The Future of Hong Kong Energy – Reliable, Affordable & Low Carbon

Where Do We Go From Here?
Electricity Generation for Now and Beyond 2020

Event Organizer
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Adjunct Professor
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Outline

1. Brief Overview of Hong Kong Electricity Generation Sector


3. Now and Beyond 2020 - What can be Considered?
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.

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 with interim review in 2013.

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 2012, maximum demand was 6,769MW (31.3% reserve margin) and sales of electricity for local consumption was 31.995 billion kWh (74.4% of Hong Kong total).
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 3,766MW. In 2012, maximum demand was 2,494MW (51% reserve margin) and sales of electricity for local consumption was 11.036 billion kWh (25.6% of Hong Kong total).

(Source: Power Assets Group Website)

Hong Kong Electricity System - Overview

Total Installed Capacity = 12,654MW
2012 Maximum Demand = 9,263MW
2012 Reserve Margin = 36.6%
2012 Electricity Sale = 43 billion kWh

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).

Sources:
CLP Power Website
Power Assets Group Website.
**Energy Trilemma / Electricity System Objectives**

**World Energy Council – Energy Trilemma (Energy Sustainability Index 2013)**

**UK Electricity System Objectives (Electricity Market Reform Policy Review 2012)**

- **Energy Security → Security of Supply**
- **Energy Equity → Affordability**
- **Environmental Sustainability → Climate Change**

**Sources:**

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**Issue 1: System Demand/Reserve Margin ⇐ Reliability**

<table>
<thead>
<tr>
<th>Year</th>
<th>Installed Capacity (MW)</th>
<th>Electricity Local Consumption (billion kWh)</th>
<th>Maximum Demand (MW)</th>
<th>Reserve Margin</th>
<th>GDP (Current Price HK$million)</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>12,654</td>
<td>40.33</td>
<td>9,032/40.1%</td>
<td>1,503,351</td>
<td>6,857,100</td>
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<tr>
<td>2007</td>
<td>12,654</td>
<td>40.85</td>
<td>9,876/43.2%</td>
<td>1,650,756</td>
<td>6,916,300</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>12,654</td>
<td>40.94</td>
<td>9,338/38.9%</td>
<td>1,707,487</td>
<td>6,957,800</td>
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</tr>
<tr>
<td>2009</td>
<td>12,654</td>
<td>41.50</td>
<td>9,278/38.6%</td>
<td>1,659,245</td>
<td>6,972,800</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>12,654</td>
<td>41.86</td>
<td>9,236/37.5%</td>
<td>1,846,505</td>
<td>7,024,200</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>12,654</td>
<td>42.06</td>
<td>9,200/37.5%</td>
<td>1,936,083</td>
<td>7,071,600</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>12,654</td>
<td>43.03</td>
<td>9,263/36.6%</td>
<td>2,041,900</td>
<td>7,154,600</td>
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</tr>
</tbody>
</table>

Change (6 Yrs)

- **Consumption:** 6.7% over a period of 6 years (~1% per year)
- **Max Demand:** 9,338MW in 2008 (influenced primarily by weather, not GDP)
- **Reserve Margin:** 35.5%+ (level dictates the need for new Installations)

- **2,150MW Coal Fired Units** will retire towards 2020, i.e. total capacity reduces to 10,500MW.
- Some or all have to be replaced by Gas-Fired units or Imported Nuclear Power?
- **Reserve Margin:** 35.5% to 25% (If) can minimize/defer Replacements? Can retain 99.999% reliability beyond 2020?

### Issue 2: Fuel/Energy Security (Coal & Nuclear Beyond 2020)

#### Coal Supply

- **Fuel Cost:** HK$0.28/kWh (Sept 2013)

#### Imported Nuclear Power

- **Fuel Cost:** HK$0.50/kWh (Sept 2013)

Day Bay Nuclear Power Station (2x984MW) annual production: 14 billion kWh: 70% to CLP only via GD/CLP 400kV power grid (31.7% of CLP Fuel Mix i.e. 24% of HK Fuel Mix).

In Sept 2009, the Contract for supply of Imported Nuclear to CLP extended to 2034. Can we increase from 70% to 85% to reduce emissions at lower cost?

(Source: CLP Website/Seminar Paper & World Coal Association Website)

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### Issue 2: Fuel/Energy Security (Natural Gas Beyond 2020)

- **HEC:** Supply of natural gas from Guangdong LNG Terminal started in 2006 by two contracts (25 years and 5 years) adequate for 33% in fuel mix believed up to end 2014. New/Extension of Contract for supply of additional but costly gas is required for beyond 2020.

- **CLP:** Supply of gas from Yacheng 13-1 Gas Field since 1996 rapidly depleting. In August 2008, MOU on energy-cooperation signed by HKSAR Govt and Central People’s Govt to provide 3 new sources of supply (WEPII, Shenzhen LNG Terminal and South China Sea gas field) to meet Hong Kong’s next 20 years requirement. Supply of new and costly gas from WEPII to CLP has commenced in 2013.

