


能源及環境學院  
SCHOOL OF ENERGY  
AND ENVIRONMENT



香港城市大學  
City University  
of Hong Kong


Public Consultation  
Future Development of the  
Electricity Market  
31 March 2015



**Public Consultation  
Future Development of the  
Electricity Market**

**Dr C W Tso's Submission to LegCo  
Panel on Economic Development**  
(Email Address: [panel\\_edv@legco.gov.hk](mailto:panel_edv@legco.gov.hk))

29 May 2015



Dr C W Tso  
Adjunct Professor

## Contents

1. Overview of Hong Kong Electricity Sector
2. Current Scheme of Control Agreements – Issues & Concerns
3. Post 2018 Regulatory Regime – Views & Suggestions



School of Energy and Environment, City University of Hong Kong

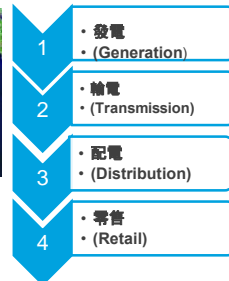
1

# 1. Background Information

## Hong Kong Current Electricity Market

Electricity in Hong Kong has always been supplied by two investors-owned power companies operating in a vertically integrated electricity market:

- The Hongkong Electric Company Ltd (**HKE**) incorporated in 1890 
- CLP Power Hong Kong Ltd (**CLP**) incorporated in 1901. 



Vertically-integrated  
Market Structure

Both power companies do not have a franchise but their operations are regulated by the **Environment Bureau** under two separate 10-Year Scheme of Control Agreements (SCAs) with **CLP** and **HKE** valid till 2018.



Sources: CLP Power, Power Assets and Environment Bureau Websites.

## CLP Power Electricity Generation

**CLP** supplies electricity to Kowloon and the New Territories, including Lantau and Cheung Chau (**green areas**).

**Electricity** is generated from **Black Point** Power Station, **Castle Peak** Power Station, **Penny's Bay** Power Station, **Daya Bay Nuclear** Power Station and **Guangzhou Pump Storage** Power Station.

**CLP** currently has a total installed capacity of **8,888MW**. In 2014, maximum demand was **7,030MW** (**26.4%** reserve margin) and sales of electricity for local consumption was **32,925 GWh** (75% of Hong Kong total)

Fixed Assets: HK\$101.24billion



(Source: CLP Group Website)

School of Energy and Environment, City University of Hong Kong

4

## HKE Electricity Generation

**HKE** supplies electricity to Hong Kong Island and Lamma Island.

**Electricity** is generated at **Lamma Power Coal-Fired and Gas-Fired Stations** plus Hong Kong's first grid-connected 800kW **Wind Power** and largest 1,000kW **Solar PV System**.

**HKE** currently has a total installed capacity of **3,737MW**. In 2014, maximum demand was **2,460MW** (**51.9%** reserve margin) and sales of electricity for local consumption was **10,955 GWh** (25% of Hong Kong total)

Fixed Assets: HK\$49.14billion

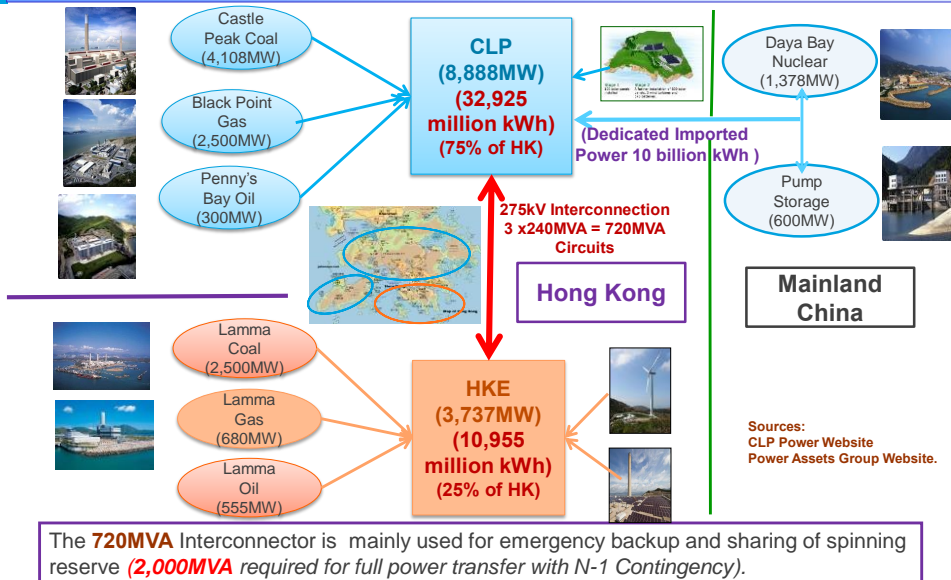


(Source: Power Assets Group Website)

School of Energy and Environment, City University of Hong Kong

5

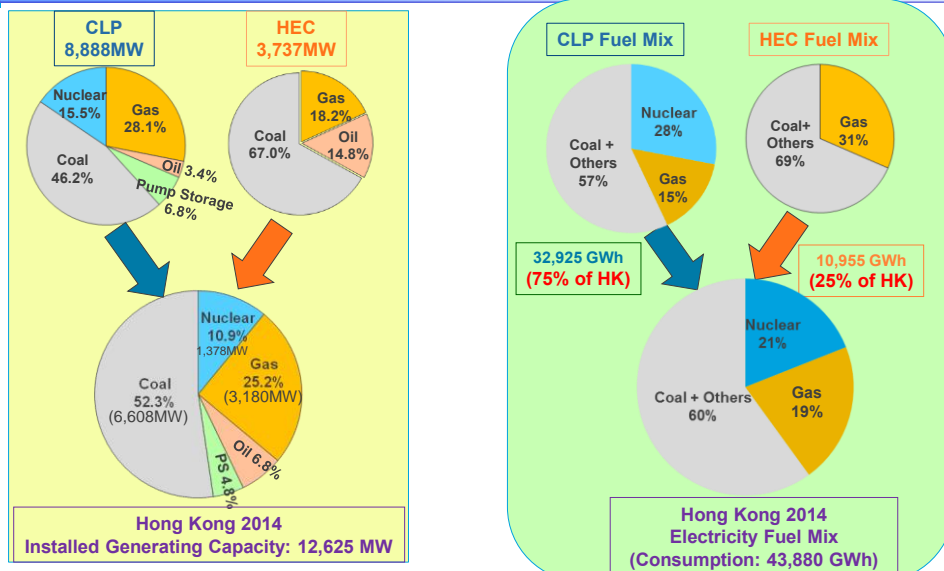
## Hong Kong Electricity Generation Sector (2014)



