

IEEE Open Forum Hong Kong Electricity Market Now, Till 2018 and Beyond

Electricity Generation in Hong Kong – Outlook and Challenges

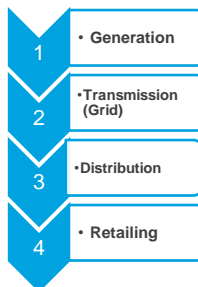


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20 April 2013

Electricity Supply in Hong Kong

Electricity in Hong Kong has always been supplied by two **vertically-integrated** power companies: The Hongkong Electric Company Ltd (**HEC**) which was incorporated in 1890, and CLP Power Hong Kong Ltd (**CLP**) which was incorporated in 1901.

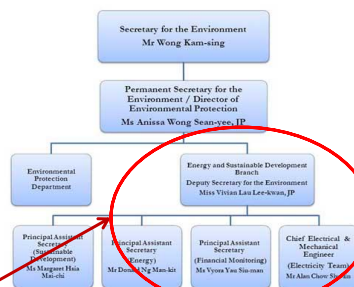


Vertically-integrated

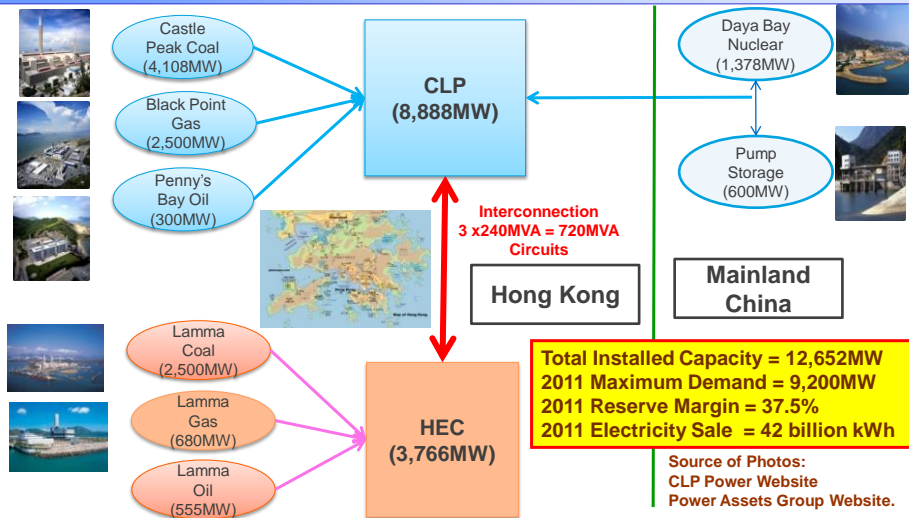
Both power companies do not have a franchise but their operations are regulated by the **Energy and Sustainable Development Branch of the Environment Bureau** under Scheme of Control (SOC) Agreements.

(Source: Environment Bureau Website)

The HKSAR Government entered into two **10-year term** Scheme of Control Agreements (**SCAs**) dated 7 January 2008, one with **CLP** and another with **HEC**. The SCAs are valid till **2018** with a 5-year interim review in 2013 (now underway).



Hong Kong Electricity System: Interconnected ?



The **720MVA** Interconnector is mainly used for emergency backup and sharing of spinning reserve (**2,000MVA** required for full power transfer with N-1 Contingency).