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

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### Issue 3: Affordability (Electricity Tariff – Current)

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
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<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Changes</th>
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<tbody>
<tr>
<td>CLP (HK$/kWh)</td>
<td></td>
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</tr>
<tr>
<td>Av. Basic Tariff</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>77.4</td>
<td>80.0</td>
<td>80.0</td>
<td>85.0</td>
<td>84.2</td>
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<td>Steady</td>
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<tr>
<td>Fuel Clause Charge</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>11.8</td>
<td>11.5</td>
<td>14.1</td>
<td>17.8</td>
<td>22.4</td>
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<td>double</td>
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<tr>
<td>Rebate</td>
<td></td>
<td></td>
<td></td>
<td>-3.3</td>
<td>-2.1</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Av. Net Tariff</td>
<td>87.2</td>
<td>87.3</td>
<td>87.1</td>
<td>91.1</td>
<td>89.2</td>
<td>91.5</td>
<td>94.1</td>
<td>98.7</td>
<td>104.5</td>
<td>+19.8%</td>
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<th>2005</th>
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<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Changes</th>
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<tbody>
<tr>
<td>HEC (HK$/kWh)</td>
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</tr>
<tr>
<td>Av. Basic Tariff</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>94.5</td>
<td>94.5</td>
<td>93.1</td>
<td>94.1</td>
<td>94.7</td>
<td></td>
<td>Steady</td>
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<tr>
<td>Fuel Clause Charge</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>25.4</td>
<td>25.4</td>
<td>30.2</td>
<td>37.0</td>
<td>40.2</td>
<td></td>
<td>1.5 times</td>
</tr>
<tr>
<td>Av. Net Tariff</td>
<td>103.3</td>
<td>110.0</td>
<td>117.4</td>
<td>127.4</td>
<td>119.9</td>
<td>119.9</td>
<td>123.3</td>
<td>131.1</td>
<td>134.9</td>
<td>+30.6%</td>
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<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong Kong (HK$/kWh)</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Av. Net Tariff (weighted)</td>
<td>89.2</td>
<td>93.0</td>
<td>94.7</td>
<td>100.2</td>
<td>96.9</td>
<td>96.6</td>
<td>101.4</td>
<td>106.8</td>
<td>112.1</td>
<td>+25.6%</td>
</tr>
</tbody>
</table>

- Basic Tariff: steady over 8 years
- Fuel Cost: nearly double over 4 years
- Average Net Tariff: Still Highly Competitive

Sources: 
LegCo Paper LCQ15 (2011), CLP Group and Power Assets Websites

### Issue 3: Affordability (Impact of Fuel Cost) Beyond 2020

- All new gas contracts signed/or to be signed by power companies are long term “Take or Pay Contract” and based on Asian Market price of US$18-21/mmBtu i.e. about 3 to 4 times of old gas contracts (1996 & 2006) of around US$6/mmBtu.
- Current Tariff will have to go up significantly from 2015 onwards due to using more quantity of costly gas to meet increasingly tightened emission caps in 2015, 2017, 2020 and beyond.

Sources: 
http://www.infomine.com
Legislative Council Paper No. CB(1)1024/11-12(01) (11 Dec 2012) (CLP)
**Issue 4: Pollutants & Carbon Emissions**

Electricity Generation Produced

- 44% SO2 (13,860 Tonne)
- 26% NOx (29,640 Tonne)
- 16% RSP (995 tonne)

67% CO2 (28 million Tonne) (2010)

**2010 Carbon Emission**

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**Issue 4: Emission Caps (Now and Towards 2020)**

<table>
<thead>
<tr>
<th>2010 TM Emission Caps (Tonne)</th>
<th>2015 TM Emission Caps (Tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO2</td>
<td>NOx</td>
</tr>
<tr>
<td>CLP</td>
<td>15,750</td>
</tr>
<tr>
<td>HEC</td>
<td>9,370</td>
</tr>
<tr>
<td>Total</td>
<td>25,120</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2017 TM Emission Caps (Tonne)</th>
<th>Further Tightening Emission Caps</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO2</td>
<td>NOx</td>
</tr>
<tr>
<td>CLP</td>
<td>5,199</td>
</tr>
<tr>
<td>HEC</td>
<td>5,200</td>
</tr>
<tr>
<td>Total</td>
<td>10,399</td>
</tr>
<tr>
<td>7 Years Change</td>
<td>-58.6%</td>
</tr>
</tbody>
</table>

Emission Caps already “Shaping” Fuel/Energy Mix?

