

能源及環境學院
SCHOOL OF ENERGY
AND ENVIRONMENT



Public Consultation on the Future Fuel Mix for Electricity Generation

Submission to the Panel on Economic Development, Legislative Council
(5 May 2014)

(Attention: Hon James TIEN Pei-chun, Panel Chairman)




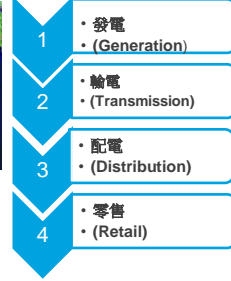
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Electricity Supply in Hong Kong

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 (**HEC**) 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 **HEC** valid till 2018.



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

CLP 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 2013, maximum demand was **6,699MW (32.7% reserve margin)** and sales of electricity for local consumption was **31,783 billion kWh (74.7% of Hong Kong total)**



(Source: CLP Group Website)

HEC Electricity Generation

HEC supplies electricity to Hong Kong Island and Lamma Island.

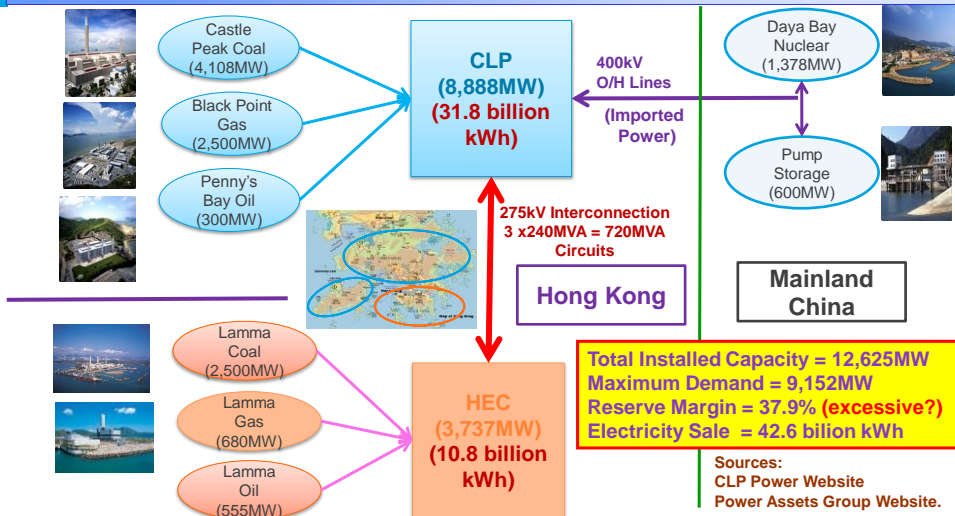
Electricity is generated at Lamma Power Coal-Fired and Gas-Fired Stations plus Hong Kong's first grid-connected 800kW Wind Power and largest 1,000kW Solar PV System.

HEC currently has a total installed capacity of 3,737MW. In 2013, maximum demand was 2,453MW (52.3% reserve margin) and sales of electricity for local consumption was 10,773 billion kWh (25.3% of Hong Kong total)



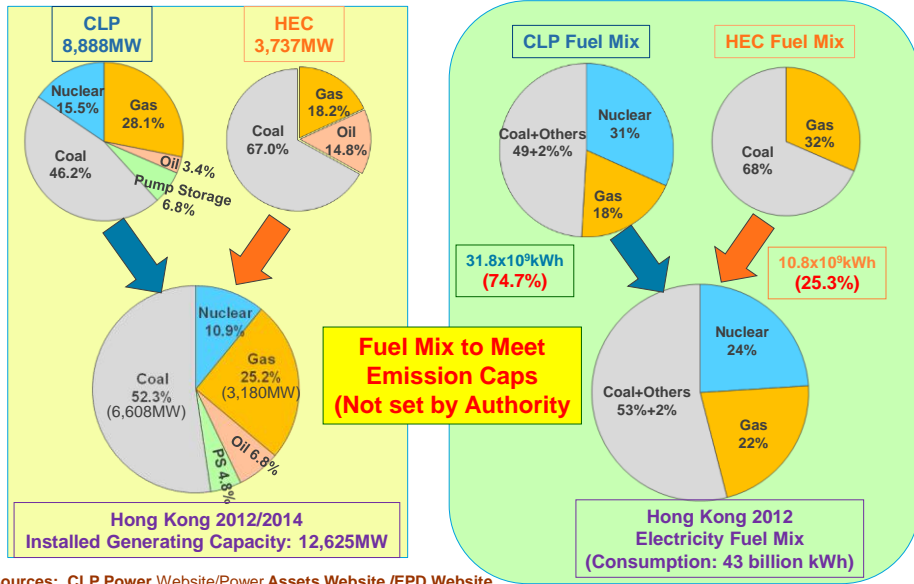
(Source: Power Assets Group Website)