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Generation Capacity Profile

CLP	Coal Fired	Gas Fired	Oil Fired	Nuclear	Pump Storage
Castle Peak P/S	4,108MW (4x350+4x677)	0		0	0
Black P/S	0	2,500MW (8x312.5)		0	0
Penny's Bay P/S			300MW (3x100)		
Daya Bay P/S	0	0	0	1,378MW (70% of 1,968)	
Pump Storage P/S	0	0	0	0	600MW (50% of 1,200)
% of Installed Capacity	46.2%	28.1%	3.4%	15.5%	6.8%

CLP's Total Generation Capacity: 8,888MW; 2011 Max Demand: 6,702MW => 32.6% Reserve Margin

HEC	Coal Fired	Gas Fired	Oil Fired	Wind Turbine	Solar PV
Lamma P/S	2,500MW (3x250+5x350)	680MW (335+345)	555MW (4x125+1x55)	0	0.55MW
Lamma Wind	0	0	0	0.8MW	0
% of Installed Capacity	67.0%	18.2%	14.8%	0.02%	0.01%

HEC's Total Generation Capacity: 3,766; 2011 Max Demand: 2,498MW => 50.8% Reserve Margin

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Electricity Consumption (2006-2011)

Year	Electricity Sales (Consumption) (billion kWh)	System Maximum Demand (MW)	GDP (Current Price (HK\$million))	Population
2006	40.33	9,032	1,503,351	6,857,100
2007	40.85	8,836	1,650,756	6,916,300
2008	40.94	9,338	1,707,487	6,957,800
2009	41.50	8,926	1,659,245	6,972,800
2010	41.86	9,278	1,777,720	7,024,200
2011	42.06	9,200	1,935,195	7,071,600
Change from 2006 to 2011	+4.3%	+1.8%	+28.7%	+3.1%

(Sources: LegCo Paper LCQ15 (2011), HK Annul Digest of Statistics and CLP/HEC Annual Reports)

- Hong Kong's increase in **Electricity Consumption (+4.3%)** over a period of **5 years** did not follow the trend of **GDP (+28.7%)**, but quite close to **Population growth (3.1%)**
- System Maximum Demand** (determines "installed generation capacity") was highest in 2008 (**9,338MW**). Max Demand in 2011 dropped to **9,200 MW** (CLP: 6,702 + HEC: 2,498).
- Installed Generation Capacity of 12,654MW remains unchanged from 2006 to 2011 translates to **Generation Reserve Margin of 37%** in 2011 (*Do we need that for 99.999% Supply Reliability ???*).

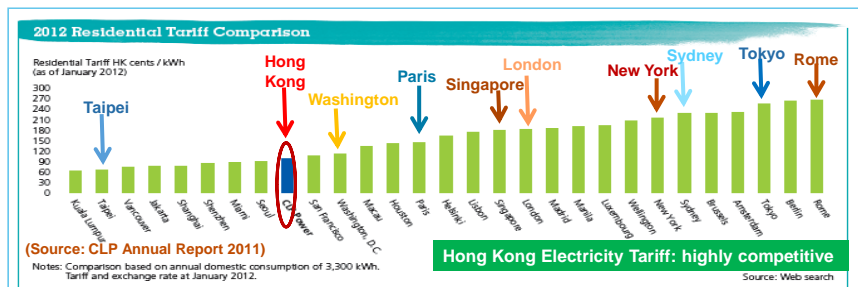
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Electricity Tariffs (2005 – 2013) : Challenge?

	2005	2006	2007	2008	2009	2010	2011	2012	2013	Change 2005 to 2013 (8 Yrs)
CLP (HK\$ c/kWh)										
Av. Basic Tariff	-	-	-	-	77.4	80.0	80.0	84.2	84.2	
Fuel Clause Charge	-	-	-	-	11.8	11.5	14.1	17.8	22.4	
Rebate								-3.3	-2.1	
Av. Net Tariff	87.2	87.3	87.1	91.1	89.2	91.5	94.1	98.7	104.5	+19.8%
HEC (HK\$ c/kWh)										
Av. Basic Tariff	-	-	-	116.9	94.5	94.5	93.1	94.1	94.7	
Fuel Clause Charge				10.5	25.4	25.4	30.2	37.0	40.2	
Av. Net Tariff	103.3	110.0	117.4	127.4	119.9	119.9	123.3	131.1	134.9	+30.6%

