Environmental Protection Department
The Government of the Hong Kong Special Administrative Region

Agreement No. CE 15/2016 (EP)

Review of the Air Quality Objectives - Feasibility Study

Executive Summary

March 2020

AECOM Asia Company Limited

AECOM

Environmental Protection Department

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1 BACKGROUND

1.1 In accordance with section 7A of the Air Pollution Control Ordinance (APCO) (Cap 311), the Government has to conduct a review of the Air Quality Objectives (AQOs) at least once every five years and submit a review report to the Advisory Council on the Environment (ACE) after completing the review. In this connection, the Environmental Protection Department (EPD) commissioned AECOM Asia Company Limited in November 2016 to assist in the conduct of the AQOs Review (the Review) under the Agreement No. CE 15/2016(EP).

1.2 The Review was completed in December 2018 and the Government submitted a review report to the ACE in February 2019. This Executive Summary provides a concise account of the background, process and the assessment findings of the Review.

2 AIR QUALITY OBJECTIVES IN HONG KONG

2.1 The prevailing AQOs include 12 AQOs parameters. Having regard to the recommendations of the World Health Organization (WHO) and the practices of other advanced economies, the following guiding principles have been adopted in the Review when setting the AQOs and in conducting the subsequent reviews:

(a) With AQOs aimed at protecting public health, a progressive approach should be adopted with a view to achieving the WHO's "Air Quality Guidelines Global Update 2005" (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 benchmarked against the interim and ultimate targets of the WHO AQGs.

2.2 Section 7A of the APCO requires the Secretary for the Environment (SEN) to review the AQOs at least once every five years beginning 1 January 2014 (i.e. by 31 December 2018), and thereafter in each successive five-year period. It also requires SEN to submit to the ACE a report of the review as soon as practicable after a review is conducted.

2.3 Schedule 5 to the APCO prescribes 12 AQOs for seven key air pollutants (namely, 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)). The prevailing AQOs, which took effect on 1 January 2014, are benchmarked against a combination of WHO AQGs and their Interim Targets (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 (**Table 1**).

2.4 As a result of a series of emission control measures implemented in recent years, the concentrations of key air pollutants in Hong Kong have reduced by about 30% between 2014 and 2018. In 2018, 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. With the on-going implementation of emission control measures, the Government's 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 are the remaining air pollution problems to be tackled.

Table 1 Hong Kong's Prevailing Air Quality Objectives and WHO AQGs

Air Pollutants	Averaging Time	World Health Organization Air Quality Guidelines				Prevailing HK AQOs	
		WHO IT-1 [1] ($\mu g/m^3$)	WHO IT-2 [1] ($\mu g/m^3$)	WHO IT-3 [1] ($\mu g/m^3$)	WHO AQGs ($\mu g/m^3$)	Conc. ($\mu g/m^3$)	No of Exceedances Allowed
Respirable Suspended Particulates (RSP/PM_{10})	Annual	70	**50**	30	20	50 (IT-2)	Not applicable
	24-hr	150	**100**	75	50	100 (IT-2)	9
Fine Suspended Particulates ($FSP/PM_{2.5}$)	Annual	**35**	**25**	15	10	35 (IT-1)	Not applicable
	24-hr	**75**	**50**	37.5	25	75 (IT-1)	9
Nitrogen Dioxide (NO_2)	Annual	-	-	-	**40**	40 (AQGs)	Not applicable
	1-hr	-	-	-	**200**	200 (AQGs)	18
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)	Not applicable

Note:
IT – Interim Targets
XX **Prevailing AQOs adopted**

World Health Organization's Air Quality Guidelines and Interim Targets as the Benchmark of Hong Kong's AQOs

2.5 The WHO AQGs have promulgated a set of ITs and ultimate targets for various key air pollutants including RSP/PM_{10}, $FSP/PM_{2.5}$, SO_2, NO_2, O_3, CO and Pb, based on a wealth of studies on the effects of air pollution on health. The WHO AQGs 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 targets of meeting the AQGs. At present, no country has fully adopted the ultimate targets of WHO AQGs as its air quality standards.

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

[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."*

exceedances in setting the ITs and ultimate targets for the air pollutants concerned.

3 THE REVIEW PROCESS

Engaging the Stakeholders

3.1 To undertake the Review, an AQOs Review Working Group (the Working Group) was formed in mid-2016 which led by the Under Secretary for the Environment. The Working Group consisted of about 60 members from the fields of air science, medical professions, environmental groups, academics, chambers of commerce, professional institutions and trade representatives, as well as representatives from relevant Government bureaux/departments (B/Ds)[2].

3.2 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 were 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 was 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, i.e. "Emission Reduction Estimation and Air Quality Modelling", and "Health and Economic Impact Assessment", with members enlisted from the AS&H Sub-group. Air quality assessments on the implementation of air quality improvements measures were carried out to evaluate air quality improvements as well as possible scope for tightening the AQOs. More than 30 meetings were held among the Working Group, Sub-groups and Task Forces during the Review.

3.3 In order to evaluate the air quality improvements, year 2025 was adopted 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.

3.4 Besides, the practicability of implementing various new measures was assessed in different time frames, including:

- Short-term measures: likely to produce results by 2025 or earlier;
- Medium-term measures: ready for consideration in the next AQOs review period (2019-2023);
- Long-term measures: required detailed planning or further study to ascertain the practicability for implementation beyond the next AQOs review period (2019-2023); and
- Others: considered as not practicable, short of air quality benefits or not suitable to be considered under the current scope of the Review.

Engaging the Public

3.5 Apart from engaging the stakeholders in the Working Group, EPD also staged public engagement and consultation to gather views from the community.

3.6 After identifying and deliberating the list of the possible new measures in the Sub-groups as well as focus groups (see paragraph 4.6), EPD launched a 5-week public engagement between September and October 2017. Further details are elaborated in paragraph 4.9.

[2] The Government B/Ds included 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 on top of the Environment Bureau and EPD.

3.7 After completing the air quality assessments and identifying possible scope for tightening the AQOs, EPD reported the review findings to the ACE and the Panel on Environmental Affairs (EA Panel) of the Legislative Council (LegCo) in March 2019 and launched a 3-month public consultation between July and October 2019 to collect public views on the review findings. Further details are elaborated in paragraphs 7.6 and 7.7.

4 KEY FINDINGS OF THE REVIEW

Possible New Air Quality Improvement Measures

4.1 In the Review, a total of 80 possible new measures were identified. 70 of the measures were identified and deliberated in the Sub-groups of the E&PG, MT and RT 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.

