Appendix 1 to ACE Paper 1/2019

Report on the Review of Air Quality Objectives (AQOs)

The Government has completed the review of the Air Quality Objectives (AQOs) conducted pursuant to section 7A of the Air Pollution Control Ordinance (APCO) (Cap. 311) in December 2018. This report sets out the background, process and outcome of the review.

BACKGROUND

World Health Organisation's Air Quality Guidelines and Interim Targets

2. The World Health Organisation (WHO)'s "Air Quality Guidelines Global Update 2005" (the WHO Guidelines) have promulgated a set of Air Quality Guidelines (AQGs) and Interim Targets (ITs) for various key air pollutants including respirable suspended particulates (RSP/PM_{10}), fine suspended particulates ($FSP/PM_{2.5}$), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), carbon monoxide (CO) and lead (Pb), based on a wealth of studies on the effects of air pollution on health. The WHO Guidelines state that *"the [air quality] standards set in each country will vary according to specific approaches to balancing risks to public health, technological feasibility, economic considerations and other political and social factors. ... The guidelines recommended by WHO acknowledge this heterogeneity and recognize in particular that, in formulating policy targets, governments should consider their own local circumstances carefully before using the guidelines directly as legal standards."* The setting of ITs by WHO enables governments to, having regard to their local circumstances, progressively tighten their air quality standards towards the ultimate goal of meeting the AQGs. At present, no country has fully adopted the AQGs as its air quality standards.

3. To minimise non-compliance of AQOs or ITs owing to uncontrollable circumstances such as extreme weather, the WHO explicitly states in the WHO Guidelines that for legally binding standards, quantifiable compliance criteria in the form of number of acceptable exceedances, should be defined[1]. The WHO Guidelines do not provide any recommendations on the number of allowable exceedances in setting the AQOs and ITs for the air pollutants concerned. To illustrate that the number of allowable exceedances for different air pollutants

[1] Chapter 8 of the WHO Guidelines states that *"when the [air quality] standards are to be legally binding, criteria must be identified to determine compliance. This is quantified through the number of acceptable exceedances over a certain period of time. ...Compliance criteria are defined in each country in order to compare the most representative data with the standards, and to minimize the designation of non-compliance owing to uncontrollable circumstances such as extreme weather."*

concentration limits vary among different places, the same Chapter provides as examples the European Union (EU)'s number of allowable exceedances for the 8-hour ozone standard is 25 times per year, and South Africa's number of allowable exceedances for the 24-hour nitrogen dioxide is three times per year.

Air Quality Objectives in Hong Kong

4. Having regard to the recommendations of the WHO and the practices of other advanced economies, the following guiding principles have been adopted by the Government in setting AQOs and in conducting its subsequent reviews –

(a) For protection of public health, a progressive approach be adopted with a view to achieving the WHO AQGs as an ultimate goal, with reference to international practices, the latest technological developments and local circumstances in accordance with the WHO recommendations, ; and

(b) The AQOs should be benchmarking against the AQGs and ITs of the WHO.

5. In view of the above guiding principles, the current air quality management policy of Hong Kong is to improve air quality to achieve the ultimate WHO AQGs to protect public health, through introducing various measures to reduce emissions from various sources such as power stations, industrial activities, road vehicles, etc. The main function of the statutory AQOs, apart from being an interim goal for developing short term air quality improvement plans, also served as a benchmark for consideration of designated projects under the Environmental Impact Assessment Ordinance (EIAO) as well as a key factor to be considered when deciding whether a licence should be issued to a specified process under the Air Pollution Control Ordinance. Hence in accordance with the WHO recommendations, it is necessary for the setting of the statutory AQOs to take into consideration the latest technological development and the availability of practicable air quality improvement measures.

6. To ensure a progressive approach be adopted to improve air quality, Section 7A of the APCO requires the Secretary for the Environment (SEN) to review the AQOs at least once in the five years beginning 1 January 2014 (i.e. by 31 December 2018), and thereafter in each successive five-year period. It also provides SEN to submit to the Advisory Council on the Environment (ACE) a report of the review as soon as practicable after a review is conducted.

7. Schedule 5 to the APCO prescribes 12 AQOs for seven key air pollutants (namely, RSP/PM_{10}, FSP/$PM_{2.5}$, SO_2, NO_2, O_3, CO and Pb). The prevailing AQOs, which took effect on 1 January 2014, are benchmarked against a combination of WHO AQGs and their ITs. Among the 12 AQOs, six of them are already set at WHO AQGs levels, i.e. SO_2 (10-min), NO_2 (both 1-hour and annual), CO (both 1-hour and 8-hour) and Pb (annual), whereas the remaining are set at WHO ITs levels (**Annex A**).

8. As a result of a series of emission control measures implemented in recent years, the concentrations of key air pollutants have reduced by about 30 per cent over the past five years. In 2017, except for O_3 and NO_2, the AQOs for the remaining air pollutants (i.e. SO_2, RSP/PM_{10}, FSP/$PM_{2.5}$, CO and Pb) have already been attained, as set out in **Annex B**. With our on-going emission control programmes, the target of "broadly attaining the current ambient air quality AQOs by 2020" remains valid. The high roadside NO_2 level (whose annual concentrations are currently more than two times the AQO limit) as well as the rising trend of ozone however remain to be the key challenges of air pollution we need to tackle.

THE MODUS OPERANDI OF THE REVIEW

9. To undertake the AQOs Review, a Working Group (the Working Group), led by the Under Secretary for the Environment (USEN), has been formed in mid-2016. There are some 60 members from the fields of air science, health, green groups, academics, chambers of commerce, professional bodies and trade representatives, as well as representatives from relevant Government bureaux/departments (B/Ds), including the Environment Bureau (ENB) and the Environment Protection Department (EPD) as the lead B/D, and the Development Bureau, the Transport and Housing Bureau, the Civil Engineering and Development Department, the Electrical and Mechanical Services Department, the Department of Health, the Marine Department, the Planning Department, and the Transport Department.

10. Four dedicated Sub-groups, namely Energy and Power Generation (E&PG) Sub-group, Marine Transportation (MT) Sub-group, Road Transportation (RT) Sub-group and Air Science and Health (AS&H) Sub-group were formed under the Working Group. The first three Sub-groups are tasked to identify possible new air quality improvement measures under their respective areas, and evaluate the practicability of implementing the possible new measures. The focus of the AS&H Sub-group is on assessing the air quality improvements and health benefits that might result from the possible new measures, with a view to determining the possible scope for further tightening the AQOs. More in-depth discussions were also carried out under two respective Task Forces on "Emission Reduction Estimation and Air Quality Modelling", and "Health and Economic Impact Assessment", with members enlisted from the AS&H Sub-group. Besides, a consultant has been engaged to assist in the air quality impact assessments of air quality improvements measures and arranging stakeholders' engagement of the AQOs Review. More than 35 meetings among these Working Group, four Sub-groups and two Task Forces have been held. The structure of the Working Group is at **Annex C**. The Terms of reference and membership of the Working Group and the four Sub-groups are at **Annex D-1 to D-5**.

FINDINGS OF THE REVIEW

A. New Air Quality Improvement Measures

Possible New Air Quality Improvement Measures Examined by the Working Group

11. The E&PG, MT and RT Sub-groups have identified **70** possible new measures and deliberated on their practicability of implementation, taking into account technical and operational feasibility, trade demand and reactions, cost-effectiveness, implementation time frame and the likely public reaction, etc. Year 2025 has been used as the assessment year, taking into consideration the target of broadly attaining the current AQOs by 2020 and the statutory requirement to review the AQOs at least once every five years.

Energy and Power Generation Sub-group

12. The 15 measures discussed by this Sub-group were broadly categorized into the following groups –

(a) Building energy efficiency measures
(b) Use of renewable energy (RE)
(c) Fuel mix for electricity generation
(d) Operation of power generation plants
(e) New solar energy technology
(f) Use of biomass as fuel
(g) Energy storage

Marine Transportation Sub-group

13. The 17 measures discussed by this Sub-group were broadly categorized into the following groups –

(a) Use of clean fuel
(b) Technical measures
(c) Fuel economy, energy efficiency and port management
(d) Others

Road Transportation Sub-group

14. The 38 measures discussed by this Sub-group were broadly categorized into the following groups –

(e) Tunnel toll policy and toll collection method
(f) Maintenance and repair of vehicles exhaust system
(g) Fostering a “pedestrian-friendly” and “bicycle-friendly” environment

(h) Promotion of low-emission transport mode
(i) Utilisation of Intelligent Transport Systems
(j) Land use and transport infrastructure planning
(k) Managing road space
(l) Others

15. Amongst the possible new measures discussed, **27** are considered by the relevant Sub-groups as either on-going or already under consideration by the relevant B/Ds which are likely to produce results by 2025 or earlier (or **short-term measures**); **four** measures are considered ready for further deliberation in the next AQOs review period (or **medium-term measures**) (i.e. before the end of 2023); **13** measures require detailed planning or further study to ascertain the practicability for implementation beyond the next review period (or **long-term measures**) and **26** measures are considered as not practicable, short of air quality benefits or not suitable to be considered under the current scope of the review (**others**). These 70 possible new measures and the deliberations on the practicability of implementation at the Sub-groups of E&PG, MT and RT are at **Annexes E-1** to **E-3** respectively.

Measures in respect of Other Emission Sources Examined by Separate Focus Groups

16. EPD has also engaged relevant stakeholders through separate focus group meetings to explore possible new measures to control emissions from other emission sources that are not covered in the three Sub-groups (e.g. products containing volatile organic compounds (VOC), non-road mobile machinery (NRMM), civil aviation, etc.). **Eight** additional measures including **three** short-term ones have been identified. A list of these eight possible new measures from other emission sources and the deliberations on the practicability of implementation by the focus groups is set out at **Annex F**.

New Measures Announced in the 2018 Policy Address

17. In addition, two new Government initiatives targeting roadside emissions announced in the 2018 Policy Address are likely to produce results by 2025. They are – (a) to tighten the emission standards for newly registered motor cycles to Euro IV in 2020; and (b) to launch an incentive-cum-regulatory scheme to progressively phase out Euro IV diesel commercial vehicles by end of 2023.

18. The practicability of the measures as set out in paragraphs 12 to17 above are summarised in Table 1.

Table 1 Summary of New Air Quality Improvement Measures

	Short-term	**Medium-term**	**Long-term**	**Others**	**Total**
Working Group					
E&PG	11	-	1	3	15
MT	2	2	5	8	17

	Short-term	Medium-term	Long-term	Others	Total
RT	14	2	7	15	38
Subtotal	*27*	*4*	*13*	*26*	*70*
Focus Groups					
Non-road mobile machinery	1	1	-	1	3
Cooking fumes	-	2	-	-	2
VOC-containing products	2	-	-	-	2
Civil aviation	-	-	-	1	1
Subtotal	*3*	*3*	-	*2*	*8*
2018 Policy Address	*2*	-	-	-	*2*
Total	**32**	**7**	**13**	**28**	**80**

Public Views on the Possible New Measures

19. After the Working Group and the E&PG, MT and RT Sub-groups have deliberated on the possible new measures, EPD launched a 5-week public engagement exercise between 11 September and 14 October 2017, and held two public forums to solicit and gauge public views on the possible new air quality improvement measures identified (paragraphs 12-16 above). A dedicated webpage was also set up to collect public views on the possible new measures[2]. Of the about 370 written submissions received, most were related to air quality improvement measures which had been discussed at the E&PG Sub-group (e.g. promotion of renewable energy), MT Sub-group (e.g. use of clean fuel), and RT Sub-group (e.g. fostering pedestrian-friendly and bicycle-friendly environment). For those views which had not been deliberated by the three Sub-groups, they were mainly covered in the current policies/initiatives (such as promotion of electric vehicles and expansion of the charging facilities, enforcement of idling engines, and enhancement of regional collaboration for improving air quality). A few comments related to the general air quality management and approach adopted for the current AQOs Review (e.g. suggestion on membership of the Working Group) were also received despite that they were not directly related to air quality improvement measures.

B. <u>Air Quality Assessments</u>

Projection of Air Quality

20. To ascertain whether it is practicable to tighten the AQOs, EPD, with the aid of the consultant mentioned in paragraph 10 above, has assessed the air quality of

[2] Members of the public can submit their views on the following questions :-

1. Any views and comments on possible new air quality improvement measures discussed during the review?
2. Any other suggestions on possible new air quality improvement measures?

Hong Kong in 2025 based on the following, in accordance with methodologies agreed at the AS&H Sub-group, as proposed by the Emission Reduction Estimation & Air Quality Modelling Task Force set up under it[3]:

Hong Kong

(a) projected 2025 baseline emissions on a business-as-usual basis[4]; and

(b) emission reductions arising from the implementation of on-going and committed measures[5], the 15 short-term measures identified by the Working Group and focus group(s)[6] that have quantifiable emission reduction results, as well as the two new Government initiatives targeting roadside emissions announced in the 2018 Policy Address as mentioned in paragraphs 12-17.

Pearl River Delta (PRD) Region

(c) the PRD Region emission targets for 2020[7] were adopted as 2025 emissions, since official projection beyond 2020 is currently not available.

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[3] The AS&H Sub-group endorsed the use of the updated "Pollutants in the Atmosphere and their Transport over Hong Kong" (PATH-2016), as the air quality model for conducting air quality assessment (Annex C to AS&H Paper 1/2017 dated 20 February 2017: https://www.epd.gov.hk/epd/sites/default/files/epd/english/environmentinhk/air/air_quality_objectives/files/Annex%20C%20to%20AS%26H%20Paper%201_2017.pdf

[4] 2015 was used as the base year. Air quality assessment was made for 2020 to evaluate the compliance status of the prevailing AQOs taking into account the implementation of on-going and committed Government's initiatives until 2020, and the 2020 emission reduction targets as agreed between the HKSAR Government and the Guangdong (GD) Provincial Government (see footnote 5 below).

[5] Examples of the on-going and committed measures include -

- Phasing out some 82 000 old diesel commercial vehicles (i.e. pre-Euro, Euro I, Euro II and Euro III models) including light buses, goods vehicles and non-franchised buses through an incentive-cum-regulatory approach. Moreover, new diesel commercial vehicles registered after February 2014 are subject to a service life limit of 15 years.
- Starting from January 2019, a new legislation has been implemented to mandate vessels to use low sulphur fuel within Hong Kong waters to further reduce the emission from marine vessels. The new control requirement dovetails the establishment of a domestic emission control area (DECA) in the PRD Region.
- Progressive tightening up the statutory emission caps on three key air pollutants, namely SO_2, NO_x, and RSP (PM_{10}), from power plants via the promulgation of Technical Memorandum for Allocation of Emission Allowances in Respect of Specified Licences (TM) issued under the APCO.

[6] Of the 30 short term measures identified by the Working Group and focus group(s), 15 measures have quantifiable emission reduction results (nine E&PG measures, two MT measures, one RT measure, and three measures on other emission sources from focus groups). The measures are set out in Annexes E and F.

[7] In November 2012, the HKSAR Government and the GD Provincial Government endorsed an emission reduction plan for the PRD Region up to 2020 which set the 2015 emission reduction targets and 2020 emission reduction ranges for four major air pollutants, namely SO_2, nitrogen oxides (NO_X), RSP and VOC, with 2010 as the base year. A mid-term review study was completed by the two Governments in December 2017 which concluded the achievement of emission reduction targets for 2015 and finalised the emission reduction targets for 2020. The two Governments will jointly launch a study on post-2020 air pollutant emission reduction targets and concentration levels for Hong Kong and GD.

Areas of the Mainland outside the PRD Region

(d) 2020 emissions in the outer areas of the Mainland obtained from other official sources.

21. The air quality assessment results[8] indicate that there would be continuous improvement in PM_{10}, $PM_{2.5}$, NO_2 and SO_2, while O_3 levels would have slight increase[9]. The continuous improvement in air quality is brought by the implementation of the on-going measures and committed initiatives (see footnote 5), as well as new Government initiatives targeting roadside emissions (e.g. new measures in paragraph 17). The relevant figures for 2025 are summarised in Table 2 below. The pollutant concentration distributions over the Hong Kong territory in 2025 are illustrated in **Annex G**.

Table 2 Comparison of 2025 air quality assessment and the air quality recorded in 2015

Pollutants	**Averaging Time**	**Prevailing HK AQOs**		**2015 Air Quality [a]**		**2025 Air Quality Assessment [b]**	
		Conc. ($\mu g/m^3$)	**No. of Exceedance Allowed Amongst Stations**	**Conc. ($\mu g/m^3$)**	**Highest No. of Exceedance Amongst Stations**	**Conc. ($\mu g/m^3$)**	**Highest No. of Exceedance**
RSP/PM_{10}	Annual	50 (IT-2)	NA	45	NA	37	NA
	24-hr	100 (IT-2)	9	110 (10^{th} highest)	18	90 (10^{th} highest)	6
$FSP/PM_{2.5}$	Annual	35 (IT-1)	NA	30	NA	24	NA
	24-hr	75 (IT-1)	9	78 (10^{th} highest)	11	72 (10^{th} highest)	8
NO_2	Annual	40 (AQO)	NA	64	NA	67	NA
	1-hr	200 (AQO)	18	271 (19th highest)	67	199 (19th highest)	18
SO_2	24-hr	125 (IT-1)	3	58 (4^{th} highest)	0	26 (4^{th} highest)	0
O_3	8-hr	160 (IT)	9	182 (10^{th}	24	216 (10^{th}	30

[8] Based on a modelling grid size of 1 km x 1 km.

[9] The projected slight increase in the O_3 concentration in 2020/2025 is largely due to reduction in nitric oxide (NO) emissions from motor vehicles as a result of control measures being/to be implemented (phasing out diesel commercial vehicles, tightened vehicle emission standards, etc.). While such vehicle emission control measures would help effectively reduce the concentrations of NO_2, which is one of the key pollutants causing health impacts to the public, the reduction in NO due to the control measures would reduce the titration effect on O_3 (i.e. removal of O_3 from its reaction with NO), thereby leading to slight increase in O_3 levels especially in areas with higher traffic flow.

Pollutants	Averaging Time	Prevailing HK AQOs		2015 Air Quality [a]		2025 Air Quality Assessment [b]	
		Conc. ($\mu g/m^3$)	No. of Exceedance Allowed Amongst Stations	Conc. ($\mu g/m^3$)	Highest No. of Exceedance Amongst Stations	Conc. ($\mu g/m^3$)	Highest No. of Exceedance
				highest)		highest)	

NA – Not Applicable

a. 2015 air quality is based on the measurement data of 12 general air quality monitoring stations. Highest concentration among the 12 general air quality monitoring stations is presented.

b. 2025 air quality assessment result is based on the territorial wide air quality modelling outcome. Spatial maximum concentration and maximum number of exceedances are presented.

Possible Scope for Tightening of the AQOs

NO_2, SO_2 (10-min), CO and Pb

22. The AQOs for NO_2, SO_2 (10-min), CO and Pb are already set at the most stringent WHO AQG levels. Hence our focus are on PM_{10}, $PM_{2.5}$, SO_2 (24-hr) and O_3, with a view to identifying possible scope for further tightening their current AQOs based on the air quality assessment results for Hong Kong in 2025 as set out in Table 2 above.

RSP/PM_{10} and O_3

23. The 2025 air quality assessment results show that the concentrations of RSP/PM_{10} and O_3 in 2025 will not be able to meet the AQOs, if they are to be tightened to the next level, i.e. WHO IT-3 for **RSP/PM_{10} (both annual and 24-hr)** and AQG for **O_3**, as set out in Table 3 below. In fact, the concentrations in most areas in Hong Kong will far exceed the AQOs if raised to the next higher level.