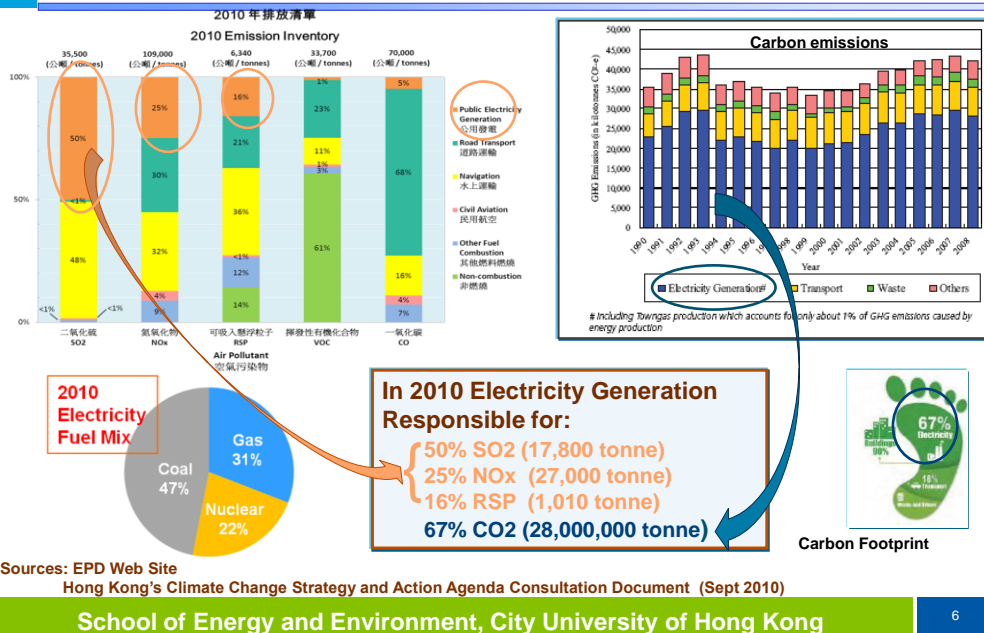
(Sources: LegCo Papers LCQ15 (2011), CB(1)297/12-12 (01)(2012) \$ CB(1)1024/11-12(01) (2012))



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Emissions from Electricity Generation: Challenge?



Tightening Permissible Emissions: 2005 to 2010

《 Air Pollution Control Ordinance, 》 (APCO) : Specified Process Licence is required for electricity generation in Hong Kong.

	2005 Fuel Mix (approx.)		
	Coal	Gas	Nuclear
CLP	40%	30%	30%
HEC	100%	0%	0%
Total	55.6%	22.2%	22.2%

CLP: 8 gas Units (2,500MW), 8 coal units (4,108MW), nuclear (1,378MW)

HEC: No gas units, 8 coal units (2,500MW: 3 units equipped with FGD and LNB)

In 2008, HK Govt. issued the first Technical Memorandum under APCO to allocate "Permissible Emissions" commencing on 1st January 2010 (Schedule 4 of SCA). (**Not CO₂**)

	2005 Emissions Inventory				2010 Emission Caps (TM)			
	SO ₂ (Tonne)	Nox (Tonne)	RSP (Tonne)	CO ₂ (kTonne)	SO ₂ (Tonne)	Nox (Tonne)	RSP (Tonne)	CO ₂ (kTonne)
CLP	46,100	27,900	1,900	17,600	15,750	26,710	790	-
HEC	31,000	18,500	1,500	9,900	9,370	15,890	470	-
Total	77,100	46,400	3,400	27,500	25,120	42,600	1,260	-
Reduction					-67.4%	-8.2%	-62.9%	

Sources: CLP/HEC 2006/2010 Annual Reports/Sustainability Reports; Legislative Council LC Paper No. CB(1)517/10-11 (Nov 2010)

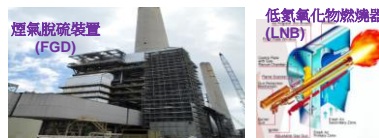
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2010 Emission Performance (Recap)