Hong Kong Electricity Generation (2013)

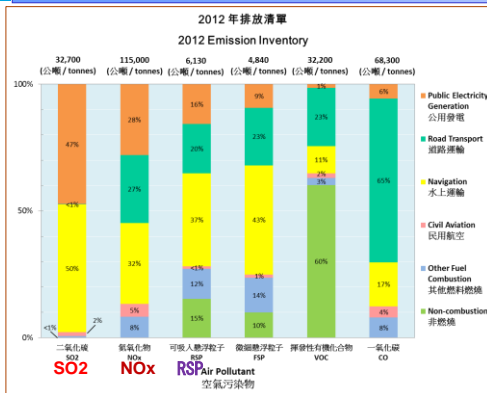


The 720MVA Interconnector is mainly used for emergency backup and sharing of spinning reserve (2,000MVA required for full power transfer with N-1 Contingency).

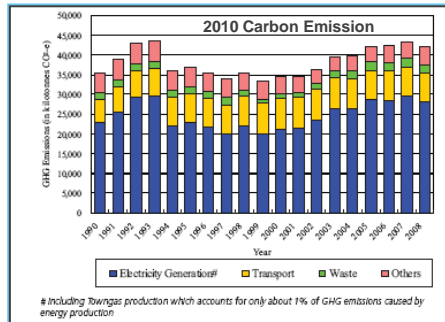
Installed Capacity Mix & Electricity Fuel Mix



Hong Kong Pollutants & Carbon Emissions

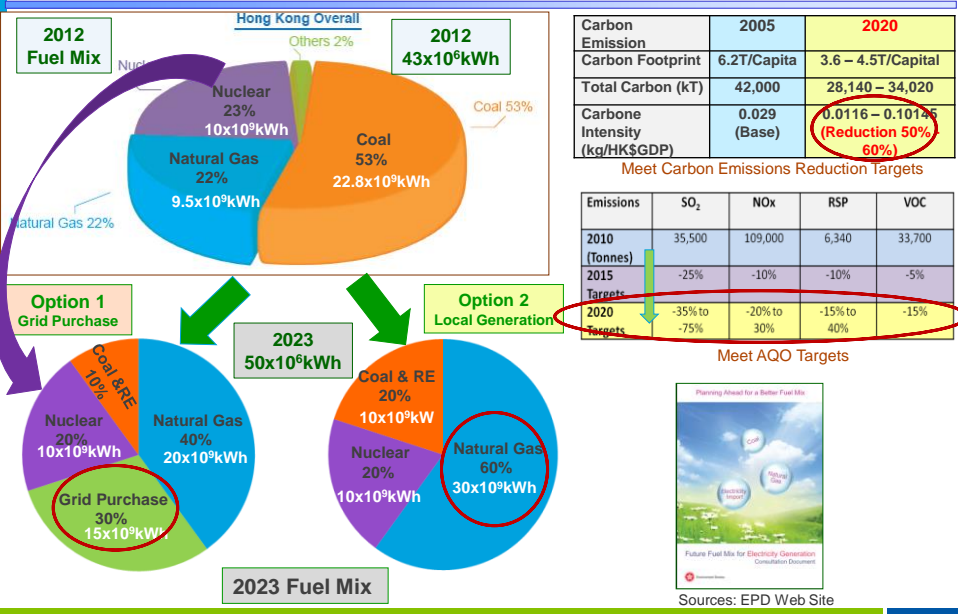


Pollutants	Navigation	vs	Electricity
SO ₂	50%	vs	47%
Nox	32%	vs	28%
RSP:	37%	vs	16%



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

Tackling Emissions in Hong Kong



Q.1 Competing Objectives (Extent of Coverage ?)