4.2 The E&PG Sub-group had deliberated 15 measures which were broadly categorized into seven groups:

(i) Building energy efficiency measures
(ii) Use of renewable energy (RE)
(iii) Fuel mix for electricity generation
(iv) Operation of power generation plants
(v) New solar energy technology
(vi) Use of biomass as fuel
(vii) Energy storage

4.3 The MT Sub-group had deliberated 17 measures which were broadly categorized into four groups:

(i) Use of clean fuel
(ii) Technical measures
(iii) Fuel economy, energy efficiency and port management
(iv) Others

4.4 The RT Sub-group had deliberated 38 measures which were broadly categorized into eight groups:

(i) Tunnel toll policy and toll collection method
(ii) Maintenance and repair of vehicles exhaust system
(iii) Fostering a “pedestrian-friendly” and “bicycle-friendly” environment
(iv) Promotion of low-emission transport mode
(v) Utilisation of Intelligent Transport Systems
(vi) Land use and transport infrastructure planning
(vii) Managing road space
(viii) Others

4.5 Amongst the possible new measures discussed, 27 were considered by the relevant Sub-groups as short-term measures since they were either on-going or already under consideration by the relevant Government B/Ds; four measures were considered as medium-term measures; 13 were considered as long-term measures; and 26 measures were considered as not practicable, short of air quality benefits or not suitable to be considered under the current scope of the Review (i.e. others).

4.6 EPD had also engaged relevant stakeholders through separate focus group discussions to explore possible new measures to control emissions from other emission sources which were not covered in the three measures 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 were identified.

4.7 Two new initiatives announced in the 2018 Policy Address targeting at roadside emissions which would likely produce results by 2025 were also taken into consideration in the Review. The two initiatives were: launching an incentive-cum-regulatory scheme to progressively phase out Euro IV diesel commercial vehicles; and tightening the emission standards for newly registered motor cycles to Euro IV in 2020.

4.8 The above new air quality improvement measures are provided in Appendices A to D. Breakdown of these new measures in terms of their practicability of implementation is summarised in **Table 2**.

Table 2 Summary of New Air Quality Improvement Measures

Sector	Short-term	Medium-term	Long-term	Others	Total
Energy and Power Generation	11	-	1	3	15
Marine Transportation	2	2	5	8	17
Road Transportation	16 [1]	2	7	15	40 [2]
Non-road mobile machinery	1	1	-	1	3
Cooking fumes	-	2	-	-	2
VOC-containing products	2	-	-	-	2
Civil aviation	-	-	-	1	1
Total	**32**	**7**	**13**	**28**	**80**

Note:
1. The road transportation sector included two new short-term initiatives announced in the 2018 Policy Address
2. For ease of accounting the measures and avoid duplication, two measures were considered short-term and medium-term; and one measure was considered short-term to long-term. All three concerned measures were counted as short-term measures.

Public Views on the Possible New Measures

4.9 After identifying and deliberating the list of the possible new measures in the Working Group as well as focus groups, EPD launched a 5-week public engagement 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 above. A dedicated webpage was also set up to collect public views on the possible new measures[3]. Of about 370 written submissions received in the engagement period, most of the public views were related to air quality improvement measures which had been discussed at the E&PG Sub-group (e.g. fuel mix for electricity generation, promotion of renewable energy), MT Sub-group (e.g. use of clean fuel), and RT Sub-group (e.g. promotion of low-emission transport mode). For those views which had not been deliberated by the three Sub-groups, most of them were already covered in the current policies/measures (such as enforcement of idling engines, promotion of electric vehicles and expansion of the charging facilities, and strengthening regional collaboration for air quality improvement). Some other comments were related to the general air quality management and approach adopted for the current Review (e.g. suggestions on membership of the Working Group) and were not directly related to air quality improvement measures.

Air Quality Assessments

Basis for Projecting Air Quality

4.10 To evaluate the improvement in air quality with the implementation of new measures and the possible scope for tightening the AQOs, the air quality of Hong Kong in 2025 was assessed

[3] 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?

using the PATH-2016 model[4] with the following assumptions as agreed at the AS&H Sub-group and its Emission Reduction Estimation & Air Quality Modelling Task Force[5].

Hong Kong

- projected 2025 baseline emissions on a business-as-usual basis[6] (BAU).
- emission reductions arising from the implementation of on-going and committed measures[7], the 15 short-term measures identified by the Working Group and focus group(s)[8] that had quantifiable emission reduction results, as well as the two new Government initiatives targeting roadside emissions announced in the 2018 Policy Address as mentioned in paragraph 4.7 above.

Pearl River Delta (PRD) Region

- the PRD Region emission targets for 2020[9] were adopted as 2025 emissions, since official projection beyond 2020 was not available during the review period.

the Mainland (areas outside the PRD Region)

- 2020 emissions in the outer areas of the Mainland obtained from other official sources.

4.11 The air quality assessment results indicated that there would be continuous improvement in RSP/PM_{10}, FSP/$PM_{2.5}$, NO_2 and SO_2 concentrations brought by the implementation of on-going and committed measures (see footnote 7), as well as new measures, while O_3 levels would have a slight increase[10]. The assessment results for 2025 are summarised in **Table 3** below.

[4] The modelling grid size of 1 km x 1 km was adopted.

[5] The use of the updated "Pollutants in the Atmosphere and their Transport over Hong Kong" (PATH-2016) was endorsed under the AS&H Sub-group as the air quality model for conducting air quality assessment. Please refer to Annex C to AS&H Paper 1/2017 dated 20 February 2017, link: 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

[6] The Review used 2015 as the base year. Air quality was assessed for 2020 to evaluate the compliance status of the prevailing AQOs taking into account the implementation of on-going and committed Government's measures until 2020, and the 2020 emission reduction targets as agreed between the Hong Kong Special Administrative Region (HKSAR) Government and the Guangdong (GD) Provincial Government (see footnote 9 below).

[7] The Government has implemented air quality improvement measures extensively in the past several years, examples included phasing out some 82 000 pre-Euro IV old diesel commercial vehicles (DCVs) including light buses, goods vehicles and non-franchised buses; new DCVs registered after February 2014 would be subject to a service life limit of 15 years; starting from January 2019, a new legislation was implemented to mandate vessels to use low sulphur fuel within Hong Kong waters to further reduce the emission from marine vessels; 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.

[8] Of the 30 short term measures identified by the Working Group and focus groups, 15 measures had 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 provided in Appendices A to D.

[9] 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/PM_{10} and VOCs, 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 are jointly assessing air pollutant emission reduction targets and concentration levels for Hong Kong and GD beyond 2020.

[10] The projected slight increase in the O_3 concentration in 2020/2025 was 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.

