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18 June 2014

Mr WONG Kam Sing
Secretary for the Environment
Environment Bureau
16/F, East Wing, Central Government Offices
2 Tim Mei Avenue, Tamar
Hong Kong

Dear Mr WONG

Public Consultation on Future Fuel Mix for Electricity Generation

The Hong Kong Institution of Engineers is concerned on the well-being of the people and the long-term development of Hong Kong.

In view of the recent consultation on Future Fuel Mix for Electricity Generation for Hong Kong, the HKIE joined with the Engineering Forum to organise a forum on 21 May 2014, and we are pleased that Ms Christine Loh, Under Secretary for the Environment, attended the forum and exchanged views with our members.

We are pleased to provide herewith our views and suggestions on the subject for your consideration.

Thank you.

Yours sincerely

Ir Raymond CHAN Kin Sek
President
The Hong Kong Institution of Engineers

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Enclosure

Views from the Hong Kong Institution of Engineers on Future Fuel Mix for Electricity Generation

Introduction

The Hong Kong Institution of Engineers (HKIE) aims at ensuring and enhancing the living of the people in Hong Kong and the steady development of our economy. Hence, we believe that having a strategic plan for our long term power supply would be vital to support all the essential activities and functions in Hong Kong.

2. With now more frequent contact and closer cooperation of the HKSAR with the surrounding regions in the Pearl River Delta (PRD) and in the Mainland, we are well aware that various issues concerning the development in Hong Kong may also have effects to other regions. For electricity supply, Hong Kong should then take a wide perspective, and the planning horizon for the fuel mix should be in longer term, say, up to 20 years.

3. In regard to the Public Consultation on Future Fuel Mix for Electricity Generation ("the Consultation Document") launched by Environment Bureau, the HKIE would like to put forth and elaborate our views on this important subject as follows for consideration.

Observations and Analysis on the Options Proposed

4. It is noted that in the Consultation Document, two Options are raised, i.e. Option 1 - Importing more electricity through purchase from the Mainland power grid; and Option 2 - Using more natural gas for local generation. We think that each Option should be carefully assessed in itself apart from comparing the two Options under various criteria to see their respective impacts.

Reliability

5. The reliability of local power utilities has reached a world class level and stays amongst the best in the world for long that any deterioration of it can hardly be tolerated and accepted by the Hong Kong community. As a densely populated metropolitan and with over 50% of the buildings installed with lifts, any power interruption in Hong Kong may pose serious security and safety risks. Hence, the HKIE believes that every endeavour should be taken to maintain the high reliability of the local power utilities.

6. With reference to the experience in Macau, it is known that 92% of the electricity is imported from China Southern Grid (CSG), which has a performance record of about 2 minutes per year (or a reliability of 99.9996%) for supply to the city[1]. In

[1] Press Release on 31 March 2014, Copmanhia de Electriciidade de Macau http://www.cem-macau.com/CEM-Annual-General-Meeting,13959

2012, import to Macau consists of multiple transmission lines of a total capacity of 1750 MVA with 500 MVA back-up transmission[2] and local generation has a capacity of 472 MW, to meet its maximum demand of 766 MW. It should be noted that high reliability in Macau is achieved through investment in redundancy and backup. The large entertainment complexes in Macau have equipped with their own large capacity backup generators and numerous uninterruptible power supply (UPS) to cater for unplanned outages. However, it is also aware that EHV (extra high voltage) supply to Macau has suffered occasional interruptions or voltage dips due to various reasons.

7. Putting the perspective in the Hong Kong situation, we as a commercial and financial centre could not afford to have degradation in electricity supply reliability. Reliability of customer supply in Hong Kong is measured within several minutes of unplanned customer interruption per year (<1 minute with Hong Kong Electric and 2.3 minutes with CLP Power), whereas it is noted that the reliability with CSG is measured in hours (an average of 2.3 hours in CSG urban areas per year though better for Guangzhou at 1.5 hours and Shenzhen at 0.8 hours)[3].

8. As Option 1 highly depends on the security of supply of the CSG, system instability might be caused due to collapse of interdependent networks or extreme weather events, leading to disastrous brown-out or blackout. In case of interruption in the CSG, local supply of electricity is required, but it would be difficult for a "full-time" standby power plant to re-start and generate electricity instantly in case of emergency. Therefore, 30% grid import without dedicated transmission will most likely reduce supply reliability in Hong Kong. While Hong Kong may build up a reserve capacity in local generation to mitigate the effect of over-reliance on import, unless this is Renewable Energy (which is by its nature intermittent), maintaining the required capacity over the long term will incur equipment under-use and costs. Option 1 therefore leaves much room of concern on the reliability; and if for implementation it would require more measures that can fully address such reliability concern without any environmental or other benefits.