Geopolitical & Social Factors

Fuel Supply Availability & Security (fuel reserve/ sources /supply routes; Middle-East conflicts; tension in South China Sea; Ukraine crisis....)

Self-Reliance (populism/culture conflict) or Same as other Mainland Cities (integration)

Impact on Employment /Workforce

Impact on Knowledge, Technology & Skills Development

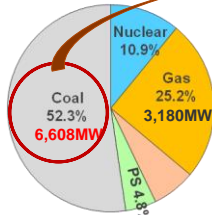
Emissions within Hong Kong or covering neighboring areas

Green Economy & Sustainable Development



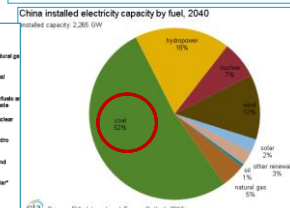
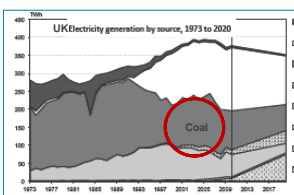
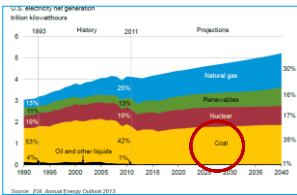
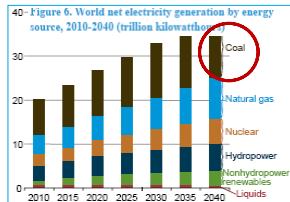
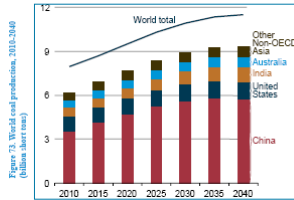
Q.2 Diminishing Coal for Electricity Generation ?

2012 Installed Capacity Mix



	2023 Installed Capacity	2023 Fuel Mix (Coal)	2023 Annual Consumption	Required Capacity (65% Load Factor + 10% System Loss)	2013 Idled Capacity
Option 1	4,350MW	10%	5 billion kWh	980MW	3,370MW
Option 2	4,350MW	20%	10 billion kWh	1,960 MW	2,390MW

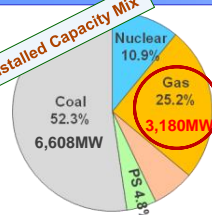
Should we re-visit Hong Kong's 1997 Policy on NO new coal-fired power plant ? (Fuel Security)



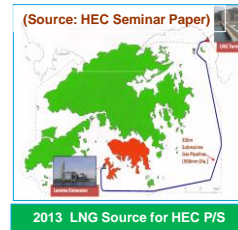
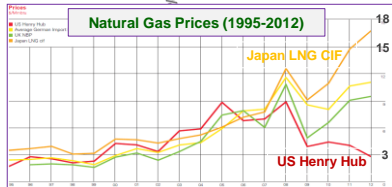
Sources: USEIA and IEA Reports

Q.3 Natural Gas for Electricity Generation (New LNG Terminal ?)

2012 Installed Capacity Mix



	2012 Installed Capacity	2023 Fuel Mix (Gas)	2023 Annual Consumption	Required Capacity (65% Load Factor + 10% System Loss)	Additional New Capacity
Option 1	3,180MW	40%	20 billion kWh	3,920MW	740MW
Option 2	3,180MW	60%	30 billion kWh	5,880MW	2,700MW

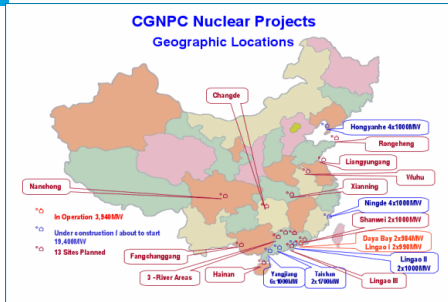


Electricity consumption in 2023 for Option 2 requires supply of additional 3 million tonne of natural gas => can support viable operation of a **LNG Terminal in HK** => benefits:

