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

PURPOSE

This paper seeks Members' views on the Government's proposal to reduce emission allowances for power plants starting from 1 January 2024 by way of issuing a new Technical Memorandum (TM) (i.e. the Eighth TM) under Section 26G of the Air Pollution Control Ordinance (Cap. 311) (APCO).

BACKGROUND

2. Road transport, marine vessels and electricity generation are major local sources of emission of air pollutants. Through the various measures implemented, we have had gradual improvements in air quality over the years. During the last 10 years (i.e. from 2009 to 2018), the concentrations of sulphur dioxide (SO₂), nitrogen dioxide (NO₂), respirable suspended particulates (RSP) and fine suspended particulates (FSP) recorded at general air quality monitoring stations dropped by 57%, 22%, 30% and 35% respectively. In the same period, the concentrations of SO₂, NO₂, RSP and FSP recorded at roadside decreased by 50%, 25%, 36% and 29% respectively.

3. To reduce emissions from power generation, the Government has been requiring the power companies (i.e. CLP Power Hong Kong Limited (CLP) and the Hongkong Electric Company, Limited (HEC)) to use natural gas in their new power generating units since 1997. We also, via specified licence control, demanded the two companies to adopt the best practicable means to reduce air pollutant emissions, including 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 put a cap on 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., SO₂, 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. Seven TMs were issued in 2008, 2010, 2012, 2014, 2015, 2016 and 2017 respectively. The First TM set the emission allowances for the emission years between 2010 and 2014¹. The emission allowances for the Second, Third and Fourth ones took effect from 1 January 2015, 1 January 2017 and 1 January 2019 respectively while those for the Fifth, Sixth and Seventh TM will take effect from 1 January 2020, 1 January 2021 and 1 January 2022 respectively.

6. The emission allowances under the Seventh TM were determined with due regard to the electricity demand forecasts in the period 2022 - 2023 by CLP and HEC, the progress of increasing local gas generation to around 50% of the total fuel mix for electricity generation by 2020, new technology to upgrade existing gas-fired units, and CLP's continued efforts to import 80% of nuclear output from the Daya Bay Nuclear Power Station (DBNPS) beyond 2018. The emission allowances under the Seventh TM are at the **Annex**.

7. When setting the emission allowances under the Seventh TM in 2017, we undertook to conduct a review of the TM in two years (i.e. 2019) to take account of the latest development on the building of new gas-fired units and the progress of the retirement of existing coal-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 2019, the new emission allowances can take effect from 1 January 2024.

¹ According to Section 26G(5) of the APCO, the four-year advance notice requirement as set out in Section 26G(4) does not apply to the First TM.

THE REVIEW

8. Under Section 26G(2) of the APCO, the Secretary, in making the emission allocations for a type of specified pollutant, 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 and 2018 the efficiency upgrading work for three of their existing gas-fired units with enhancement in generation capacity and improvement in emission performance. Similar efficiency upgrading work of the remaining five existing gas-fired units will be completed by CLP by 2023 for enhancing the performance including emissions reduction. For HEC, there is currently one gas-fired unit in the Lamma Power Station. HEC has no plan to enhance the generation capacity and emission performance of the existing gas-fired unit as three new gas-fired units will be put into operation from 2020 to 2023.

11. In view of limited room for further retrofits, revamping the fuel mix for electricity generation is the most effective way to further reduce emissions from power plants. As outlined in the Hong Kong's Climate Action Plan 2030+, the Government will continue to phase out the use of 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. The Government last entered into new Scheme of Control Agreements (SCAs) with the two power companies in April 2017. Under the SCAs, the power companies

submitted their five-year Development Plans² relating to the provision and future expansion of their electricity supply systems. The Development Plans covered, among others, the construction of two new gas-fired generating units with better fuel efficiency and emission performance, and the replacement of existing coal-fired units which are scheduled for retirement. The Government approved the five-year Development Plans in July 2018. The two new gas-fired generating units, each for HEC and CLP, will be put into operation in 2023. The proportion of gas generation will be further increased from around 50% of the total fuel mix for electricity generation by 2020 (“Fuel Mix Target”) to about 57% in 2024. The Government has also approved the two power companies to construct and operate an offshore liquefied natural gas terminal (LNG Terminal) to enhance the security and diversity of natural gas supply, enabling more stable power supply for Hong Kong.