School of Energy and Environment, City University of Hong Kong

6

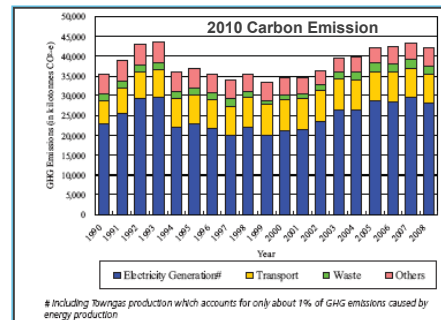
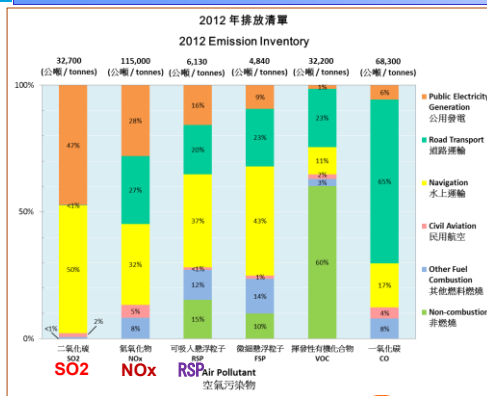
## Installed Capacity Mix & Electricity Fuel Mix (2014)



School of Energy and Environment, City University of Hong Kong

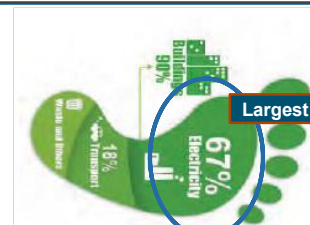
7

## Hong Kong Pollutants & Carbon Emissions



Pollutants	Navigation	vs Electricity
SO <sub>2</sub>	50%	vs 47%
Nox	32%	vs 28%
RSP:	37%	vs 16%

2<sup>nd</sup> Largest



Sources: EPD Web Site  
Hong Kong's Climate Change Strategy and Action Agenda Consultation Document (Sept 2010)

School of Energy and Environment, City University of Hong Kong

8

## Hong Kong Emissions Reduction Targets (2020)

Emissions	SO <sub>2</sub>	NO <sub>x</sub>	RSP	VOC
2010 (Tonnes)	35,500	109,000	6,340	33,700
2015 Targets	-25%	-10%	-10%	-5%
2020 Targets	-35% to -75%	-20% to 30%	-15% to 40%	-15%

Air Pollutants Reduction Targets



Source :  
[http://www.enb.gov.hk/sites/default/files/New\\_Air\\_Plan\\_en.pdf](http://www.enb.gov.hk/sites/default/files/New_Air_Plan_en.pdf)

Carbon Emission	2005	2020
Carbon Footprint	6.2T/Capita	3.6 – 4.5T/Capital
Total Carbon (kT)	42,000	28,140 – 34,020
Carbon Intensity (kg/HK\$GDP)	0.029 (Base)	0.0116 – 0.0145 (Reduction 50% - 60%)

Carbon Emissions Reduction Targets



Source:  
[http://www.epd.gov.hk/epd/sites/default/files/epd/english/climate\\_change/files/Climate\\_Change\\_Booklet\\_E.pdf](http://www.epd.gov.hk/epd/sites/default/files/epd/english/climate_change/files/Climate_Change_Booklet_E.pdf)

School of Energy and Environment, City University of Hong Kong

9

## Tightening Power Plant Emissions to Meet Hong Kong 2020 Emissions Reduction Targets

2010 Emission Caps (1 <sup>st</sup> TM)				2015 Emission Caps (2 <sup>nd</sup> TM)		
	SO <sub>2</sub> (Tonne)	NO <sub>x</sub> (Tonne)	RSP (Tonne)	SO <sub>2</sub> (Tonne)	NO <sub>x</sub> (Tonne)	RSP (Tonne)
CLP	15,750	26,710	790	5,702	17,532	531
HEC	9,370	15,890	470	6,780	10,020	300
Total	25,120	42,600	1,260	12,482	27,552	831
Reduction	Base			-50.3%	-35.3%	-34.1%

2017 Emission Caps (3 <sup>rd</sup> TM)				2019 Emission Caps (4 <sup>th</sup> TM)		
	SO <sub>2</sub> (Tonne)	NO <sub>x</sub> (Tonne)	RSP (Tonne)	SO <sub>2</sub> (Tonne)	NO <sub>x</sub> (Tonne)	RSP (Tonne)
CLP	5,199	16,500	500	4,970	16,500	500
HEC	5,200	9,450	250	4,250	8,980	200
Total	10,399	25,950	750	9,200	25,480	700
Reduction	-58.6%	-39.1%	-40.5%	-63.4%	-40.2%	-44.4%

**Electricity Consumption - 2010 (41.8 GWh) => 2020 (48 GWh) (15% Growth)**

Sources: Legislative Council LC Paper No. CB(1)2256/11-12(05) (Nov 2012)  
 Legislative Council Paper [http://www.legco.gov.hk/yr14-15/english/subleg/brief/201442ss5\\_brf.pdf](http://www.legco.gov.hk/yr14-15/english/subleg/brief/201442ss5_brf.pdf)  
 Future Fuel Mix for Electricity Generation Consultation Document (March 2014)  
 CLP/HEC Annual Reports/Sustainability Reports