<table>
<thead>
<tr>
<th>2012 Actual Emissions (Tonne)</th>
<th>CLP to increase Gas from 20% to 40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO2</td>
<td>NOx</td>
</tr>
<tr>
<td>CLP</td>
<td>8,680</td>
</tr>
<tr>
<td>HEC</td>
<td>4,090</td>
</tr>
<tr>
<td>Total</td>
<td>12,770</td>
</tr>
</tbody>
</table>

Sources: EPD Web Site; CLP 2012 Sustainability Report; Power Assets 2012 Sustainability Report

**School of Energy and Environment, City University of Hong Kong**
**Issue 4: Emission Caps/Fuel Mix (Now and Beyond 2020)**

<table>
<thead>
<tr>
<th>Emission Type</th>
<th>2005</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Emission</td>
<td>6.21</td>
<td>3.6 – 4.5</td>
</tr>
<tr>
<td>Total Carbon (kT)</td>
<td>42,000</td>
<td>28,740 – 34,900</td>
</tr>
<tr>
<td>Carbon Footprint (kg/HK$GDP)</td>
<td>0.029</td>
<td>0.016 – 0.0145 (Reduction 50% - 60%)</td>
</tr>
</tbody>
</table>

**Sources:** EPD Web Site; CLP Group Website ; Power Assets Website

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**Issue 5: RE for Electricity Generation Now & Beyond 2020**

**Propose 300MW offshore wind farm at capital cost over HK$10 billion** can generate about 580 million kWh electricity (1.2% HK’s electricity supply) with capacity factor of 22% due to low wind speed (5 to 6m/s) close to Equator. *(Intermittent Nature…Worth?)*

**Proposed Waste to Energy Incineration Plant** can produce about 1% of Hong Kong electricity supply using Renewable Energy.

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HK Electricity Market - Now : How Good or How Bad?

STATUS QUO: Vertically Integrated – Regulated thro’ SCAs till 2018

- **Reliability?** 99.999% one of the Best in the world *(Can we trim down Reserve Margin?)*
- **Accessibility?** Almost 100% coverage ...one of the best in the world
- **Affordability?** One of the Lowest among developed economies with limited resources endowment *(To go up soon due to use more costly gas……Fuel Mix policy?)*
- **Pollutants Emission?** Most coal-fired plants fitted with state-of-art emissions reduction systems + world class CCMT gas-fired plant *(Huge reductions made already!)*
- **Carbon Emission?** 67% of Hong Kong *(6T/Capita below world average of 7T/capital)* *(can reduce by using less coal……Fuel Mix Policy?)*

World Energy Council
Energy Sustainability Index
Hong Kong Ranking: **40 (ABD)** in 2012 due to Deteriorating Energy Security *(Imported Fuels & Electricity)*

Now and Beyond 2020 – What can be Considered?

What do Hong Kong People want or What do they complaint about?

- **Huge Profits Made?** HK$44.3 billion Revenue => HK$13.2 billion Profits after tax in 2012 but electricity prices often go up higher than inflation *(Pressure Groups?)*
- **Price Disparity?** Why consumers on Hong Kong Island pay about 30% more
- **Consumer Choice?** Why consumers in many developed economies have choices of suppliers but NOT in Hong Kong? *(Competition => Lower Price?)*

1. **Setting Right Fuel/Energy Mix** *(Impacted tariff/reliability/emissions)* must consider:
- Market structure/size
- Generation plant mix/residual life
- Fuel sources/security/cost
- Maturity/safety of green/clean-energy technology
- Projected electricity consumption
- Levels of air pollutants/carbon emissions reductions
- Time line for implementation

2. **Establishing Energy Authority**: statutory body responsible for formulating sustainable Energy Policy, regulating electric power/gas industries with clear regulatory framework; addressing “energy poverty”; promoting energy efficiency/conservation/demand side management, studying viability of bringing in electricity from the Mainland and introducing some forms of competition; etc.
Now and Beyond 2020 – What can be considered?

3. Upgrading Interconnector: To increase the existing capacity from 720MVA to 2,000MVA (N-1 Contingency) for full energy transfer
   • To reduce Spinning Reserve and scale down Reserve Margin
   • To Integrate power grids of CLP & HEC for bringing electricity (nuclear power or viable RE) from the Mainland to Hong Kong Island => reduce use of coal or rely less heavily on costly gas for emissions reduction.

4. Introducing Smart Grid: To make best use of exiting assets, enhance reliability and efficiency, introduce demand response and off-peak/real time tariffs, facilitate “peak shaving”, reduce/defer replacement of retired units or new additions, and cap/slow down price increase.

5. Gradually Opening Up Generation Sector: Integrate CLP and HEC Power Grids to form an Integrated Power Grid owned and operated by a New Entity (including CLP, HEC & others); 67% of electricity demand covered by Vesting Contracts leaving 33% for contesting to reduce current price disparity and later on to facilitate 3rd party entry (Wholesale Market requires huge set-up cost and ISO in place to connect all market players).

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Lessons Learned from Overseas Experiences

• Regulated or Deregulated Electricity Market: No “MODEL” can fit all (market size, capacity mix, market players, political/economic/social settings, etc)
• Get Stakeholders involved and seek consensus (open, transparent……)
• Promote consumers awareness & education: Most Consumers think price of electricity must drop once the Market is deregulated - An Incorrect Concept
• Electricity is part of our lives. Sound policy and clear regulatory framework are needed for Hong Kong to support its transition to a clean, low carbon economy.

Sources:
- http://obaid-tips.blogspot.hk/2012/05/dont-be-afraid-to-change.html

Thank You!