13. RE generated from distributed solar and wind power systems offers proven alternatives to the burning of fossil fuels for power generation since it is ready to be harnessed, inexhaustible, and more importantly, it causes no pollution. As part of the Government’s commitment to the development of RE in Hong Kong, Feed-in Tariff (FiT) was introduced in the new SCAs to encourage the private sector and the community to invest in distributed RE as the power generated could be sold to the power companies at a rate higher than the normal electricity tariff rate to help recoup the cost of their investments.

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

- (a) the progress of increasing local gas generation, including the construction of new gas-fired units and replacement of some existing coal-fired generating units, which are scheduled for retirement after reaching the end of their service life in coming years;
- (b) the progress of upgrading 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 2023;
- (d) the projected local electricity consumption in the period from 2024 to 2025;

² CLP’s Development Plan covers the period from Oct 2018 to Dec 2023; HEC’s Development Plan covers the period from Jan 2019 to Dec 2023.

and

- (e) the projected electricity intake from RE sources.

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

- (a) HEC is building a new gas-fired unit (Unit L12) with an installed capacity of 380MW at its Lamma Power Station Extension for operation in 2023 in addition to the two gas-fired units (Units L10 and L11) approved in the previous Development Plan. When Unit L12 starts operation, the gas generation ratio (on sent-out basis) will increase from around 55% in 2022 to about 70% in 2024, thus allowing further reduction of the emission allowances;
- (b) the retirement of three existing coal-fired units (i.e. Units L2, L4 and L5) and the reduced generation from the remaining coal-fired units will also contribute to the reduction in emission allowances;
- (c) the electricity demand for the Hong Kong Island is forecasted to drop by around 4% in the period 2024 to 2025 as compared to that of 2022 when setting the Seventh TM. The forecasted reduced electricity demand is partly due to the energy efficiency measures outlined in the Energy Saving Plan³; and partly due to new incentives to promote energy efficiency and conservation (EE&C)⁴ under the new SCA; and
- (d) the slight increase in electricity intake from RE, reduced electricity demand in 2024 and 2025 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 28% for SO₂, 34% for NO_x and 3% for RSP as compared to the levels in the Seventh TM.

³ The "Energy Saving Plan for Hong Kong's Built Environment 2015~2025+" sets a target of reducing Hong Kong's energy intensity by 40% by 2025 using 2005 as the base.

⁴ Power companies have strengthened the support to customers on adopting energy efficiency and conservation initiatives, such as enhancing the energy efficiency performance of building services installations and encouraging households to save energy.

16. As for CLP, the assessment is summarised as follows –
- (a) CLP is building a new gas-fired unit of 550 MW (Unit D2) at its Black Point Power Station. After the commencement of operation of the Unit D2 in 2023, CLP's gas generation ratio (on sent-out basis) will increase from around 48% in 2022 to about 53% in 2024, allowing further reduction in the emission allowances;
 - (b) the retirement of two coal-fired units at Castle Peak Power Station (i.e. Units A1 and A2) by 2023 and the reduced generation from the remaining coal-fired units will also contribute to the reduction in emission allowances;
 - (c) at its Black Point Power Station, three of the eight gas-fired units have been upgraded, thereby increasing their generation capacity by 8%, i.e. 75 MW or 25 MW each, and reducing its NO_x emissions by around 30%. CLP will upgrade the remaining five gas-fired units by 2023, which will further reduce its NO_x emissions;
 - (d) DBNPS would continue to supply 80% of its annual nuclear power output to CLP beyond 2023⁵;
 - (e) the electricity demand for CLP is forecasted to drop by around 4% in the period 2024 to 2025 as compared to that of 2022 when setting the Seventh TM. The forecast of reduced electricity demand is due to the energy efficiency measures outlined in the Energy Saving Plan and the new incentives to promote EE&C under the new SCA;
 - (f) the electricity intake from RE sources will increase after the operation of the Integrated Waste Management Facility and other waste to energy facilities; and
 - (g) in view of the development set out in paragraph 16(a) to (f) above, it is estimated that CLP's emission allowances could be reduced by 49% for SO₂, 27% for NO_x and 26% for RSP in the period 2024 to 2025 as compared to the levels in the Seventh TM.