School of Energy and Environment, City University of Hong Kong

10

## 2,150MW New Gas Fired Power Plants required to Replace Coal Fired Power Plants by 2020

### Hong Kong Coal - Fired Generating Units

	Location	Units	Capacity (MW)	Commissioning Year	End of Book Life*	
CLP	Castle Peak A	A1	350	1982	2017	
		1,400MW	A2	350	1983	2018
		A3	350	1984	2019	
		A4	350	1985	2020	
	Castle Peak B	B1**	677	1986	2021	
		2,708MW	B2**	677	1987	2022
		B3**	677	1988	2023	
		B4**	677	1990	2025	
HEC	Lamma Island	L1	250	1982	2017	
		2,500MW	L2**	250	1982	2017
		L3	250	1983	2018	
		L4**	350	1987	2022	
		L5**	350	1988	2023	
		L6	350	1992	2027	
		L7	350	1995	2030	
		L8	350	1997	2032	
Total CLP			4,108		2,708MW	
Total HEC			2,500		1,750 MW	
Total CLP + HEC			6,608		4,458 MW	

\*Coal-fired Plant 35 Years Service Life

\*\* Retrofitted with FGD/SCR/LNB in 2010/11 (HK\$10 billion) + Life Extension for Castle Peak B Units and Lamma L4/L5 Units  
 Sources: <http://www.cb.cityu.edu.hk/ms/eepru/?page=article>



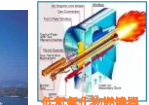
Castle Peak Coal-Fired



Source: CLP Power Website



Lamma Coal-Fired



Source: HEC Website

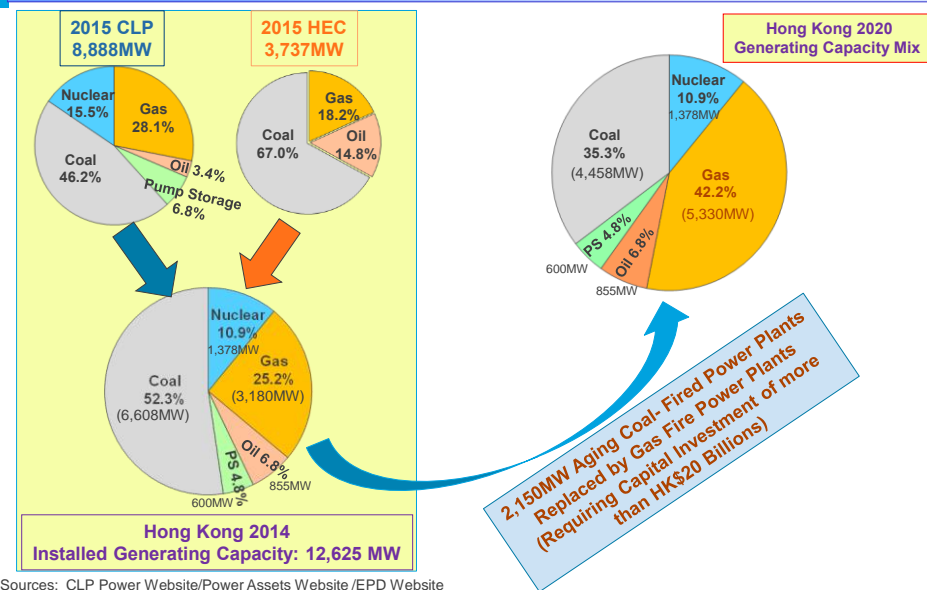
\*\* CLP HK\$9 billion FGD/SCR Project (2010/11)

\*\* HECHK\$1 billion FGD/LNB Project (2009/10)

School of Energy and Environment, City University of Hong Kong

11

## Installed Capacity Mix (More Gas-Fired Units in 2020)



### 3. Scheme of Control Agreements (SCAs) – Issues & Concerns



## Current Scheme of Control Agreements (SCAs)

### The Scheme of Control: Current Contract Term (between CLP and HKSAR Government)

Oct 2008      10-year      Sep 2018      5-year      Sep 2023

- Electricity supply is regulated through the Scheme of Control (SoC) Agreement which is a contract signed between CLP and the Government to serve customers in Kowloon, the New Territories and Lantau Island
- The SoC has been in place for over 50 years. It has been renewed from time to time and has served Hong Kong well over the years
- The current SoC has a 10-year term (Oct 2008 to Sep 2018) with a Government option to extend on the same terms for 5 years to 2023
- The annual permitted return under the SoC is 9.99% of the SoC Companies average net fixed assets other than renewable energy investments, and 11% on renewable energy investments
- In the event that the 5-year extension is not exercised by the Hong Kong Government, the SoC Companies will continue to earn the permitted return until 30 September 2023 on all approved investments made on or before 30 September 2018, or as approved by the Government thereafter
- The current SoC includes a provision to give the SoC Companies protection for stranded costs, which may arise as a result of future changes to the market structure which adversely impact on the SoC Companies' ability to recover and to earn returns on existing investments approved by the Government in accordance with the SoC

The Scheme of Control Agreement entered into by the Government of the Hong Kong Special Administrative Region and the following companies:

CLP Power (Hong Kong) Limited  
Econohold Energy Limited  
and  
Castle Peak Power Company Limited

The Scheme of Control Agreement entered into by the Government of the Hong Kong Special Administrative Region and the following companies:

The Hongkong Electric Company, Limited  
and  
Hongkong Electric Holdings Limited

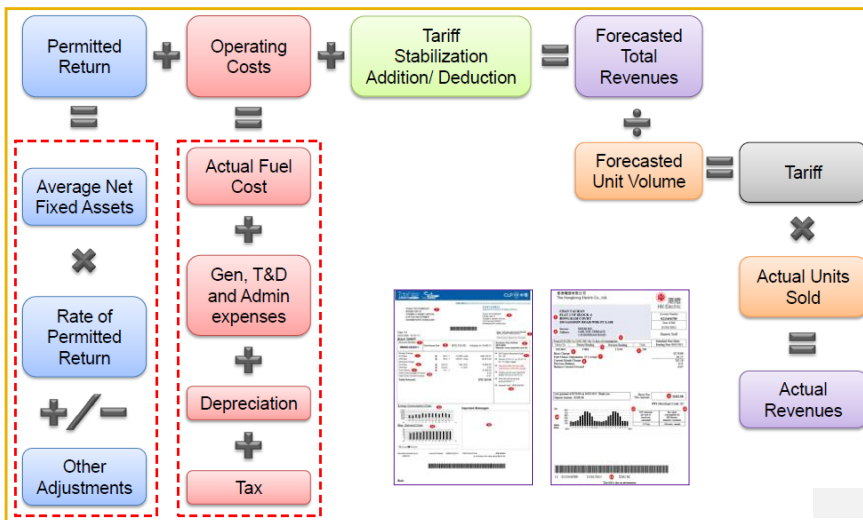
**N.B. Similar Contract Term of SCA signed between HKE and HKSAR Government**