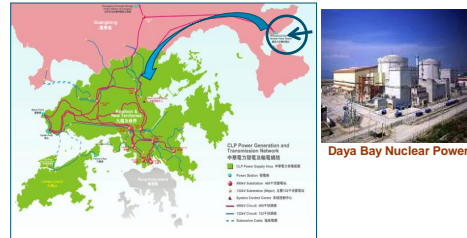
- **Security** of supply and lower price volatility (sourcing flexibility & storage)
- Replacement of **towngas** with 100% natural gas (reduce cost/emissions)
- **CNG/LNG** as fuel for transport sector (facilitate Mainland heavy vehicles)
- **New jobs** & development of **expertise/skills** for energy/engineering sector



Q.4 Imported Nuclear Power (More from Dedicated Source?)



Source: <http://theenergycollective.com/breakthroughinstitut/198441/chinese-nuclear-and-future-energy-innovation>



Source: CLP Power Website

Daya Bay (2x 984MW) produces around 14 billion kWh of electricity annually of which **70%** (10 billion kWh) is imported by **CLP** to its supply area in Hong Kong through the 400kV Guangdong-CLP interconnection. In Sept 2009, the supply contract between Daya Bay and CLP was extended to 2034.

Technically Feasible to increase Daya Bay Nuclear Power Station's Sent Out Capacity to **CLP** from 70% up to 85%, i.e. **12 Billion kWh** (24% of 2023 Hong Kong Fuel Mix). But have to check 400kV Transmission Lines Capacity, 600MW Pump Storage Capacity, Import Load Profile, etc. ?

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Q.5 Renewable Energy for Electricity Generation (Viable ?)



HEC Proposed 100MW Offshore Wind Farm



CLP Proposed 200MW Offshore Wind Farm

Propose 300MW offshore wind farm at capital cost over **HK\$10 billion** can generate about **650 million kWh** electricity (**1.3%** HK's 2023 consumption) with capacity factor of 25% due to rather low wind speed (close to Equator). (*Intermittent Nature...Not too sure viable?*)



Proposed Waste to Energy Incinerator

Suggest to proceed with the proposed 3,000t/day waste to energy incineration plant : part of Waste Management System to tackle waste disposal can generate about **500million kWh** electricity ... Bonus (**1%** of HK's 2023 consumption).

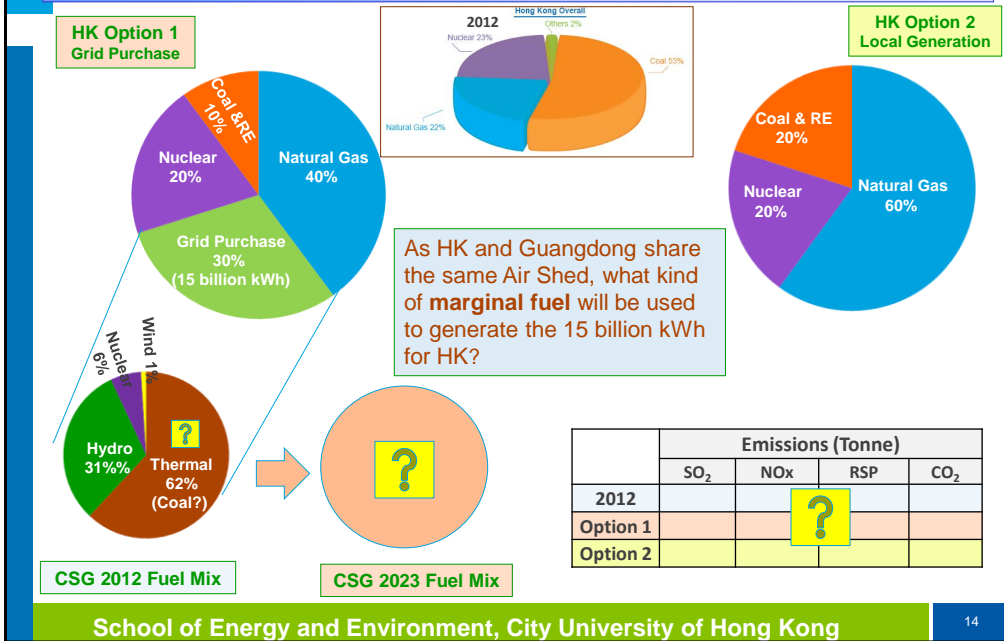
Suggest to put in place incentives to encourage individuals and companies to use renewable energy to generate electricity with friendly arrangement for feeding it into the power grid.