⁵ In 2014, CLP reached an agreement with Daya Bay Nuclear Power Station to increase the proportion of electricity supply to Hong Kong from 70% to 80% of the plant's output over the next five years. The agreement was extended for another five-year period from 2019 to 2023 in December 2018.

17. In ascertaining the emission allowances for HEC and CLP, we will also follow the established mechanism (paragraphs 21 and 22 below) in the Seventh TM by taking into account the actual intake of the electricity generated from RE and the unit emission factors of coal-fired and gas-fired units.

18. For HEC, a total of about 7 GWh electricity intake from RE per year is estimated to be obtained in 2024 and 2025. While the Lamma Winds and photovoltaic systems at Lamma Power Station will continue to supply RE of about 2 GWh per year, the distributed RE systems including those joining the FiT Scheme will supply about 5 GWh of RE per year to HEC's grid.

19. For CLP, a total of about 283 GWh and 614 GWh electricity intake from RE per year are estimated to be obtained in 2024 and 2025 respectively. The RE sources include the Sludge Treatment Facility (T·PARK) in Tuen Mun, Phase 1 and Phase 2 of the Organic Resources Recovery Centre in Siu Ho Wan, North Lantau (O·PARK1) and Sha Ling, North District (O·PARK2) respectively, electricity generation utilizing landfill gas from the West New Territories (WENT) Landfill, the Integrated Waste Management Facility (IWMF) in Shek Kwu Chau and surplus electricity from distributed RE systems joining the FiT Scheme. Breakdown of electricity intake from RE sources in 2024 and 2025 are presented in Table 1 below.

Table 1: Breakdown of electricity intake from RE in 2024 and 2025 (GWh)

RE Facilities		2024	2025
HEC	Lamma Winds and photovoltaic systems	2	2
	Distributed RE systems	5	5
Total of HEC's RE		7	7
CLP	T·PARK	3	3
	O·PARK1	14	14
	O·PARK2	24	24
	WENT Landfill Gas Generation	68	68
	IWMF	149	480
	Distributed RE systems	25	25
	Total of CLP's RE	283	614
Electricity sector		290	621

20. Electricity intake from the RE sources will offset both gas and coal generation broadly according to the fuel mix ratio⁶. After considering the electricity intake from RE, the projected emissions for the power plants of the two power companies in 2024 and beyond are presented in Table 2 below, together with the reductions relative to the respective Seventh TM levels –

Table 2: Projected Emissions in 2024 and beyond (tonnes per year)

		Sulphur dioxide	Nitrogen oxides ^[@]	Respirable suspended particulates
HEC	Lamma Power Station and Lamma Power Station Extension (mixed fuel)	1 590 [-28%]	3 230 [-34%]	116 [-3%]
CLP	Black Point Power Station (gas-fired)	255 [-20%]	2 291 [-32%]	125 [2%]
	Castle Peak Power Station (coal-fired)	1 303 [-53%]	6 907 [-25%]	149 [-39%]
	Penny's Bay Gas Turbine Power Station (oil-fired)	2 [0%]	2 [0%]	1 [0%]
	Total of CLP's Stations	1 560 [-49%]	9 200 [-27%]	275 [-26%]
Electricity sector		3 150 [-40%]	12 430 [-29%]	391 [-20%]

[@] Expressed as nitrogen dioxide

Note: The figures in square brackets are the reduction in percentage when compared with the emission allowances stipulated in the Seventh TM.