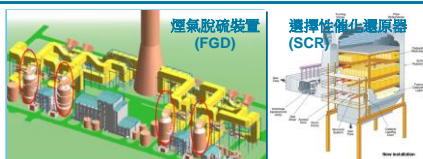
	2010 Fuel Mix		
	Coal	Gas	Nuclear
CLP	39.9%	30.1%	30.0%
HEC	67%	33%	0%
Total	47%	31%	22%

HEC: 2 sets of new gas units (680MW), low sulphur coal, 3 coal units retrofitted (950MW) with advanced emission reduction systems.

CLP: 6 x 312.5MW gas units, ultra low sulphur coal, 4x677MW coal units retrofitted with advanced emission reduction systems.



HEC 950MW Coal-Fire Units – FGD and LNB (HK\$1billion)



CLP 2,708MW Coal-Fired Units - FGD and SCR (HK\$9billion)

	2010 Emission Performance		
	SO ₂ (Tonne)	Nox (Tonne)	RSP (Tonne)
CLP Actual	12,300	21,200	790
(Cap)	(15,750)	(26,710)	(790)
HEC Actual	5,490	9,710	240
(Cap)	(9,370)	(15,890)	(470)

Sources:

- Legislative Council LC Paper No. CB(1)517/10-11 (Nov 2010)
- CLP/HEC 2011 Annual Reports/Sustainability Reports
- EnB Website SOC Agreements

HK\$10 billion invested by CLP/HEC in retrofitting coal-fired units with advanced emission reduction systems (9.99% Return)
{HEC >30% better => +0.1% to Return}

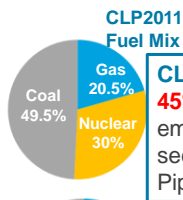
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Tightening Permissible Emissions: 2010 to 2015

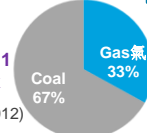
	2010 Emission Caps (TM)			2015 Emission Caps (TM)		
	SO ₂ (Tonne)	Nox (Tonne)	RSP (Tonne)	SO ₂ (Tonne)	Nox (Tonne)	RSP (Tonne)
CLP	15,750	26,710	790	5,702	17,532	531
HEC	9,370	15,890	470	6,780	10,020	300
Total	25,120	42,600	1,260	12,482	27,552	831
Reduction	Base			-50.3%	-35.3%	-34.1%

	Emission Performance		
	SO ₂ (Tonne)	Nox (Tonne)	RSP (Tonne)
CLP 2011 (2015 Cap)	9,827 (5,702)	21,168 (17,532)	781 (531)
HEC 2011 (2015 Cap)	4,200 (6,780)	8,840 (10,020)	210 (300)



CLP: double gas in fuel mix to **45%** is required to meet 2015 emission caps (gas from the second West-East Gas Pipeline begins in early 2013)

HEC 2011 Fuel Mix



HEC: 2011 fuel mix (67% coal and 33% gas) is adequate to meet 2015 emission caps

Sources:

- *Legislative Council LC Paper No. CB(1)2256/11-12(05) (Nov 2012)
- #CLP/HEC 2011 Annual Reports/Sustainability Reports

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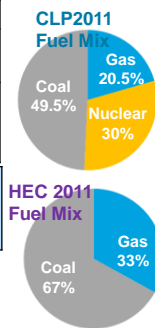
Tightening Permissible Emissions: 2015 to 2017

	2015 Emission Caps (TM)			2017 Emission Caps (TM)		
	SO ₂ (Tonne)	Nox (Tonne)	RSP (Tonne)	SO ₂ (Tonne)	Nox (Tonne)	RSP (Tonne)
CLP	5,702	17,532	531	5,199	16,500	500
HEC	6,780	10,020	300	5,200	9,450	250
Total	12,482	27,552	831	10,399	25,950	750
Reduction	Base			-16.7%	-5.8%	-9.7%