Table 3 Comparison of 2025 air quality assessment with the next higher level of the AQOs for RSP/PM_{10} and O_3

Pollutants	Averaging Time	Prevailing HK AQOs		Next Higher Standard ($\mu g/m^3$)	2025 Air Quality Assessment Results [a]	
		Conc. ($\mu g/m^3$)	No. of Exceedance Allowed Amongst Stations		Conc. ($\mu g/m^3$)	Highest No. of Exceedance against the Next Higher Standard
RSP/PM_{10}	Annual	50 (IT-2)	NA	30 (IT-3)	37	NA
	24-hr	100 (IT-2)	9	75 (IT-3)	90 (10^{th} highest)	22
O_3	8-hr	160 (IT)	9	100 (AQG)	216 (10^{th} highest)	113

NA – Not Applicable

a. 2025 air quality assessment result is based on the territorial wide air quality modelling outcome.

Spatial maximum concentration and maximum number of exceedances are presented.

SO_2

24. The air quality assessment results indicate that the SO_2 concentrations in 2025 can meet the next higher level of AQO for **SO_2 (24-hr)** i.e. WHO IT-2, with the current number of exceedance allowable (three) remains unchanged (Table 4).

Table 4 Comparison of 2025 air quality assessment with the next higher level of AQO for SO_2

Pollutants	Averaging Time	Prevailing HK AQOs		Next Higher Standard ($\mu g/m^3$)	2025 Air Quality Assessment Results [a]	
		Conc. ($\mu g/m^3$)	No. of Exceedance Allowed Amongst Stations		Conc. ($\mu g/m^3$)	Highest No. of Exceedance against the Next Higher Standard
SO_2	24-hr	125 (IT-1)	3	50 (IT-2)	26 (4^{th} highest)	0

a. 2025 air quality assessment result is based on the territorial wide air quality modelling outcome. The maximum number of exceedances is presented.

FSP/$PM_{2.5}$

25. The air quality assessment results show that the annual averaged concentrations of FSP/$PM_{2.5}$ in 2025 can possibly meet the next **FSP/$PM_{2.5}$ (annual)** level at WHO IT-2). As for **FSP/$PM_{2.5}$ (24-hour)**, there is potential to meet the next level at WHO IT-2, if the number of allowable exceedances is to be relaxed from the current nine to 35[10] (Table 5).

Table 5 Comparison of 2025 air quality assessment with the next higher level of AQOs for FSP/$PM_{2.5}$

Pollutants	Averaging Time	Prevailing HK AQOs		Next Higher Standard ($\mu g/m^3$)	2025 Air Quality Assessment Results [a]	
		Conc. ($\mu g/m^3$)	No. of Exceedance Allowed Amongst Stations		Conc. ($\mu g/m^3$)	Highest No. of Exceedance against the Next Higher Standard

[10] Elevated concentrations of particulate matters including $PM_{2.5}$ are mainly due to uncontrollable factors including unfavourable meteorological conditions or regional air pollution influence. Setting suitable number of allowable exceedances for avoiding uncontrollable exceedances for legally binding air quality standard is in line with WHO Air Quality Guidelines Chapter 8. (Please also see footnote 1 above). According to the air quality modelling results, the highest number of exceedances against IT-2 is 33. A certain extent of buffer is needed, and hence it would be more realistic if the maximum number of allowable exceedances is set at 35.

Pollutants	Averaging Time	Prevailing HK AQOs		Next Higher Standard ($\mu g/m^3$)	2025 Air Quality Assessment Results [a]		
		Conc. ($\mu g/m^3$)	No. of Exceedance Allowed Amongst Stations		Conc. ($\mu g/m^3$)		Highest No. of Exceedance against the Next Higher Standard
FSP/$PM_{2.5}$	Annual	35 (IT-1)	NA	25 (IT-2)	24 [b]		NA
	24-hr	75 (IT-1)	9	50 (IT-2)	72 (10^{th} highest)	47 (36^{th} highest)	33

NA – Not Applicable

a. 2025 air quality assessment result is based on the territorial wide air quality modelling outcome. Spatial maximum concentration and maximum number of exceedances are presented.

b. A small area of less than 2 km^2 near Hong Kong-Shenzhen Border reaches 24$\mu g/m^3$.

26. Summarising paragraphs 22 to 25 above, there is scope for tightening the AQOs of SO_2 and FSP/$PM_{2.5}$ such that the concentrations of the pollutants could possibly meet the tightened AQOs by 2025 as below:

(a) the 24-hour AQO for SO_2 can be tightened from the WHO AQGs IT-1 (125$\mu g/m^3$) to IT-2 (50$\mu g/m^3$) with the current number of exceedance allowed (three) remains unchanged; and;

(b) the annual AQO for FSP/$PM_{2.5}$ can be tightened from IT-1 (35$\mu g/m^3$) to IT-2 (25$\mu g/m^3$), and its 24-hr AQO from IT-1 (75$\mu g/m^3$) to IT-2 (50$\mu g/m^3$), with the number of exceedances allowed increased from the current nine to 35.

C. Health and Economic Impact Assessment (HEIA)

27. Improvements in air quality can bring along health benefits, such as reducing premature deaths, hospital admissions, clinic visits, and medical cost in particular in relation to respiratory and cardiovascular diseases, and indirectly raising labour productivity. There are various methodologies and approaches for assessing the health and economic impact of air pollution, each with their specific assumptions as well as limitations. After discussions, the AS&H Sub-group, on the suggestion of the Health and Economic Impact Assessment Task Force set up under it, has agreed[11] to conduct the HEIA based on a tool developed by the Chinese University of Hong Kong[12].

[11] AS&H Paper 4/2016 dated on 2 December 2016 and Annex C to AS&H Paper 2/2017 dated 7 June 2017. Links:
https://www.epd.gov.hk/epd/sites/default/files/epd/english/environmentinhk/air/air_quality_objectives/files/AS%26H%20Paper%204_2016.pdf
https://www.epd.gov.hk/epd/sites/default/files/epd/english/environmentinhk/air/air_quality_objectives/files/Annex%20C%20to%20AS%26H%20Paper%202_2017.pdf

[12] The tool was developed by the Chinese University of Hong Kong under the study "Developing an

28. As with all HEIA, the assessment could be limited by the availability of certain health and economic data for the estimation of the risks and costs of specific diseases. On health impact, the choice of health outcomes for assessments (e.g. hospital admissions, clinic visits) was partly limited by insufficient epidemiological evidence of a cause-effect relationship, and partly by the wide variations in the relative risks (RR) of some pollutant-disease pairs reported in different studies. Regarding the economic benefits of the health impact, the indirect cost based on the Value of a Statistical Life (VOSL[13]) method is an important source of uncertainty in the economic impact assessment (paragraph 31 below). There are also views that attaching monetary value to one's health or life may not be appropriate. Hence, the HEIA methodology and findings below should be read bearing in mind the limitations and uncertainties, and are only for reference purpose.

29. To assess the ***Health Impact*** attributable to the changes in air quality level between 2015 (base year) and 2025 (target year), the RR (or concentration-response functions) of specific health outcomes (e.g. hospital admissions, clinic visits, mortality) as a result of a unit change in air pollutant concentration has been identified. In drawing up the RR, local references were adopted as far as practical; otherwise, references from the WHO or from other places were adopted (**Annex H**). The 2015 health statistics[14] baseline data and the RR are then used to assess the health benefits due to the projected air quality improvements in 2025.

30. Based on the air quality assessment results of 2025, improvement in the long-term exposure (in terms of annual concentration level of $PM_{2.5}$ and NO_2) might reduce about 1,850 premature deaths, as compared with 2015. About 1,530 cases of hospital admission (through the Accident and Emergency Departments operated by the Hospital Authority) and 262,580 cases of clinic visits (both public and private

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Instrument for Assessing the Health and Economic Impacts of Air Pollution in Hong Kong" commissioned by EPD, which was completed in 2016. The tool was developed based on the internationally accepted methodologies incorporating the local health statistics and air quality data. The association between long term and short term exposures of air pollution and the health outcomes was established by cohort studies, time-series studies and statistical models. For morbidities, local concentration-response (CR) functions were adopted. For mortalities, CR functions recommended by WHO were adopted in the study owing to a lack of local CR functions. To assess the health impact of air pollution, the pollutant concentration values of WHO AQGs were taken to be the reference level, assuming the health impact of the pollutant concentration level below the WHO AQGs was zero. Though pollutant concentrations below this level still have health effects, statistical uncertainties in the exposure-response function below the WHO AQGs levels are much higher.

[13] The "VOSL" approach refers to the amount of money a person (or society) is willing to spend to save a life. It is derived from the trade-offs people are willing to make between fatality risk and wealth. Hence, it varies among different areas/countries and could be diverse. The measurement of monetary gain in preventing premature mortality based on the VOSL approach is only for indicative purpose.

[14] Health statistics such as mortality and morbidities (e.g. respiratory and cardiovascular diseases) were obtained from the Census and Statistics Department and the Hospital Authority.

practitioners) might be saved owing to improvement in short-term exposure (in terms of 1-hr or 24-hr concentration levels) of air pollutants, in particular the improvement of 1-hr concentration level of NO_2, as compared with 2015. Nevertheless, the slight increase in O_3 concentration level in 2025, as above-mentioned in paragraph 21, could offset some of the health benefits[15] owing to short-term exposure of air pollutants. A summary is at **Annex I**.

31. On the ***economic benefits*** of the health impact attributable to the changes in air quality level between 2015 (base year) and 2025 (target year), the direct savings from hospital admissions and clinic visits[16] were estimated at about HK$ 96 million while the saving in productivity loss[17] which was broadly estimated at about HK$ 150 million. Based on the VOSL approach and with an estimated VOSL value of about HK$18 million[18], the monetary gain in preventing the premature death was estimated at a total of about HK$ 33 billion (equivalent to about 1,850 premature deaths saved). All costs are adjusted to 2017 values. A summary is at **Annex J**.

DISCUSSION AT THE WORKING GROUP

32. The Working Group discussed the review findings at its meeting on 18 December 2018. Major issues discussed include the quantification of emission reduction for new air quality improvement measures identified, the importance of the "practicability" of these measures in considering the scope for the tightening of the AQOs; the adequacy of the HEIA conducted; and the scope for tightening of the AQOs. On these issues, while most members had no major problems with the review findings, a few members had expressed different views. The digest of the meeting is at **Annex K**.

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[15] The hospital admission and clinic visits owing to the predicted increase in O_3 concentration in 2025 were estimated at about 30 cases and 8,210 cases respectively.

[16] The savings due to the potential reduction in hospital admissions of patients with cardiovascular and respiratory diseases through the Accidents and Emergency Departments operated by the Hospital Authority are assumed at a unit attendance cost of HK$1,230 (as of 2017 value). The unit costs of clinic visits to general practitioner (GP) and general outpatient clinic (GOPC) are assumed at $250 and $445 respectively (as of 2017 value). All these costs are based on the study of the CUHK (footnote 12).

[17] The associated productivity loss due to hospital admission and clinic visit is estimated based on the median length of hospital stay (four days for cardiovascular illnesses and three days for respiratory illnesses) and a sick leave of one day granted by the attending doctor. The productivity loss is a broad-brush estimate for reference only given that different estimation methods (e.g. different lengths of hospital stay, different lengths of sick leave) may yield quite different results.

[18] The VOSL is based on the average of VOSL in 2012 from European WHO Regional Office Report (US$2,872,817, as the upper limit) and VOSL in China from a World Bank reference (US$1,171,048 as the lower limit). These values were adjusted to the price in 2017 based on composite consumer price index, at about HK$18,103,200. These two references entailed the upper and lower bounds of the VOSL.

33. The Working Group endorsed the findings regarding tightening of the AQOs at paragraph 26 above. On whether there would be scope to further tighten the AQOs for SO_2 and PM_{10}, the Working Group also asked that additional assessments should be conducted to supplement the available information and the assessment results should be provided to the Advisory Council on the Environment for reference.

Environment Bureau /
Environmental Protection Department
February 2019

ANNEX A

Hong Kong Air Quality Objectives (AQOs) *vs.* World Health Organization Air Quality Guidelines (AQGs)

Pollutants	Averaging Time	World Health Organization Air Quality Guidelines				Prevailing HK AQOs	
		WHO IT-1[1] (µg/m^3)	WHO IT-2[1] (µg/m^3)	WHO IT-3[1] (µg/m^3)	WHO AQGs (µg/m^3)	Conc. (µg/m^3)	No of Exceedances Allowed
Respirable Suspended Particulates (RSP/PM_{10})	24-hr	150	**100**	75	50	100 (IT-2)	9
	Annual	70	**50**	30	20	50 (IT-2)	NA
Fine Suspended Particulates (FSP/$PM_{2.5}$)	24-hr	**75**	**50**	37.5	25	75 (IT-1)	9
	Annual	**35**	**25**	15	10	35 (IT-1)	NA
Nitrogen Dioxide (NO_2)	1-hr	-	-	-	**200**	200 (AQGs)	18
	Annual	-	-	-	**40**	40 (AQGs)	NA
Sulphur Dioxide (SO_2)	10-min	-	-	-	**500**	500 (AQGs)	3
	24-hr	**125**	**50**	-	20	125 (IT-1)	3
Carbon Monoxide (CO)	1-hr	-	-	-	**30,000**	30,000 (AQGs)	0
	8-hr	-	-	-	**10,000**	10,000 (AQGs)	0
Ozone (O_3)	8-hr	**160**	-	-	100	160 (IT)	9
Lead (Pb)	Annual	-	-	-	**0.5**	0.5 (AQGs)	NA

Notes:

[1] IT – WHO's interim targets

xx **Current AQOs adopted**

ANNEX B

AQOs Compliance Status in 2017

Station		Long-term				Short-term							
		PM_{10}	$PM_{2.5}$	NO_2	Pb	O_3	NO_2	PM_{10}	$PM_{2.5}$	SO_2		CO	
		1-year			1-year	8-hr	1-hr	24-hr	24-hr	10-min	24-hr	1-hr	8-hr
General Station	Central/ Western	✓(35)	✓(23)	✓(40)	✓	✓	✓	✓	✓	✓	✓	--	--
	Eastern	✓(33)	✓(20)	×(42)	✓	✓	✓	✓	✓	✓	✓	--	--
	Kwun Tong	✓(39)	✓(23)	×(44)	✓	✓	✓	✓	✓	✓	✓	--	--
	Sham Shui Po	✓(33)	✓(21)	×(54)	✓	✓	✓	✓	✓	✓	✓	--	--
	Kwai Chung	✓(35)	✓(23)	×(57)	✓	✓	×	✓	✓	✓	✓	--	--
	Tsuen Wan	✓(33)	✓(22)	×(52)	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Tseung Kwan O	✓(31)	✓(18)	✓(28)	✓	×	✓	✓	✓	✓	✓	✓	✓
	Yuen Long	✓(40)	✓(22)	×(41)	✓	×	✓	✓	✓	✓	✓	✓	✓
	Tuen Mun	✓(43)	✓(27)	×(46)	✓	×	✓	✓	✓	✓	✓	✓	✓
	Tung Chung	✓(34)	✓(21)	✓(36)	✓	×	✓	✓	✓	✓	✓	✓	✓
	Tai Po	✓(32)	✓(22)	✓(39)	✓	×	✓	✓	✓	✓	✓	--	--
	Sha Tin	✓(31)	✓(21)	✓(34)	✓	×	✓	✓	✓	✓	✓	--	--
	Tap Mun	✓(35)	✓(20)	✓(10)	✓	×	✓	✓	✓	✓	✓	✓	✓
Roadside Station	Causeway Bay	✓(46)	✓(31)	×(97)	✓	✓	×	✓	✓	✓	✓	✓	✓
	Central	✓(33)	✓(21)	×(80)	✓	✓	×	✓	✓	✓	✓	✓	✓
	Mong Kok	✓(38)	✓(27)	×(81)	✓	✓	×	✓	✓	✓	✓	✓	✓

Notes:

Unit of concentration : $\mu g/m^3$

"✓" Complied with the AQO

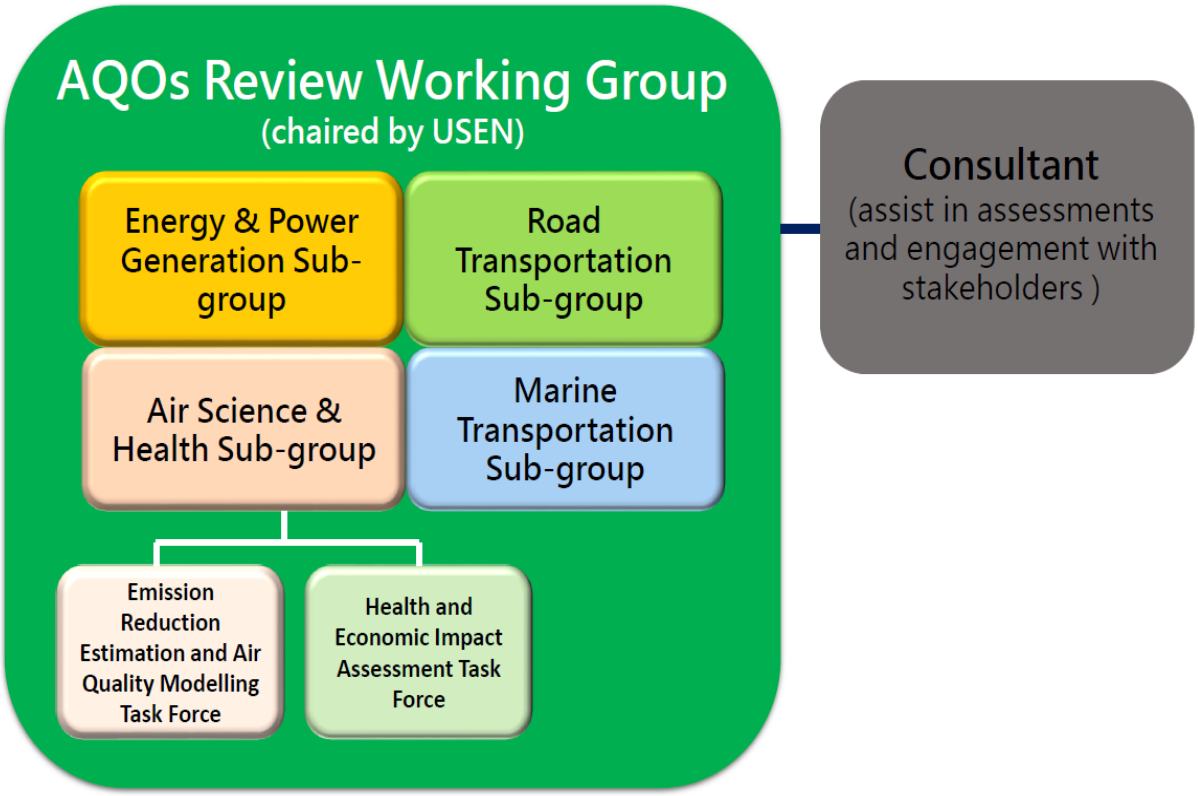
"×" Not in compliance with the AQO

"--" Not measured

**Figures in brackets are concentration levels of three key air pollutants (RSP/PM_{10}, $RSP/PM_{2.5}$ and NO_2).*

ANNEX C

Management Structure of the AQOs Review



ANNEX D-1

Terms of Reference and Membership of the Working Group

Terms of Reference

1. To engage relevant stakeholders including air scientists, health experts, academics, professionals, green groups, community leaders and the business sector to enable thorough deliberations on key aspects of the AQO review including air science and health as well as potential air quality improvement measures on power and energy sector, road and marine transportation, etc.; and