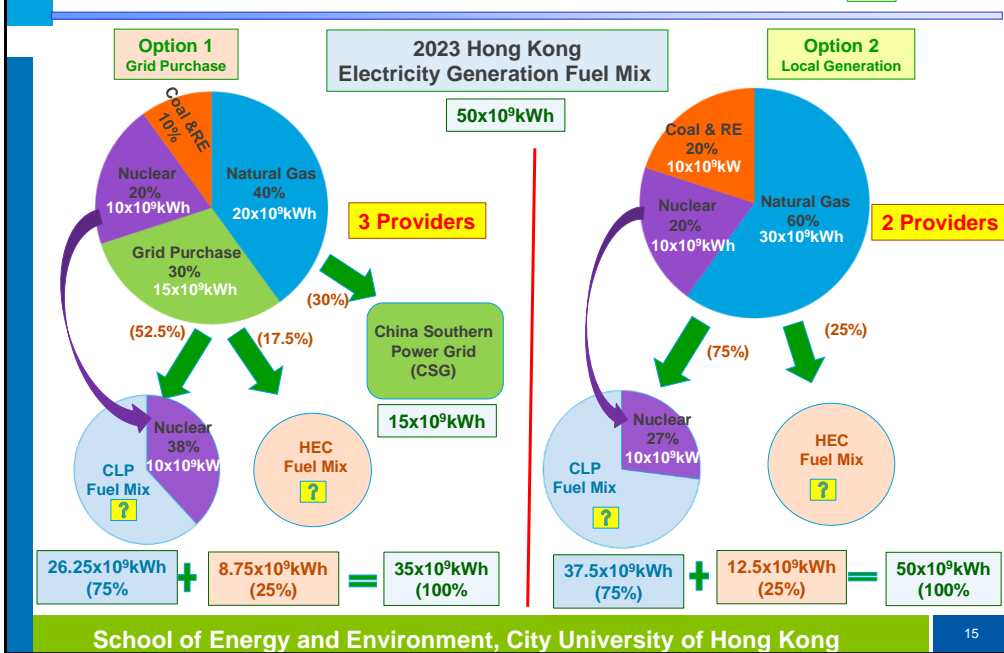
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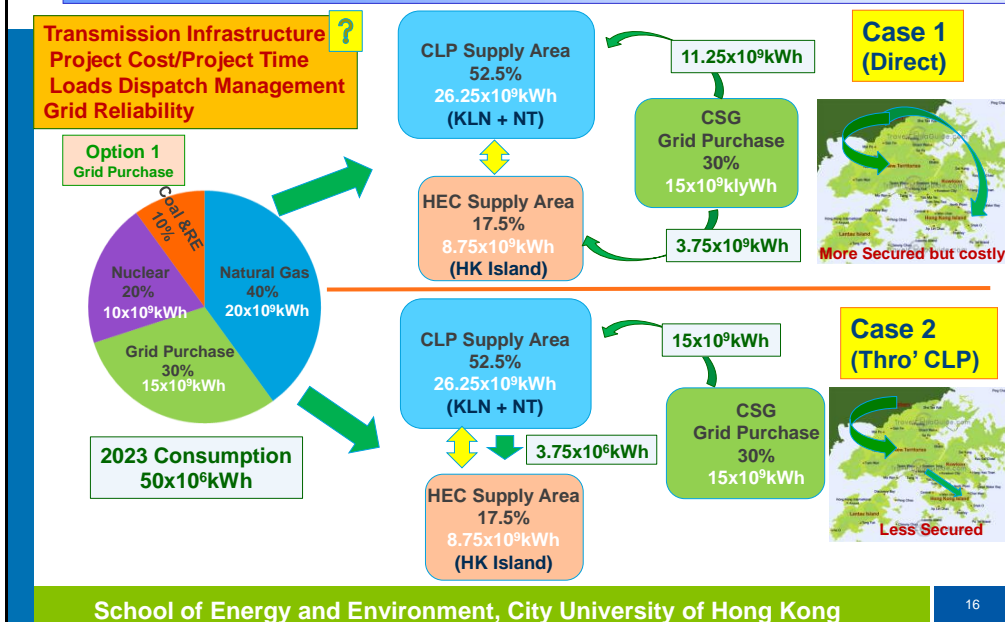
Q.6 Emissions Reduction Performance (More Data ?)