9. Meanwhile, Option 2 is a well proven one with reliability of supply over 99.999%, and is conceived as substantially more reliable in this sense. In fact, the local HK Electric and CLP Power systems have already been interconnected since 1980s. The advantage of this locally controlled interconnection for mutual emergency support has been fully realised and this has helped to maintain their excellent supply reliability records. However, international experiences show that multi-regional interconnected systems can be more prone to system disturbances; as one part can cause cascade problems to other parts of the interconnected systems, or even massive blackouts in the worst cases as listed below:-

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[2] 2012 Sustainability Report, Companhia de Electricidade de Macau
http://www.cem-macau.com/IMG/pdf/Sustainability2012.pdf

[3] Corporation Social Responsibility Report 2013, China Southern Power Grid Company Limited
http://www.csg.cn/shzr/zrbg/201405/P020140515547853771135.rar

Article	Millions of people affected	Location	Date
July 2012 India blackout	670	India	31 July 2012
July 2012 India blackout	330	India	30 July 2012
2009 Brazil and Paraguay blackout	87	Brazil, Paraguay	10–11 Nov 2009
2003 Italy blackout	55	Italy, Switzerland, Austria, Slovenia, Croatia	28 Sep 2003
Northeast blackout of 2003	55	the United States, Canada	14–15 Aug 2003

Affordability

10. It is agreed that in considering the future electricity supply options, financial consideration is an important factor, though not the ultimate point of concern. It would be worth to project and compare the cost for either Option for the capital cost investment as well as the maintenance and depreciation for the necessary constructions of each of them. However, given the lack of details and forecasts provided for either Option, it would be difficult to have an accurate cost comparison of the two Options in this regard.

11. While in the Consultation Document it is indicated that both Option 1 and Option 2 may lead to similar quantum of increase in electricity generation cost, more projection figures are suggested to be provided to illustrate the situation. In fact, the cost for Option 1 would be mainly due to the investment cost of grid infrastructure plus various uncertain cost elements related to electricity purchase. A long term power purchase agreement has to be entered to ensure the proposed cross-boundary power import a pragmatic business case. Adopting Option 1 might in future put Hong Kong less flexible in catering for the possible decrease in electricity consumption due to societal awareness of energy saving or the dramatic drop of cost of natural gas due to technological advancement.

12. The cost of Option 1 relies on the cost of the electricity generation in CSG which is subject to direction from regulators, inflation in China and currency appreciation. These factors are not under the buyer's control, and so the affordability for Option 1 is uncertain and seems not transparent enough to make a judgment at this moment. The overall cost may or may not be reduced if the market is open to CSG or other power grids in future for competition. For Macau, it is noted that the electricity import price had increased by around 30% over the past five years. A similar example to this situation is our water supply. Due to the high investment cost of importing Dongjiang water to Hong Kong, we experience the dilemma of continually importing expensive water which might not all be necessary for a certain period. In fact, the water cost has increased by around 27% from 2009 to 2013.

13. For Options 2, the local power companies are under the surveillance of the Government and the public, and future tariff increase will be closely monitored and probably controlled. Furthermore, the purchase of natural gas could be from various sources by competitive price while there is not yet clear pricing information for Option 1 for assessment. Hence, Option 2 would seem to provide a more competitive environment for cost control.

14. Nevertheless, both Options will depend on the price of gas but with Option 2 more so. Due allowance should also be given to the cost of its long distance transport of gas supply from elsewhere. Gas price is traditionally volatile and it remains to be seen as to how the recent discovery of gas in the vicinity may assist gas produce affordability for Hong Kong. However, it is noted that with shale gas boom in the US, export of gas to Asian countries after completing its liquefaction facilities around 2017 would seem practicable. The recent discovery of gas in the vicinity coupled with huge Sino-Russian gas deal sealed may provide more gas supply to the Asia market. In this respect, Hong Kong should consider developing liquefied natural gas facilities to be able to freely access international markets. In this way, it is possible to better stabilise the gas price and this will favor the use of more natural gas in CSG which in turn may improve its environmental performance of Option 1 (if the CSG adopts more gas in electricity generation), and helps in the affordability for Hong Kong's electricity generation under Option 2.

Safety

15. Safety as a top priority can never be compromised. In regard to electricity generation safety, no form of power generation, be it coal, natural gas or nuclear, is totally risk free. However, it is perceived that Option 2 would ensure that electricity is generated, transmitted, distributed and used in a safer and more efficient manner as both local utilities companies are well-established and have many years of successful experience in delivering reliable electricity supplies to Hong Kong safely.

