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Review of the Sixth Technical Memorandum for Allocation of Emission Allowances for Power Plants

PURPOSE

This paper seeks Members' views on our proposal to reduce emission allowances for power plants starting from 1 January 2022 by way of issuing a new Technical Memorandum (TM) (i.e. the Seventh TM) under Section 26G of the Air Pollution Control Ordinance (Cap. 311) (APCO).

BACKGROUND

2. Road transport, marine and electricity generation are major local sources of emission of air pollutants. Through the various measures implemented over the years, we see a gradual improvement in air quality. Between 2012 and 2016, the concentrations of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), respirable suspended particulates (RSP) and fine suspended particulates (FSP) recorded at general air quality monitoring stations dropped by 18%, 8%, 19% and 21% respectively. In the same period, the concentrations of SO_2, NO_2, RSP and FSP recorded at roadside decreased by 30%, 31%, 28% and 28% respectively.

3. To reduce emissions from power generation, we have required new power generating units to use natural gas since 1997, and to adopt the best practicable means to reduce air pollutant emissions by means of specified licence control, which includes retrofitting coal-fired generating units (coal-fired units) with flue gas desulphurisation and denitrification systems whenever practicable, maximising the

use of existing gas-fired generating units (gas-fired units), prioritising the use of coal-fired units equipped with emission control devices, using low-emission coal and upholding the performance of the emission control devices.

4. We amended the APCO in 2008 to empower the Government to cap the emissions of power plants. Section 26G provides for the Secretary for the Environment (the Secretary) to allocate emission allowances for three specified pollutants, i.e. SO_2, nitrogen oxides (NO_x) and RSP, for power plants by way of a TM. Section 26G(4) requires a TM to be issued at least four years before the commencement of the emission year (a period of 12 months commencing on 1 January in each year) that it takes effect.

5. Six TMs were issued in 2008, 2010, 2012, 2014, 2015 and 2016 respectively. The First TM set the emission allowances for the emission years between 2010 and 2014. The emission allowances for the Second and Third ones took effect from 1 January 2015 and 1 January 2017 respectively while those for the Fourth, Fifth and Sixth TM will take effect from 1 January 2019, 1 January 2020 and 1 January 2021 respectively.

6. The emission allowances under the Sixth TM were determined with due regard to the reduction in electricity demand forecasts in 2021 for both CLP Power Hong Kong Limited (CLP) and the Hongkong Electric Company, Limited (HEC) as compared to those in 2020[1], and taking also into account that CLP would endeavour to continue importing 80% of nuclear output from the Daya Bay Nuclear Power Station (DBNPS) beyond 2018. The emission allowances under the Sixth TM are at the **Annex**.

7. When setting the emission allowances under the Sixth TM last year, we committed to a review of the TM in 2017 to take account of the latest development on the building of new gas-fired units, which will affect the fuel mix for electricity generation and hence emissions in future years. If we are able to issue a new TM for commencement within 2017, the new emission allowances will take effect from 1 January 2022.

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[1] The projected load reduction was in part attributable to the Energy Saving Plan for Hong Kong's Built Environment 2015~2025+ (the Energy Saving Plan) released by the Government in May 2015, which set a target of reducing energy intensity in Hong Kong by 40% by 2025 when compared to 2005.

THE REVIEW

8. Under Section 26G(2) of the APCO, the Secretary, in making the emission allocations, shall:

(a) have regard to the best practicable means (BPM) for preventing the emission of that type of pollutant;

(b) have as his purpose the attainment and maintenance of any relevant air quality objective ; and

(c) have regard to whether the emission of that type of pollutant would be, or is likely to be, prejudicial to health.

9. To meet the emission allowances set under the new TM, both power companies will have to continue to maximise the use of gas-fired units, prioritise the use of coal-fired units equipped with advanced emission control devices, use low-emission coal and uphold the performance of the emission control devices.

10. The extensive retrofits that the power companies undertook in the past to reduce emissions from their coal-fired units have left limited room for further retrofit. CLP completed in 2016 the efficiency upgrading work for one of their existing gas-fired unit with improvement in emission performance. Similar efficiency upgrading work of two more gas-fired units will be carried out by CLP by 2018 for enhancing the performance including emissions reduction.