2. To report findings of the Working Group to Secretary for the Environment for his consideration in the review of AQO.

Membership

Chairperson :	Under Secretary for the Environment
Vice-chairperson :	Deputy Director of Environmental Protection (3)
Members :	All members of the Sub-groups

ANNEX D-2

Terms of Reference and Membership of the Energy and Power Generation Sub-group

Terms of Reference

1. To identify new practicable air quality improvement measures for energy and power generation;

2. To evaluate the feasibility of implementing the measures having regard to the availability of proven technology, time for implementation, economic and social implications and other relevant factors; and

3. To prioritize the new air quality improvement measures based on the practicability of implementation.

Membership

Chairperson :	Under Secretary for the Environment
Vice-chairperson :	Deputy Director of Environmental Protection
Members :	Dr. CHAN Ka Lung
	Ir Cary CHAN
	Mrs. Christine CHEUNG*
	Professor Larry CHOW
	Ir FONG Wai Man, Edmond
	Mr. Prentice KOO
	Mr. LAW Ka Chun, Joseph
	Mr. Brandon LIU
	Ms. Susanna NG
	Professor SO Wai Man, Raymond, B.B.S, J.P.
	Ir YEE Tak Chow
	Dr. William YU
	Representatives from Development Bureau**
	Representatives from Environment Bureau
	Representatives from Electrical and Mechanical Services Department
	Representatives from Environmental Protection Department
	Representatives from Planning Department**

Note:

* Resigned from the Working Group in February 2017

**To attend on a need-basis

ANNEX D-3

Terms of Reference and Membership of the Marine Transportation Sub-group

Terms of Reference

1. To identify new practicable air quality improvement measures for marine transportation;

2. To evaluate the feasibility of implementing the measures having regard to the availability of proven technology, time for implementation, economic and social implications and other relevant factors; and

3. To prioritize the recommended air quality improvement measures based on the practicability of implementation.

Membership

Chairperson :	Under Secretary for the Environment
Vice-chairperson :	Deputy Director of Environmental Protection
Members :	Mr. Arthur BOWRING
	Mr. Jeff BENT
	Mr. CHIANG Sui Ki
	Ms. Jessie CHUNG
	Mr. Ellis CHUNG
	Mr. FUNG Pak Sing
	Mr. HO Lap Kee, Sunny, J.P.
	Mr. KEUNG Siu Fai
	Mr. David KONG Cheuk Lum
	Mr. KWOK Tak Kee
	Mr. LIU Jian Hua, John
	Ms. Sandy MAK
	Mr. NG Ka Wing, Simon
	Mr. Tony TONG
	Mr. WONG Yui Cheong, David
	Mr. Danny WU
	Representatives from Transport and Housing Bureau
	Representatives from Environmental Protection Department
	Representatives from Marine Department

ANNEX D-4

Terms of Reference and Membership of the Road Transportation Sub-group

Terms of Reference

1. To identify new practicable air quality improvement measures for road transportation;
2. To evaluate the feasibility of implementing the measures having regard to the availability of proven technology, time for implementation, economic and social implications and other relevant factors; and
3. To prioritize the new air quality improvement measures based on the practicability of implementation.

Membership

Chairperson :	Under Secretary for the Environment
Vice-chairperson :	Deputy Director of Environmental Protection
Members :	Mr. Evan AUYANG
	Mr. CHAING Stanley Tandon Lal
	Hon. CHAN Choi Hi, M.H.
	Ms. CHEUNG Kit Yi, Suzanne
	Ir FUNG Man Keung
	Mr. FUNG Kin Wai, Patrick
	Ir Dr. HO Chi Shing, David, J.P.
	Dr. HUNG Wing Tat
	Hon. KWAN Sau Ling
	Mr. LEE Chak Cheong, Roger
	Dr. LEE Yiu Pui, Ringo
	Mr. Paul LI
	Mr. LING Chi Keung
	Mr. NG Hoi Shan, Aaron
	Mr. Daniel NG
	Mr. SO Sai Hung
	Mr. TANG Wing Hong, Madison
	Mr. TUNG Ching Leung
	Mr. WONG Leung Pak, Matthew
	Representatives from Development Bureau
	Representatives from Transport and Housing Bureau
	Representatives from Civil Engineering and Development Department
	Representatives from Environmental Protection Department
	Representatives from Planning Department
	Representatives from Transport Department

ANNEX D-5

Terms of Reference and Membership of the Air Science and Health Sub-group

Terms of Reference

1. To review the latest development on air quality standards and the health effects of air pollution;

2. To advise on the methodologies on air science and health assessments, including emission estimation, air quality assessment and projection, cost benefit analysis of air quality improvement measures and health impact assessment; and

3. To advise on the assessment of air quality improvements and health benefits under different control scenarios.

Membership

Chairperson :	Under Secretary for the Environment
Vice-chairperson :	Deputy Director of Environmental Protection
Members :	Professor Peter BRIMBLECOMBE
	Professor FUNG Chi Hung, Jimmy*
	Dr. LAM Yun Fat, Nicky
	Professor LAU Kai Hon, Alexis
	Mr. LEE Tak Kong, Alfred, M.H.
	Dr. LEUNG Chung Chuen, Roland
	Ir LO Pak Cheong
	Mr. LOONG Tsz Wai
	Dr. MAK Hoi Cheung, Eunice
	Dr. MAN Chi Sum, J.P.
	Dr. NING Zhi
	Dr. SO Kit Ying, Loletta
	Professor TIAN Lin Wei
	Professor WANG Tao
	Professor WONG Tze Wai*
	Dr. YIM Hung Lam, Steve
	Representatives from Development Bureau
	Representatives from Civil Engineering and Development Department
	Representatives from Department of Health
	Representatives from Environmental Protection Department
	Representatives from Planning Department

Note:

* Resigned from the Working Group in December 2016 and joined the consulting team to undertake the AQO Review consultancy study.

ANNEX E-1

List of Possible New Air Quality Improvement Measures and their Practicability of Implementation - Energy and Power Generation

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
A. Building energy efficiency measures		
A1. Encourage stakeholders in the commercial sector and the non-government sector, e.g. universities and hospital to adopt demand-side management (DSM) measures*	Short-term	The Government has established dialogue platforms with relevant stakeholders in the built environment to discuss ways to promote green buildings and to explore energy saving targets and measures. So far the results have been encouraging. The measure has been implemented and is on-going. *[Update: The Government has taken forward this measure under the Energy Saving Plan for Hong Kong's Built Environment 2015～2025+ which sets a target of reducing Hong Kong's energy intensity by 40% by 2025 using 2005 as the base. Achieving this target requires actions by the whole community. To this end, the Government has established a dialogue platform with relevant stakeholders in the built environment under the "4Ts" framework (namely target, timeline, transparency and together) to discuss ways to promote green buildings and to explore energy saving targets and measures. Under the post-2018 Scheme of Control Agreements (SCAs) which was signed on 25 April 2017, power companies will be incentivised to introduce relevant programmes.]*
A2. Explore building energy efficiency measures for old existing buildings which are not covered by the Buildings Energy Efficiency Ordinance*	Short-term	Ditto.
A3. Encourage major electricity users to reduce peak	Short-term (See Update)	The pursuit of this proposed measure would hinge on whether Advanced Metering Infrastructure (AMI, or smart meters) technologies could be successfully introduced into Hong Kong, and that will be subject to the outcome of the pilot scheme as well as AMI development proposal from the two power companies and the

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
load demand so as to reduce the operation and emissions from coal-fired generating units for coping with peak load demand		Government's assessment of the feasibility and tariff implication of the proposal. As the development of AMI technologies in Hong Kong is still at initial stage, the Government and the power companies would have to carry out more in-depth studies and tests on its application in Hong Kong. *[Update: In the light of the approval of the power companies' 2019-2023 Development Plans by the Government in July 2018, the power companies will replace their electromechanical meters by smart meters in seven years to support the energy efficiency & conservation initiatives (including reducing peak load demand) under the post-2018 Scheme of Control Agreements. Hence, this measure which was originally regarded as a long term measure when deliberated in the Energy and Power Generation Sub-group is now brought forward as a short-term measure.]*
B. Use of renewable energy		
B1. Encourage or provide incentives for the private sector to develop distributed renewable energy (RE)*	Short-term	The Government will continue to create the conditions to promote the development of distributed RE by the private sector, such as establishing Feed-in Tariff (FiT) and RE certificate systems. Work on the proposed measure has commenced and is on-going. *[Update: The two power companies introduced their FiT Schemes in October 2018 and January 2019 respectively to provide incentives for individuals and organisations to encourage them to invest in RE. The power companies also introduced the RE Certificates Scheme in January 2019. Individuals and organisations can show their support for RE through purchasing RE Certificates.]*
B2. Facilitate distributed RE systems to connect to the power grid*	Short-term	The Government will continue to explore new measures to facilitate the connection of distributed RE to the power grid, such as exploring the introduction of FiT and RE certificates. Work on the proposed measure has commenced and is on-going. *[Update: The two power companies introduced their FiT Schemes in October 2018 and January 2019 respectively to provide incentives for individuals and organisations to encourage them to invest in RE. The power companies also introduced the RE Certificates Scheme in January 2019. Individuals and organisations can show their support for RE through purchasing RE Certificates.]*
B3. Encourage the development of more	Short-term	The Government is already on a committed path to turn our waste into renewable energy. With regard to the waste-to-energy (WtE) projects already completed and being planned, it is estimated that the share of RE from waste will make up about 1% of total electricity demand by 2024. To further meet Hong Kong's long term

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
waste-to-energy facilities, such as waste incinerators, organic resources recovery centres, etc. for waste disposal as well as recovering energy for local use*		needs for proper handling of solid waste, the Government has commenced a study for planning of future waste management and transfer facilities up to 2041. One of the major objectives of the study was to identify whether Hong Kong would need additional WtE facilities to meet our future waste management needs. Work on the proposed measure has commenced and is on-going.
B4. Increase the use of wind and solar energy in electricity generation*	Short-term	The Government is committed to applying RE in wider and larger scale in the immediate years ahead based on mature and commercially available technologies, including wind, solar and WtE. It has to be pointed out that the consumers will need to pay a higher electricity tariff as a result of increasing the share of RE in our electricity generation. Work on the proposed measure has commenced and is on-going.
C. Fuel mix for electricity generation		
C1. Replacement of coal-fired generating units by gas-fired units*	Short-term	The Government has already announced that to meet the new carbon intensity reduction target of 65% to 70% by 2030, Hong Kong will continue to phase down the remaining coal plants as they reach their normal retirement life in the next decade and replace them with natural gas and non-fossil fuel sources. The measure has progressively been implemented.
C2. Consider importing more nuclear electricity from the Mainland	Others	Given the diverse views on the use of nuclear power received during the 2014 public consultation on future fuel mix for electricity generation, the present arrangement of maintaining the current nuclear import at around 25% of our fuel mix in 2020 has already struck a balance among different opinion. The future fuel mix plan (including the share of nuclear electricity) would be worked out having regard to, for instance, environmental performance, public acceptance, tariff impact and future electricity demand.
D. Operation of power generation plant		
D1. Upgrade burners of gas-fired generating units to improve fuel efficiency and emission	Short-term	The Government has been working with the power companies to explore potential upgrading of existing gas-fired generating units with a view to enhancing fuel efficiency and emission performance. The measure has been implemented and is on-going.

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
performance*		
D2. Review operations of gas-fired power generating units with a view to identifying further emission reduction potential	Short-term	Power companies have been required to maximise the operation of their existing gas-fired generating units to meet the emission caps as stipulated in the Technical Memorandum as well as other environmental targets. Given the technical and operational constraints, there is limited scope to further increase the operation of gas-fired units so as to reduce emission from power plants.
E. New solar energy technology		
E1. Explore the idea of "SolarRoad" for promoting the use of solar energy	Others	The measure is considered not practicable to be implemented within the time horizon of this AQO review given the immaturity of the solar road technology and the technical constraints for its application in congested environment like Hong Kong.
F. Use of biomass as fuel		
F1. Explore the use of waste materials such as corncobs, waste wooden pallets (i.e. biomass) as fuel*	Short-term	Other than the biomass potential of municipal solid waste (MSW), there is a limited supply of other biomass in Hong Kong. The Government has covered in its major waste management work plans a number of WtE facilities including sludge treatment facilities (STF), integrated waste management facilities (IWMF) Phase I, and a network of organic waste treatment facilities (OWTF) to capture the biomass energy from our MSW and transform them to electricity. With regard to the WtE projects already completed and being planned, it was estimated that the electricity generated from these WtE facilities will make up about 1% of total electricity demand by the early 2024. The measure has been implemented and on-going.
G. Energy storage		
G1. Explore the feasibility of using electric vehicles (EV) as electrical energy storage for power grid	Others	The proposed measure is considered not practicable to be implemented within the time horizon of this AQO review given that the vehicle-to-grid (V2G) technology is only at experimental stage and that a number of technical issues remain to be overcome, e.g. impact EV's battery service life due to frequent charging and discharging. Also, the relatively small number of EVs in Hong Kong may not be sufficient for the implementation of the V2G technology.

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
G2. Explore the use of old EV batteries as an electrical energy storage system for the power grid	Long-term	It is considered that the proposed measure is unlikely to become practicable within the time horizon of this AQO review given that the technology of using retired EV batteries for grid storage is still at experimental stage. Nevertheless, when the technology is developed and there are more EVs and retired batteries in Hong Kong, the proposed electrical energy storage system might be applicable to the power plants. It is thus advisable for the Government and power companies to keep watching of the development and consider conducting trials when opportunity arises.

Remark: * These are the short-term measures that have quantifiable emission reduction results.

ANNEX E-2

List of Possible New Air Quality Improvement Measures and their Practicability of Implementation - Marine Transportation

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
A. Use of Clean Fuel		
A1. Explore the use of Liquefied Natural Gas (LNG) for marine vessels	Long-term	The issue of having LNG bunkering capability in Hong Kong is more than an air quality issue. While its availability could facilitate the use of LNG as marine fuel here, particularly for local vessels and regional river trade vessels, having that capability is also tied-in with Hong Kong's port longer-term competitiveness at a time when the Mainland is developing LNG vessels. While the need for LNG bunkering facilities in Hong Kong is not imminent, the trade nevertheless shares the view that using LNG in marine application is an international trend and if LNG bunkering facilities are available in Hong Kong, more LNG vessels including container vessels and cruise ships might be used in the Pear River Delta (PRD) region. It is thus advisable for the Government to sort out the technical requirements and associated safety regulations for using LNG in marine vessels to prepare for a wider use of LNG vessels. Besides, the Government should also watch closely the relevant developments for planning ahead the development of LNG bunkering facilities in Hong Kong. The availability of the necessary expertise in the use of LNG and its bunkering, as well as the possibility of sharing the LNG bunkering facility by different sectors, e.g. LNG supply for power plants and marine vessels, are also relevant. In addition, as the ports in the PRD region are developing LNG bunkering, the Government should explore potential collaboration with the PRD region.
A2. Explore the use of biofuel (e.g. B5), fuel cell, Liquefied Petroleum Gas (LPG), compressed natural gas (CNG), methanol, nuclear and renewable energy, etc. for marine vessels	Long-term	The use of fuel cell, LPG, methanol, nuclear and renewable energy as marine fuel are subject to a number of technical constraints and commercial considerations, making these fuels not ready to be used in merchant shipping. Biofuel and CNG might be technically viable on local vessels, while their uses are still subject to the availability of the necessary fuel bunkering facilities and supply chain network to secure stable supply of the fuels. Since the international trend in the development of clean marine fuel does not focus on developing these alternative fuels for a wide use in merchant shipping, they are considered not commercially viable as marine fuel in Hong Kong in the foreseeable future. The

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
		Government should keep a close watch on this development.
A3. Explore the use of hybrid, diesel electric and electric vessels	Long-term	Owing to the maturity of the technology, relatively low retrofit/installation cost and little operation constraint, diesel-electric vessels are well accepted by the marine trade. To fully exploit the benefits of a diesel-electric propulsion system, the vessel must have distinct operation regimes that require different power inputs. For example, it serves cruise ships well because of its high power loading for hotel services. There are very few local data on the performance of hybrid-electric systems on local vessels. The ferry that has been retrofitted with a diesel-electric power system under the Pilot Green Transport Fund started its trial in end of 2016. It will provide us such local trial data. Nevertheless, it is rather unlikely that distinct operation regimes with different power demands represent the mainstream operation patterns of local vessels. For hybrid and electric vessels, there are a few successful applications overseas. Nevertheless, their use is subject to high investment cost and a number of operational constraints such as the need to accommodate large and heavy battery pack onboard, restriction to short-haul and low-speed travel and the need of onshore power supply to charge up the electric vessels. Large-scale commercialization of diesel-electric, hybrid and electric vessels in local vessel operations is not anticipated in the short term. Nevertheless, local vessel operators are suggested to make application to the Pilot Green Transport Fund for subsidies to test out these technologies in their vessels. The Government should keep close monitoring of the technology development in adopting these technologies in local marine application.
A4. Ocean-going vessels (OGVs) at berth to use marine diesel with lower fuel sulphur content, e.g. not exceeding 0.1%*	Short-term	Mandating OGVs at berth to use marine diesel with fuel sulphur content not exceeding 0.1% is technically feasible in the short-term if sufficient supply of 0.1% sulphur marine diesel in Asia could be ascertained. The shipping trade would be further consulted on the availability of the compliant fuel in Asia. However, a more important issue is the additional operating cost on OGV operators due to the use of the more expensive lower sulphur diesel, which would have adverse implications for our port competitiveness. To minimize these implications, the proposed initiative should tie in with the implementation plans in other competing neighbouring ports, particularly those in the PRD region. The Government should watch closely the development of the PRD Domestic Emission Control

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
		Area (DECA), in particular the review on whether to further tighten the fuel sulphur limit to 0.1% by end 2019. Starting from January 2019, vessels within the PRD DECA are required to use low sulphur marine fuel (sulphur content not exceeding 0.5%) and the Ministry of Transport also plans to determine whether to further tighten the fuel sulphur limit in the PRD DECA to 0.1% by end 2019. The Government would proceed to ascertain the availability of the 0.1% sulphur fuel in Asia and assess the implications to the trade with a view to introducing the new measure as soon as practicable. *[Update: A DECA will be set up in the PRD region requiring vessels to use low sulphur fuel (sulphur content not exceeding 0.5%). In Hong Kong, the Air Pollution Control (Fuel for Vessels) Regulation mandates vessels plying Hong Kong wat*er to use low sulphur marine fuel (sulphur content not exceeding 0.5%) from 1 January 2019. *Regulating fuel sulphur content should be pursued on a regional basis to avoid jeopardizing the competitiveness of local ports. The Government will closely monitor developments.]*
A5. Local vessels to use electricity from the power grid while at berth*	Short-term	The primary objective of this proposed initiative is to provide electricity from the power grid to local vessels to satisfy their electricity demand during berthing at non-operational period or maintenance. Some of the local vessel operators have indeed been getting electricity from the dockside for the electrical appliance onboard. The operators of local vessels generally welcome the setting up of fixed electricity supply installations at ferry terminals by the power companies to supply electricity to local vessels at berth, so as to minimise the need to run the auxiliary engines or generators, hence saving fuel cost and reducing the need of maintenance. In current practice, the operators of local vessels can approach the power companies for the setting up of power supply installations at the piers for their use, provided that the conditions such as space, safety and operation requirements could be satisfied by the power companies and the relevant authorities. The measure has already been adopted by some local vessel operators.
A6. River trade vessels to use on-shore power supply (OPS) while at berth at terminals	Others	Container terminals in Kwai Tsing and the river trade terminal in Tuen Mun, where river trade vessels are berthed, are privately run. The pursuit of this initiative would hinge on whether OPS would become a major trend warranting investment from the terminal operators. However, both the container terminal and the RTV operators considered that the proposed initiative would impose operational constraints on their operations. In addition, the terminals do not have sufficient space for setting up the required infrastructure

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
		and OPS facilities. The limited space at terminals and the mode of operation, viz quick mooring and turnaround at terminals for RTV, may make them impracticable to use OPS. The possible measure is considered not practicable.
A7a. Ocean-going vessels (OGVs) to use OPS while at berth at Cruise Terminal	Long-term	Majority of the ports with OPS for cruise ships are located in the North America and Northern Europe, hence the number of OPS-ready cruise ships to the Asia Pacific is not expected to increase significantly in the near future. Nevertheless, some cities in the PRD region are developing their cruise terminals. They are planning to set up there OPS facilities and intend to provide substantial financial subsidies on electricity charges to encourage the use of OPS in cruise ships. Given the development, cruise companies might consider deploying their OPS-ready cruise ships to the PRD region. The electricity demand for cruise vessels during berthing is high and their berthing time could last for 12 hours or more. The use of OPS could minimize their emissions, thereby reducing their impacts to neighbouring areas. The Government should continue to keep close monitoring of the development so that timely action could be taken to pursue the use of OPS for cruise ships.
A7b. OGVs to use OPS while at berth at container terminals	Others	The container terminals in Kwai Tsing are privately run. The pursuit of this initiative would hinge on whether OPS would become a major trend warranting investment from container terminal operators. Without a unified standard for OPS, power supply of OPS station might not necessarily be compatible with OGV's shipboard electrical system. In addition, container terminals do not have sufficient space to accommodate the required OPS infrastructure and facilities. These constraints are insurmountable, given the space constraint. The measure is therefore considered impracticable.
B. Technical Measures		
B1. Impose emission standards on outboard engines of local vessels	Medium-term	It is technically feasible for small local vessels including sampans and pleasure crafts to use low-emission 2-stroke and 4-stroke petrol outboard engines to reduce their emissions. These petrol-fueled outboard engines covering a wide range of horsepower outputs and complying with the 2-star or 3-star ratings of the California Air Resources Board (CARB) emission standards are readily available in Hong Kong from the major suppliers or official dealers. Nevertheless, a detailed consultation with the shipping trade is required to ascertain its implementation. The Government would thoroughly consult the relevant trade to address its concerns before pursuing this possible measure.