	Emission Performance		
	SO ₂ (Tonne)	Nox (Tonne)	RSP (Tonne)
CLP 2011 (2015 Cap) (2017 Cap)	9,827 (5,702) (5,199)	21,168 (17,532) (16,500)	781 (531) (500)
HEC 2011 (2015 Cap) (2017 Cap)	4,200 (6,780) (5,200)	8,840 (10,020) (9,450)	210 (300) (250)

Sources:

*Legislative Council LC Paper No. CB(1)2256/11-12(05) (Nov 2012)
#CLP/HEC 2011 Annual Reports/Sustainability Reports



CLP: double gas in fuel mix to **>45%** is required to meet 2017 emission caps (Gas from the second West-East Gas Pipeline begins in early 2013)

HEC: 2011 fuel mix (67% coal and 33% gas) is quite adequate to meet 2017 emission caps (Based on 1% per year increase in consumption)

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Addressing 2020 Carbon Reduction Target !

Sept 2010 Consultation Document : *Hong Kong's Climate Change Strategy and action Agenda for the Coming Decade* : aiming to reduce Hong Kong's carbon intensity by **50% to 60%** in 2020 compared with 2005 level.

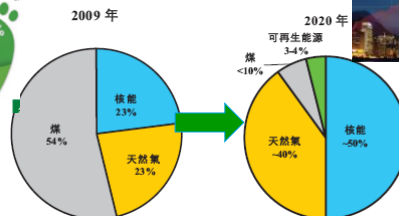
Electricity generation produces **67%** of carbon emission => main plank of strategy is to **revamp fuel mix**.

Nuclear: from 23% to 50%

CLP: Daya Bay P/S (30%) inadequate requiring 20% new nuclear source, additional pump storage capacity, Tx, etc.
HEC: needs complete new nuclear infrastructure, new submarine Tx lines

Natural Gas: from 23% to 40%

CLP: existing 8 gas-fired units adequate but gas from WEPII is expensive.
HEC: needs new gas-fired unit and new gas supply (high price)



Coal: from 54% to 6% - 7%

CLP: 4x350MW units (A Station) retired, but most 4x677MW units (B Station) retrofitted with emission reduction system in 2011 (HK\$9B) may be idle.

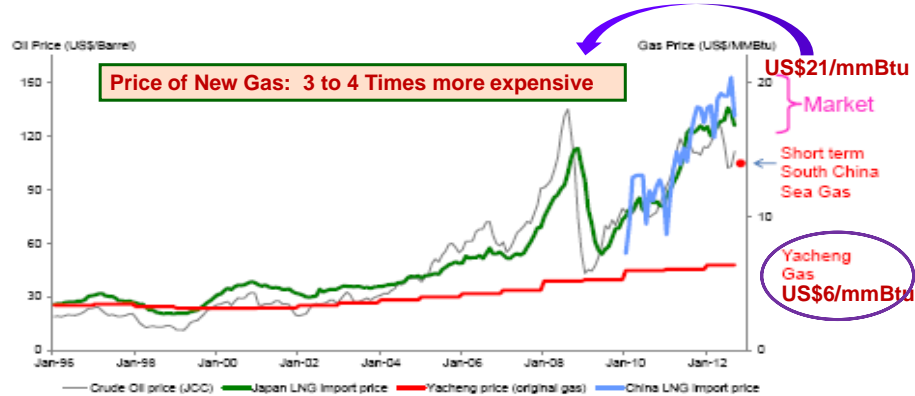
HEC: 3x250MW (Stage 1) units retired, but most 950MW units retrofitted with emission reduction system in 2010 (HK\$1B) may be idle.

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More Natural Gas to Reduce Emissions => Expensive?