16. For Option 1, Hong Kong can hardly control whether the sources of energy generation are safe. There is still much room to expect on the construction safety in the Mainland for Option 1 as well as on the hazards/environmental impacts that should be better controlled for those communities living close to those power plants supplying electricity to Hong Kong if Option 1 is pursued.

Environmental Impact and Performance

17. Environmental impact is a very significant concern in assessing the electricity supply options. Arising from this concern, we suggest the Government to clarify whether the carbon and air pollutant emissions targets shall be capped at the 2020 level in the next two decades, or if a further tightening is foreseen.

18. It is important that any import of fuel mix should utilise plants that have a low environmental footprint, so that Hong Kong would not export air emissions and do not indirectly cause environmental damage to the communities close to those power plants supplying electricity to Hong Kong. Option 1 proposed in the Consultation Document for importing 30% electricity from the CSG would result in emissions to be

put on the account of CSG instead of that of Hong Kong. Inevitably, this would seem to transfer our emissions reduction responsibility to CSG as elaborated further below.

19. It is noted that Option 1 does not specify the source and fuel for the electricity generation. It is aware that Guangdong is heavily reliant on coal for powering its economic growth and its coal generation fleets are expanding rapidly. Even though nuclear power, hydropower and even power transmitting from Yunnan and Guizhou provinces are already utilised, additional generations have to be dispatched for exporting power to Hong Kong. Given that Guangdong's coal generation capacity will be expanded by 50% within the 12th Five Year period (by 2015), the marginal fuel to meet the extra demand for exporting power to Hong Kong might have to be by lower-efficiency coal generation units, and hence it is likely that the net emissions under Option 1 will be increased. This proposition is supported by the 0.918kgCO2-e/kWh carbon emission factor published in the 2012 Sustainability Report of CEM[4]. As such, Option 1 may not be greener than Option 2. At worst, this will still deprive the rights of people in Guangdong or other provinces in the PRD supplying electricity to Hong Kong to enjoy the benefit of lower emissions.

20. New coal fired generation was banned in Hong Kong more than 15 years ago. Hong Kong has been using natural gas for electricity generation since 1996. With much higher thermal efficiency of 50% to 60% (versus about 35% of coal-fired units) and much lower emissions compared with coal, local natural gas generation can be seen as a clear choice for delivering cost-efficient and cleaner energy to consumers. It is therefore considered that more local generation by gas, as in Option 2, would be more preferable for its benefit of emissions reduction at source.

21. From an environmental perspective, if the objective of this Consultation Document is to identify cleaner alternatives for phasing out existing coal fired generation in Hong Kong, Option 2 can better achieve this objective by increasing the percentage of the relatively cleaner natural gas in the fuel mix. Meanwhile, there is considerable uncertainty for Option 1 because the sources of generation are unidentified and thus the claimed emissions reduction cannot be justified unless a dedicated transmission from the CSG power grid with green energy sources is used.

22. Meanwhile, in regard to construction of infrastructures for each Option, the building of interconnecting facilities within Hong Kong will be substantial in Option 1 bearing in mind that the new interconnection is to be capable of transmitting about 30% of power of the territory. Environmental impact of the additional infrastructure for Option 1 could be huge as compared to that for Option 2, in which the construction work involved will mainly be the replacement of coal-fired generators to gas-fired ones on existing locations and an associated liquefied natural gas (LNG) terminal. Hong Kong has fully mastered the technical knowhow for constructing and operating natural gas generation units with proven track record. In order to meet the emissions caps set under the 2nd Technical Memorandum of Air Pollution Control

[4] 2012 Sustainability Report, Companhia de Electricidade de Macau
http://www.cem-macau.com/IMG/pdf/Sustainability2012.pdf

Ordinance (APCO), local power companies have to increase gas share in their fuel mix to about 40% from 2015. Given that land is available within the existing sites used of local generation, the lead time for building a local natural gas generation units will only be around 4 years. Therefore, increasing gas share in our fuel mix from 40% to 60% in eight years, from 2015 to 2023, is practical and manageable.

Flexibility and Diversification for Fuel Mix

23. The gist of the fuel mix is reaching flexibility in choice against volatility, delivering more diversified fuels, and an opportunity for smooth and gradual transition to enable more choice to the Hong Kong electricity market. As Option 2 relies 60% on natural gas and Option 1 40%, we should be cautious for over-dependence on natural gas since the worldwide trend of switching to natural gas will make its supply volatile.