11. Revamping the fuel mix for electricity generation is most effective to further reduce emissions from power plants. As outlined in the Hong Kong's Climate Action Plan 2030+, the Government would continue to phase down coal in local electricity generation, optimise the implementation of renewable energy (RE) to help reduce emissions from coal-fired units and make the city's buildings and infrastructure more energy efficient.

12. When determining the emission allowances for the two power companies under the new TM, we have also taken account of the following –

(a) the progress of increasing local gas generation to around 50% of the total fuel mix for electricity generation by 2020 ("Fuel Mix Target") so as to meet the Government's pledged environmental targets for 2020[2], including the construction of new gas-fired units and replacement of some old power generating units, which are scheduled for retirement after reaching the end of their service life in coming years;

(b) new technology to upgrade existing gas-fired units for improving their NO_x emission performance as well as thermal efficiency;

(c) the practicability to maintain the current import of 80% of nuclear output from DBNPS to CLP after 2018; and

(d) the projected local electricity consumption in the period 2022 to 2023.

13. Based on the above considerations, our assessment for HEC is as follows –

(a) HEC is building a new gas-fired unit (Unit L11) with an installed capacity of 380MW at its Lamma Power Station Extension for operation in 2022. As an interim measure to achieve the 2020 Fuel Mix Target (i.e. 50% gas generation) thus contributing to the meeting of the pledged environmental targets, including the carbon intensity reduction target, HEC will keep an existing gas-fired unit in service, which was originally scheduled for retirement in 2020, until Unit L11 is commissioned in 2022. When Unit L11 starts operation in 2022, the gas generation ratio will increase from 50% in 2020 to 55%, thus allowing further reduction of the emission allowances;

(b) the electricity demand for the Hong Kong Island is forecasted to drop by around 2% in the period 2022 to 2023 as compared to that of 2021 when the Sixth TM will take effect. The forecasted reduced electricity demand is partly due to the energy efficiency measures outlined in the Energy Saving Plan; and

[2] The pledged environmental targets for 2020 are to reduce the carbon intensity by 50-60% by 2020 when compared to 2005; and to reduce the emissions of SO_2 by 35-75%, NO_x by 20-30% and RSP by 15-40% by 2020 when compared to 2010.

(c) the reduced electricity demand in 2022 and 2023 and the availability of more gas-fired electricity generating capacity could reduce the reliance on coal-fired units for power generation. It is estimated that HEC's emission allowances in the new TM could be reduced by 23% for SO_2, 21% for NO_x and 8% for RSP as compared to the levels in the Sixth TM.

14. As for CLP, the assessment is as follows –

(a) CLP is building a new gas-fired unit of 550 MW (Unit D1) at its Black Point Power Station. Unit D1, after commencement of operation in 2020, will increase CLP's gas generation ratio from around 25% in 2015 to about 49% in 2020, contributing to the achievement of the 2020 Fuel Mix Target for meeting the pledged environmental targets, including the carbon intensity reduction target, and allowing for further reduction of its emission allowances;

(b) at its Black Point Power Station, one of the eight gas-fired units has been upgraded, thereby increasing its generation capacity by 8%, i.e. 25 MW, and reducing its NO_x emissions by around 30%. CLP will upgrade two more gas-fired units by 2018, which will further reduce its NO_x emissions;

(c) DBNPS would continue to supply 80% of its annual nuclear power output to CLP beyond 2018;

(d) the electricity demand for CLP is forecasted to increase by around 1% in the period 2022 to 2023 as compared to that of 2021 when setting the Sixth TM ; and

(e) the limited increase in electricity demand forecast in 2022 to 2023 and the availability of more gas-fired electricity generation capacity could reduce the reliance on coal-fired units for power generation. It is estimated that its emission allowances could be reduced by 27% for SO_2, 12% for NO_x and 12% for RSP in the period 2022 to 2023 as compared to the levels in the Sixth TM.