Gas Price Trend



CLP Gas Prices : Yacheng ~\$6 ; Short term South China Sea ~\$14. Market ~\$18-\$21

燃點生活力量
Energy for Life

CLP 中電

Source: Legislative Council LC Paper No. CB(1)1024/11-12(01) (11 Dec 2012)

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More Nuclear Power: Safety Concern ?

Fukushima Daiichi Nuclear Power Plant: released huge hazardous radioactive materials to atmosphere; discharged highly radioactive waste water to the sea => causing severe damages to environment, ecosystems and food chains.

Germany: permanently shut down 8 of its reactors and pledged to close the rest by 2022.

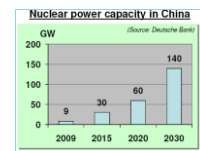
Italy: voted overwhelmingly to keep their country non-nuclear.

Switzerland & Spain : banned construction of new reactors.

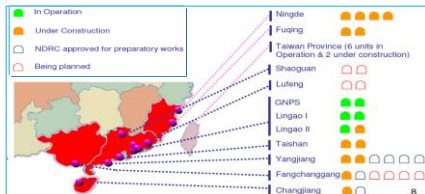
Japan: dramatic reduction of reliance on nuclear power.

Mexico: sidelined construction of 10 reactors (go for gas units).

Belgium: phasing out nuclear plants



15 Reactors (12GW)
=1.8% in 2011



Mainland urgently needs nuclear power plant to improve air quality and reduce carbon footprint

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RE to address 2020 Carbon Reduction Target ?



HEC Proposed 100mW Offshore Wind Farm



CLP Proposed 200MW Offshore Wind Farm

Propose 300MW offshore wind farm at capital cost of **HK\$10 billion (11% Return)**, can generating about **560million kWh** electricity (**1.2%** HK's total electricity supply) => **+0.01%** return). *Can be achieved by energy conservation/efficiency.*



Proposed Waste to Energy Incineration Plant

Proposed 3,000t/day waste to energy incineration plant (HK\$15B): part of Waste Management System to tackle waste disposal can generate about **500million kWh** electricity.

300MW Wind Farm + Waste to Energy Incineration Plant can only produce about **2%** of Hong Kong electricity supply. *(Not 3% to 4% as perceived)*

Fuel Mix => Policy Driven ?

	Coal	Oil	Gas	Nuclear	Renewable	Hydro	Others	Year
Hong Kong	54%	Negligible	23%	23%	Negligible	0	0	2009
	54%	Negligible	24%	22%	Negligible	0	0	2011
Singapore	0	16.9%	77.2%	0	Negligible	0	5.9%	2010
Korea	41%	4%	16%	37%	2%		0	2009
Japan	41%		26%	23%	10%		0	2009
France		5%	4%	77%	13%		0	2009
Germany	51%	Negligible	14%	23%	17%		5%	2010
UK		36%	42%	16%	6%		0	2009
USA	44.9%	1.0%	2.4%	20.3%	6.9%	3.6%	0	2009

Fuel Mix for Electricity Generation in Hong Kong

- In line with most developed economies
- Mainly driven by Government Policy on Setting Emission Limits

Challenges Ahead ?

- **Customer Perception/Choice:** Unbundling Electricity Supply Chain by introducing competition can stimulate technical innovation, enhance operating efficiency and productivity, provide choices of supply and lower consumer prices.
- **Electricity Tariff:** Now still competitive but will go up significantly due to increasing use of more expensive natural gas from new sources to meet emission caps.
- **Reliability:** One of the highest in the world ==> affected not only by reserve margin but fuel security due to increasingly heavily reliance on natural gas and nuclear energy from Mainland.
- **Increased Interconnection:** to reduce reserve margin, enhance reliability and efficiency of power system, and facilitate formation of common grid needed for market reform.

Electricity is vital for the effective operation of our society, and hence should form part of a sound and sustainable energy policy :
economic growth, environmental and energy security as fundamental goals.

**Hong Kong has
Energy Policy ?**

Thank You !