PROPOSED EMISSION CAPS FOR NEW TM (Eighth TM)

Emission Allowances for Existing Electricity Works

21. Based on the above review, we propose to promulgate the Eighth TM to allocate the emission allowances from 2024 onwards to each of the existing power plants by the following method, as adopted in the Seventh TM –

⁶ It is projected that in 2024/2025, fuel mix ratio of local electricity generation from CLP's gas-fired and coal-fired units is around 76% to 24%, whereas the ratio of HEC is around 70% to 30%.

Emission allowances to be allocated and ascertained

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Emission allowances that are required with the use of best practicable means (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., about 7 GWh and 614 GWh ⁷ for HEC and CLP respectively) in accordance with the (composite) unit emission factors of coal-fired/gas-fired units

22. The formulae for allocating the emission allowances to the four power plants of the two power companies are presented in the tables below –

Table 3(a): Lamma Power Station and Lamma Power Station Extension

	Quantity of Emission Allowance for 2024 and thereafter
SO ₂	$1\,590 + (7 - A) \times 0.150^*$
NO _x [[@]]	$3\,230 + (7 - A) \times 0.308^*$
RSP	$116 + (7 - A) \times 0.011^*$

Table 3(b): Black Point Power Station

	Quantity of Emission Allowance for 2024 and thereafter
SO ₂	$255 + (467 - B) \times 0.014^\wedge$
NO _x [[@]]	$2\,291 + (467 - B) \times 0.122^\wedge$
RSP	$125 + (467 - B) \times 0.007^\wedge$

Table 3(c): Castle Peak Power Station

	Quantity of Emission Allowance for 2024 and thereafter
SO ₂	$1\,303 + (147 - C) \times 0.219^\#$
NO _x [[@]]	$6\,907 + (147 - C) \times 1.162^\#$
RSP	$149 + (147 - C) \times 0.025^\#$

⁷ For CLP, it is projected that gas generation at Black Point Power Station and coal generation at Castle Peak Power Station to be offset by the RE intake are 467 GWh (i.e. 76% of the total anticipated RE intake) and 147 GWh (i.e. 24% of the total anticipated RE intake) respectively.

Table 3(d): Penny’s Bay Gas Turbine Power Station

	Quantity of Emission Allowance for 2024 and thereafter
SO ₂	2
NO _x ^[@]	2
RSP	1

^[@] Expressed as nitrogen dioxide

* Composite unit emission factors of coal-fired and gas-fired units in Lamma Power Station based on the projected fuel mix ratio (around 70% gas and 30% coal) in 2024/2015

^ Unit emission factors of gas-fired units in Black Point Power Station in 2024/2015

Unit emission factors of coal-fired units in Castle Peak Power Station in 2024/2025

where –

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

B is the aggregate of total net sent-out electricity output (in GWh) from the RE Systems to the electricity grid connected to Black Point Power Station in the emission year; and

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

Emission Allowances for New Electricity Works

23. In the event that there will be new electricity works⁸, 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 Seventh 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 2024 would be as follows -

⁸ "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 has been banned since 1997. New generating units shall be gas-fired units.

Table 4: New Electricity Works

	Quantity of Emission Allowance for 2024 and thereafter
SO ₂	$36 \times (D/300) \times (E/12) - F \times 0.018^{\wedge}$
NO _x ^[@]	$55 \times (D/300) \times (E/12) - F \times 0.028^{\wedge}$
RSP	$14 \times (D/300) \times (E/12) - F \times 0.007^{\wedge}$

[@] Expressed as nitrogen dioxide

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

where –

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

E 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

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

Next Review

24. 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 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

25. If the proposed Eighth TM commences before the end of 2019, the new emission allowances will take effect starting from 1 January 2024, pursuant to Section 26G(4) of the APCO.