15. The projected emissions for the power plants of the two power companies in 2022 and beyond are presented in Table 1 below, together with the reductions relative to the respective Sixth TM levels –

Table 1: Projected Emissions in 2022 and beyond (tonnes per year)

		Sulphur dioxide	**Nitrogen oxides** [@]	**Respirable suspended particulates**
HEC	Lamma Power Station and Lamma Power Station Extension (mixed fuel)	2 210 [-23%]	4 910 [-21%]	120 [-8%]
CLP	Black Point Power Station (gas-fired)	319 [15%]	3 381 [-17%]	123 [14%]
	Castle Peak Power Station (coal-fired)	2 759 [-30%]	9 237 [-10%]	246 [-21%]
	Penny's Bay Gas Turbine Power Station (oil-fired)	2 [0%]	2 [0%]	1 [0%]
	Total of CLP's Stations	3 080 [-27%]	12 620 [-12%]	370 [-12%]
Electricity sector		5 290 [-25%]	17 530 [-15%]	490 [-11%]

[@] Expressed as nitrogen dioxide

Note: The figures in square brackets are the percent reduction comparing with the emission allowances stipulated in the Sixth TM.

16. Based on the above projected emissions, in ascertaining the emission allowances for HEC and CLP, we will also follow the established mechanism (paragraphs 17 and 18 below) in the Sixth TM by taking into account the actual intake of the electricity generated from RE and the unit emission factors of coal-fired units[3]. For RE facilities, the Lamma Winds of HEC and its photovoltaic system at Lamma Power Station will continue to supply RE of about 2 GWh per year in total to HEC's power grid. The Sludge Treatment Facility in Tuen Mun, which started operation in 2015, and Phase 1 of the new Organic Waste Treatment Facilities in Siu Ho Wan, North Lantau, which will start operation by the end of 2017, are expected to supply about 32 GWh of surplus electricity per year to CLP's power grid when fully

[3] Unit emission factors of coal-fired units are the averaged emission of specified pollutants (i.e., SO_2, NO_x and RSP) owing to the generation of 1 GWh electricity from coal-fired generating units in the power plant, expressed in tonne/GWh.

commissioned. CLP will develop landfill gas electricity generation at West New Territories (WENT) Landfill with generation capacity of around 68 GWh for operation beginning in the third quarter of 2018. Besides, the Integrated Waste Management Facility in Shek Kwu Chau is also a potential RE facility and is expected to start providing RE by 2024. Further assessment will be conducted in our next review of TM when more details are available.

PROPOSED EMISSION CAPS FOR NEW TM (Seventh TM)

Emission Allowances for Existing Electricity Works

17. Based on the above review, we propose to promulgate the Seventh TM to allocate the emission allowances from 2022 onwards to each of the existing power plants by the following method, as adopted in the Sixth TM –

Emission allowances to be allocated and ascertained	
=	Emission allowances that are required with the use of BPM (i.e. those presented in Table 1 above)
plus/minus	Emission allowances to be added/deducted owing to deviation of the actual intake of RE from the anticipated intake (i.e. 2 GWh and 100 GWh for HEC and CLP respectively) in accordance with the unit emission factors of coal-fired units

18. The formulae for allocating the emission allowances to the four power plants are presented in the tables below –

Table 2(a): Lamma Power Station and Lamma Power Station Extension

	Quantity of Emission Allowance for 2022 and thereafter
SO_2	2 210 + (2 – A) × 0.459*
NO_x [@]	4 910 + (2 – A) × 0.922*
RSP	120 + (2 – A) × 0.018*

Table 2(b): Black Point Power Station

	Quantity of Emission Allowance for 2022 and thereafter
SO_2	319
NO_x [@]	3 381
RSP	123

Table 2(c): Castle Peak Power Station

	Quantity of Emission Allowance for 2022 and thereafter
SO_2	$2\ 759 + (100 - B) \times 0.343^{\#}$
NO_x [@]	$9\ 237 + (100 - B) \times 1.148^{\#}$
RSP	$246 + (100 - B) \times 0.030^{\#}$