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
B2. Install emission reduction device (e.g. particulate filters) to reduce particulate matters (PM) emitted from local vessels	Others	The proposed measure on local vessels is subject to a number of technical constraints and additional cost implications, including the lack of applicable experience in merchant shipping, increase in exhaust back pressure and fuel consumption, insufficient space for the retrofit, additional investment and fuel costs, etc. With these constraints, the scope for applying the proposed measure on local vessels is very limited. Nevertheless, interested local vessel operators may make use of the Pilot Green Transport Fund (PGTF) to conduct trials of retrofitting diesel particulate filters (DPF) on their marine engines to check on technical feasibility and performance in reducing PM emissions from their vessels. The scope for application of the proposed measure is very limited.
B3. Impose control on nitrogen oxides (NOx) emissions from engines of local vessels	Others	The use of these NOx reduction technologies on local vessels are subject to a number of technical uncertainties, constraints and additional cost implications. Hence, the scope for its application on local vessels is very limited. Nevertheless, interested local vessel operators may make use of the PGTF to conduct trials of testing out NOx reduction technologies to check the technical feasibility and emission reduction performance at their vessels. Given the constraints, the scope for applying the proposed measure on local vessels are very limited.
C. Fuel economy, energy efficiency and port management		
C1. Explore financial incentive and disincentive schemes to encourage liners to use less polluting OGVs calling Hong Kong ports	Medium-term	Given the uncertain economic outlook ahead and the possibility to jeopardize Hong Kong's port competitiveness, the shipping trade would prefer the provision of financial incentive schemes over disincentive schemes. Nonetheless, as OGVs calling Hong Kong may visit other ports in the PRD region, the implementation of financial incentive schemes to encourage OGVs operators to deploy green vessels would only be effective if it is pursued in collaboration with other ports. The trade suggests that the Government maintain dialogue with OGV operators and other stakeholders on the best strategy to pursue the initiative on a regional basis.
C2. Optimise port efficiency to shorten waiting and turnaround time of OGVs and river trade vessels at container terminals, river trade terminals and public cargo working areas (PCWA)	Others	Measures to optimize port efficiency have been extensively discussed in the Hong Kong Maritime and Port Board (HKMPB), which is an appropriate platform for focused and effective discussions between the different sectors of the maritime and port industries. The Government would keep in view the discussions in the HKMPB, and would take on board the outcome of the discussions to study the associated emission reduction potential.

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
C3. Slow-steaming of OGVs in Hong Kong waters	Others	Owing to the busy marine traffic and navigational safety considerations, the scope to further extend the existing speed restricted areas or to lower their speed limits for OGVs would be limited. Establishing a new speed restricted area in the eastern Hong Kong waters in Mirs Bay would not be effective in emission reduction as the OGVs to and from Yantian would be travelling at reduced speeds of 7 – 10 knots in Mirs Bay after the proposed pilot boarding stations are established in the area by 2017. For the southeastern Hong Kong waters where OGVs travel at a higher speed of about 15 – 20 knots for a short duration, the Marine Department and the marine trade have reservation on the practicability of establishing speed restricted area as it would be constrained by various factors including marine safety concern due to reduced maneuverability of large vessels at low speed and impact to ship engines, difficulty of enforcing speed limit for transiting OGVs, and the relatively short duration in transiting the southeastern Hong Kong waters. The scope for establishing speed restricted area in the southeastern Hong Kong waters is not practicable.
C4. Encourage academia to carry out studies on fuel and energy efficient measures in terms of operation and maintenance for local vessels; and collaboration between academia and local marine trade for the development of best practice guidelines and award system to facilitate adoption of the measures	Long-term	Funding is currently available to support academic studies and trials related to fuel and energy efficient measures on local vessels. However, there is little collaboration between the academia and the local marine trade in initiating studies on the fuel and energy efficient measures for their wider adoption. The Government should explore opportunities to facilitate long-term collaboration between the local marine trade and academia in pursuing this measure.
D. Other suggestions		
D1. Remove floating rubbish for smooth operation of small local vessels	Others	Not related to air quality improvement and not further discussed in the Sub-group.
D2. Government to expedite the approval process of new local vessels		Not related to air quality improvement and not further discussed in the Sub-group.

Remark: * These are the short-term measures that have quantifiable emission reduction results.

ANNEX E-3

List of Possible New Air Quality Improvement Measures and their Practicability of Implementation - Road Transportation

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
A. Tunnel toll policy and toll collection method		
A1. Review the tunnel toll policy and level to alleviate traffic congestion, thereby reducing the emission caused by congestion at the tunnels	Short-term	The Government has been adopting a multi-pronged approach in tackling road traffic congestion. Toll adjustment is one of the measures to achieve traffic diversion. The Transport and Housing Bureau (THB) had commissioned a consultancy study on the overall strategy and feasible options for the rationalisation of traffic distribution among the three road harbour crossings (RHCs) and the three land tunnels connecting the New Territories and Kowloon. The Government will submit toll adjustment proposals covering the six tunnels to the Panel on Transport of Legislative Council for discussion in the 2017-18 legislative year. *[Update: The Government announced a toll adjustment proposal for the rationalisation of traffic among the three RHCs in October 2018 and consulted the Legislative Council Panel on Transport on 16 November 2018.]*
A2. Consider replacing the existing toll collection system with completely automatic systems	Others	THB believed the reason for traffic congestion was due to the saturation of traffic capacity at the RHCs and there was no direct relation between traffic congestion and the toll collection systems. *[Update: The Transport Department (TD) plans to issue in-vehicle units to vehicle owners from Q3 2020 for toll payment by the free-flow tolling system (FFTS) at Tseung Kwan O – Lam Tin Tunnel (TKO-LTT) upon its commissioning in late 2021. TD also plans to subsequently roll out FFTS at all other government tolled-tunnels and roads by phases, with an indicated timeframe for completion within two to three years after the commissioning of TKO-LTT.]*

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
B. Maintenance and repair of vehicle exhaust system		
B1. Propose to use chassis dynamometer for testing vehicle tailpipe emissions	Others	The programmes targeting excessive emission problems of diesel commercial vehicles (DCVs) and the poor maintenance problem of the petrol and LPG vehicles have reduced considerably the number of their gross emitters. Gross emitters now account for only a small part of the DCVs, the petrol and LPG vehicle fleet. Furthermore, the reduction in gross emitters has also resulted in discernible roadside air quality improvement in respect of particulate and NO_2 levels. As such, it would be difficult to seek sufficient support from the community to make passing the dynamometer test mandatory for vehicles undertaking roadworthiness examination, particularly when taking such a test could cause a significant increase in vehicle examination fee and time. Instead, EPD should consider taking action focusing on gross emitters should it be warranted. The measure is considered cost-ineffective and unjustified.
B2. Tighten the annual vehicle examination for private cars from over six years old to over three years old (or consider adopting vehicle kilometres travelled as the vehicle examination criterion)	Others	Private cars are not the key source of air pollution at the roadside. Based on the data collected from the remote sensing scheme, private cars found with excessive emissions represent less than 1% of the scanned vehicles and the average age of these high-emitting private cars is around 13 years. Furthermore, private cars aged 4 to 6 years are usually still in good shape as most components are still under warranty from the manufacturers. Therefore, the current requirement for annual vehicle examination for private cars (i.e. from over six years old) is appropriate and adequate. There are no strong justifications to tighten the annual vehicle examination for private cars from over six years old to over three years old. Nevertheless, the Government will continue to promote the importance of vehicle maintenance and repair.
B3. Provide vehicle tailpipe emission testing equipment for rent by small and medium-sized vehicle repair workshops	Others	Vehicle tailpipe emission testing equipment affordable by the trade, such as portable five-gas analyzer and smokemeter are common tools in vehicle repair workshop. Dynamometer emission test service for diesel vehicles is also available in the market if a vehicle repair workshop needs such service to assist its emission diagnosis and repair. It is noted that some vehicle mechanics are now offering specialist diagnostic services for vehicles of advanced engine design. These services can better help the trade than providing rental of equipment. EPD will continue to work with Vocational Training Council (VTC), repair trade and vehicle manufacturers in organizing seminars and workshops to help the vehicle repair trade meet the advancement of vehicle technologies and cope with the aging workforce and shortage of skilled technicians.

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
B4. Establish a maintenance information database of vehicle tailpipe emission system	Short-term	When Euro VI vehicle emission standards are introduced, vehicle manufacturers will have to provide access to vehicle maintenance information for new vehicle models at reasonable fees. Besides, EPD will upkeep the cooperation with the VTC, repair trade and vehicle manufacturers in organizing training and workshops for the vehicle repair trade to share experience/information on vehicle maintenance, which the vehicle repair trade considers useful.
B5. Raise awareness on the importance of vehicle maintenance and repair	Short-term	The Government will keep up the effort on promoting the importance of vehicle maintenance and repair so that the vehicle repair trade and vehicle owners could understand the benefits of proper vehicle maintenance for reducing vehicle emissions.
C. Fostering a "pedestrian-friendly" and bicycle-friendly" environment		
C1a. Foster "pedestrian-friendly" environment (such as widening of footpaths, construction of covered walkways and enhancing the pedestrian connections) to encourage people to walk *in existing new towns and urban areas*	Short to medium-term	The Sub-group acknowledged the Government's work on this front (e.g. implementing various pedestrianisation schemes ranging from full-time pedestrian precinct zones to footpath-widening works, providing covers on certain public pedestrian walkways connecting to public transport facilities, developing elevated walkway systems and hillside escalator and elevator systems, etc.), and has offered some suggestions. The Government will continue to promote walkability to reduce the need of the public using mechanised transport mode for short distance commuting.
C1b. Foster "pedestrian-friendly" environment (such as widening of footpaths, construction of covered walkways and enhancing the pedestrian connections) to encourage people to walk *in new towns and new development areas (NDAs)*	Long-term	The proposed measures are in fact part of the Smart City initiatives being pursued in the new towns and NDAs. Generally, there should not be insurmountable problems rendering the provision of pedestrian connectivity not technical feasible. Nonetheless, technical feasibility and environmental impact have to be investigated in detail at planning and detailed design stage for NDAs.
C2a. Foster "bicycle-friendly" environment and study into the provision of ancillary facilities for cycling (such as provision of	Short to medium-term	The Sub-group noted the Government's work on this front, and has offered some suggestions. The Government will continue to foster "bicycle-friendly" environment in existing new towns.

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
cycling track network and bicycle parking spaces, park-and-ride facilities at public transport interchanges and bike-friendly policies to facilitate carriage of bicycles on public transport) *in existing new towns and urban areas*		As regards urban areas, the traffic is generally very heavy, with narrow and crowded roads. On-street loading and unloading activities are frequent, with many vehicles passing by and needing to stop temporarily. Owing to road safety considerations, the Government does not encourage the public to use bicycles as a mode of transport in urban areas. *[Update: There are no plans to provide bicycle park-and-ride facilities at public transport interchanges. Cycling for commuting purposes in urban areas is not encouraged on road safety grounds.]*
C2b. Foster "bicycle-friendly" environment and study into the provision of ancillary facilities for cycling (such as provision of cycling track network and bicycle parking spaces, park-and-ride facilities at public transport interchanges and bike-friendly policies to facilitate carriage of bicycles on public transport) *in new towns and NDAs*	Long-term	This measure is in fact part of the Smart City initiatives being pursued in NDAs. Generally, there should not be insurmountable problems rendering the provision of cycle tracks not technically feasible. Nonetheless, technical feasibility and environmental impact have to be investigated in detail at planning and detailed design stage. *[Update: There are no plans to provide bicycle park-and-ride facilities at public transport interchanges. Cycling for commuting purposes in urban areas is not encouraged on road safety grounds.]*
C3. Set up cycling and walking shared space at harbourfront areas	Long-term	Referencing to the successful overseas examples for shared use of space between pedestrians and cyclists along the harbourfront areas, the concept should be carefully looked into in the Hong Kong context. At the planning and detailed design stages, technical feasibility and environmental impact would have to be conducted, as well as a study into possible implications to the Protection of Harbour Ordinance. Besides, there is road safety concern for the shared use of space by cyclists and pedestrians because of their different speeds (pedestrian around 4 km/h, cyclists on average 20 to 30 km/h) and maneuvering modes. The feasibility of this measure is subjected to further studies.
C4. Establish lower vehicle speed limits zones (e.g. 30km/h)	Others	This measure has been assessed together with "Foster "pedestrian-friendly" environment" (Measure C1) as it carries the same spirit.

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
in community roads, school zone and areas with elderly centres, to foster pedestrian environment		*[Update: TD has tentatively selected some areas in Sham Shui Po and Central for testing of low speed zones. The objectives are to enhance road safety for all and in particular for pedestrians, as well as to improve pedestrian environment. TD is studying details of the trial including the extent of the test sites with a view to commencing the trial by end 2019.]*
D. Promotion of low-emission transport mode		
D1. Tram or electric bus interchange schemes at busy road sections (e.g. Nathan Road) to replace the franchised bus services so as to reduce the number of buses and boarding/alighting passengers on the road section	Others	The Government's long-term policy is to have zero emission buses running across the territory. Therefore, the Government is subsidizing the franchised bus companies to trial single-deck electric buses. Due to the technical constraints of the current single-deck electric buses available in the market, electric buses are not able to fully support franchised bus operation and therefore could not replace most of the existing franchised buses at this stage. Furthermore, franchised bus companies and passengers will not welcome the proposal on tram or electric bus interchange schemes. The bus route rationalisation and bus-bus interchange (BBI) concessionary schemes implemented by franchised bus companies in recent years have already achieved the effect of alleviating traffic congestion and roadside emissions in busy road sections. The Government will continue to closely monitor the development of electric vehicles. The Government will also support the installation of ancillary facilities and at the same time encourage scientific research and development so as to facilitate the introduction on our local market electric bus models that meet local operational requirements. The Government will consider including the promotion of electric buses as one of the considerations when formulating relevant policies, and will not rule out the provision of economic incentives for promoting the development of electric buses. It is not yet practicable to replace bus services on busy corridors with trams or electric buses due to inadequate road space and given that the feasibility of adopting electric buses on a wide scale in Hong Kong is yet to be proven. The Transport Department (TD) will continue to work with bus operators to pursue bus route rationalisation and encourage them to offer more BBI concessionary schemes with a view to alleviating traffic congestion and roadside emissions in busy road sections.
D2. Electric vehicles pilot schemes - switching the existing vehicle fleet of selected routes to electric vehicles (EVs)	Long-term	Replacing conventional buses/minibuses with electric ones can help improve the roadside air quality. The Government's ultimate policy objective is to have zero emission buses running across the territory. The ongoing trials for 36 electric buses could help assess their operational performance under local conditions to ascertain whether there are suitable

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
		models on the market that meet local operational requirements. The Government will encourage the franchised bus companies to try out double-deck electric buses when suitable ones are available on the market. The Government will continue to encourage the minibus operators to try out green and innovative transport technologies through the PGTF. The Government will closely monitor the technological development of EVs and the EV market, and will review the strategy of promoting EVs accordingly The Sub-group recommended that the Government should take more proactive and positive measures to support the installation of ancillary facilities, while at the same time look into an approach to actively promote the use of electric buses so as to facilitate the introduction in our local market suitable electric bus models that meet local operational requirements. The Sub-group suggested that the Government should establish a task-force with bus operators to identify suitable EVs and relevant ancillary facilities for conducting trials with a hope to replace the current franchised buses.
D3. Promotion of hybrid private cars	Others	Although the technology of hybrid car is mature and hybrid cars have lower fuel consumption than conventional cars, they still have tailpipe emissions. On the other hand, the technology of electric vehicle has become mature and that electric vehicles have no tailpipe emissions and are more energy efficient than hybrid cars. The Government's priority is to promote the use of electric vehicles instead of hybrid cars. To promote the use of EVs in Hong Kong, a Steering Committee on the Promotion of Electric Vehicles chaired by the Financial Secretary was set up in 2009 to provide steer on the strategy and measures for the promotion of EVs. Among various measures, the Government has been waiving the first registration tax concession on EVs since 1994 and will continue the waiver until 31 March 2017. The Government is also expanding the public charging network for EVs and provide technical support to those who are interested in setting up charging facilities for EVs. With the advances in the technology of electric vehicles which have no tailpipe emissions, it is considered more beneficial to promote the use of electric vehicles instead of hybrid cars in terms of air quality benefits. *[Update: concession on first registration tax for electric private car will continue until 31 March 2021. The Government will review the concessions before the expiry date.]*