Q.7 How to Allocate Fuel Mix to CLP/HEC ?

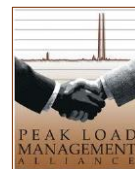


Q.8 Option 1 (Grid Purchase) - Transmission System ?



Q.9 Grid Purchase (Option 1) - Reliability Issue ?

1. Power system interconnection is a kind of **marriage**, because two systems become **one** when they operate in synchronism.
2. In any synchronous network, **disturbances** in one location are quickly felt in other locations. After interconnecting, a system that used to be isolated from disturbances in a **neighboring system** is now vulnerable to those disturbances.
3. As **major blackouts** in North America and Europe in **2003** demonstrated, large-scale disturbances can propagate through interconnections and result in **cascading outages**, bringing down systems that had previously been functioning normally.
4. Minimizing the likelihood that an interconnection will lead to such problems as **voltage collapse, dynamic and transient instability, or cascading outages** due to propagated disturbances requires extensive planning studies, computer modeling, **exchange of data between the interconnected systems and well-coordinated operation**. **Can this be done efficiently & effectively ?**

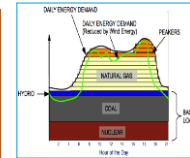


Q.10 Grid Purchase (Option 1) - Peak Demand & Quality ?

Year 2012	CSG	Hong Kong
Installed Capacity	202,000MW	12,654 MW
Generation	825 billion kWh	47 billion kWh (43 billion kWh consumption)
Maximum Demand	?	9,263MW
Reserve Margin	?	36.6% (Firm)
System Reliability	?	99.999%



Proposed Imported electricity accounts for 30% of Hong Kong Consumption, i.e. 15 billion kWh (less than **2%** of CSG Generation). The issue is not just to look at the installed and generation capacity but **load profile, max demand and reserve margin** (firm capacity) to ensure adequate supply to Hong Kong during **summer peak** demand periods. Furthermore, is 30% Grid Purchase is for **“Base Load”** ?



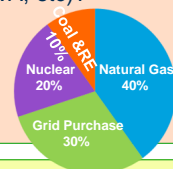
Reliability and Quality of electricity supply in terms of frequency and voltage are vital for **Hong Kong** to function to efficiently and effectively as **global financial, logistics and services hubs**, whereas the economy of **Macau** (2012 consumption was 4.2 billion kWh with nearly 90% of electricity from CSG) is mainly based on tourism and gaming (Major Gaming/Resorts Complex in Macau has its own back-up power supply).



Q.11 Investment/Production Costs & Tariffs - Data ?

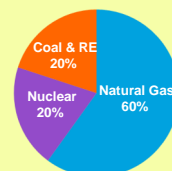
Option 1 (Grid Purchase) – What are the

- cross-boundary Transmission System: (i) separately to CLP Grid/HEC Grid or (ii) to CLP Grid and then to HEC Grid via interconnectors (routes, length, MVA, DC/AC, etc)?
- upgrading of interconnection between CLP and HEC (routes, length, MVA, etc)?
- setting up/operation of load dispatch management centre?
- local grid reinforcement and back-up generation capacity?
- stranded costs of existing generation infrastructure (coal-fired units)?
- CSG electricity price for Hong Kong?