Table 2(d): Penny's Bay Gas Turbine Power Station

	Quantity of Emission Allowance for 2022 and thereafter
SO_2	2
NO_x [@]	2
RSP	1

[@] Expressed as nitrogen dioxide

* Unit emission factors of coal-fired units in Lamma Power Station in 2022

\# Unit emission factors of coal-fired units in Castle Peak Power Station in 2022

where –

A is the aggregate of total net sent-out electricity output (in GWh) from the Renewable Energy Systems to the electricity grid of Lamma Power Station and Lamma Power Station Extension in the emission year; and

B is the aggregate of total net sent-out electricity output (in GWh) from the Renewable Energy Systems to the electricity grid of Castle Peak Power Station in the emission year.

Emission Allowances for New Electricity Works

19. In the event that there will be new electricity works[4], we will, as in the past, allocate emission allowances based on the emission performance of a new gas-fired unit having adopted BPM for emission reduction. We also propose to retain the mechanism in the Sixth TM to cater for the possible intake of RE by new electricity works. Accordingly, the formulae for allocating and ascertaining the emission allowances in respect of each of the specified pollutants for possible new electricity works, with respect to the same reference installed capacity adopted in the previous TM, i.e., 300 MW, for emission years starting from 1 January 2022 would be as presented in the table below.

Table 3: New Electricity Works

	Quantity of Emission Allowance for 2022 and thereafter
SO_2	36 × (C/300) × (D/12) – E × 0.018^
NO_x [@]	55 × (C/300) × (D/12) – E × 0.028^
RSP	14 × (C/300) × (D/12) – E × 0.007^

[@] Expressed as nitrogen dioxide

^ Unit emission factors of gas-fired units equipped with latest emission control device

where –

C is the total installed capacity (in MW) of the New Electricity Works; or 300 (i.e., reference installed capacity), whichever is smaller;

D is the total number of months in the emission year after the commencement of operation of the New Electricity Works and part of a month is taken as a full month in the determination; and

E is the aggregate of total net sent-out electricity output (in GWh) from the Renewable Energy Systems to the electricity grid of the New Electricity Works in the emission year.

[4] "New electricity works" refers to new entrant (i.e., in addition to HEC and CLP) coming into the electricity generation industry after the commencement of the proposed TM. The use of coal in new electricity generation plants was banned since 1997. New generating units shall be gas-fired units.

Next Review

20. This review has taken account of all the new gas-fired generating units which have been approved by the Government. We will thus maintain the normal practice to review a TM at a frequency of no less than once every two years to enable timely revision of the emission allowances.

Commencement Date of New Emission Caps

21. If the proposed Seventh TM commences before the end of 2017, the new emission allowances will take effect starting from 1 January 2022, pursuant to section 26G(4) of the APCO.

Special Events

22. The emission allowances to be allocated under the proposed new TM are premised on the timely commissioning of the new gas-fired units (Unit L11 for HEC and Unit D1 for CLP) and availability of 80% nuclear energy import from DBNPS to CLP in 2019 and beyond. It is also expected that two more existing gas-fired units at Black Point Power Station would be upgraded. Should there be any uncontrollable factors that affect the additional nuclear power supply or the commissioning schedule of the gas-fired units, we will deal with them under the existing mechanism of the APCO when the power companies invoke the special event provision under Section 26K of the APCO to adjust their emission caps. We will not lightly adjust the emission caps under the special event mechanism unless the incidents are proven to be outside the control of power companies and they have proven to have made their best endeavour to avoid such happenings.

ENVIRONMENTAL IMPLICATIONS

23. As compared with the emission allowances for 2021 set under the Sixth TM, the proposed Seventh TM will see a further tightening of 25% for SO_2, 15% for NO_x as well as 11% for RSP for the electricity sector. The reduction will help improve air quality, given that emissions from the electricity sector account for 37%, 28% and 11% respectively of the territory-wide emissions of these pollutants in 2015.