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
D4. Exploring the use of new-energy vehicles	Others	Natural gas (NG) or hydrogen vehicles are not viable in Hong Kong as it is not practicable to find enough suitable locations for setting up NG/hydrogen filling stations and their storage facilities due to our high development density as well as the explosive nature of NG/hydrogen. The Government will continue to keep in view the development of new energy vehicles in the market.
E. Utilisation of intelligent transport systems (ITS)		
E1. Launch one-stop mobile app for the public to choose the most time-saving, economical and low-emission transportation mode	Short-term	The "Hong Kong eTransport" mobile application currently provides transport mode and route search function based on journey time and fare. It is possible to include the environmentally-friendly transport mode information in "Hong Kong eTransport" through the provision of useful tips. While this may not bring about substantial improvement to roadside air quality, it helps increase the public awareness and understanding of the low-emission transport modes. EPD will work closely with TD in this regard. *[Update: The TD launched an all-in-one mobile application "HKeMobility" in July 2018 which integrated three mobile applications of TD, namely "Hong Kong eTransport", "Hong Kong eRouting" and "eTraffic News". The public can acquire real-time traffic and transport information and plan their journeys through "HKeMobility" anytime and anywhere.]*
E2. Launch one-stop mobile app for the public to access real-time information on car parking vacancies which helps them choose the best parking location and shorten the driving distance	Short-term	TD has been encouraging operators of commercial public carparks to make better use of information technology to disseminate real-time parking vacancy information of their carparks. The Government has taken forward this measure by updating the "Hong Kong eRouting" smartphone application in 2016 to disseminate real-time parking vacancy information of about 50 car parks (including government car parks). TD will continue to encourage car park operators to provide and disseminate real-time parking vacancy data of their car parks. *[Update: The TD launched an all-in-one mobile application "HKeMobility" in July 2018 which integrated the mobile applications namely "Hong Kong eTransport", "Hong Kong eRouting" and "eTraffic News". As at end 2018, the public could access parking vacancy information of about 270 public car parks through "HKeMobility".]*
E3. Implement electronic road pricing (ERP) scheme to tackle	Long-term	The Sub-group in principle agreed that reaching a consensus within the community is crucial to successful implementation of the ERP Pilot Scheme. The Sub-group

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
road traffic congestion at busy roads		acknowledged that the Government would conduct an in-depth feasibility study to formulate detailed options for the next stage of public discussion. *[Update: The Government is conducting an in-depth feasibility study on the ERP Pilot Scheme in Central and its adjacent areas and will put forward specific proposals in the first half of 2019 for stakeholder consultation.]*
E4. Introduce ITS (e.g. manage traffic flow by traffic signal control, install smart sensors and surveillance cameras for illegal parking enforcement)	Short, medium, to long-term, depending on individual ITS measure	The Government has been applying diverse technologies to develop ITS under a three-pronged approach, *viz* dissemination of traffic information to the public, traffic control and supporting traffic enforcement. Regarding the further use of ITS, further studies will be required for specific measures. The practicability for implementation of different measures depends on the nature of the proposed use, e.g. extending the scope of existing ITS is comparatively more practicable than introducing measures that may need to reach consensus in the community. *[Update: To disseminate more real-time traffic information to members of the public, additional traffic detectors are being installed along strategic routes with a view to collecting more real-time traffic data such as traffic volume and speed, as well as enhancing transport efficiency. The installation of traffic detectors is implemented in two phases. The first phase commenced in June 2018 under which 45 traffic detectors were installed along North Lantau Highway in mid-December 2018. The tender assessment for the second phase is in progress, with the target date to commence works in March 2019.* *On traffic control, the TD is planning to introduce the pilot intelligent traffic signal system with sensors for pedestrians and vehicles at road junctions starting from 2021. By using sensors to detect real-time traffic volume, the allocation of green time for pedestrians and vehicles could be optimised, which could minimise unnecessary waiting time for both pedestrians and vehicles at signalised junctions, facilitate smooth traffic flow and enhance pedestrian movement.* *Regarding the suggestion of using surveillance cameras for illegal parking enforcement, the Government has been actively examining the application of new technologies to enhance enforcement efficiency and strengthen the deterrent effect. The Energising*

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
		Kowloon East Office of the Development Bureau has been collaborating with the Police since 2018 to conduct a Proof of Concept Trial on the "Kerbside Loading and Unloading Bay Monitoring System" in Kowloon East. Since November 2018, there has been another Proof of Concept Trial, which is about "Illegal Parking Monitoring System". *In addition, the Police are planning a separate trial by mounting cameras on selected lampposts that provide good vantage points and making use of video analytics technology for actual enforcement operation against certain traffic offences which more commonly cause traffic congestion, including illegal stopping of vehicles at a bus stop and stopping at a no-stopping restriction zone.* *Depending on the results of the aforesaid trials and taking into account such relevant factors as technical feasibility and cost-effectiveness, the Government will duly consider whether to apply such systems and technologies to facilitate the Police to combat illegal parking.]*
F. Land use and transport infrastructure planning		
F1. Through proper land use planning to redress the current imbalance in home-job distribution and bring jobs closer to home so as to reduce commuting time and private car usage	Long-term	The Sub-group agreed on this measure which would in the long term improve traffic and air quality, and provided some recommendations in this aspect.
F2. Use urban planning and design solutions together with transport management to improve air ventilation in high density development	Short-term	The Sub-group acknowledged the works to improve air ventilation in district and site levels by the Government, and provided some recommendations. The Government will continue to work on these to improve the air ventilation.
F3. Conduct comprehensive review on the development of road transportation infrastructure	Medium-term	The Sub-group noted the Transport and Land Use Assessment in respect of Hong Kong 2030+ is being conducted by the Government, and hoped the Government will promote strategic study on railways and highways after Hong Kong 2030+ has been completed.

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
and networks (such as construction of new tunnels and roads) to cope with population growth and to tackle road traffic congestion		*[Update: The Government is preparing to take forward strategic studies on railways and major roads beyond 2030 based on the results of Hong Kong 2030+ and its public engagement exercise with regard to the planning directions for Hong Kong beyond 2030.]*
F4. Provide low-emission transport mode to the residents of NDAs	Long-term	It should be feasible to construct a low-emission mode of transport in the development of new towns and NDAs. In fact, the Government has actively considered the suitable environmentally-friendly transport systems in projects such as Hung Shui Kiu and Kai Tak Developments.
F5. Enhance district-based publicity on bus route rationalisation*	Short-term	Bus route rationalisation can enhance the efficiency of bus network for more cost-effective usage of bus resources, and improve air quality. However, the bus route rationalisation will lead to inconvenience to some passengers, or changes to passengers" travelling pattern. The Government considers the extensive publicity should continue as it would benefit the consultation on bus routes rationalisation and the implementation of the proposals. TD pursues the rationalisation of bus routes on an ongoing basis. Suitable publicity to build up awareness of the benefits of bus route rationalisation to air quality will be arranged as appropriate to help canvass community's support during consultation of bus route rationalisation proposals and before their implementation.
G. Managing road space		
G1a. Manage the growth of vehicles in particular private cars *(note: G1a and G1b were originally one item. As they are in fact two ideas, they are now separated into two items)*	Short-term	On managing the growth of vehicles (in particular private cars), the Sub-group noted that the Government is taking forward progressively the recommendations of the Transport Advisory Committee in the Report on Study of Road Traffic Congestion in Hong Kong, including recommendations to contain the growth of private car fleet size through increasing the first registration tax (FRT) and annual licence fee for private cars and raising the "fuel levy" for diesel private cars. The Sub-group acknowledged that the implementation of both fiscal and non-fiscal measures to control private car growth needs the consensus and support of the community and Legislative Council as legislative amendments are required.
G1b. Raise the first registration tax and annual licence fees of more polluting vehicles *(note: G1a and G1b were*	Others	On control over highly polluting vehicles, the Government has been implementing a wide range of measures targeting high emitting vehicles, including programmes to phase out pre-Euro IV DCVs, limit the service life of newly registered DCVs, and inspection programs to identify highly emitting vehicles and request them to fix their problems and

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
originally one item. As they are in fact two ideas, they are now separated into two items)		undergo vehicle emission tests, etc. Therefore, vehicle owners and the transport trades would object to the introduction of additional measures to further raise the licence fees and FRT for high emission vehicles. Moreover, some members pointed out that it would be difficult to set the criteria for determining licence fees based on emission levels. Therefore, this measure to impose higher licence fee on more polluting vehicles is not practicable.
G2. Enhance enforcement against illegal parking	Short-term	The Sub-group acknowledged that the Police had been focusing on the problem of illegal parking as well as other traffic problems on a district level, and often conducted territory-wide enforcement programme to tackle illegal parking. The Sub-group considered that enhancing enforcement towards illegal parking could improve traffic congestion problem, hence improve roadside air quality. It also acknowledged professional drivers' suggestion to increase parking space, as well as their opposition to raise the level of parking fines. *[Update: In 2018, the Police issued approximately two million fixed penalty tickets against illegal parking, an increase of 9% as compared to the corresponding figure in 2017, which reflects the determination and effectiveness of the Police in combating illegal parking. The Police will continue to step up enforcement actions against offences causing obstruction to traffic, including illegal parking, in accordance with the Selected Traffic Enforcement Priorities.]*
G3. Review on-street metered parking fees	Short-term	The Sub-group in general agreed that the parking meter charges at present are very low, and there is room for increasing the charges to disincentivise drivers circulating on streets waiting for parking spaces, thereby worsening traffic congestion on some roads. However, the Sub-group acknowledged that this measure may induce increase of pricing in some private carparks. *[Update: The Government plans to introduce an amendment bill into the LegCo within 2019* *to increase the maximum fee chargeable for use of on-street metered parking spaces.]*
H. Other suggestions		
H1. Provide information on the energy efficiency, emission	Others	The Government stipulated the vehicle exhaust emission standards and the noise emission standards. All new vehicle models are required to comply with the relevant standards.

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
performance and noise level of vehicles, etc., to facilitate the public to make a more environmentally-friendly choice		There are discrepancies between laboratory measurement results and actual performance of the vehicles in everyday driving. The driving cycle used to measure energy efficiency also varies between countries, and hence data collected are not comparable. There are also no internationally agreed standards on vehicle fuel efficiency. EMSD will continue to keep in view developments in other countries on vehicle fuel efficiency standards and tests. Also, vehicle dealers have been providing fuel consumption figures of light duty vehicles (design weight not more than 3.5 tonnes) including private cars to potential purchasers upon request.
H2. Set out objectives/policies to support the use of cleaner vehicle fuels	Others	The Government has been implementing a comprehensive vehicle emission control programme to reduce the emissions from motor vehicles to improve roadside air quality. As for motor vehicle fuels, the Government's standing policy is to adopt the most stringent motor vehicle fuel standards when they become practicable for Hong Kong. The Government also encourages the transport trade to test out the practicality and performance of different green transport technologies through the PGTF. The Government will continue its multipronged approach in reducing tailpipe emissions from motor vehicles, and monitor relevant international developments so as to adopt the most stringent motor vehicle fuel standards and introduce cleaner fuels when they become practicable for Hong Kong.
H3. Extend the coverage areas of the existing low emission zones and their restriction to other vehicle types	Others	The Sub-group noted that the Government had been taking multipronged approach to improve roadside air quality. A number of effective measures have been put in place to reduce tailpipe emissions from the entire vehicle fleet. Such measures are more effective than extending the coverage of the low emission zones. The Government will continue the multipronged approach and consider the latest technological developments as well as the effectiveness of current measures when formulating policies for further improvement of roadside air quality.
H4. Address the personal and operational needs of heavy vehicle drivers, such as provision of parking space and arrangement of meal and rest breaks at the Kwai Chung Container Terminals area, so as to reduce air pollution arising	Medium-term	The Sub-group acknowledged the work by the Government on increasing commercial vehicle parking space, and recommended the Government to step up its efforts in this area with a view to providing more commercial parking space for long term / short term parking. [*Update: According to the available short-term tenancy (STT) parking reports, the utilisation rates of STT car parks ranged from 40% to 91%. While there was illegal parking at the Container Port Area, the problem was not significant relative to the available parking spaces at the STT car parks. Thus, the current overall parking spaces*

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
from idling engines		*in the Container Port Area are considered sufficient to meet the demand.*]
H5. Set up a continuous and effective priority road network for public vehicles	Others	Given the role of franchised buses as road-based mass carriers, TD had already set up 25 kilometres of bus-only lanes and 14 designated bus gates as at March 2017. Initial proposals for designating new bus-only lanes at various locations have also been put forward in the report of the Public Transport Strategy Study. TD will keep in view the need and feasibility of expanding the bus priority measures as appropriate. *[Update: Most of the new bus-only lanes proposed under the Public Transport Strategy Study are not supported by the local community during the local consultation and are unlikely to be implemented.]* The setting up of a priority road network for public vehicles may have huge adverse effect on the effectiveness of the entire road network. Not only that this measure may worsen traffic congestion, the congestion may also extend beyond the starting point of the priority road network, preventing public transport vehicles from entering the priority road network thus reducing the effectiveness of the measure. Moreover, the possible measure may affect the current loading/unloading and picking up/setting down activities, causing inconvenience to other road users. In fact, some public vehicles may even change lanes due to the blockage by buses ahead which are picking up or setting off passengers in the priority network. This would have significant impact on other road users and the feasibility of this possible measure is doubtful. This possible measure requires further detailed research.
H6. Review the policy on replacement of franchised buses	Others	Franchised bus companies have pledged to deploy buses under the age of 18 in providing franchised bus services under normal circumstances. All Euro I buses have already retired from services, while the EPD has been working with the franchised bus companies to retrofit Euro II and Euro III buses with selective catalytic reduction devices to reduce roadside emissions from these buses. On the other hand, further tightening of the maximum age limit of the franchised bus fleets might not be practicable as there could be substantial implications for the efficient operation of franchised bus services. The higher cost arising from more frequent replacement of vehicles would create pressure for fare increase which might eventually affect the basic fare level. In addition, it is not environmentally-friendly to replace franchised buses well before their design lifespan ends.
H7. Provide funding to support	Others	There is no strong justification to set up this funding proposal. Members of the public

Possible New Measures	Practicability of Implementation	Assessments of the Sub-group
District Councils for implementing air quality improvement projects		who would like to conduct innovative projects that can help improve air quality can apply for funding from existing resources such as the Environment and Conservation Fund.
H8. Raise public awareness on environmental protection, promote green living and encourage the public to use public transport systems as well as low emission transportation options	Short-term	The Government's long standing policy is to promote the use of public transport system as the main transport mode and to encourage the public to make use of the highly efficient mass transit transport systems and other public transport services. The Government also promotes walkability through the provision of pedestrian walkways and foster bicycle-friendly environment in new towns and NDAs through the provision of cycling lanes. The Sub-group considered that the general public might have little understanding of the positive impact of using green transport modes including walking and cycling on air quality. Members suggested that the Government should proactively provide information on pedestrian walkway systems and cycling network via social platforms commonly used by the public or the Government's existing mobile applications (e.g., pedestrian walkways and footbridges from Wanchai to Sheung Wan, etc.) to help the public recognise that they could commute over a short distance comfortably through walking on pedestrian walkways, thereby changing their behaviour - to use public transport more, walk more and drive less to ease traffic congestion and hence improve roadside air quality. This is an on-going measure. The Government will make efforts to promote walking and cycling, and the use of public transport services.

Remark: * These are the short-term measures that have quantifiable emission reduction results.

ANNEX F

List of Possible New Air Quality Improvement Measures and their Practicability of Implementation - Other Emission Sources

Possible New Measures	Practicability of Implementation	Deliberations at the Focus Groups
VOC-containing products		
1. Review the feasibility to impose VOC limits on consumer products that are not regulated under the Air Pollution Control (Volatile Organic Compounds) Regulation[19]*	Short-term	Some non-regulated consumer products whose VOC contents comply with the CARB standards are available in the local market. For some others, reformulation or changing the source of import can be the possible means to achieve compliance, while the commercial feasibility would be subject to the additional costs involved, which, if significant, may possibly result in the cease of import of certain consumer products to Hong Kong by the suppliers. A thorough consultation with the trade is necessary to identify the categories of consumer products that are technically and commercially feasible to be regulated. Nevertheless, some major local suppliers considered that 2025 is a reasonable timeframe for the implementation of this measure.
2. Review the feasibility to further tighten the VOC limits on regulated architectural paints*	Short-term	Low-VOC or VOC-free architectural paints are becoming dominant on the global market. Some architectural paints in water-based format are already available in the local market and could give comparable performance as the conventional solvent-based paints, though additional cost may incur. A preliminary engagement with the local suppliers of architectural paints revealed that they generally support the tightening of VOC limits for some architectural paints. It is suggested that the trade be consulted thoroughly on the implementation details for pursuing the measure.
Non-road mobile machinery (NRMM)		
3. Explore the feasibility to further tighten the emission standards on regulated	Medium-term	Although this measure is technically feasible and it is the international trend to progressively tighten the emission standards on NRMM, considerations on the availability of large variety of compliant machines supplied from different overseas markets, the

[19] The VOC Regulation sets limits on the VOC contents of 51 types of architectural paints/coatings, 7 types of printing inks and 6 broad categories of consumer products (air fresheners, hairsprays, multi-purpose lubricants, floor wax strippers, insecticides and insect repellents) in phases starting from 1 April 2007, and was amended in October 2009 to extend the control in phases starting from 1 January 2010 to other high VOC-containing products, namely 14 types of vehicle refinishing paints/coatings, 36 types of vessel and pleasure craft paints/coatings, and 47 types of adhesives and sealants.

Possible New Measures	Practicability of Implementation	Deliberations at the Focus Groups
machines newly supplied to Hong Kong		additional cost implications to the relevant local trade and their acceptance need to be carefully evaluated and addressed before this possible measure could be pursued.
4. Explore the feasibility to further tighten the emission standards on non-road vehicles newly supplied to Hong Kong*	Short-term	For tightening the statutory emission standards on newly supplied non-road vehicles in Hong Kong, driven by the fact that the emission standards for certain newly registered road vehicles in Hong Kong was tightened to Euro VI in phase starting from 1 July 2017, the trade considered this initiative to be practicable.
5. Explore the feasibility of retrofitting exempted regulated machines and non-road vehicles to improve their emission performance	Others	There are not many countries having conducted a large scale retrofit programme on non-road machines. The trade has concerns on the technical feasibility of retrofitting existing NRMM with emission reduction device. Besides, significant cost implications are anticipated owing to the large number of exempted regulated machines / non-road vehicles in Hong Kong as well as the high costs of installation, operation and maintenance of the retrofitting. The trade considered that retrofitting existing NRMM with emission reduction device was not practicable.
Cooking fume emissions		
6. Explore the feasibility of using new types of air pollution control equipment	Medium-term	There are multiple matured high-efficiency technologies / equipment which can supplement the currently widespread metal filters or electrostatic precipitators. Some of these technologies, such as the activated carbon filters, wool fiber filters and the ultraviolet (UV)-ozone system, are considered less space occupying, relatively less complicated in technology while still maintaining a high-efficiency in the removal of cooking fume emitted from the restaurants. Thus, the aforementioned equipment can be considered more feasible to install in the Hong Kong restaurants. On the other hand, there are other certain equipment and technologies, which owing to the requirements of installation spaces or the technological complexity, are considered being more difficult to introduce into most of the Hong Kong restaurants. Subsequent to the discussions of various types of new air pollution control equipment (APCE) among the stakeholders, it is considered that electrostatic precipitators coupled with hydrovent is a mature, practicable and effective means to reduce cooking fume emissions. It would be more feasible for the Administration to collaborate with the trade to explore the practicability of using new APCE in reducing cooking fume emissions.
7. Promote "low-emission" cooking (e.g. use of clean and	Medium-term	In general, the promotion of changing the method of cooking could be considered as a feasible way to reduce the emission from cooking fumes since adopting a more healthy

Possible New Measures	Practicability of Implementation	Deliberations at the Focus Groups
efficient cooking stoves and healthy cooking style, etc.)		way of cooking may potentially both achieving the goal of reducing cooking fume emissions, and meet the public's expectation in maintaining a more healthy diet. Promotion of adopting low-saturated-fatty acid cooking oil might also be desirable. Furthermore, the change of fuel type from gas-fueled to electrical cooking stoves would also aided in reducing the emission. However, due to the nature of cuisine styles in Hong Kong, the promotion of replacing of stoves in commercial restaurants might meet certain resistance. During the engagement with the stakeholders, they were generally supportive to promote the "low emission" cooking method in the longer run.
Civil aviation		
8. Review on aviation emission control in the local context	Others	Taking into account the adoption of the International Civil Aviation Organisation (ICAO) aircraft engine emission standards and the measures implemented or considered by the Civil Aviation Department (CAD), Airport Authority Hong Kong (AAHK) and airline operators, it is considered that reducing aircraft emissions requires the concerted effort from the global aviation industry and there is limited room for further aviation emission reduction measures in the local context under the scope of the current AQOs Review. (Note: For measures to reduce emissions from ground service equipment in the airport, they were assessed under "NRMM".)