Source: CLP Group 2014 Annual Results Analyst Briefing 25 Feb 2015  
HKSAR Government Environment Bureau Website

School of Energy and Environment, City University of Hong Kong

14

## Current Arrangement for Setting Electricity Tariff



Source: Yee, T.C. Hong Kong Electricity Market – Review & Way Forward presented to HKPolyU School of Accounting & Finance, 23 January 2015

School of Energy and Environment, City University of Hong Kong

15



## Current Approval/Monitoring Mechanism/Process



Source: Yee, T.C. Hong Kong Electricity Market – Review & Way Forward presented to HKPolyU School of Accounting & Finance, 23 January 2015

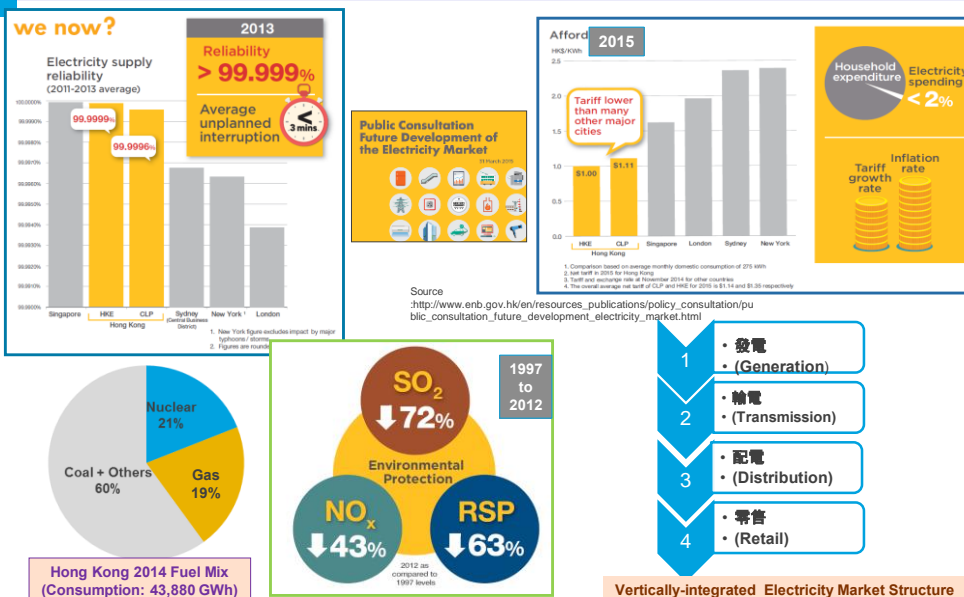
### Major Issues of Concern

- Energy Advisory Committee is not a Statutory Body and plays an advisory role
- Advisory Council on the Environment deals with EIA for new/retrofit electricity-related projects
- Absence of Statutory Public Hearings on the need, timing and costs of new/retrofit electricity-related projects (improvement of transparency, accountability and public participation)
- Absence of a statutory Energy Authority for Policy Formulation and Regulations Enforcement

School of Energy and Environment, City University of Hong Kong

16

## Current Electricity Sector Performance (1/2)



School of Energy and Environment, City University of Hong Kong

17

## Current Electricity Sector Performance (2/2)

The current model of electricity market structure and the regulatory regime through SCAs have been in operation in Hong Kong for the past 50 year, the **Reliability and Affordability** are so far highly impressive compared with other developed economies... so why should Hong Kong go for change just for the sake of change?

### Major Issues of Concern

- All Business Risks (*investments, fuel costs, operation expenses, forecasting error etc.*) passed on to Consumers (*gold plated infrastructures, less incentives to secure competitive fuel sources and improve productivity, etc. under current SCAs*). The use of permitted RoR (rate of return) based on the ANFA could encourage excessive investment (gold-plated infrastructure)
- Consumers have no choice of service providers (*captive customers*) under current Vertically Integrated Market Structure (*see Slides 20 & 21*).
- The current rather low electricity price can not be maintained when the amount of natural gas in fuel mix is increased from 19% in 2014 to 50% (*Singapore's fuel mix has more than 90% gas*).
- RE Wind/PV Capacity: 2MW (*0.016% of total Installed Capacity of 12,625MW*) producing about 2 GWh (*0.005% of HK 2014 consumption*) is far too decimal in electricity fuel mix for Hong Kong as a developed economy and Asia World City.
- The scope of emissions limits imposed on power stations only apply to air pollutants (*SO<sub>2</sub>, NO<sub>x</sub> and RSP*), not CO<sub>2</sub> to address global warming leading to climate change.

## Promotion of RE - Current SCA Arrangement for Power Companies

Renewable Energy Incentive (SCA Schedule 6) Source: EnB Website/CLP Website/HKE Website

11. The Renewable Energy Incentive Factor for any Year which is a full calendar year is the figure shown in the right hand column of the table below which corresponds with the Renewable Energy Performance, expressed as a percentage, achieved by the Companies in respect of that Year determined in accordance with paragraph 12.