TARIFF IMPLICATIONS

24. The construction of one new gas-fired unit each by the two power companies would allow them to achieve the proposed emission allowances for 2022 and onwards. HEC estimates that total capital expenditure involved for building Unit L11 is about $4.1 billion, while CLP estimates that for Unit D1 is about $5.5 billion. As for their tariff implication, it is premature at this stage to make any meaningful assessment for 2022 and beyond. This is because how the increase in capital investment will be reflected in electricity tariff would depend on a host of factors, including the future fuel costs, the pace of capital investments, operating costs, sales volume, as well as future movements in the Tariff Stabilisation Fund and the Fuel Clause Recovery Account.

25. The power companies will present their tariff assessment to the Administration annually in accordance with the relevant regulatory mechanism under the Scheme of Control Agreement (SCA).

CONSULTATION

26. We have consulted the two power companies about the proposal to further tighten the emission caps. While they agree that the commissioning of their new gas-fired units would help further reduce emissions from their power plants, they consider the proposed new emission allowances, which have been tightened further taking into account the increase in gas generation, extremely challenging. Nevertheless, they are supportive of (a) the new energy efficiency and conservation initiatives proposed by the Government in the "Energy Saving Plan for Hong Kong's Built Environment 2015~2025+"; and (b) the fuel mix for 2020 with a view to cutting emissions from electricity generation. They are committed to working closely with the Government to ensure compliance while maintaining a reliable supply of electricity to the customers. They also agree to another review of the TM to be conducted not later than 2019.

27. Both power companies also see the compliance of the emission allowances contingent upon availability of fuels of the right quality. They have also put forward that any forced outages or a drop in the performance of the generating units or emission control equipment due to ageing problem or natural deterioration will jeopardize their compliance with the new emission allowances. HEC has also raised its concern that with progressive retirement of its two oldest coal-fired units and one gas-fired unit, the drop in its available generating capacity would pose a

challenge to the sourcing of the right kind of low-emission coal with sufficiently high heating value to compensate for the smaller available generating capacity. Should the operation of the power plants encounter events that are beyond their control and with significant emission implications (e.g. cessation or insufficient supply of low-emission coal, unexpected increase in power demand, increase in sulphur content of the natural gas supplied, less than expected nuclear energy made available to CLP for 2022, and/or other related issues falling outside their control), they may have to resort to the special event provision under Section 26K of the APCO to adjust their emission allowances accordingly. When necessary, we will handle these special events in accordance with the APCO.

WAY FORWARD

28. We plan to submit the Seventh TM to the Legislative Council under Section 37B(1) of the APCO for negative vetting in October 2017. Our target is to commence the Seventh TM before the end of 2017, thus fulfilling the statutory requirement to provide the power companies with at least four years' lead time for the tightened emission allowances to take effect from 1 January 2022.

Environmental Protection Department
June 2017

Annex

Emission Allowances for Existing Electricity Works under the Sixth TM (tonnes per year)

(a) Lamma Power Station and Lamma Power Station Extension

	2021 and thereafter
Sulphur dioxide	2 870 + (2 – A) × 0.529
Nitrogen oxides [@]	6 220 + (2 – A) × 0.938
Respirable suspended particulates	130 + (2 – A) × 0.017

(b): Black Point Power Station

	2021 and thereafter
Sulphur dioxide	278
Nitrogen oxides [@]	4 063
Respirable suspended particulates	108

(c): Castle Peak Power Station

	2021 and thereafter
Sulphur dioxide	3 930 + (32 – B) × 0.407
Nitrogen oxides [@]	10 245 + (32 – B) × 1.062
Respirable suspended particulates	311 + (32 – B) × 0.031

(d): Penny's Bay Gas Turbine Power Station

	2021 and thereafter
Sulphur dioxide	2
Nitrogen oxides [@]	2
Respirable suspended particulates	1

[@] Expressed as nitrogen dioxide

where –

A is the aggregate of total net sent-out electricity output (in GWh) from the Renewable Energy Systems to the electricity grid of Lamma Power Station and Lamma Power Station Extension in the emission year; and

B is the aggregate of total net sent-out electricity output (in GWh) from the Renewable Energy Systems to the electricity grid of Castle Peak Power Station in the emission year.