24. As the capacity of electricity imported from the Mainland as proposed by Option 1 is substantial, the interconnection built between the Mainland and Hong Kong may pave the way for new entrants of suppliers in the electricity market when the current Scheme of Control Agreement (SCA) expires. Yet for Option 1, with two long-term power purchase agreements supplying 50% of electricity to Hong Kong in place (i.e. 20% from Daya Bay and future 30% from CSG plus similar long term gas supply contracts for another 40% of electricity), will not give any more room for change with the balance 10% in the next two to three decades. Furthermore, based on the current centralised electricity market in the Mainland, it may not be fully possible to buy electricity from the most competitive electricity generation sources through the grid and hence could not open up the electricity market through grid import.

25. Nevertheless, Option 2 would not rule out or diminish the possibility of open electricity market in future. For Option 2 to have better impact, diversification should not be limited to the types of resources, and should be extended to the diversified sources of resources such as the global sourcing LNG and possibility of local re-gasification of LNG, in form of gas receiving station or floating storage and offloading unit. Other proven and commercialised technologies can also be introduced to supplement the normal natural gas generation.

26. For decades, the Government has tried optimally regulated Hong Kong's electricity sector and delivered its energy policy objectives by means of a bilateral agreement with the power companies – under the SCA, with its effectiveness demonstrated over years. Under the SCA regime, the two power companies have been seen complying with requirements on safety, security, reliability and environmental performances laid down by the Government. The capital and operating expenses proposed by the two power companies in their 5-year Development Plan are stringently vetted and approved by the Government. Not only the actual tariffs are reviewed by the Government, the actual operating performances of the two power companies are audited by the Government. The current transparent regulatory regime has been successfully delivering reliable and quality electricity supply services to end consumers at reasonable and competitive costs and compatible

with the environmental and economic needs for the community in Hong Kong performance laid down by the Government at internationally low tariffs. The achievement attained by the Hong Kong power companies is vividly demonstrated by the top electricity supply quality ranking of Hong Kong among 148 economies given by the World Economic Forum in 2013[5].

27. The capital and operating expenses (and hence tariffs) proposed by the two power companies in their 5-year Development Plan are stringently audited, vetted and approved by the Government. Increasing local gas generation proposed in Option 2 is a proven business-as-usual operation and development model for Hong Kong. Under the stringent scrutiny of the Government set out in the SCA framework, timely completion of natural gas generation units with high quality and cost-effectiveness to meet Hong Kong's demand is to be expected. Option 2 seems much more transparent to consumers and it subject to higher Hong Kong regulatory control than the grid purchase option proposed.

Contingency

28. It is concerned that Option 1 might mean higher uncertainty in terms of land/route requisition, time and cost on planning, design and construction of the grid infrastructure for power import. In contrast, Option 2 would have minimal uncertainty due to the progressive replacement of coal-fired plants by gas-fired plants, readily available land in the existing power station sites, and mature transmission infrastructure from these sites linking to HK networks. Holding back from installing local plants on the one hand and possible failure to build the grid infrastructure in time on the other hand would put Hong Kong more at risk. Hence, it is opined that Option 2 would seem more flexible than Option 1 because of shorter lead time and less capital investment (i.e. building new gas-fired plants when compared with building new grid infrastructure). Option 2 would also allow a step-by-step approach in increasing the number of generation units.

Economic Consideration

29. For Option 1, the minimum lead time for the significant infrastructure required for importing 30% of Hong Kong's total electricity demand from the Mainland would be around 10 years. Taking into consideration of the complexities associated with land acquisition, environmental impact assessments and potential judicial reviews, the lead time for the cross-border transmission infrastructure may well exceed 10 years. The upfront capital investment required for the new cross-border transmission infrastructure could be in the order of tens of billions of HK dollars.

30. It is generally believed that Option 2 could enhance local economic development, improve local engineering prospects and job markets, and nurture local expertise. In addition, the incremental nature of adding individual local natural gas generation units

[5] The Global Competitiveness Report 2013-14, World Economic Forum
http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2013-14.pdf

in response to demand requirement will better suit Hong Kong's future pattern of demand growth.