Table 3 Comparison of 2025 air quality assessment results and the measured air quality in 2015

Air Pollutants	Ave. Time	Prevailing HK AQOs		2015 Air Quality [1]		Air Quality Assessment for 2025 [2]	
		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 (WHO IT-2)	Not applicable	45	Not applicable	*37*	Not applicable
	24-hr	100 (WHO IT-2)	9	110 (10^{th} highest)	18	*90* (10^{th} highest)	6
$FSP/PM_{2.5}$	Annual	35 (WHO IT-1)	Not applicable	30	Not applicable	*24*	Not applicable
	24-hr	75 (WHO IT-1)	9	78 (10^{th} highest)	11	*72* (10^{th} highest)	8
NO_2	Annual	40 (WHO AQG)	Not applicable	64	Not applicable	67	Not applicable
	1-hr	200 (WHO AQG)	18	271 (19th highest)	67	199 (19th highest)	18
SO_2	24-hr	125 (WHO IT-1)	3	58 (4^{th} highest)	0	*26* (4^{th} highest)	0
O_3	8-hr	160 (WHO IT)	9	182 (10^{th} highest)	24	216 (10^{th} highest)	30

Note:
1. 2015 air quality was based on the measurement data of 12 general air quality monitoring stations. The highest concentration among the 12 general air quality monitoring stations was presented.
2. 2025 air quality assessment result was based on the territorial wide air quality modelling outcome. Spatial maximum concentration and maximum number of exceedances were presented.

5 SUPPLEMENTARY AIR QUALITY ASSESSMENT

5.1 At the Working Group meeting in December 2018, the review findings were presented for Members' consideration and discussion. The discussions covered the quantification of emission reduction for new air quality improvement measures, the importance of the practicability of the implementation of new air quality improvement measures; the adequacy of the Health and Economic Impact Assessment (HEIA); and the scope for tightening of the AQOs. On these issues, while most Members had no major problems with the review findings, a few experts had expressed different views.

5.2 The Working Group endorsed the findings regarding tightening of the AQOs of SO_2, $FSP/PM_{2.5}$ presented in Section 7 below. In addition, the Working Group recommended to further analyse the tightening of the AQOs of SO_2 and RSP/PM_{10} by conducting additional assessments to supplement the assessment results and conclude the assessments.

5.3 Based on the supplementary assessment, it was further ascertained that the AQOs of RSP/PM_{10} (annual and 24-hr) could not be tightened from WHO IT-2 to IT-3 and a similar conclusion was drawn that the 24-hr AQO of SO_s could not be further tightened to the ultimate target of WHO AQG by simply increasing the number of exceedances given the source of emissions was mainly locally based (e.g. power plants, vessels, industrial activities, etc.).

6 HEALTH AND ECONOMIC IMPACT ASSESSMENT (HEIA)

6.1 Undoubtedly, air quality improvements bring along health benefits, such as reducing premature deaths, hospital admissions, clinic visits, and direct 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, agreed[11] to conduct the HEIA based on the Tool Study developed by the Chinese University of Hong Kong[12].

6.2 The method and the choice of health outcomes from the Tool Study were adopted for assessing the mortalities and morbidities (e.g. respiratory disease, cardiovascular disease, and the specific illness such as asthma, etc.) due to long-term and short-term exposure of air pollutants (FSP/$PM_{2.5}$, NO_2, SO_2 and O_3) where reliable relative risks (RRs) were available. Local references of RRs were adopted as far as practical; otherwise, references from the WHO or from other places were adopted. In the aspect of the economic benefits of the health impact, the indirect cost based on the Value of a Statistical Life[13] (VOSL) method was estimated though it was an important source of uncertainty in the economic impact assessment. There were also views that attaching monetary value to one's health or life may not be appropriate. Hence, the HEIA methodology and findings were for reference purpose only.

6.3 To assess the health impact attributable to the changes in air quality level between 2015 and 2025, concentration-response (CR) functions[14] of specific health outcomes (e.g. hospital admissions, clinic visits, mortality) as a result of a unit change in air pollutant concentration was identified. The 2015 health statistics[15] baseline data and the CR functions (local CR functions were used as far as possible, otherwise CR functions recommended by WHO were adopted) were then used to assess the health benefits due to the projected air quality improvements in 2025.

6.4 Based on the air quality assessment results of 2025, improvement in the long-term exposure (in terms of annual concentration level of FSP/$PM_{2.5}$ 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 practitioners) might be saved due to the improvement in short-term exposure (in terms of 1-hr or 24-hr concentration levels) of air

[11] The discussions from the AS&H Sub-Group can be found in the AS&H Paper 4/2016 of 2 December 2016 and Annex C to AS&H Paper 2/2017 of 7 June 2017, which available at:
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 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 monetary gain in preventing premature mortality based on the VOSL approach is a broad-brush estimate and only for indicative purpose.

[14] The health risk of a population attributed by air pollution is usually represented by a CR function established by epidemiological studies. A CR function represented the relationship between the concentration of an air pollutant and the risk of a health outcome.

[15] 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.

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 assessed, could offset some of the health benefits[16] owing to short-term exposure of air pollutants. Overall health benefits are summarised at **Table 4.**

Table 4 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 [1]
		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 [3]	NA	
	COPD [2]	158	686	-27 [3]		--
	Asthma	72	470	-17 [3]		--
Clinic visits saved (for new episodes of URTI)	GOPC visits	858	8,226	-293 [3]		262,577
	GP visits	104,895	254,351	-7,921 [3]		
Long term health outcome: Reductions in number of premature deaths						
Mortality (Short-term exposure, all ages)		28	350	-3 [3]	12	*See Note 4*
Mortality (Long-term, aged 30 and above)		865	983	NA	NA	1,848

Note:
COPD denotes Chronic Obstructive Pulmonary Disease
GOPC denotes General Outpatient Clinic
GP denotes General Practitioner
URTI denotes Upper Respiratory Tract Infections
NA means health outcomes not assessed as the RR for the respective air pollutant is either statistically not significant or available.

1. 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.
2. 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 CR functions.
3. The negative (-) sign indicates the air pollutant exerts negative impact.
4. Short-term premature death is covered in the long-term premature death.

6.5 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[17] were estimated at about HK$ 96 million while the saving in productivity loss[18]

[16] 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.

[17] 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 were assumed at a unit attendance cost of HK$1,230. The unit costs of clinic visit to general practitioner (GP) and general outpatient clinic (GOPC) were assumed at $250 and $445 respectively. All these costs were based on the study of the CUHK. All values were adjusted at 2017 price level.

[18] The associated productivity loss due to hospital admission and clinic visit was estimated based on the median length of hospital stay (four days for cardiovascular illnesses and three days for respiratory illnesses) and a medical leave of one day of clinic visits. The productivity loss was a broad-brush estimate for reference only

was broadly estimated at about HK$ 150 million (See **Table 5**). Based on the VOSL approach and with an estimated VOSL value of about HK$18 million[19], the monetary gain in preventing the premature death was estimated at a total of about HK$ 33 billion (equivalent to about 1,850 premature deaths saved) (See **Table 6**). All costs were adjusted to 2017 price level.