Option 2 (Local Generation) – What are the

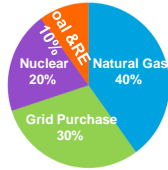
- number of new gas-fired generating units for CLP and HEC ?
- additional natural gas receiving/control stations ?
- additional gas supply lines to power station (if required) ?
- stranded costs of existing generation infrastructure (coal-fired units)?
- projected gas price for new gas supply contract?



Production cost is important **but “Market Structure and Regulatory Regime”** has huge impact on working out the Electricity Tariff.

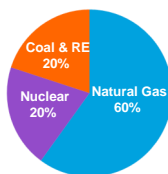
Q.12 What's Impact on Future Market Structure ?

Option 1 Grid Purchase



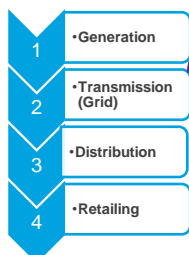
- Integration of CLP/HEC Grids into a Single Grid (as non-contestable part of a liberalized market) to facilitate future market reform
- 30% Grid Purchase is under "Vested Contract", based load or not ?
- 70% load shared by CLP & HEC based on Supply Area consumption?
- No contesting mechanism => "Market Power" Providers simply increased from 2 to 3?
- Issue of demarcation of work and responsibility of system load management, electricity supply reliability and quality, etc ?

Option 2 Local Generation

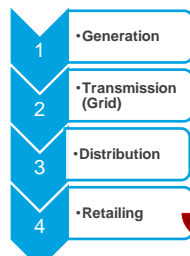


- Possibly preferred by current market players to retain full control of ownership, management and operation of power infrastructures ?
- Confidence in terms of electricity of supply reliability and quality
- Sites for new gas-fired plants to replace retired coal-fired plants and to meet future demand ? (existing sites should be enough as footprint for gas-fired plant is less than 1/2 of coal-fired plant)
- Extension of current regulatory regime => Assets snowball?
- Possibly like a nail in the coffin for future market liberalization?
- But current regulatory regime offers world class reliability and services and also lowest electricity tariffs among developed economies.

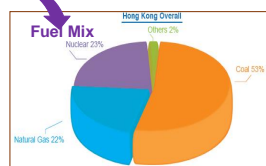
Q.13 Market Reform & Fuel Mix (Which one first ?)



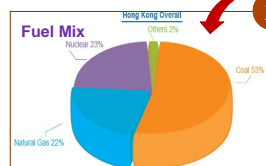
Vertically Integrated Market



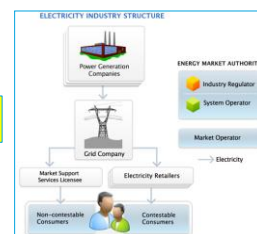
Vertically Integrated Market



OR



1



Liberalized Market

?

2

1

Q.14 Option 1 (Grid Purchase) or Option 2 (Local Generation)



Option
1 or 2



SCMP Editorial (March 26, 2004) - Power Options Short on Detail (Extracts)

The revamp goes beyond striking the right fuel balance for cleaner power supply. The decision will have an impact on the future power regime. The public awaits **more information** to help them make an informed choice.

Fully Agreed !

Q.15 Do We Have a Comprehensive Energy Policy ?

It appears that what Hong Kong has in place is a set of **Energy Policy Objectives** covering mainly the area of electricity and town gas services, but not a well-structured, cohesive and comprehensive policy covering all energy and energy-related issues.

Having said that, there are several major initiatives and measures adopted or being pursued by the Hong Kong Government to address the issues of energy security, climate change, environmental protection and ecology conservation in its pursuit of green economy and sustainable development. However, all these are on a “**piece-meal**” base approach attempting to cover both supply side and demand side.

Given energy is vital for the effective operations of our society and a driving force for quality human development and economic prosperity, it is of paramount importance to have in place a sound and sustainable **Energy Policy** which can maintain a balance among the fundamental goals of economic growth, energy security, affordability and environmental quality which are competing with times. Setting our goals, strategies and action plans should take due consideration of Hong Kong's unique geographical, economic, social and political circumstances, human capacity and endowment on natural resources.

The above echoes the motion passed by the LegCo in January 2012 urging the Government to establish an energy management authority to explore Hong Kong's long term energy demand, formulate and execute an **Energy Policy**.

Thank You !

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