Remark: * These are the short-term measures that have quantifiable emission reduction results.

ANNEX G

Predicted Air Quality in 2025

Respirable Suspended Particulates (RSP/PM_{10})

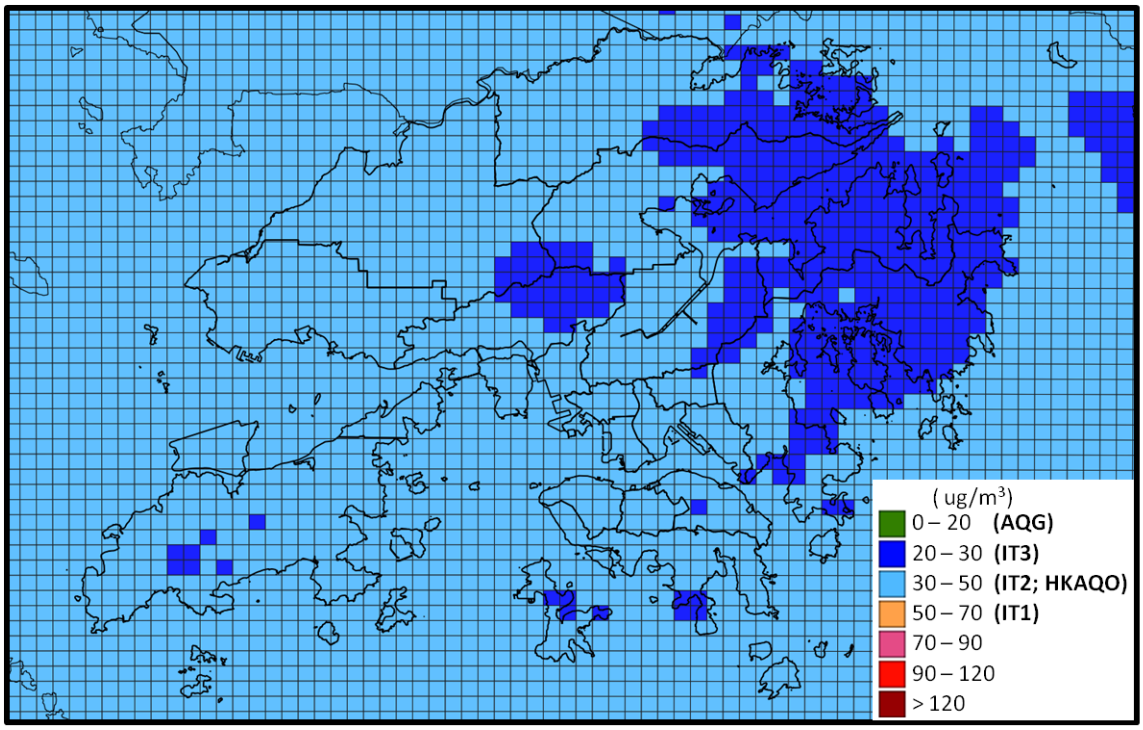


Figure 1 – Annual averaged RSP/PM_{10} concentration in 2025

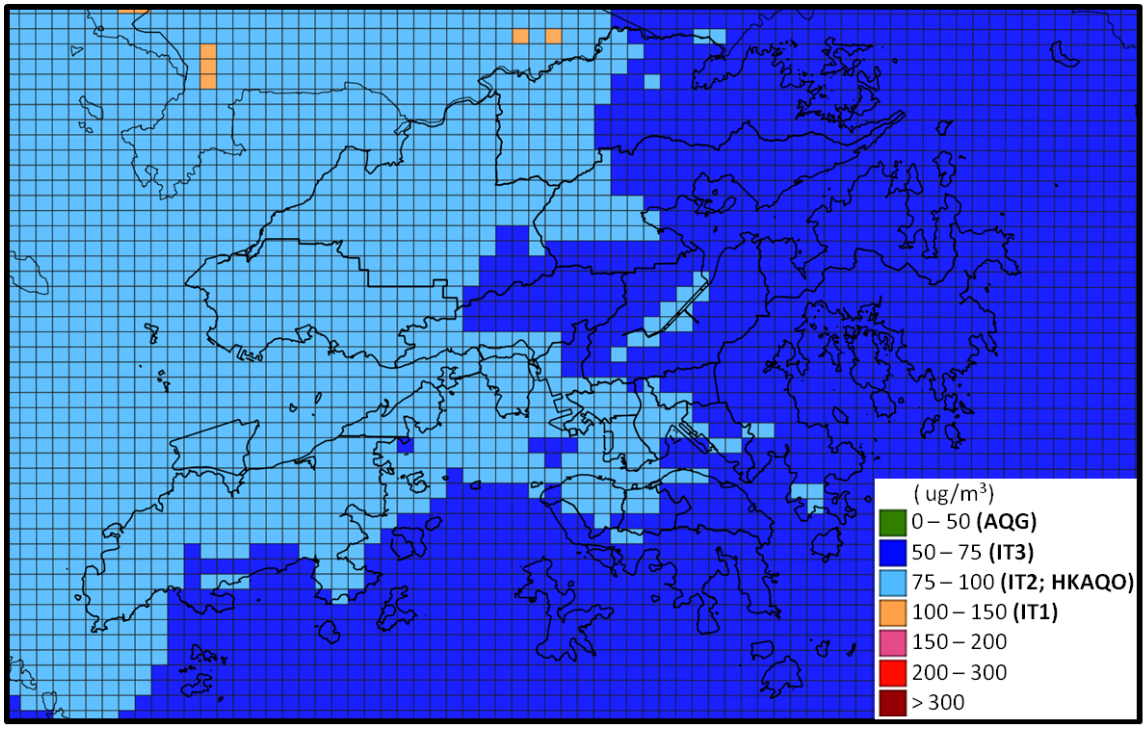


Figure 2 – 10th highest daily RSP/PM_{10} concentration in 2025

Fine Suspended Particulates (FSP/$PM_{2.5}$)

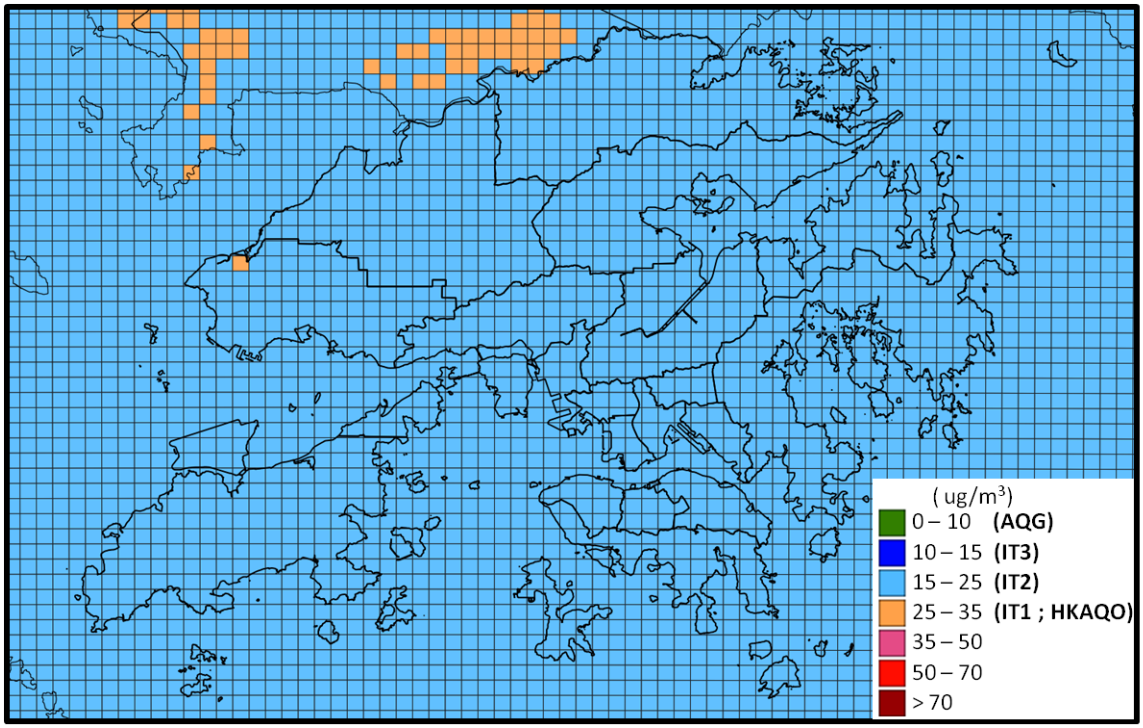


Figure 3 – Annual averaged FSP/$PM_{2.5}$ concentration in 2025

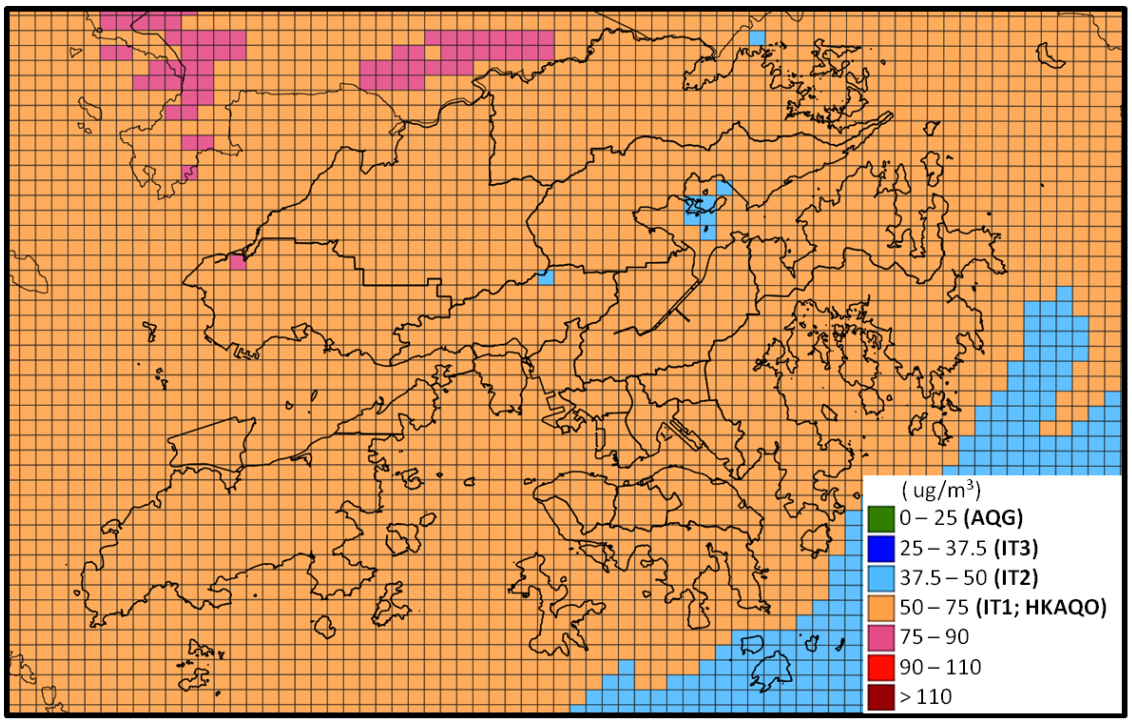


Figure 4 – 10th highest daily FSP/$PM_{2.5}$ concentration in 2025

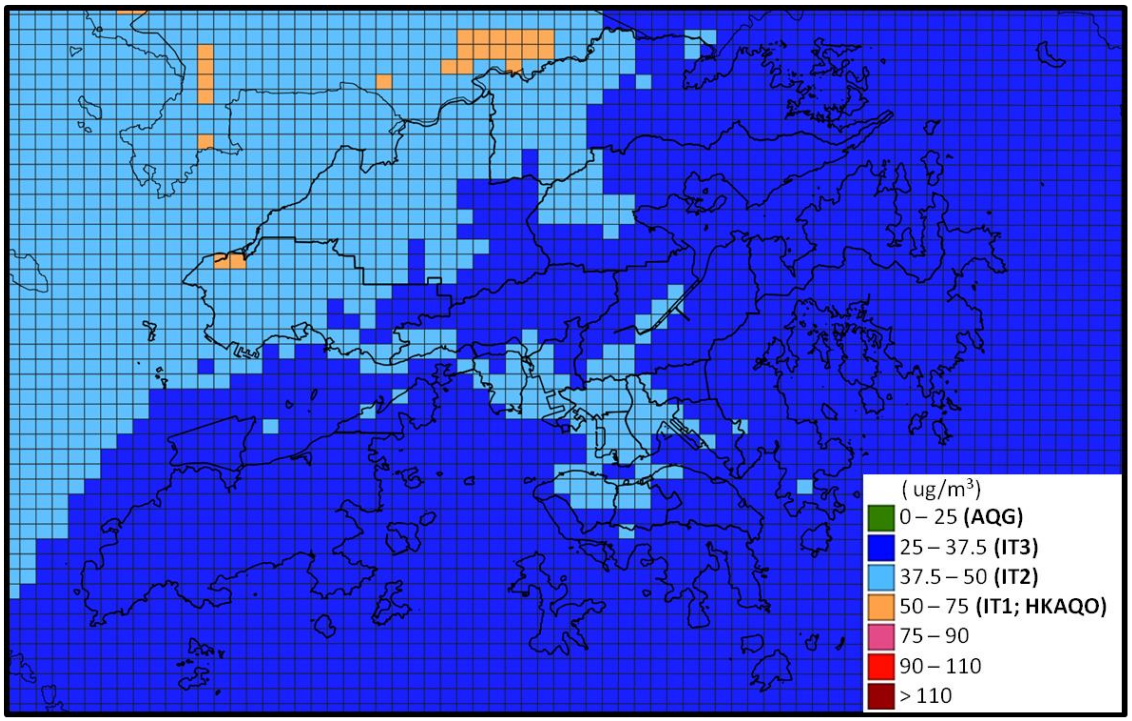


Figure 5 – 36th highest daily FSP/$PM_{2.5}$ concentration in 2025

Nitrogen Dioxide (NO_2)

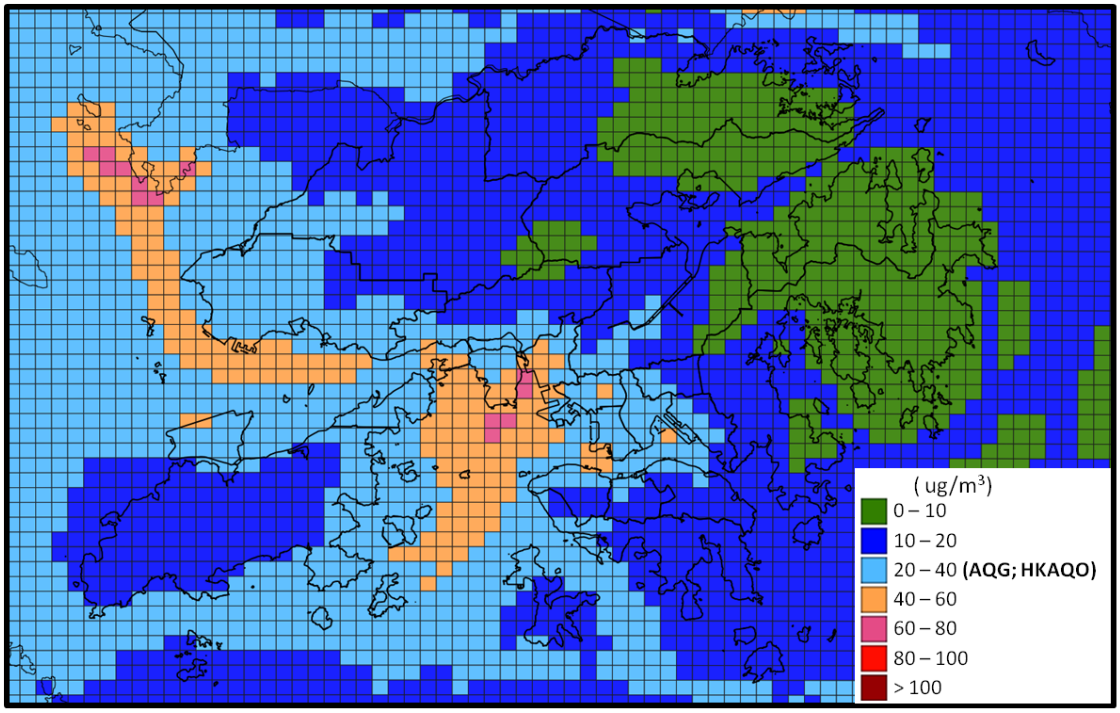


Figure 6 – Annual averaged NO_2 concentration in 2025

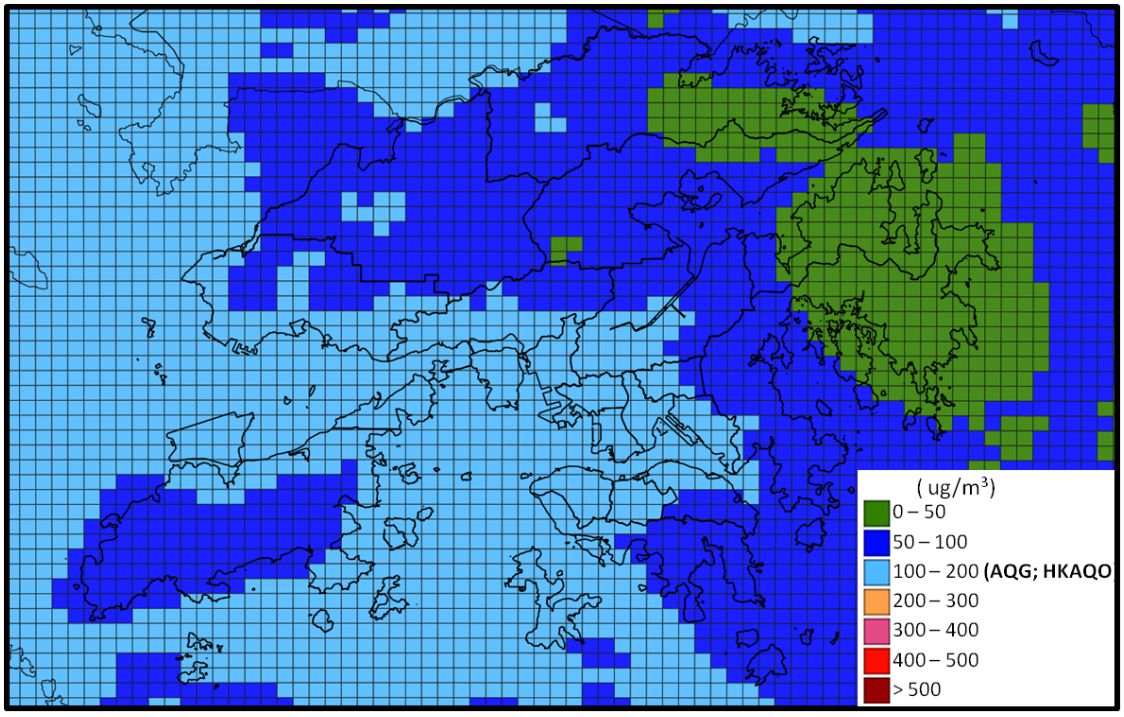


Figure 7 – 19th highest hourly NO_2 concentration in 2025

Sulphur Dioxide (SO_2)