Table 5 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$)			
	Hospital Admissions [1]	Clinic Visits [2]	Productivity Loss [3]	Total [4]
FSP/$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 [5]	-2,110,635 [5]	*-4,641,840* [5]	-7,165,725 [5]

Note:
1. The cost of hospital admissions related to Accidents and Emergency (A&E) attendance due to cardiovascular and respiratory diseases and the cost of hospital beds.
2. The cost of clinic visits included doctor consultation of both public and private practitioners due to new episodes of upper respiratory tract infections (URTIs).
3. The productivity loss due to hospital admission and clinic visit was 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 was 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.
4. The short-term impacts of different air pollutants were not added up to avoid double-counting of economic benefits. The maximum cost benefits among the air pollutants (i.e. NO_2) was taken as representative figures, which marked in **bold**.
5. The negative (-) sign meant there could be additional costs incurred.

Table 6 Economic benefits due to prevented premature deaths in 2025 compared with 2015

Air Pollutants	Economic Costs Saved (HK$) [1]	
	Long-term premature deaths expressed in VOSL [2]	Total [3]
FSP/$PM_{2.5}$	15,659,273,600	**33,454,725,500**
NO_2	17,795,451,900	

Note:
1. Figures were rounded to the nearest hundred.
2. The "VOSL" approach refers to the amount of money a person (or society) was willing to spend to save a life. It was derived from the trade-offs people are willing to make between fatality risk and wealth. Hence, VOSL among different areas/countries could vary and be diverse. The measurement of monetary gain in preventing premature mortality based on the VOSL approach was only for indicative purpose.
3. The long-term impacts could be added up as the overlapping effects of the two pollutants (i.e. FSP/$PM_{2.5}$ and NO_2) had been taken into account.

given that different estimation methods (e.g. different lengths of hospital stay, different lengths of sick leave) may yield quite different results.

[19] The VOSL was the average of two VOSL values in 2012, which entailed the upper and lower bounds of the VOSL. It included an upper bound from a report of the WHO Regional Office for European (US$2,872,817) and a lower bound of VOSL in China from a reference in the World Bank (US$1,171,048). These values were adjusted to the price in 2017 based on composite consumer price index (CPI), at about HK$18,103,200.

7 ASSESSMENT OUTCOMES AND SCOPE FOR TIGHTENING THE AQOs

Air Quality Assessment Results

7.1 Given that the AQOs for NO_2, SO_2 (10-min), CO and Pb were already set at the most stringent WHO AQG levels, the 2025 air quality assessments were focused on the RSP/PM_{10}, FSP/$PM_{2.5}$, SO_2 (24-hr) and O_3, where their AQOs were set at the interim targets of the WHO AQG.

7.2 The 2025 air quality assessment results, including the supplementary analysis, revealed that the concentrations of RSP/PM_{10} and O_3 in most areas of Hong Kong in 2025 would not be able to meet the next higher level of the WHO AQG, i.e. WHO IT-3 for RSP/PM_{10} (both annual and 24-hr) and AQG for O_3, as set out in **Table 7** below.

Table 7 Comparison of 2025 air quality assessment with the next higher level of the AQOs for RSP/PM_{10} and O_3

Air Pollutants	Ave. Time	Prevailing HK AQOs		Next Tier of WHO AQGs ($\mu g/m^3$)	Air Quality Assessment Results for 2025 [1]	
		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 (WHO IT-2)	Not applicable	30 (WHO IT-3)	37	Not applicable
	24-hr	100 (WHO IT-2)	9	75 (WHO IT-3)	90 (10^{th} highest)	22
O_3	8-hr	160 (WHO IT)	9	100 (WHO AQG)	216 (10^{th} highest)	113

Note:
1 The 2025 air quality assessment results were based on the territorial wide air quality modelling outcome. Spatial maximum concentration and maximum number of exceedances are presented.

7.3 The air quality assessment results indicated that the SO_2 concentrations in 2025 could meet the next higher level of 24-hr AQO of i.e. WHO IT-2 (50$\mu g/m^3$), with the current number of exceedance allowable (three) remains unchanged (see **Table 8)**.

Table 8 Comparison of 2025 air quality assessment with the next higher level of AQO for SO_2

Air Pollutants	Ave. Time	Prevailing AQOs		Next Tier of WHO AQGs ($\mu g/m^3$)	2025 Air Quality Assessment Results [1]	
		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 (WHO IT-1)	3	50 (WHO IT-2)	26 (4^{th} highest)	nil

Note:
1. The 2025 air quality assessment results were based on the territorial wide air quality modelling outcome. The maximum number of exceedances is presented.

7.4 The air quality assessment results showed that the annual averaged concentrations of FSP/$PM_{2.5}$ in 2025 could possibly meet the next WHO IT-2 (annual level) (25$\mu g/m^3$). As for the 24-hr AQO of FSP/$PM_{2.5}$, the next level at WHO IT-2 (50$\mu g/m^3$) could be met if the number of allowable exceedances was adjusted from the current nine to about 35[20] (see **Table 9**) to take into account of the uncontrollable factors.

[20] Elevated concentrations of particulate matters including FSP/$PM_{2.5}$ could be 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 Chapter 8 of the WHO AQGs. According to the air quality modelling results, the highest number of exceedances against WHO IT-2 level was about 33. Hence, to cater for uncontrollable factors, it would be prudent to set the maximum number of allowable exceedances at 35.

Table 9 Comparison of 2025 air quality assessment with the next higher level of AQOs for FSP/$PM_{2.5}$

Pollutants	Ave. Time	Prevailing AQOs		Next Tier of WHO AQGs ($\mu g/m^3$)	2025 Air Quality Assessment Results [1]		
		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 (WHO IT-1)	NA	25 (WHO IT-2)	24 [2]		Not applicable
	24-hr	75 (WHO IT-1)	9	50 (WHO IT-2)	72 (10^{th} highest)	47 (36^{th} highest)	33 [3]

Note:
1. 2025 air quality assessment result was based on the territorial wide air quality modelling outcome. Spatial maximum concentration and maximum number of exceedances are presented.
2. The air quality assessment revealed that the annual concentration of FSP/$PM_{2.5}$ in a small area near Hong Kong and Shenzhen boundary would reach 24$\mu g/m^3$.
3. It was suggested to adjust the number of allowable exceedances to 35 to accommodate the uncontrollable factors (e.g. extreme weather conditions) and model uncertainty.

Scope for Tightening the AQOs

7.5 Based on the air quality assessment results, the scope for tightening the AQOs are summarised as follows, and refer to **Table 10**:

(a) There was no scope for tightening the AQOs of RSP/PM_{10} and O_3;

(b) the 24-hour AQO of SO_2 could be tightened from the current WHO IT-1 (125$\mu g/m^3$) to IT-2 (50$\mu g/m^3$) with the number of exceedance allowed (three) remains unchanged,

(c) the annual AQO of FSP/$PM_{2.5}$ could be tightened from the WHO IT-1 (35$\mu g/m^3$) to IT-2 (25$\mu g/m^3$), and

(d) the 24-hr AQO of FSP/$PM_{2.5}$ from WHO IT-1 (75$\mu g/m^3$) to IT-2 (50$\mu g/m^3$), with the number of exceedances allowed to be adjusted from the current nine to 35.