Renewable Energy Performance	Renewable Energy Incentive Factor
5% or above	0.05%
Less than 5% and greater than or equal to 2%	0.03%
Less than 2% and greater than or equal to 1.5%	0.02%
Less than 1.5% and greater than or equal to 1.0%	0.01%
Less than 1.0%	0



### Areas of Concern:

- On top of Higher Permitted Rate of Return of 11% for Net RE Fixed Assets
- Encourage excess investment in RE installations

## Promotion of RE - Current SCA Arrangement for Consumers

### **RENEWABLES (Current SCA Schedule 6)**

Source: EnB Website/CLP Website/HKE Website

#### *Grid Connection for Embedded Renewables*

8. The Companies shall offer standardised arrangements (such arrangements shall be subject to the prior written agreement of the Government) for back-up power supply for customers with embedded Renewable Energy Systems in Hong Kong. Customers with embedded Renewable Energy Systems are those who supply a portion of their electricity demand with Renewable Energy Systems at their own premises. Grid connection arrangements shall be made between the prospective grid user and the Companies, on reasonable terms and subject to applicable technical and safety standards, including the technical and safety requirements stipulated in the latest Technical Guidelines on Grid Connection of Renewable Energy Power Systems issued by the Electrical and Mechanical Services Department of the Government. **Technical & Setup Cost Hurdles**
9. Special cases, such as spill power (occasional surplus electricity from a customer of the Companies with an embedded Renewable Energy System), shall be considered on a case-by-case basis on reasonable terms. **Not Mandatory**

## Promotion of Energy Efficiency & DSM – Current SCA Arrangement

1. The power companies can obtain an incentive of 0.01% of ANFA if they meet the annual target of conducting energy audits for the customers (150 cases for CLP and 50 cases for HKE annually)
2. The power companies can obtain another 0.01% of ANFA if the energy saving attributable to the improvement works carried out by the customers based on the energy audits conducted by the power companies meets the target level of 12GWh for CLP and 3 GWh for HKE.
3. The power companies have agreed to use the performance incentives obtained through energy savings to set up funding schemes to provide subsidies on a matching basis to non-commercial building owners to carry out energy efficiency improvement works
4. The power companies have each set up an annual loan fund (CLP: \$25million and HKE: \$12.5million) to provide loans to non-Government customers to implement energy saving initiatives identified in energy audits.
5. The power companies have provided rebate and discount to domestic and SME customers with low levels of consumption.

#### **Area of Concern:**

- **No off-peak hours tariff structure (tariff discount for using electricity during non-peak hours) to reduce system maximum demand => defer investment for increase in generation capacity**

### 3. Post 2018 Regulatory Regime - Views & Suggestions

### Consumer Choice – Perception

**Choice** involves mentally making a decision: judging the merits of multiple options and selecting one or more of them. One can make a choice between imagined options or between real options followed by the corresponding action. Most people regard having choices is important as a **human right**, though a severely limited or artificially restricted choice can lead to discomfort with choosing, and possibly an unsatisfactory outcome. In contrast, a choice with excessively numerous options may lead to confusion, regret of the alternatives not taken. (Source: <http://en.wikipedia.org/wiki/Choice>)

It is generally believed that the ability to choose an electricity service provider can give consumers a greater variety of pricing plans and allows the consumers more freedom to determine what is the best option to meet the needs (unique or common) of their household or business in terms of the following trade-offs:

- High Reliability (*notably business and affluent consumers*)
- Low Cost (*notably grass root consumers*)
- Environmental Friendly (Green Fuels/RE) (*notably green conscience & affordable consumers*)
- Caring, Transparent & Responsive Services (*desirable by all consumers*)

This requires the unbundling of the electricity market chain, i.e. **introduction of competition** to both generation sector and retail sector. Most consumers believe that a deregulated market can facilitate competitive entry, encourage the development of innovative products, enhance efficient operation of assets and improve the quality of choices. So Consumers will have the opportunity to take full advantage of available choices.

## Introduction of Competition: Unlikely in Near Term

Overseas experiences in liberalised electricity market reveal that the commercial (business & industry) bulk consumers do benefit the most, notably the price of electricity, at the expenses of domestic consumers.

Furthermore, the unique situation of Hong Kong (*private ownership of HK\$150 billion assets, relative small and geographical constrained market plus community preference for local electricity generation*) and the huge costs of setting up and execution of highly complex regulatory framework/controls incurred for a deregulated market make it unlikely to introduce genuine competition on a sizable scale to the Hong Kong Electricity Market.

Hence, regulation of the financial, technical and operational affairs of CLP and HKE will again have to be exercised through the **SCAs** after the expiry of the current 10-year term in 2018.



School of Energy and Environment, City University of Hong Kong

24

## Future Contractual Arrangements for New SCAs (1/4)

- **Duration** – Given the hugely capital intensive infrastructure with service life ranging from 30 years for power generation plant to 60 years for cables and buildings, and also the need for a stable and certain environment for such long-term investment, it is considered appropriate to retain the duration of the future contractual arrangement at 10 years with the option for the government to extend the term for another 5 years at the same permitted rate of return.
- **Permitted Rate of Return** – At least 8% (approx. 4% above local inflation) of rate of return is considered reasonable to attract capital intensive long-term investment. It is noted nominal vanilla WACC (weighted average cost of capital), a kind of RoR estimated based on gearing-weighted average of pre-tax cost of debt and post-tax cost of equity, adopted by several developed economies is around 8% for the electricity sector. The use of WACC rather than ANFA could partially address the concern of unnecessary excessive investments. Furthermore, same RoR should apply to Renewable Energy based capital.
- **Tariff Approval Mechanism** – It is noted that the Net Tariff paid by the consumers is made up of two parts, viz. Basic Tariff and Fuel Clause Charge. The Basic Tariff covers operating expenses, standard fuel charges and permitted return to the power companies. The Fuel Clause Charge reflects the changing price of fuels and is borne by consumers and payable to the power companies on a cost-pass through basis. The power companies can adjust through the Fuel Clause Recovery Account from time to time to reflect changes in the cost of fuels. It is considered desirable to have both the projected Net Tariff and the Basic Tariff Rate stated in the power company's Development Plan (DP) have to be approved by the Authority if either one exceeds the approved DP by a margin of 5%.

School of Energy and Environment, City University of Hong Kong

25

## Future Contractual Arrangements for New SCAs (2/4)

- **Fuel Cost Arrangement** – As shown on Slide 7, Hong Kong's fuel mix in 2014 was 60% coal, 21% nuclear and 19% gas. The government's proposed fuel mix in 2020 is 50% gas, 25% nuclear and remaining coal (less than 25%).

Regarding imported nuclear power, it is noted that the supply of nuclear electricity from the Day from Daya Bay Nuclear Power Station (DBNP) has been extended for further term of 20 years from 2014 up to 2034 and the amount would be increased to 80% of the total output of DBNP. It is expected the cost will be rather stable and likely go up in line with inflation adjustment.

