTION 2*	Using more natural gas for local generation	20%	-	60%	20%

* The above fuel mix ratios aim at providing a basis for planning the necessary infrastructure for electricity supply. Flexibility should apply to actual deployment of each fuel type, having regard to the circumstances happening on the ground. (See paragraph 4.43)

¹² Inclusive of a small percentage of oil

Table 6: Summary of the relative performance of the proposed options

Safety	<ul style="list-style-type: none"> • Both options pose no specific safety risks to Hong Kong.
Reliability	<ul style="list-style-type: none"> • Option 1: large-scale grid purchase is untested in Hong Kong, but our assessment suggests that it is technically feasible. Hong Kong should be able to benefit from the strong support provided by CSG's entire power grid with multiple sources of supply. Arrangements can be made to retain local back-up generation capacity to cater for emergencies. Detailed technical studies are required. • Option 2 : local generation has a proven track record of reliability.
Affordability	<ul style="list-style-type: none"> • No substantial difference in average unit cost of electricity based on information available and current projections. A preliminary estimate is that they will roughly double the unit generation cost over the five years from 2008 to 2012. Actual tariff implications cannot be ascertained at this stage. • Option 1: there may be concerns on Hong Kong becoming a captive buyer. • Option 2: heavy reliance on natural gas as a single fuel type will increase the susceptibility of tariffs to price volatility of natural gas.
Environmental performance	<ul style="list-style-type: none"> • Both options can meet the 2020 environmental targets for better air quality and carbon emission performance. • Option 1: it would lower local emissions further when the cross-boundary infrastructure is fully completed in around 2023 and may facilitate access to more diversified and greener fuel types otherwise not available to Hong Kong. • Option 2: the prospect of any further significant improvement to our environment may be rather limited over a long period of time after commissioning of new generation facilities.
Implications for the post-2018 electricity market	<ul style="list-style-type: none"> • Option 1: it may enhance interconnection between the two local power grids, and hence provide more room to introduce competition at the generation level. • Option 2: the extent to which new suppliers may take part in local generation is affected by the availability of land for any new generation facilities. Allowing existing power companies to construct new generating units may add to the potential stranded costs that consumers will have to bear if we are to open up the electricity market in future.
Diversification	<ul style="list-style-type: none"> • Option 1: it will allow us to tap into various types of cleaner fuels which would otherwise not be available to Hong Kong. • Option 2: it will increase the risk of heavy reliance on a particular fuel type.
Flexibility in scaling up future supply	<ul style="list-style-type: none"> • Option 1: it offers a more viable and sustainable option in the longer run in meeting the electricity demand of Hong Kong, as it does not require any new land sites in Hong Kong to accommodate new generation facilities. • Option 2: there may not be the flexibility to catch up with rising demand because of difficulty in identifying suitable sites for building new power plants.
Other social implications	<ul style="list-style-type: none"> • Pursuing Option 1 would mean that the scale of local generation currently operated by the two power companies may be reduced. Impact on local employment to be carefully managed with regard also to the outcome of the review of post-2018 electricity market.

The Government's open position

5.3 The Government adopts an open position on the two fuel mix options presented in this consultation document. Each option has its pros and cons and could meet our energy policy objectives. It is a difficult but important decision that carries far-reaching implications for Hong Kong's future economic and social development. It is a decision that the community as a whole has to reflect upon now. Your views are crucial.

Running up to 2023

5.4 We would map out the way forward upon completion of the public consultation. If a decision is taken then to import more electricity through purchase from the Mainland power grid, detailed technical studies and discussion with relevant parties would be conducted to confirm supply reliability. We would make sure that robust contingency arrangements are put in place for a smooth changeover. On the price of electricity, we would ensure that the outcome of negotiation among parties concerned would serve the best interest of the public, and that the ultimate package should not go beyond the cost of local generation, by natural gas in the longer term. If it is decided to go for more local generation by natural gas, we would ensure that there would be adequate supply of natural gas.

Key points of consultation

5.5 Your views are invited, particularly on the following -

- How do you view each of the two fuel mix options with regard to safety, reliability, cost, environmental performance and other relevant considerations?
- Which of the two fuel mix options do you prefer? Why?