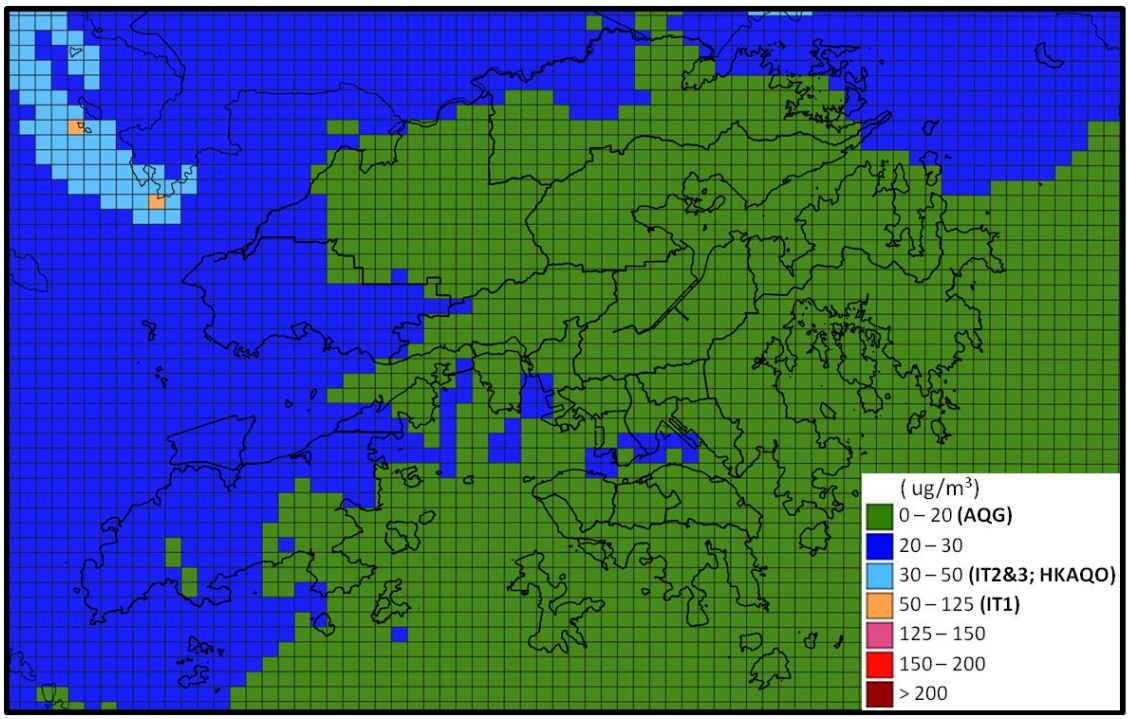


Figure 8 – 4th highest daily SO_2 concentration in 2025

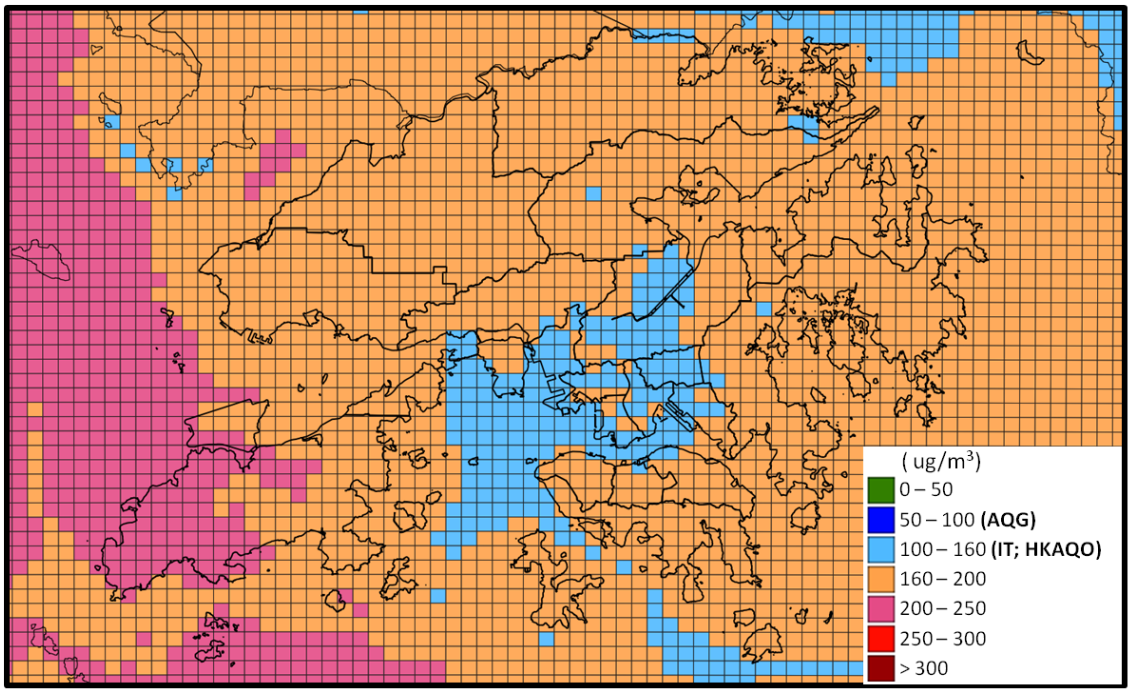


Figure 9 – 10th highest daily maximum 8-hour O_3 concentration in 2025

ANNEX H

Relative Risks of Health Outcomes and Formula to estimate the change in health outcome attributable to changes in air pollution level

A) Relative Risks of short-term and long-term exposures of air pollutants

Health Outcomes		Relative Risks per 10μg/m^3 (95% Confidence Interval)			
		FSP/$PM_{2.5}$ (Daily mean)	**NO_2 (Daily Mean)**	**O_3 (Daily 8-hr maximum)**	**SO_2 [1] (Daily mean)**
Short-term Health Outcomes (Morbidities)					
Emergency hospital admissions	Cardiovascular diseases (all ages)	1.0066 [2] (1.0036 - 1.0097)	1.0100 [3] (1.0073 - 1.0126)	NA	1.0098 [3] (1.0057 - 1.0139)
	Respiratory diseases (all ages)	1.0097 [4] (1.0065 - 1.0129)	1.0075 [3] (1.0050 - 1.0100)	1.0081 [3] (1.0058 - 1.0104)	NA
	COPD [5]	1.031 (1.026 - 1.036)	1.026 (1.022 - 1.031)	1.034 (1.030 - 1.040)	
	Asthma [6]	1.021 (1.015 - 1.028)	1.028 (1.021 - 1.034)	1.034 (1.029 - 1.039)	
New episodes of URTI	GP visits [7]	1.021 (1.010 - 1.032)	1.030 (1.020 - 1.040)	1.025 (1.012 - 1.038)	
	GOPC visits [8]	1.005 (1.002 - 1.009)	1.010 (1.006 - 1.013)	1.009 (1.006 - 1.012)	
Mortality		1.004097 [9] (1.001806-1.006394)	1.0103 [3] (1.0069-1.0137)	1. 0034 [3] (1.0002-1.0066)	1.0091 [3] (1.0040 -1.0142)
Long-term Health Outcome					
Mortality		1.062 [10] (1.040 - 1.083)	1.039 [11] (1.022 - 1.056)	NA	NA

Notes:
COPD = Chronic Obstructive Pulmonary Disease
GOPC = General Outpatient Clinic
GP = General Practitioner
URTI = Upper Respiratory Tract Infections
NA = Health outcome not assessed as the Relative Risk for the respective air pollutant is either statistically not significant or available.

1. Although the health outcome is comparatively less significant than other air pollutants, as some of the possible new air quality improvement measures would have emission reduction potential on SO_2, the Relative Risks for SO_2 is provided for reference.
2. Qiu et al, 2013. Differential Effects of Fine and Coarse Particles on Daily Emergency Cardiac Hospitalizations in Hong Kong. Atmospheric Environment *64* 296-302; and personal communications with Dr. H. Qiu. The RR was presented for each interquartile increase in $PM_{2.5}$ in the published paper. Dr. Qiu was requested to provide the RR for each 10 μg/m^3 increase in $PM_{2.5}$ concentration, i.e. 1.0066 as quoted above.
3. Wong et al., 2010. Part 4. Interaction between Air Pollution and Respiratory Viruses: Time Series Study of Daily Mortality and Hospital Admissions in Hong Kong. In: Public Health and Air Pollution in Asia (PAPA): Coordinated Studies of Short-Term Exposure to Air Pollution and Daily Mortality in Four Cities. HEI Research Report 154, Health Effects Institute, Boston, MA.
4. RR for respiratory diseases is obtained through the personal communications with Dr. H. Qiu.

The excess risk of mortality reported in PAPA Study (Wong et al, 2010) with PM_{10} were 0.63% and 0.69% (equivalent to RRs of 1.0063 and 1.0069) and were somewhat lower than the RR for $PM_{2.5}$, as the effect of PM_{10} on health is smaller than that of $PM_{2.5}$.

5. Ko et al., 2007a. Temporal relationship between air pollutants and hospital admissions for Chronic Obstructive Pulmonary Disease in Hong Kong. Thorax *62* 779-784.
6. Ko et al., 2007b. Effects of air pollution on asthma hospitalization rates in different age groups in Hong Kong. Clinical and Experimental Allergy *37* 1312-1319.
7. Wong et al., 2006. Association between Air Pollution and General Practitioner Visits for Respiratory Diseases in Hong Kong. Thorax *61* 585-591.
8. Tam et al., 2014. Association between air pollution and general outpatient clinic consultations for upper respiratory tract infection in Hong Kong. PLOS ONE 9(1) e86913, 1-6. (Note: In Tam's study, only RR for PM_{10} was available. This is used as a proxy of RR for $PM_{2.5}$ in this study. In general, RR for PM_{10} is slightly lower in magnitude than that for $PM_{2.5}$.)
9. Tam, (2016), unpublished data. RR of all-cause, cardiovascular and respiratory mortality from Prof. W. Tam based on time series of PM2.5 on all-cause mortality between 2001 and 2010.
10. Hoek el al., 2013. Long-term air pollution exposure and cardio-respiratory mortality: a review. Environmental Health *12* 43.
11. WHO, 2013. Health risks of air pollution in Europe – HRAPIE project. Recommendations for concentration-response functions for cost-benefit analysis of particulate matter, ozone and nitrogen dioxide. Copenhagen: WHO Regional Office for Europe. (Note: the overlapping effect on PM has been considered. The original RR is 1.055 (1.031 – 1.080) per 10μg/m^3).

B) The health impact arising from a change in air pollution is estimated by the following formula:

Attributable health outcomes = Baseline health outcome data x AF

where "AF" is the attributable fraction, RR is the relative risk estimated by the formulae below:

Equation 1: $\mathrm{AF} = (\mathrm{RR} - 1)/\mathrm{RR}$

Equation 2: $\mathrm{RR} = \mathrm{e}^{\frac{\ln(\mathrm{RR\ per\ 10\ \mu g/m^3})}{10} * (x-y)}$ *where "x" is referred to air pollutant concentration at a specific year (in μg/m^3), and "y" as counterfactual target/desired level is referred to the WHO AQG (in μg/m^3)*

ANNEX I

Health Benefits Attributable to the Changes in Air Quality Level Between 2015 (Base Year) and 2025 (Target Year)

Health Outcomes		Air Pollutants				Max. Short-term Impact / Total Mortality[a]
		FSP/$PM_{2.5}$	**NO_2**	**O_3**	**SO_2**	
Short term health outcome: Reductions in number of hospital admissions and clinic visits						
Emergency hospital admissions saved	Cardiovascular diseases	92	704	NA	25	1,528
	Respiratory diseases	213	*824*	-25 [c]	NA	
	COPD [b]	158	686	-27 [c]		--
	Asthma	72	470	-17 [c]		--
Clinic visits saved (for new episodes of URTI)	GOPC visits	858	8,226	-293 [c]		262,577
	GP visits	104,895	254,351	-7,921 [c]		
Long term health outcome: Reductions in number of premature deaths						
Mortality (Short-term exposure, all ages)		28	350	-3 [c]	12	*d*
Mortality (Long-term, aged 30 and above)		865	983	NA	NA	1,848

Notes:
COPD = Chronic Obstructive Pulmonary Disease
GOPC = General Outpatient Clinic
GP = General Practitioner
URTI = Upper Respiratory Tract Infections
NA = Health outcome not assessed as the Relative Risk for the respective air pollutant is either statistically not significant or available.

a. To avoid double-counting of health effects, short-term impacts of different air pollutants are not added up. Instead, the maximum value among the air pollutants is taken.
b. COPD, influenza and pneumonia are examples of respiratory diseases. Asthma is a sub-class of COPD. While separate quantification was performed for COPD and asthma (both belong to the class of respiratory diseases), influenza and pneumonia could not be assessed due to the lack of reliable local concentration-response functions.
c. The negative (-) sign indicates the air pollutant exerts negative impact.
d. Short-term premature death is covered in the long-term premature death.

ANNEX J

Economic Benefits of the Health Benefits Attributable to the Changes in Air Quality Level Between 2015 (Base Year) and 2025 (Target Year)

Table 1: Economic benefits due to savings in hospital admissions, clinic visits and associated productivity loss in 2025 compared with 2015

Air Pollutants	Economic Costs Saved (HK$)			
	Hospital Admissions [a]	Clinic Visits [b]	Productivity Loss [c]	Total [d]
$PM_{2.5}$	5,510,850	26,605,560	*59,785,600*	91,902,010
NO_2	28,848,240	67,248,320	*150,004,400*	**246,100,960**
SO_2	540,750	NA	*56,000*	596,750
O_3	-413,250 [e]	-2,110,635 [e]	*-4,641,840* [e]	-7,165,725 [e]

Notes:

a. The cost of hospital admissions relates to Accidents and Emergency (A&E) attendance due to cardiovascular and respiratory diseases and cost of hospital beds.

b. The cost of clinic visits includes doctor consultation of both public and private practitioners due to new episodes of upper respiratory tract infections (URTIs).

c. The productivity loss due to hospital admission and clinic visit is estimated based on the median length of hospital stay (four days for cardiovascular illnesses and three days for respiratory illnesses) and a sick leave of one day granted by the attending doctor. The productivity loss is only a broad-brush estimate for reference only given that different estimation methods (e.g. different lengths of hospital stay, different lengths of sick leave) may yield quite different results.

d. To avoid double-counting of economic benefits, short-term impacts of different air pollutants are not added up, the maximum cost benefits among the air pollutants (i.e. NO_2) is taken as representative figures, which marked in **bold**.

e. The negative (-) sign means there could be additional costs incurred.

Table 2: Economic benefits due to avoided premature deaths in 2025 compared with 2015

Air Pollutants	Economic Costs Saved (HK$) [a]	
	Long-term premature deaths expressed in VOSL [b]	Total [c]
$PM_{2.5}$	15,659,273,600	**33,454,725,500**
NO_2	17,795,451,900	

Notes:

a. Figures are rounded to the nearest hundred.

b. The "VOSL" approach refers to the amount of money a person (or society) is willing to spend to save a life. It is derived from the trade-offs people are willing to make between fatality risk and wealth. Hence, it varies among different areas/countries and could be diverse. The measurement of monetary gain in preventing premature mortality based on the VOSL approach is only for indicative purpose. The VOSL is based on the average of VOSL from European WHO Regional Office Report and VOSL in China from a World Bank reference and then adjusted to the price in 2017, at about HK$18,103,200. These two references entailed the upper and lower bounds of the VOSL.

c. The long-term impacts can be added up as the overlapping effects of the two pollutants (i.e. $PM_{2.5}$ and NO_2) have been taken into account.

ANNEX K

AIR QUALITY OBJECTIVES (AQO) REVIEW WORKING GROUP

Digest of the 4th Meeting held on 18 December 2018 at 3:00 p.m. in Conference Hall, 2/F, West Wing, Central Government Office, 2 Tim Mei Avenue, Tamar

Present:

Mr. C. W. TSE	Under Secretary for the Environment **(Chairperson)**, ENB
Mrs. Alice CHEUNG	Deputy Director of Environmental Protection (3) (**Vice-Chairperson**), EPD
Prof. Peter BRIMBLECOMBE	
Prof. TIAN Lin-wei	
Dr. Loletta SO Kit-ying	
Dr. Steve YIM Hung-lam	
Mr. Alfred LEE Tak-kong	
Mr. LOONG Tsz-wai	
Prof. WANG Tao	
Dr. CHAN Ka-lung	
Ir. YEE Tak-chow	
Mr. Brandon LIU	
Mr. Paul LI	
Ir. Dr. David HO Chi-shing	
Mr. Matthew WONG Leung-pak	
Mr. Stanley Tandon Lal CHAING	
Mr. TUNG Ching-leung	
Mr. Evan AUYANG	
Ms. Suzanne CHEUNG Kit-yee	
Mr. Patrick FUNG Kin-wai	
Mr. Aaron NG Hoi-shan	
Mr. LING Chi-keung	
Dr. Ringo LEE Yiu-pui	
Mr. Jeff BENT	
Mr. FUNG Pak sing	
Mr. KEUNG Siu-fai	
Mr. Danny WU	
Mr. Simon NG	

Prof. John LIU Jianhua	
Ms. Irene PANG	Chief Assistant Secretary (Works) 3, DEVB
Ms. Queenie LEE	Principal Assistant Secretary for the Environment (Electricity Reviews), ENB
Ms. Fanny CHEUNG (1)	Assistant Secretary for the Environment (Energy) 1, ENB
Mr. Marquis YIP (2)	Assistant Secretary (Transport)10B, THB
Ms. Emily SOM (3)	Assistant Secretary (Transport)2B, THB
Mr. Ricky WONG	Deputy Head of Civil Engineering Office (Port & Land), CEDD
Mr. Ringo MOK	Deputy Project Manager (South), CEDD
Mr. M. H. LEE (4)	Principal Transport Officer / Bus & Railway 2 (Bus & Railway), T
Ms. Cici K. S. CHEUNG	Senior Engineer 1/Transport Planning (Acting), TD
Mr. Nelson HO (5)	Senior Surveyor of Ships/Planning & Training, MD
Ms. Amy CHEUNG	Assistant Director of Planning/Territorial, PlanD
Dr. Eddy NG	Principal Medical Officer (Non Communicable Diseases, DoH
Mr. Senna NG (6)	Senior Engineer (Energy Efficiency A3), EMSD
Mr. Dave HO	Assistant Director of Environmental Protection (Air Policy), EPD
Mr. Brian LAU	Principal Environmental Protection Officer (Air Policy), EPD
Dr. Kenneth LEUNG	Acting Principal Environmental Protection Officer (Air Science), EPD
Dr. S.T. MAK	Principal Environmental Protection Officer (Mobile Source), EPD
Mr. Freeman CHEUNG	Consultants' Representative (AECOM)
Mr. Marcus IP	Consultants' Representative (AECOM)
Mr. Ping KONG	Consultants' Representative (AECOM)
Mr. Karl AN	Consultants' Representative (AECOM)
Prof. Jimmy FUNG Chi-hung	Consultants' Representative (HKUST)

Mr. XuGuo ZHANG	Consultants' Representative (HKUST)
Prof. Tze Wai WONG	Consultants' Representative (CUHK)

Note:

1. Representing Mr. Paul WONG, Principal Assistant Secretary for the Environment (Energy), to attend the meeting.
2. Representing Ms. Louisa YAN, Principal Assistant Secretary (Transport)10, to attend the meeting.
3. Representing Mr. Tony LI, Principal Assistant Secretary (Transport) 2, to attend the meeting.
4. Representing Mr. Patrick WONG, Assistant Commissioner/Bus & Railway, to attend the meeting.
5. Representing Mr. K. L. LUI, Chief (Maritime Policy), to attend the meeting.
6. Representing Mr. Barry CHU, Chief Engineer (Energy Efficiency A), to attend the meeting.