Table 10 Proposed New Air Quality Objectives vs WHO AQGs

Air Pollutants	Averaging Time	World Health Organization Air Quality Guidelines				No of Exceedances Allowed	
		WHO IT-1 [1] ($\mu g/m^3$)	WHO IT-2 [1] ($\mu g/m^3$)	WHO IT-3 [1] ($\mu g/m^3$)	WHO AQGs ($\mu g/m^3$)		
Respirable Suspended Particulates (RSP/PM_{10})	Annual	70	**50**	30	20	Not applicable	
	24-hr	150	**100**	75	50	9	
Fine Suspended Particulates ($FSP/PM_{2.5}$)	Annual	**35**	***25***	15	10	Not applicable	
	24-hr	**75**	***50***	37.5	25	**9**	***35***
Nitrogen Dioxide (NO_2)	Annual	-	-	-	**40**	Not applicable	
	1-hr	-	-	-	**200**	18	
Sulphur Dioxide (SO_2)	10-min	-	-	-	**500**	3	
	24-hr	**125**	***50***	-	20	3	
Carbon Monoxide (CO)	1-hr	-	-	-	**30,000**	0	
	8-hr	-	-	-	**10,000**	0	
Ozone (O_3)	8-hr	**160**	-	-	100	9	
Lead (Pb)	Annual	-	-	-	**0.5**	Not applicable	

Note:
1 IT – Interim Targets

XX **AQOs which took effect on 1st January 2014 are indicated in green cells**

XX **Proposed new AQOs and allowable number of exceedances are shown in orange cells**

Public Views on the Scope for Tightening the AQOs

7.6 EPD reported the scope for tightening the AQOs to the ACE and the EA Panel of the LegCo in March 2019 and launched a 3-month public consultation between July and October 2019 to collect public views. Two consultation forums for the public and stakeholders were held, and views were exchanged with professional institutions, a business chamber and a concern group.

7.7 A webpage for the consultation uploaded with consultation document and an online views collection form was set up to facilitate views collection. A total of 282 submissions were received, including 246 views collection forms and 36 written submissions. The major views from the general public towards the proposed tightening of the AQOs were as follows:

a. Most of the respondents agreed that we should follow the recommendations of the WHO AQGs to continuously explore new air quality improvement measures and balance the development of the society, with a view to progressively tightening the AQOs to the ultimate targets of the WHO AQGs;

b. The public did not raise any objection to the proposed tightening of the 24-hour AQO of SO_2 and annual AQO of $FSP/PM_{2.5}$; and

c. Slightly more than half of the respondents understood or had no comment on the proposed tightening of AQOs (including the 24-hour AQO of $FSP/PM_{2.5}$). There were responses which supported explicitly the adjustment of the number of exceedances allowed to 35, coupled with the tightening of the concentration level of the 24-hour AQO of $FSP/PM_{2.5}$. Also, about one-fourth of the submissions opposed or had reservation to the proposed adjustment of the number of exceedances allowed to 35.

8 AREAS FOR IMPROVEMENT AND IMPLICATIONS FOR UPDATING AQOs

8.1 AQOs are the yardstick for local air quality and the benchmarks for air quality assessments for Designated Projects (DPs) under the Environmental Impact Assessment Ordinance (EIAO) (Cap 499). Under the EIAO, approval of EIA reports and issue of environmental permits (EPs) have to make reference to the prevailing AQOs at the time when a decision is made by the Director of Environmental Protection (DEP) on the EIA report. The introduction of new AQOs may create certain constraints on the ongoing projects that have already been granted with an EP based on the current AQOs. In the event that an amendment to the scope of such a project should warrant an application for variation of the EP (VEP), the application of the new AQOs may cause substantial changes to the original design of the project and have major cost and programming implications.

8.2 Having considered the need to provide regulatory certainty for DPs with EPs already granted to preserve the integrity of EIA system as an ongoing mechanism, the Environment Bureau (ENB) and EPD could consider providing a transitional period for 36 months, as in the case when the prevailing AQOs took effect from 1 January 2014.

8.3 Given that the AQOs review is an ongoing process, the Government may consider the following suggestions for improving the robustness of the review:

a. Collect more recent or official emission data / inventory for the air quality assessment;

b. Consider to expand the selection and assessment on health endpoints (e.g. illustrating the benefits of air quality improvement by identifying and evaluating other relevant health endpoints and the associated economic gains such as influenza and pneumonia); and

c. Extend the Working Group members to other relevant professional institutions, trade associations, etc. in light of the nature of air quality improvement measures.

9. CONCLUSIONS

9.1 EPD set up a Working Group to engage extensively stakeholders from various sectors such as road transportation, marine transportation, energy, air quality experts and academics, professional bodies, environmental groups, etc. for consulting their views on the implementation of possible new measures with a view to improving the air quality of Hong Kong in different time frames as well as the methodologies and tools for assessing the air quality improvement and health and economic impact.

9.2 Best available emission and meteorological data, air quality model, i.e. PATH-2016 and HEIA assessment tools were used to evaluate the 2025 air quality improvements, the associated health benefits and scope for tightening the AQOs.

9.3 After taking into account of public views collected from the 3-month public consultation and other factors, it is suggested that the three AQOs including 24-hour AQO of SO_2, 1-year and 24-hour AQOs of FSP/$PM_{2.5}$ could be further tightened from WHO IT-1 to IT-2 levels through legislative amendment of the APCO.