Regarding coal, the price of coal has been dropping steady for the past 4 years and is expected to remain stable at that level. Furthermore, the amount of coal used as fuel will be decreased substantially in the next few years to meet the emission caps, and hence the impact of coal price on the tariff is diminishing. (Source: <http://www.infomine.com/investment/metal-prices/coal/all/>)



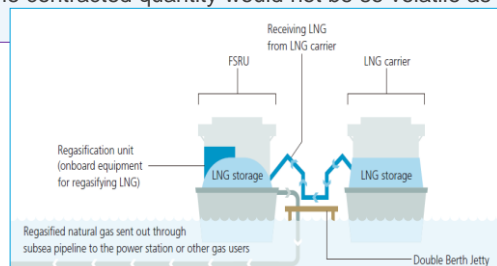
School of Energy and Environment, City University of Hong Kong

26

## Future Contractual Arrangements for New SCAs (3/4)

- **Fuel Cost Arrangement (continued)** – Regarding natural gas, it should be noted that CLP signed a 20-year gas supply contract (West to East 2<sup>nd</sup> Pipe Line gas) in 2013 and HKE entered another gas supply contract in 2014 (duration not known but would not be at least 5 years) in addition of its first 25-year gas supply contract signed in 2005 (Guangdong LNG Terminal gas). It is believed that all these gas supply contracts are take-or-pay contracts with price adjustment factors including oil price and possibly have floor/cap price clauses in place. It is not too sure the quantity of existing gas supply contracts has already taken due consideration of the government's intent of increasing the content of natural gas in fuel mix to 50%, but at least to 40% as proposed in the 2010 Consultation Document on Hong Kong's Climate Change Strategy and Action Agenda. It is reckoned that the price of natural gas of the contracted quantity would not be so volatile as perceived by the public.

However, to ascertain long term security of gas supply, reduce price volatility, power companies can project more accurately the Net Tariff in their DPs, it is suggested to conduct detailed study on the technical feasibility and economic viability of having a floating LNG Terminal in Hong Kong as a source of gas supply.



Source: CLP Annual Report 2014

School of Energy and Environment, City University of Hong Kong

27

## Future Contractual Arrangements for New SCAs (4/4)

- **Incentive and Penalty Schemes** – Given the permitted RoR in the new SCAs would be less than the current 9.99%, it is reasonable to retain the current adjustments for Supply Reliability, Operational Efficiency and Customer Services in the new SCAs.
- Regarding **Emission performance**, it is noted that the emissions limits have already imposed on power stations through Technical Memorandum under the APCO. Hence, there is no need to include in the new SCAs any incentive for outperformance or penalty under performance.
- Regarding **Generation Reserve Margin**, it is suggested to include a penalty (say 0.01%) on exceedance of the permitted maximum reserve margin (say 25%) to ensure vigilance in forecasting system maximum demand, in assessing the need for new generation capacity and in management of system/plant operations
- Regarding **Excess Generating Capacity**, the current arrangement is considered appropriate.

## RE Incentive for Power Companies – Current/New SCAs

### Renewable Energy Incentive (Current SCA Schedule 6)

Source: EnB Website/CLP Website/HKE Website

11. The Renewable Energy Incentive Factor for any Year which is a full calendar year is the figure shown in the right hand column of the table below which corresponds with the Renewable Energy Performance, expressed as a percentage, achieved by the Companies in respect of that Year determined in accordance with paragraph 12.

Renewable Energy Performance	Renewable Energy Incentive Factor
5% or above	0.05%
Less than 5% and greater than or equal to 2%	0.03%
Less than 2% and greater than or equal to 1.5%	0.02%
Less than 1.5% and greater than or equal to 1.0%	0.01%
Less than 1.0%	0

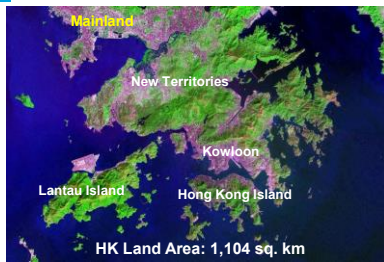


### Comment & Suggestion:

- Current SCAs arrangement is considered too generous based on of 11% RoR for Net RE Fixed Assets
- Suggest to retain the current incentive factor provided same RoR applies to both Net RE Fixed Assets and Non RE Net Fixed Assets.



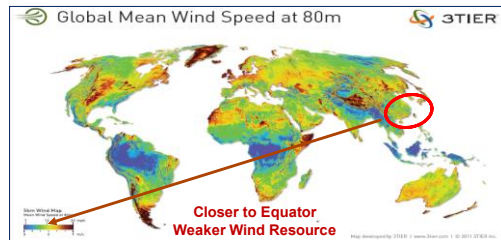
## HK Geographical Setting/Wind Resource – Wind Farms



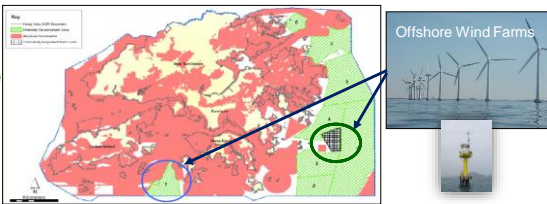
Densely populated urban environment and a mountainous terrain (about **75%** of Hong Kong's total area is **countryside** (including **40%** designated as **Country Park**).