Respond to this consultation

5.6 Please send your comments to us before **18 June 2014** by email, mail or facsimile to the following addresses –

Address : Electricity Reviews Division
Environment Bureau
15/F, East Wing, Central Government Offices
2 Tim Mei Avenue
Tamar, Hong Kong

E-mail : fuel_mix@enb.gov.hk

Facsimile : 2147 5834

For the ease of responding to this Public Consultation and to facilitate subsequent analysis, a standard response form is provided at **Annex**.

If you have any enquiries, please contact us on 3509 8639.



Response Form

Public Consultation on Future Fuel Mix for Electricity Generation for Hong Kong

Please send this response form to us on or before **18 June 2014** by one of these means:

mail: Environment Bureau, Electricity Reviews Division, 15/F, East Wing,
Central Government Offices, 2 Tim Mei Avenue, Tamar, Hong Kong

e-mail: fuel_mix@enb.gov.hk

fax: 2147 5834

Part 1 (See Notes)

This is a corporate response (representing the views of a group or an organisation) or
 individual response (representing the views of an individual)

by _____
(name of person or organisation)

at _____ and _____
(telephone) (e-mail)

Part 2

Fuel Mix Options

FUEL MIX	IMPORT		NATURAL GAS	COAL (& RE)
	NUCLEAR (DBNPS)	GRID PURCHASE		
Existing (2012)	23%	-	22%	55%**
OPTION 1*	20%	30%	40%	10%
Importing more electricity through purchase from the Mainland power grid	Total : 50%			
OPTION 2*	20%	-	60%	20%
Using more natural gas for local generation				

* The above fuel mix ratios aim at providing a basis for planning the necessary infrastructure for electricity supply. Flexibility should apply to actual deployment of each fuel type, having regard to the circumstances happening on the ground.

** Inclusive of a small percentage of oil

Part 3

Specific Questions for Consultation

Q1: How do you view each of the two fuel mix options with regard to safety, reliability, cost, environmental performance and other relevant considerations? (Please indicate your view on **EACH** of the two options.)

Option	Support	Not Support	Reason for NOT supporting (You can tick more than one box)
1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Safety <input type="checkbox"/> Reliability <input type="checkbox"/> Affordability <input type="checkbox"/> Environmental performance <input type="checkbox"/> Others (please specify): _____ _____
2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Safety <input type="checkbox"/> Reliability <input type="checkbox"/> Affordability <input type="checkbox"/> Environmental performance <input type="checkbox"/> Others (please specify): _____ _____

Q2: Which of the two fuel mix options do you prefer? Why? (Please tick **ONLY ONE** box)

Option 1

Option 2

Reasons: (You can tick more than one box below)

Safety

Reliability

Affordability

Environmental Performance

Others

Please specify: _____

Part 4

Other Comments and Suggestions

Notes :

1. It is optional for you to supply your personal data in Part 1 of this response form. Any personal data provided may be transferred to the relevant Government bureaux and departments for purposes directly related to this consultation exercise. The Government bureaux and departments receiving the data are bound by such purposes in their subsequent use of such data.
2. The names and views of individuals and organisations which put forth submissions in response to this Consultation Document (“senders”) may be published for public viewing after conclusion of the public consultation exercise. The Government may, either in discussion with others (whether privately or publicly), or in any subsequent report, attribute comments submitted in response to this Consultation Document.
3. To safeguard senders’ data privacy, we will remove senders’ relevant data (if provided), such as residential / return addresses, email addresses, identity card numbers, telephone numbers, facsimile numbers and signatures, where provided, when publishing their submissions.
4. We will respect the wishes of senders to remain anonymous and / or keep the views confidential in part or in whole. If the senders request anonymity in the submissions, their names will be removed when publishing their views. If the senders request confidentiality of their views, their submissions will not be published.
5. If the senders do not request anonymity or confidentiality in the submissions, it will be assumed that the senders can be named and the views can be published in their entirety.
6. Any sender providing personal data to us in the submission will have rights of access and correction with respect to such personal data. Requests for data access and correction of personal data should be made in writing to:

Address: Electricity Reviews Division
Environment Bureau
15/F, East Wing, Central Government Offices
2 Tim Mei Avenue, Tamar, Hong Kong

Fax number: 2147 5834

E-mail address: fuel_mix@enb.gov.hk



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