Appendix A

List of Possible New Air Quality Improvement Measures – Energy and Power Generation

Possible New Measures	Key Considerations for Implementation	Assessments at the Energy and Power Generation Sub-group	Outcome
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*	- Existing DSM measures - Way forwards to implement the DSM measures, e.g. enlisting stakeholder supports	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.]*	Short-term
A2. Explore building energy efficiency measures for old existing buildings which are not covered by the Buildings Energy Efficiency Ordinance*	Ditto	Ditto	Short-term
A3. Encourage major electricity users to reduce peak load demand so as to reduce the operation and emissions from coal-fired generating units for coping with peak load demand	Ditto	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 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 SCAs. Hence, this measure which*	Short-term

Possible New Measures	Key Considerations for Implementation	Assessments at the Energy and Power Generation Sub-group	Outcome
		was originally regarded as a long term measure when deliberated in the E&PG Sub-group was 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)*	- Public perception and acceptance - Capital cost and payback period - Space requirement for the RE system - Visual impact, e.g. glare and aesthetic consideration	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.]*	Short-term
B2. Facilitate distributed RE systems to connect to the power grid*	- Public perception and acceptance - Grid connection arrangement	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.]*	Short-term
B3. Encourage the development of more waste-to-energy facilities, such as waste incinerators, organic resources recovery centres, etc. for waste disposal as well as recovering energy for local use*	- Availability of land for the facilities - Compatibility of land use and siting having regard to urban and high rise setting - Community perception and acceptance - Environmental performance - Concerns on health, safety and hazard	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 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.	Short-term

Possible New Measures	Key Considerations for Implementation	Assessments at the Energy and Power Generation Sub-group	Outcome
	- Cost effectiveness		
B4. Increase the use of wind and solar energy in electricity generation*	- Availability of suitable land and natural resources - Cost and tariff implication	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.	Short-term
C. Fuel mix for electricity generation			
C1. Replacement of coal-fired generating units by gas-fired units*	- Future fuel mix having regard to our energy policy objectives	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.	Short-term
C2. Consider importing more nuclear electricity from the Mainland	- Future fuel mix having regard to our energy policy objectives	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.	Others
D. Operation of power generation plant			
D1. Upgrade burners of gas-fired generating units to improve fuel efficiency and emission performance*	- Cost implication - Technology advancement in fuel efficiency and emission reduction - Service life expectancy of existing gas-fired generation units	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.	Short-term
D2. Review operations of gas-fired power generating units with a view to identifying further emission reduction potential	- Requirements under the Air Pollution Control Ordinance - Operational constraints to meet electricity demand - Cost and tariff implication	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.	Short-term

Possible New Measures	Key Considerations for Implementation	Assessments at the Energy and Power Generation Sub-group	Outcome
E. New solar energy technology			
E1. Explore an idea of "SolarRoad" for promoting use of solar energy	- Road safety - Practicality - Technology maturity - Capital and maintenance costs - Maintenance and durability - Energy yield - Appearance	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.	Others
F. Use of biomass as fuel			
F1. Explore the use of waste materials such as corncobs, waste wooden pallets (i.e. biomass) as fuel*	- Precedent in using biomass as fuel - Environmental performance - Cost implication - Adaptation to existing combustion equipment and availability of commercial plants in using the biomass as fuel and their scale - Supply of biomass - Requirement for pre-treatment for the biomass - Community acceptance	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 T·PARK (sludge treatment facilities), 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.	Short-term
G. Energy storage			
G1. Explore the feasibility of using electric vehicles (EV) as electrical energy storage for power grid	- Cost implication to modify the EV charging system - Technical and safety considerations, particularly to the EV owner	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.	Others

Possible New Measures	Key Considerations for Implementation	Assessments at the Energy and Power Generation Sub-group	Outcome
	- Impacts on stability of the power grid - Site selection and security protection for charging facilities - Impact on the service life of EV battery		
G2. Explore the use of old EV batteries as an electrical energy storage system for the power grid	- Service lifetime of EV batteries - Space requirement for housing EV batteries - Technical considerations - Impacts on stability of the power grid	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.	Long-term

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

Appendix B

List of Possible New Air Quality Improvement Measures – Marine Transportation

Possible New Measures	Considerations	Assessments at the Marine Transportation Sub-group	Practicability of Implementation
A. Use of Clean Fuel			
A1. Explore the use of Liquefied Natural Gas (LNG) for marine vessels	- International trend and regulatory development in the use of clean fuel: - Technology maturity for use in onboard vessels - Availability of vessels in the market - Bunkering facilities - Fuel supply - Cost implications - Safety considerations	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 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.	Long-term
A2. Explore the use of biofuel (e.g. B5), fuel cell, Liquefied Petroleum Gas (LPG), compressed natural gas (CNG), methanol, nuclear and renewable energy, e.g. wind and solar energy, etc. for marine vessels	- International trend and regulatory development in the use of clean fuel - Technology maturity for use in on-board vessels - Availability of vessels in the market - Bunkering facilities - Fuel supply - Cost implications - Safety considerations	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 Government should keep a close watch on this development.	Long-term
A3. Explore the use of hybrid, diesel electric and electric vessels	- International trend and regulatory development in the	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-	Long-term

Possible New Measures	Considerations	Assessments at the Marine Transportation Sub-group	Practicability of Implementation
	use of clean fuel (e.g. battery development for electric vessels) - Technology maturity for use in on-board vessels - Availability of vessels in the market - Bunkering facilities - Fuel supply - Cost implications - Safety considerations	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 PGTF 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 PGTF 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%*	- International trend and regional situation in the use of lower sulphur fuel - Fuel supply - Cost implications - Trade reaction - Implications on port competitiveness	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 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	Short-term

Possible New Measures	Considerations	Assessments at the Marine Transportation Sub-group	Practicability of Implementation
		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*	- Infrastructure and ancillary facilities for power grid connection system - Availability and popularity of vessels capable to connect to the power grid - Operation and maintenance needs and cost - Trade reaction	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.	Short-term
A6. River trade vessels to use on-shore power supply (OPS) while at berth at terminals	- Infrastructure and ancillary facilities for OPS system - Availability and popularity of OPS-ready vessels - Operation and maintenance needs and cost	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 and OPS facilities. The limited space at terminals and the mode of operation, viz quick mooring and turnaround at terminals	Others

Possible New Measures	Considerations	Assessments at the Marine Transportation Sub-group	Practicability of Implementation
	- Trade reaction	for RTV, may make them impracticable to use OPS. The possible measure is considered not practicable.	
A7(a) OGVs to use OPS while at berth at Cruise Terminal	- Infrastructure and ancillary facilities for OPS system - Availability and popularity of OPS-ready vessels - Operation and maintenance needs and cost - Trade reaction	The 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.	Long-term
A7(b) OGVs to use OPS while at berth at container terminals	Ditto	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.	Others
B. Technical Measures			
B1. Impose emission standards on outboard engines of local vessels	- International regulatory development - Technology maturity and trend of usage - Cost implications - Applications to other types of local vessels - Trade reaction	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.	Medium-term

Possible New Measures	Considerations	Assessments at the Marine Transportation Sub-group	Practicability of Implementation
B2. Install emission reduction device (e.g. particulate filters) to reduce particulate matters emitted from local vessels	- Technical feasibility for installation - International trend and regulatory development in reducing PM emissions from marine vessels - Cost implications - Maintenance considerations - Trade reaction	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 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.	Others
B3. Impose control on NOx emissions from engines of local vessels	- Technology maturity and technical feasibility for installation - Cost implications - Trade reaction - International trend and regulatory development in reducing NOx emissions from marine vessels	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.	Others
C. Fuel economy			
C1. Explore financial incentive and disincentive schemes to encourage liners to use less polluting OGVs calling Hong Kong ports	- Implications on port competitiveness - Operating costs for the shipping trade - Benchmark for giving incentives / disincentives	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.	Medium-term