In Attendance:

Ms. Josephine HO	Senior Environmental Protection Officer (Air Policy) 1, EPD
Mr. K.W. NG	Senior Environmental Protection Officer (Air Science) 2, EPD
Mr. Nelson IP	Senior Environmental Protection Officer (Mobile Source) 3, EPD
Mr. Simon LAM	Environmental Protection Officer (Air Policy) 11, EPD
Mr. Nick TSANG	Environmental Protection Officer (Air Policy) 43, EPD
Mr. Roy TSANG	Environmental Protection Officer (Air Science) 42, EPD
Mr. Ambrose CHEN	Environmental Protection Officer(Mobile Source) 31, EPD
Mr. Leo LAI	Environmental Protection Officer (Air Policy) 12, EPD
Ms. Queenie CHAU	Assistant Environmental Protection Officer (Air Policy) 14, EPD

Absent with apologies:

Prof. Alexis LAU Kai-hon
Dr. Nicky LAM Yun-fat
Dr. NING Zhi

Ir. LO Pak-cheong
Dr. Eunice MAK Hoi-cheung
Dr. MAN Chi-sum
Dr. Roland LEUNG Chung-chuen
Mr. Joseph LAW Ka-chun
Prof. Larry CHOW
Ir. Edmond FONG Wai-man
Ms. Susanna NG
Ir. Cary CHAN
Dr. William YU
Mr. Prentice KOO
Mr. Madison TANG Wing-hong
Mr. Daniel NG
Dr. HUNG Wing-tat
Ir. FUNG Man-keung
Hon CHAN Choi-hi
Hon KWAN Sau-ling
Mr. Roger LEE Chak-cheong
Mr. SO Sai-hung
Mr. Arthur BOWRING
Mr. CHIANG Sui Ki
Mr. Sunny HO Lap-kee
Mr. David KONG
Mr. Tony TONG
Mr. Ellis CHUNG
Ms. Jessie CHUNG
Mr. KWOK Tak-kee
Ms. Sandy MAK
Mr. David WONG Yui-cheong

Opening Remarks

The **Chairperson** welcomed Members to the fourth meeting of the AQO Review Working Group ("Working Group").

Agenda Item 1 – Confirmation of digest of the third meeting

2. The draft meeting digest of the third meeting was confirmed without further amendment.

Agenda Item 2 – Findings of the AQOs Review (WG paper 1/2018)

3. The WG paper 1/2018 which summarised the findings of the AQOs Review had been circulated to Members before the meeting.

I. Recap background and the work done so far by the Energy and Power Generation (E&PG) Sub-group, Road Transportation (RT) Sub-group, Marine Transportation (MT) Sub-group as reported to the last Working Group in June 2017

4. **Mr. Dave Ho (EPD)** recapped the background of the AQOs Review and the work done by the Working Group:

(a) The three Sub-groups of RT, MT and E&PG had identified 70 possible new measures and deliberated on their practicability of implementation. Of these 70 measures, the Sub-groups agreed that 27 were short term, four medium term, 13 long term, and 26 were considered not practicable for implementation, short of air quality benefits or not suitable to be considered under the current scope of the review. EPD's focus groups on other emission sources had identified eight measures (including three short-term ones) not covered in the three Sub-groups. There were also two new initiatives (short-term) announced in the 2018 Policy Address.

(b) A public engagement exercise had been conducted in September and October 2017 to gauge public views on the possible new air quality improvement measures. About 370 written submissions had been received and most of them were related to measures which had been discussed at the E&PG, MT and RT Sub-groups.

(c) The Air Science and Health (AS&H) Sub-group had discussed and endorsed the methodologies for conducting the air quality assessment and the health and economic impact assessment (HEIA). At its meeting held on 13 December 2018, the Sub-group discussed the assessment on air quality, possible scope for tightening the AQOs and the HEIA. The meeting supported the findings that the AQOs for SO_2 and $PM_{2.5}$ could be tightened in accordance with paragraphs 19 to 20 of the WG paper 1/2018.

5. A member questioned whether the AS&H Sub-group had indeed endorsed the possible scope for tightening the AQOs at its meeting on 13 December 2018. The **Chairperson** recalled that at the end of the AS&H Sub-group meeting, he as the AS&H Sub-group Chairman, concluded that the meeting had considered the findings of the consultant team including the possible scope for tightening the AQOs. The **Chairperson** said that members of the AS&H Sub-group did not raise any disagreement nor reservation on submitting the findings agreed to this Working Group for consideration.

Members' Comments on Measures to Improve Air Quality

6. Some Members suggested that the Government undertake the following measures to improve air quality:

(a) Explore and promote the use of liquefied natural gas (LNG) to ocean-going vessels as many new cruise ships will use LNG as fuel;

(b) Explore the use of lightweight materials (e.g. carbon fibre) in vessels and facilitate the installation of charging facilities for electric vessels;
(c) Expedite bus route rationalization;
(d) Continue to subsidize the road transport trade to phase out old diesel commercial vehicles (DCVs);
(e) Support the development and use of electric vehicles, including electric commercial vehicles; and
(f) Continue to collaborate with the Guangdong (GD) Provincial Government to improve regional air quality.

[Post-meeting note: a member who did not attend the meeting submitted a comment after the meeting suggesting that the use of LNG for marine vessels should be brought forward as a short-term measure for its large emission benefit and the capability to enhance port competitiveness.]

7. **The Chairperson** noted Members' comments and advised Members that the Government would continue to keep abreast of the relevant technological developments with a view to introducing new practicable measures to improve air quality. The Government had long been collaborating with the GD Provincial Government to improve regional air quality. Emission reduction targets for the region for 2015 and 2020 had been set and both sides had already started a joint study on the post-2020 emission reduction targets.

8. A member said that the meeting paper did not reflect some of views on road transport measures expressed by members from the transport trade at the meetings of the RT Sub-group, such as construction of new cross-harbour tunnels or roads to alleviate traffic congestion. **Mr. Dave HO (EPD)** responded that the proposed measures had already been included in the relevant Annexes of the paper. **The Chairperson** supplemented that the focus of this meeting was on the assessment findings of the AQOs Review and the possible scope for tightening the AQOs.

Members' Comments on Emission Reduction Quantification of the Possible New Measures

9. A member commented that among the 14 short-term possible new measures on road transportation, the Government had only quantified the emission reduction of one measure, i.e. "Enhance district-based publicity on bus route rationalization". The emission reduction of the remaining 13 short-term measures, as well as the medium and long-term road transportation measures that are more effective had not been quantified, thus the improvement in air quality in 2025 might be under-estimated. A few other members suggested that the quantification of emission benefits of the short-term possible new measures, in particular those involving significant capital costs or challenging to pursue, might help canvass support from the District Councils and the public when pursuing the measures.

10. **Mr. Dave HO (EPD)** clarified that the emission reduction of most of the short-term possible new measures on road transportation identified by the RT Sub-group were much less significant or would depend on a lot of uncertain factors;

hence their emission reductions had not been quantified. The **Vice-chairperson** supplemented that the 2025 air quality assessment had already taken into account all major on-going, committed and possible new measures which have significant emission reduction potentials (e.g. tightening of vehicle emission standards, phasing out of aged and polluting diesel commercial vehicles, etc.). She added that in presenting the estimated emission benefits to the public in the upcoming public consultation exercise, the Government would set out clearly which were quantified, and which were not.

II. Report on the Air Quality Modelling Results as discussed by the Air Science and Health (AS&H) Sub-group

11. **The Consultant** gave a presentation on the air quality modelling results in 2015, 2020 and 2025:

(a) The 2015 air quality modelling results demonstrated a good agreement with the air quality monitoring data recorded at EPD's general air quality monitoring stations;
(b) Hong Kong could broadly attain the prevailing AQOs in 2020 except for ozone (O_3)(8-hr);
(c) The air quality modelling results in 2025 indicated that the implementation of on-going, committed and new measures would lead to continuous improvement in the concentration of air pollutants, except for O_3 which would have a slight increase. The projected slight increase in O_3 would be largely due to the projected reduction in nitric oxide (NO) emissions from motor vehicles as a result of emission control measures that were being/would be implemented. While such vehicle emission control measures would help effectively reduce the concentrations of nitrogen dioxide (NO_2), the reduction in NO would reduce the titration effect on O_3 (i.e., removal of O_3 from its reaction with NO), thereby leading to a projected slight increase in O_3 levels especially in areas with higher traffic flow ;
(d) The air quality assessment results indicated that the SO_2(24-hr) concentrations in 2025 could meet the next higher level of World Health Organization (WHO) Interim Target (IT), i.e. IT-2, with the current number of exceedance allowable (three) remains unchanged;
(e) The air quality assessment results showed that the annual averaged concentrations of $PM_{2.5}$ could possibly meet the next WHO level at IT-2. As for $PM_{2.5}$ (24-hour), there was potential to meet the next WHO level at IT-2, if the number of allowable exceedances were to be relaxed from the current nine to 35; and
(f) The air quality of a hypothetical scenario assuming there is no emission in Hong Kong was also presented for comparing with the projected air quality in 2025.

12. A member asked for clarification on the policy guidelines, if any, regarding the setting of the number of allowable exceedance for the AQO of $PM_{2.5}$ (24-hour). **Mr. Dave HO (EPD)** responded that reference had been made to the WHO's guidelines

that the allowable number of exceedance should be able to cater for exceedances due to uncontrollable factors (e.g. unfavorable meteorological conditions). For instance, the European Union also allows 35 exceedances for the 24-hour air quality standard for $PM_{10.}$

13. A member commented that the hypothetical scenario of "zero emission in Hong Kong" strongly suggested that the Government should step up the collaboration with the Mainland to improve air quality. Another Member suggested that the Government should prepare a work plan to comply with the prevailing AQOs. The **Chairperson** informed that the Government had been working closely with the Guangdong Provincial Government and had established regional air quality management plans to reduce emissions in Hong Kong and the PRD region with a view to improving regional air pollution.

14. A member supported the tightening of the AQO of $PM_{2.5}$ as there were scientific evidences that the long-term exposure of $PM_{2.5}$ (in terms of annual concentration) had major health benefits whereas short-term concentration variations were susceptible to unfavorable meteorological conditions. He supported the relaxation of the number of allowable exceedances of the $PM_{2.5}$ (24-hr) AQO but suggested that the scientific evidences should also be presented to the public.

III. <u>Report on the Findings of Health and Economic Impact Assessment (HEIA) as discussed by the AS&H Sub-group</u>

15. **The Consultant** gave a presentation on the findings of the HEIA:

(a) Both long term (in terms of mortalities) and short term (in terms of morbidities including hospital admissions and clinic visits) health benefits arising from the improvement in air quality in 2025 had been assessed, using the 2015 health data as baseline value;
(b) About 1848 premature death, 1528 hospital admissions and 262,277 clinic visits could be saved as a result of the improvement in air quality in 2025.
(c) The increase in O_3 concentration in 2025, however, would slightly offset some of the short term health benefits;
(d) The direct savings from hospital admissions and clinic visits were estimated at about HK$96 million while the saving in productivity loss was broadly estimated at about HK$150 million. Based on the Value of Statistical Life (VOSL) approach, the monetary gain in preventing the premature death was estimated at HK$33 billion);
(e) As with all HEIA, there were limitations to the methodology used, e.g. data on emergency hospital admission data in private hospital were not available, and the adoption of the Value of Statistical Life (VOSL) was an important source of uncertainty. .

16. A member commented that the HEIA assessment should include a scenario which all AQOs were set at AQGs levels. He also opined that standalone cost benefit analysis (CBA) for individual possible new measures should be conducted, similar to what EPD had presented in the last AQO review report. Another member considered that

health targets should be set at the outset of the review to drive policy changes, and questioned the purpose of the HEIA conducted under this review. There were also opinions that the HEIA results are on the conservative side given that health impacts to healthy individuals as a result of air quality improvement have not been assessed.

[Post-meeting note: a member submitted his comments before the meeting suggesting that CBA be conducted and economic benefits (e.g. increase in HK's competitiveness) aside from those in the HEIA be quantified. Another member submitted his comment after the meeting suggesting that the HEIA may also consider the economic impacts of air quality improvement, e.g. the cost of reaching and maintaining the AQGs levels.]

17. **Mr. Dave HO (EPD)** reminded Members that the approach and methodology for conducting the HEIA had been fully considered and endorsed by the AS&H Sub-group. New air quality improvement measures considered in the AQOs Review were prioritized primarily based on their practicability. The **Chairperson** further explained that detailed CBA on individual air pollution control measures might be more relevant when deciding on the relative priorities of the measures based on detailed CBA. For the purpose of the current AQOs Review however, all practicable short-term new air quality improvement measures were included in the projection of the 2025 air quality. The HEIA findings were for reference purpose and not for prioritizing or justifying the measures.

18. In response to a member's view that further tightening the AQOs would enhance the driving force for improving air quality to protect public health and practicability should not be the primary factor to be considered, the **Chairperson** elaborated that under the current air quality management system of Hong Kong, the driving force to improve air quality was to achieve the WHO AQGs to protect public health, and the means were by introducing various measures to reduce emissions from various sources such as power stations, industrial activities, road vehicles, etc. Instead of a driving force, the main function of the AQOs served as a benchmark for consideration of designated projects under the statutory Environmental Impact Assessment (EIA) process. When the overall air quality had been improved, naturally the AQOs should be tightened accordingly to up-lift the benchmark. The law also required that the AQOs be reviewed once every 5 years, to ensure a progressive process to achieve the ultimate goal of the WHO AQGs. Since the AQOs served as a benchmark of the statutory EIA process, practicability was a necessary consideration. Otherwise all developments in Hong Kong could be stopped due to the setting of impracticable AQOs. Regarding protection of public health, unless the WHO AQGs had been attained, the Government would continue to introduce suitable measures to improve air quality, irrespective of the AQO values.

IV. <u>Possible scope for tightening the AQOs</u>

19. **The Chairperson** recapped the identified scope for tightening of the AQOs as set out in paragraph 28 of WG Paper 1/2018:

(c) the 24-hour AQO for SO_2 can be tightened from the WHO AQGs IT-1 level at 125μg/m^3 to IT-2 level at 50μg/m^3 with the current number of exceedance

allowed (three) remains unchanged; and;

(d) the annual AQO for $PM_{2.5}$ can be tightened from IT-1 (35μg/m^3) to IT-2 (25μg/m^3), and its 24-hr AQO from IT-1 (75μg/m^3) to IT-2 (50μg/m^3), with the number of exceedances allowed increased from the current nine to 35.

20. **The Chairperson** advised Members that a Member who did not attend this meeting had written in to clarify that media reports' on his position were factually incorrect. He clarified that "…for a "health-led" revision of air quality objectives, we should progressively tighten objectives that have already been achieved (unless they are already at AQG levels), and then determine the policies needed to achieve that tightening; for those pollutants that are not in compliance, the approach should be keeping its existing level, but focus on implementing policies that can improve the corresponding pollutant. For ozone, since we are still not in compliance with the 8-hour objective, the focus should be on identifying the policies that can lower the peak 8-hour ozone concentrations.…… Finally, I want to state my support of the proposed revision of the AQOs (tightening the SO_2 and $PM_{2.5}$ objectives, and the other objectives remain the same."

21. The **Chairperson** then invited comments from Members on the possible scope for tightening the AQOs.

22. A member indicated disagreement with the review findings that there was only scope for tightening the AQOs of SO_2 and $PM_{2.5}$, but not the AQOs for respirable suspended particulates (PM_{10}) and O_3. He also opined that the AQO for SO_2 (24-hr) should be tightened to WHO AQGs level since the annual averaged concentration of SO_2 in Hong Kong in 2018 was in single digit (less than 10 μg/m^3) and did not see any reason for setting the AQO for SO_2 (24-hr) at IT-2 level (50μg/m^3).

23. Other members suggested that, aside from tightening the AQO for SO_2 (24-hr) to IT-2 with the current number of exceedance allowed (three) remains unchanged, the Government could also consider whether to tighten the AQO to AQG level with relaxation in the number of allowable exceedance.

24. A member suggested the Government conduct supplementary air quality modelling analysis to explore if there was any scope to tighten the AQOs of PM_{10}. *[Post-meeting note: A technical meeting between EPD, the consultant and the concerned Member was held on 3 Jan 2019 and supplementary air quality analyses provided by the consultant and EPD were discussed. Based on the supplementary analyses, it was agreed that the scientific findings as presented in the 4th WG meeting remained valid (i.e. the projected 2025 PM_{10} concentration could not meet the WHO-IT-3 standard) and the supplementary analysis would be incorporated in the consultant's study report]*. Some members suggested that if the analysis results indicate that the AQOs of PM_{10} could not be tightened, the Government should clearly inform the public on the works undertaken to reduce PM_{10} emission in both local and regional context and conduct further studies in the next review with a view to identifying suitable measures targeting at PM_{10}.

25. The Consultant responded that there was no scope to tighten the AQO of O_3 as revealed from the air quality assessment results. The assessment results of the hypothetical scenario of "zero emission in Hong Kong" also indicated that the concentration of O_3 in most of the Hong Kong areas still could not comply with the prevailing AQO, indicating that the O3 concentration is subject to strong regional influence. The Chairperson remarked that Hong Kong and Guangdong were taking joint efforts to improve regional air quality.

26. Considering the views expressed above, the **Chairperson** proposed and the meeting agreed that, subject to supplementary assessments on SO_2 and PM_{10} as proposed by Members in paragraph 23 and 24 above, the meeting endorsed the findings of the AQO review as set out in paragraph 28 of WG Paper 1/2018. The Secretary for the Environment would report the findings and recommendations to the Advisory Council on the Environment (ACE) with a view to conducting a public consultation in 2019. Findings of the supplementary assessments would be included in the report to ACE and in the relevant public consultation documents.

Agenda Item 3 – Any Other Business

27. No other business was raised.

28. The **Chairperson** advised Members that this meeting would be the last meeting of the Working Group. The **Chairperson** thanked Members for their participation in the Working Group and the valuable contributions to the AQO review for improving the air quality of Hong Kong,

29. The meeting was adjourned at 7:15 p.m.