Special Events

26. Under Section 26K of the APCO, the Director of Environmental Protection may adjust the emission caps when the power companies invoke the special event provision to account for any uncontrollable factors that affect the additional nuclear power supply or the commissioning schedule of the new gas-fired units which are the

prime considerations in setting the emission allowances in the Eighth TM. We have to stress that we will not adjust the emission caps under the special event mechanism automatically unless the incidents are proven to be outside the control of the power companies and they have demonstrated that they have made their best endeavour to avoid such happenings.

ENVIRONMENTAL IMPLICATIONS

27. As compared with the emission allowances for 2022 set under the Seventh TM, the proposed Eighth TM will see a further tightening of about 40% for SO₂, 29% for NO_x as well as 20% for RSP for the entire electricity sector. The reduction will help improve air quality, given that emissions from the electricity sector account for 43%, 27% and 16% respectively of the territory-wide emissions of these pollutants in 2017.

TARIFF IMPLICATIONS

28. The construction of one new gas-fired unit each by the two power companies will allow them to achieve the proposed emission allowances for 2024 and onwards. The total estimated expenditures of HEC's and CLP's new gas-fired unit are about \$5 billion and \$6 billion respectively. As for their tariff implication, it is premature at this stage to make any meaningful assessment for 2024 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 future fuel costs, pace of capital investments, operating costs, sales volume, as well as future movements in the Tariff Stabilisation Fund and the Fuel Clause Recovery Account.

29. The power companies will present their tariff assessment to the Administration annually in accordance with the relevant regulatory mechanism under the SCA.

CONSULTATION

30. We have consulted the two power companies about the proposal to further tighten the emission caps. While they have agreed with the proposed emission caps as set out in the Eighth TM and 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, challenging. Nevertheless, they are supportive of (a) the new EE&C initiatives proposed by the Government in the “Energy Saving Plan for Hong Kong’s Built Environment 2015~2025+” and the new SCAs; and (b) the Climate Action Plan 2030+ on increasing the use of natural gas in electricity generation to help achieve the carbon intensity reduction target for 2030. 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 2021.

31. Both power companies also see the compliance of the emission allowances contingent upon availability of fuels of 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. Both HEC and CLP have raised their concern on the difficulty in sourcing low-emission coal with low sulphur and ash contents as the supply sources are limited while the global demand for low-emission coal is escalating. 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 2024, unexpected delay in the upgrading works on the five existing gas-fired units and/or commissioning of the new gas-fired units (i.e. Unit L12 for HEC and Unit D2 for CLP), 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 under the existing mechanism stipulated in Section 26K of the APCO.

WAY FORWARD

32. We plan to submit the Eighth TM to the Environmental Affairs Panel of the Legislative Council (LegCo) for deliberation in July 2019 and to LegCo for negative vetting under Section 37B(1) of the APCO in October 2019. Our target is to commence this new TM before the end of 2019, 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 2024.

Environmental Protection Department
June 2019

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

(a) Lamma Power Station and Lamma Power Station Extension

	2022 and thereafter
Sulphur dioxide	$2\,210 + (2 - A) \times 0.459$
Nitrogen oxides ^[@]	$4\,910 + (2 - A) \times 0.922$
Respirable suspended particulates	$120 + (2 - A) \times 0.018$

(b): Black Point Power Station

	2022 and thereafter
Sulphur dioxide	319
Nitrogen oxides ^[@]	3 381
Respirable suspended particulates	123

(c): Castle Peak Power Station

	2022 and thereafter
Sulphur dioxide	$2\,759 + (100 - B) \times 0.343$
Nitrogen oxides ^[@]	$9\,237 + (100 - B) \times 1.148$
Respirable suspended particulates	$246 + (100 - B) \times 0.030$

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

	2022 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.