Possible New Measures	Considerations	Assessments at the Marine Transportation Sub-group	Practicability of Implementation
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)	- Strategic planning on port development - Marine traffic considerations - Feasibility - Impact on operation of container terminals, river trade terminals and public cargo working areas	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.	Others
C3. Slow-steaming of OGVs in Hong Kong waters	- Impact on marine traffic - Operating costs for the shipping trade - Trade reaction	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.	Others
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	- Availability of funding support for the studies and trials - Provision of resources for training of maritime professional and engineers, development of best practice guidelines and establishment of award system	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.	Long-term

Possible New Measures	Considerations	Assessments at the Marine Transportation Sub-group	Practicability of Implementation
	- Technology maturity, cost implications, safety considerations, availability of ancillary facilities and technical support of adopting such measures - Availability of mechanism to facilitate adoption of the measures by the trade and review of their outcomes		
D. Other suggestions			
D1. Remove floating rubbish for smooth operation of small local vessels	Note: This measures is not related to air qulaity improvement and not further discussed in the respective MT Sub-group.	Not related to air quality improvement and not further discussed in the MT Sub-group.	Others
D2. Government to expedite the approval process of new local vessels	Ditto.	Not related to air quality improvement and not further discussed in the MT Sub-group.	Others

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

Appendix C

List of Possible New Air Quality Improvement Measures – Road Transportation

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
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	- Agreements between the Government and tunnel franchisees - Ancillary road facilities and their capacity - Cost effectiveness - Implementation timeframe - Public reaction	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.]*	Short-term
A2. Consider replacing the existing toll collection system with completely automatic systems	- Agreements between the Government and tunnel franchisees - Ancillary road facilities and their capacity - Cost effectiveness - Implementation timeframe - Acceptability of tunnel users	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.]*	Others
B. Maintenance and repair of vehicle exhaust system			
B1. Propose to use chassis dynamometer for testing vehicle tailpipe emissions	- Air quality benefits - Ancillary facilities for vehicle examination - Cost effectiveness - Vehicle owners, vehicle repair trade and public reaction - Implementation timeframe	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	Others

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
		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 kilometers travelled as the vehicle examination criterion).	- Ancillary facilities for vehicle examination and handling capacity of vehicle examination centres - Vehicle owners, vehicle repair trade and public reaction - Relevant overseas experience - Cost effectiveness	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.	Others
B3. Provide vehicle tailpipe emission testing equipment for rent by small and medium-sized vehicle repair workshops	- Trade demand and reaction - Trade's concerns - Technical feasibility and cost effectiveness	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.	Others
B4. Establish a maintenance information database of vehicle tailpipe emission system	- Trade demand and reaction - Technical and operational feasibility - Cost effectiveness and implementation timeframe	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.	Short-term
B5. Raise awareness on the importance of vehicle maintenance and repair	- Drivers' and vehicle owners' reaction - Implementation timeframe	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.	Short-term

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
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*	- Ancillary road facilities and their capability - Public reaction - Cost effectiveness - Implementation timeframe - Technical feasibility and associated environmental impacts	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.	Short-term to Medium-term
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 development areas (NDAs).	- Ancillary road facilities and their capability - Public reaction - Cost effectiveness - Implementation timeframe - Technical feasibility and associated environmental impacts	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.	Long-term
C2a. 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 existing new towns and urban areas*	- Ancillary road facilities and their capability - Public reaction - Cost effectiveness - Implementation timeframe	The Road Transportation 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. 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.]*	Short-term to Medium-term
C2b. Foster "bicycle-friendly" environment and study into the provision of ancillary facilities for cycling (such as provision of cycling track	- Ancillary road facilities and their capability - Public reaction - Cost effectiveness	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.	Long-term

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
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 NDAs.	- Implementation timeframe	*[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.	- Technical feasibility - Cost effectiveness - Implementation timeframe - Public reaction	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.	Long-term
C4. Establish lower vehicle speed limits zones (e.g. 30km/h) in community roads, school zone and areas with elderly centres, to foster pedestrian environment.	- The spirit of "pedestrian-first" in this possible new measure is subsumed in C1 for consideration.	This measure has been assessed together with "Foster "pedestrian-friendly" environment" (Measure C1) as it carries the same spirit. *[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.]*	Others
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.	- Technical, operational and financial feasibility - Ancillary road facilities - Public transport trades reaction - Acceptability of the general public - Cost effectiveness - Implementation timeframe	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	Others

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
		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.	- Technical, operational and financial feasibility - Ancillary facilities - Public transport trades reaction - Acceptability of the general public - Cost effectiveness - Implementation timeframe	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 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 Pilot Green Transport Fund (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 RT 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.	Long-term
D3. Promotion of hybrid private cars	- Technical feasibility - Public reaction	Although the technology of hybrid car is mature and hybrid cars have lower fuel consumption than conventional cars, they still have tailpipe emissions.	Others

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
	- Cost effectiveness - Implementation timeframe	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.]*	
D4. Exploring the use of new-energy vehicles	- Technical feasibility - Public reaction - Cost effectiveness - Implementation timeframe	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.	Others
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	- Demand and its practicability - Feasibility of gathering information on low-emission transport mode - Cost effectiveness and implementation timeframe	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*	Short-term

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
		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	- Public demand and its practicability - Cost effectiveness - Implementation timeframe - Cooperation from carparks operated by private sector	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".]*	Short-term
E3. Implement electronic road pricing (ERP) scheme to tackle road traffic congestion at busy roads.	- Public and stakeholders' opinion - Technical feasibility - Cost effectiveness - Relevant overseas experience - Implementation timeframe (the need of conducting feasibility study, public engagement, legislation, detailed design and construction)	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 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.]*	Long-term
E4. Introduce ITS (e.g. manage traffic flow by traffic signal control, install smart sensors and surveillance cameras for illegal parking enforcement)	- Public reaction - Technical feasibility - Cost effectiveness - Implementation timeframe - Privacy concern	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.	Short-term to long-term, depending on individual ITS measure

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
		[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 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.]*	

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
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.	- Implementation timeframe - Actual demand of economic land in the long term	The RT Sub-group agreed on this measure which would in the long term improve traffic and air quality, and provided some recommendations in this aspect.	Long-term
F2. Use urban planning and design solutions together with transport management to improve air ventilation in high density development	- Implementation timeframe - Technical feasibility	The RT 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.	Short-term
F3. Conduct comprehensive review on the development of road transportation infrastructure and networks (such as construction of new tunnels and roads) to cope with population growth and to tackle road traffic congestion.	- Demand and practicality from planning perspective - Cost effectiveness - Limited development capacity of urban areas - Diverse public opinions on visual, environmental, and traffic impact during the construction of roads - The stricter air quality control as a result of the new Air Quality Objectives implemented in 2014 - Implementation timeframe	The RT 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. *[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.]*	Medium-term
F4. Provide low-emission transport mode to the residents of new development areas.	- Technical, operational and financial feasibility - Public reaction	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.	Long-term