Other Options and Tactics

31. The HKIE believes that for electricity supply and fuel mix, there can still have other possible alternatives that worth for public to deliberate. Other options could also be considered, e.g. dedicated circuit to dedicated source where we could be sure about the carbon content and reliability could be controlled. Although local renewable energy such as solar and wind energy is unlikely to provide significant amount of power due to the city's geographical constraints, more practical means to utilise these energy, like both offshore wind farms, should still be considered seriously. Other kinds of renewable energy generated from waste-to-energy through the anaerobic treatment of sludge, wastewater, municipal solid waste and food waste for biogas and electricity production should be explored more seriously and put in implementation. It may just contribute about 6-7% of the total electricity supply, but it does indicate that the Government is trying its best to develop a sustainable city with strong dedication to waste recycling and reuse. Other solutions including establishing fixed or floating LNG re-gasification facilities for power generation to enhance our generation diversification should also be given positive considerations.

32. Also, nuclear power import from new nuclear power stations in Guangdong Province can be considered. The percentage of imported nuclear power can be selected according to the emissions limits, actual electricity loading and economic consideration due to price variation of natural gas. This would provide more diversity and flexibility if there is any contingency occurred affecting the supply of natural gas or if there is any emergency events which occur in the local power stations (e.g. due to super typhoon). Nevertheless, we should strike a balance between importing nuclear power and the optimum capacity of local generation using natural gas based on a power system study so as to meet our daily electricity consumption and environmental emission targets.

33. Lifetime CO_2 emissions of nuclear is low and generally at the same level as renewable. Radiological emissions are at minute levels and any radiation level increases are only marginally detectable, without any significant impact to health or the environment. The occurrence of the Chernobyl and Fukushima accidents was mainly due to multiple human errors and the responsible government's ability to deal with nuclear emergency and prevent accident. The nuclear technology and emergency preparedness have continued to improve in the present operating reactors. Safety of the new generation of nuclear reactors under construction is further enhanced.

34. The public can deliberate on the possibility of buying nuclear power from LingAo and constructing a new interconnector between LingAo and both Kowloon/ Hong Kong Island for supplying electricity to the HEC and CLP networks, so all Hong Kong consumers can benefit from this source of low-carbon energy. The new interconnectors can also help to reinforce mutual support between Guangdong and Hong Kong to deal with contingency events in the respective power system. The design of the new interconnectors should be based on a comprehensive power system

study for the bulk transmission system in CSG and Hong Kong with a view to ensuring the stability and security of the interconnected power grids in the region.

35. Although Hong Kong has been importing nuclear power from Daya Bay in the past 20 years via CLP's 400 kV network in the New Territories and Shenzhen which is also interconnected to the 500 kV network of CSG, we are able to enjoy a high reliability of electricity supply over the years because proper backup and contingency measures are in place. In fact, Hong Kong's investment in the Daya Bay project has demonstrated a safe, clean, affordable and reliable energy supply over the past 20 years. The operation model of the present nuclear supply from the Daya Bay Nuclear Power Station through dedicated transmission lines has helped to support the high electricity reliability in Hong Kong. The reliability of supply in Hong Kong would not be affected by the additional import as long as the new interconnectors are designed and operated properly with sufficient backup generation capacity.

36. The long term cost of nuclear electricity is kept stable as its operating cost makes up for a small portion of the overall cost. The 2013 cost of Daya Bay to Hong Kong is at HK¢ 0.47/kWh while the projected cost of the most advanced AP1000 at Sanmen is at HK¢ 0.57/kWh (RMB 0.46/kWh as estimated in 2011) which is lower than the current gas fuel cost (HK¢ 0.89/kWh in April 2013) by a comfortable margin.

Conclusion

37. Based on the Consultation Document, both Options should be able to meet the energy policy objectives but to a different extent. However, it is believed that Option 2 would at present be more reliable and should be more flexible in terms of the pace of infrastructure development. It would also offer better environmental benefits in terms of emissions reduction at source and sustainability as well as regulatory control.

38. For the longer term, as reliability of the Mainland grids improves and more sources of genuinely low-carbon energy are developed, there may be opportunities for Hong Kong to have more interconnection with the Mainland, as long as supply reliability in Hong Kong is not compromised and adequate local back-up remains available. Although this is not a decision which needs to be taken now, how such interconnection might be developed technically, and how much energy would be available by when, and at what cost, should be further studied.

39. However, from the perspective of the development of engineering profession in Hong Kong, with the phase out of coal-fired power station by gas-fired generators within the territory, Option 2 could enhance local economic development, provide better local engineering prospects and enlarge job market.

40. The HKIE also suggests the Government to seriously consider more possible tactics to deal with the long term fuel mix issues, apart from the only two Options proposed. In any case, we agree that the subject should be reviewed regularly due to changing economic environment, deviation in load forecast and advance in technology. Moreover, more public discussion is needed and more other sustainable electricity supply sources should be explored before any decision is reached.