Source: <http://www.censtatd.gov.hk/hkstat/sub/so20.jsp>  
EnB/CLP/HKE Websites



Source: [http://www.3tier.com/static/tcrms/us/images/support/maps/3tier\\_5km\\_global\\_wind\\_speed.jpg](http://www.3tier.com/static/tcrms/us/images/support/maps/3tier_5km_global_wind_speed.jpg)

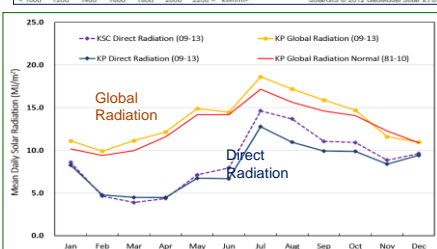
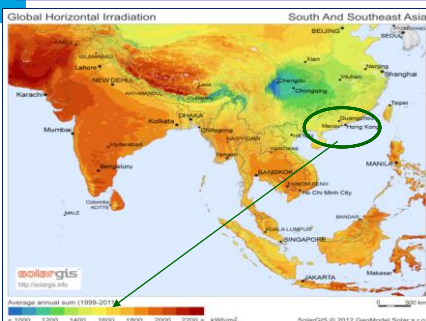


300MW Offshore Wind Farms (22 sq. km area; capital cost **>HK\$10 billion**) can generate about **600 million kWh** electricity (**1.4%** HK current consumption) (23% Capacity Factor) => Add 1% to 2% of Electricity Price

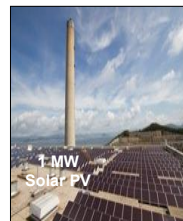
School of Energy and Environment, City University of Hong Kong

30

## RE: HK Solar Radiation Resource & Solar PV Performance



Monthly mean of daily solar radiation recorded at King's Park (KP) and Kau Sai Chau (KSC) in 2009-2013



In 2014  
**1,102,000 kWh**  
generated by TFPV  
solar power system

HKE's Lamma solar power system comprises 5,500 amorphous silicon and 3,162 amorphous/microcrystalline silicon TFPV modules (1.4mx1.1m panel) with a total rated generating capacity of **1 MW**.

(Capacity Factor is about **13%**)

Source: [http://www.hkelectric.com/web/AboutUs/SolarPowerSystem/Index\\_en.htm](http://www.hkelectric.com/web/AboutUs/SolarPowerSystem/Index_en.htm)  
[http://www.hko.gov.hk/education/article\\_e.htm?title=ele\\_00443](http://www.hko.gov.hk/education/article_e.htm?title=ele_00443)

School of Energy and Environment, City University of Hong Kong

31

## RE for Power Generation in Hong Kong (3% in Fuel Mix?)



### Other Feasible Sizable RE Sources in Hong Kong

A 3,000 T/day Integrated Waste Management Facility (**IWMF**) can generate about **480million kWh/year** surplus electricity.

A 200 T/day of Organic Waste Treatment Facility (**OWTF**) can generate about **14 million kWh/year** of surplus electricity.

A 2,000 T/day Sludge Treatment Facility (**STF**) can generate about **18 million kWh/year** of surplus electricity.

**1,128 million kWh/Year Green Electricity** (i.e. **2.35%** RE of 2020 electricity consumption of 48,000 million kWh) can be produced by:

- One 3,000 T/D IWMF (480 million kWh/Year)
- Two 200 T/D OWTF (28 million kWh/Year)
- One 2,000 T/D STF (18 million kWh/Year)
- **300MW Off-Shore Wind Farms (600 million kWh/Year) – could increase the Net Tariff by 1% to 2% if acceptable by the consumers**
- Current RE production (2 million kWh/Year)

School of Energy and Environment, City University of Hong Kong

32

## Promotion of Customers' RE for Power Generation (1/3)

### RENEWABLES (Current SCA Schedule 6)

Source: EnB Website/CLP Website/HKE Website

#### Grid Connection for Embedded Renewables

- The Companies shall offer standardised arrangements (such arrangements shall be subject to the prior written agreement of the Government) for back-up power supply for customers with embedded Renewable Energy Systems in Hong Kong. Customers with embedded Renewable Energy Systems are those who supply a portion of their electricity demand with Renewable Energy Systems at their own premises. Grid connection arrangements shall be made between the prospective grid user and the Companies, on reasonable terms and subject to applicable technical and safety standards, including the technical and safety requirements stipulated in the latest Technical Guidelines on Grid Connection of Renewable Energy Power Systems issued by the Electrical and Mechanical Services Department of the Government. **Technical & Setup Cost Hurdles**
- Special cases, such as spill power (occasional surplus electricity from a customer of the Companies with an embedded Renewable Energy System), shall be considered on a case-by-case basis on reasonable terms. **Not Mandatory**

School of Energy and Environment, City University of Hong Kong

33

## Promotion of Customers' RE for Power Generation (2/3)

### Feed-In Tariffs

- A feed-in tariff (FIT) is an energy supply policy that promotes the deployment of RE resources. **FIT offers a guarantee of payments** to RE developers for the electricity they produce. Payments can be composed of electricity alone or of electricity bundled with RE certificates. These payments are generally awarded as long-term contracts set over a period of 15 to 20 years.
- FIT policies are successful around the world, notably in **Europe**. Currently there are **six U.S. states** (*California, Hawaii, Maine, Oregon, Vermont, and Washington*) that **mandate FITs** or similar programs.

Source: [http://www.nrel.gov/tech\\_deployment/state\\_local\\_governments/basics\\_tariffs.html](http://www.nrel.gov/tech_deployment/state_local_governments/basics_tariffs.html)

### UK FIT Model

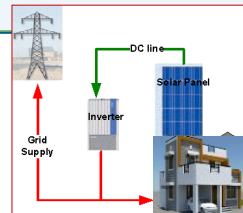
- A Government-back scheme that pays households, business, communities and organizations who create their own electricity using green technology.
- **Guarantees** a minimum payment for all electricity generated by the system (Generation Tariff), as well as an additional payment for the unused electricity produced that can be exported to the grid (Export Tariff). Example: **Solar PV** – receive up to **18.24 pence/kWh** (13.39p for new installation and 4.85p for export to the grid) and **Wind** up to **19.30 pence/kWh** (London domestic electricity charge 14.74p/kWh)

Source: <http://solarguide.co.uk/feed-in-tariff-fit>

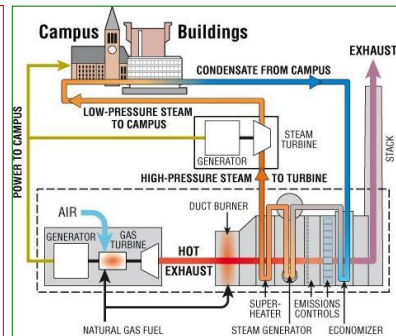
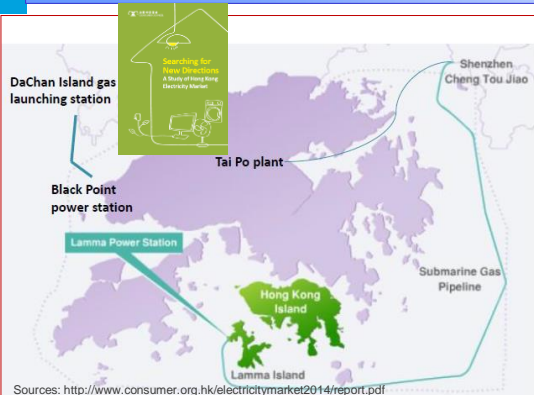
## Promotion of Customers' RE for Power Generation (3/3)