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
	- Social costs and cost effectiveness - Implementation timeframe		
F5. Enhance district-based publicity on bus route rationalisation*	- Publicity	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.	Short-term
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, the measure was then split into two.)*	- Public and transport trade's reaction - Cost effectiveness and technical feasibility - Implementation timeframe - Impact on logistic trade	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.	Short-term
G1b. Raise the first registration tax and annual licence fees of more polluting vehicles *(note: G1a and G1b were originally one item. As they are in fact two ideas, the measure was then split into two.)*	- Public and transport trade's reaction - Cost effectiveness and technical feasibility - Implementation timeframe - Impact on logistic trade	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 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.	Others

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
G2. Enhance enforcement against illegal parking	- Public reaction - Cost effectiveness - Implementation timeframe - Enforcement manpower	The RT 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.]*	Short-term
G3. Review on-street metered parking fees	- Public reaction - Cost effectiveness - Implementation timeframe	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 planned to introduce an amendment bill into the LegCo within 2019 to increase the maximum fee chargeable for use of on-street metered parking spaces.]*	Short-term
H. Other suggestions			
H1. Provide information on the energy efficiency, emission performance and noise level of vehicles, etc. to facilitate the public to make a more environmentally-friendly choice	- Cost effectiveness, trade reaction, public demand and its practicability - Implementation timeframe	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. 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. Electrical and Mechanical Services Department (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	Others

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
		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	- Technical feasibility - Trade and public reaction - Cost effectiveness - Implementation timeframe	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.	Others
H3. Extend the coverage areas of the existing low emission zones and its restriction to other vehicle types.	- Feasibility and cost effectiveness - Public and trade reaction - Implementation timeframe	The RT 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.	Others
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 from idling engines.	- Trade demand and its practicability - Cost effectiveness - Implementation timeframe	The RT 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 in the Container Port Area are considered sufficient to meet the demand.*]	Medium-term
H5. Set up a continuous and effective priority road networks for public vehicles.	- Technical feasibility - Traffic impact - Trade reaction - Implementation timeframe	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 of 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.	Others

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
		[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.	- Operational and financial feasibility of franchised bus services - Trade reaction - Public reaction - Cost effectiveness - Implementation timeframe	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.	Others
H7. Provide funding to support District Councils for implementing air quality improvement projects.	- Technical feasibility - Implementation timeframe - Effectiveness of the measure	There is no strong justification to set up this funding proposal. Members of the public 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.	Others
H8. Raise public awareness on environmental protection, promote green living and encourage the public to use	- Implementation timeframe	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	Short-term

Possible New Measures	Key Considerations for implementation	Assessments at the Road Transportation Sub-group	Practicability of Implementation
public transport systems as well as low emission transportation options		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.	
New Road Vehicles Initiatives from 2018 Policy Address			
A. tighten the emission standards for newly registered motor cycles to Euro IV in 2020*	Not applicable	EPD has planned to tighten the emission standards for newly registered motorcycles to Euro IV by introducing the related regulation from October 2020.	Short-term
B. Launch an incentive-cum-regulatory scheme to progressively phase out Euro IV diesel commercial vehicles by the end of 2023*	Not applicable	There were about 40 000 registered Euro IV DCVs. Since they were first registered before 1 February 2014, they are not subject to the statutory 15-year service life limit, nor are they eligible to the above-mentioned ex-gratia payment upon retirement. To continue the impetus of improving the roadside air quality after the completion of phasing out pre-Euro IV DCVs programme, the Government planned to progressively phase out Euro IV DCVs by end 2023. *[Update: The latest information indicated the ex-gratia payment scheme to progressively phase out Euro IV DCVs will be implemented between Oct 2020 and to the end of 2027.]*	Short-term

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

Appendix D
List of Possible New Air Quality Improvement Measures – Other Emission Sources

VOC-containing products

Possible New Measures	Key Considerations for implementation	Deliberations at the Focus Groups	Outcome
VOC-1: Review the feasibility to impose VOC limits on consumer products that are not regulated under the Air Pollution Control (Volatile Organic Compounds) Regulation[21] *	- International regulatory development - Trend of usage and performance - Cost implication - Trade reaction and public acceptance	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.	Short-term
VOC-2: Review the feasibility to further tighten the VOC limits on regulated architectural paints*	- Ditto	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.	Short-term

[21] 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.

Non-road mobile machinery (NRMM)

Possible New Measures	Key Considerations for implementation	Deliberations at the Focus Groups	Outcome
NRMM-1a: Explore the feasibility to further tighten the emission standards on regulated machines newly supplied to Hong Kong	- International regulatory development - Availability of compliant regulated machines and trend of usage - Cost implication - Trade reaction	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 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.	Medium-term
NRMM-1b: Explore the feasibility to further tighten the emission standards on non-road vehicles newly supplied to Hong Kong	Ditto	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. [*Update: the Air Pollution Control (Non-road Mobile Machinery) (Emission) (Amendment) Regulation 2018, which aims to tighten the statutory emission standards in phases for newly approved non-road vehicles to improve air quality, came into effect on 1st January 2019. Specifically, newly approved non-road goods vehicles, petrol private cars, buses with design weight of more than 9 tonnes and light buses with design weight not exceeding 3.5 tonnes are required to comply with Euro VI emission standards.]* (reference: *https://www.info.gov.hk/gia/general/201901/01/P2018123100836.htm)*	Short-term
NRMM-2: Explore the feasibility of retrofitting exempted regulated machines and non-road vehicles to improve their emission performance	- Overseas experience - Technical maturity and constraints - Cost implications - Trade reaction	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.	Others

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

Cooking fumes

Possible New Measures	Key Considerations for implementation	Deliberations at the Focus Groups	Outcome
CF-1: Explore the feasibility of using new types of air pollution control equipment	- Technology maturity and trend of usage - Applications to different types of restaurants - Capital and maintenance costs - Maintenance and durability - Trade reaction	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.	Medium-term
CF-2: Promote "low-emission" cooking (e.g. use of clean and efficient cooking stoves and healthy cooking style, etc.).	- Trend of usage - Cost implication - Safety consideration and others	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 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-fuelled to electrical cooking stoves would also aid 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.	Medium-term

Civil Aviation

Possible New Measures	Key Considerations for implementation	Deliberations at the Focus Groups	Outcome
CA-1: Review on aviation emission control in the local context.	- No specific new measure had been proposed for the control on emission from civil aviation in the review	Taking into account the adoption of the International Civil Aviation Organization (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".)	Others

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