### Suggestions for New SCAs

- Mandatory access to power grids to enable Households and Developers to connected their distributed RE or Green Technology to the existing power grids (Statutory Access Code has to be established)
- "Mandatory FIT Scheme for Households and Developers who generate their own electricity using RE or Green Technology (the cost incurred can perhaps be undertaken by government treasury but with caps on)
- "Net Metering Scheme" allows general public to produce renewable electricity onsite to "spin the meter backwards" (considered to be more feasible and acceptable to the public when compared with the FIT scheme)
- Mandatory power Back-up arrangement provided by power companies for all Distributed RE/Green Technology Generation



## New SCAs: Facilitating Distributed Generation



### New SCAs should facilitate grid access for Distributed Co-Generation from 3<sup>rd</sup> Party (Fuels : Landfill gas, natural gas, etc.)

The **waste heat** produced from **electricity** generation in Gas Fueled Power Plant can be used to provide **hot water** for the building and, via an absorption chiller, to provide **cooling** for the building (e.g. University Campus, Science Parks, Industrial Estates, Airport, etc. similar to District Cooling)

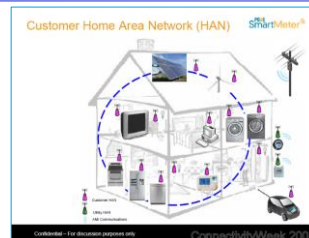
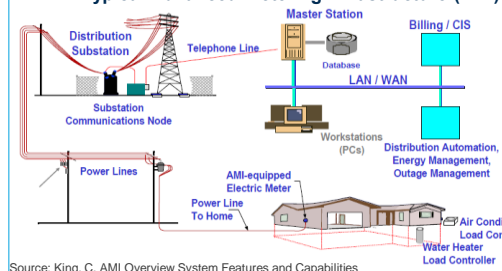
- Increase in plant efficiency from **50% to 75%** for CHP [Source: USA EPA (<http://www.epa.gov/chp/basic/efficiency.html>)]
- Reduced grid congestion and avoided transmission/distribution losses

School of Energy and Environment, City University of Hong Kong

36

## New SCAs: Promotion of DSM through AMI

### Typical Advanced Metering Infrastructure (AMI)



Smart Utility Meter

Advanced metering infrastructure (AMI) is an architecture for automated, two-way communication between a smart utility meter and a utility company. The goal of an AMI is to provide utility companies with real-time data about power consumption and enable automatic meter reading and demand response. AMI allows consumers to make informed choices about energy usage based on the price at the time of use in a competitive market. For a regulated market, AMI can facilitate the implementation of initiatives such as tariff rebate or discount for using electricity during non-peak hours (even off-peak low tariff structure), encourage energy saving and hence help reduce system maximum demand and defer investment in generation capacity. It is suggested to encourage the development of AMI in Hong Kong.

School of Energy and Environment, City University of Hong Kong

37

## Closing Remark: New SCAs/Energy Policy/Energy Authority

I concur that the unique situation of Hong Kong (*private ownership of HK\$150 billion assets , relative small and geographical constrained market plus community preference for local electricity generation*) and the huge costs of setting up and execution of highly complex regulatory framework/controls incurred for a deregulated market make it unlikely to introduce genuine competition on a sizable scale to the Hong Kong Electricity Market in the near term.

Addressing the “Future Development of the Electricity Market” is considered a piece-meal and bottom-up approach to much bigger issues of energy supply, energy security, energy efficiency, climate change, environmental protection and ecology conservation.

What Hong Kong has in place is a set of **Energy Policy Objectives** covering mainly the supply side of electricity and towngas services, but not a well-structured, cohesive and comprehensive Energy Policy. **Hong Kong needs its Energy Policy** to address both supply side and demand side covering all sectors including electricity and gas, buildings, road transport, marine navigation and civic aviation.

Setting our Energy Policy's goals, strategies and action plans should take due consideration of Hong Kong's unique geographical, economic, social, cultural and political circumstances , current energy/power market structures, human capacity and endowment on natural resources. The establishment of a statutory **Energy Authority** in Hong Kong to undertake the formulation and execution of Energy Policy is long overdue.

Dr C W Tso  
Email: [@cityu.edu.hk](mailto:@cityu.edu.hk)  
[@live.com](mailto:@live.com)  
Mobile:

 香港城市大學 City University of Hong Kong 三十周年紀念 30th Anniversary 專業 創新 國際化 Professional Creative For The World  <a href="http://www.cityu.edu.hk">www.cityu.edu.hk</a>	<b>Dr. C. W. Tso</b> BSc, MSc, DBA, CEng, FIMechE, FHKIE Adjunct Professor School of Energy and Environment  Tat Chee Avenue Kowloon, Hong Kong Tel.: (852) 3442 9490 Fax: (852) 3442 0688 E-mail: <a href="mailto:chevtso@cityu.edu.hk">chevtso@cityu.edu.hk</a> Website: <a href="http://www.cityu.edu.hk/see">www.cityu.edu.hk/see</a>
 香港城市大學 City University of Hong Kong 三十周年紀念 30th Anniversary 專業 創新 國際化 Professional Creative For The World  <a href="http://www.cityu.edu.hk">www.cityu.edu.hk</a>	<b>曹志華 博士</b> 特約教授 能源及環境學院  香港九龍德輔道 電話: (852) 3442 9490 傳真: (852) 3442 0688 電郵: <a href="mailto:chevtso@cityu.edu.hk">chevtso@cityu.edu.hk</a> 網址: <a href="http://www.cityu.edu.hk/see">www.cityu.edu.hk/see</a>