For discussion on
19 December 2018

LEGISLATIVE COUNCIL
PANEL ON ENVIRONMENTAL AFFAIRS

Progress on Improving Roadside Air Quality

PURPOSE

The Government has been implementing a series of measures to improve roadside air quality to better protect public health. This paper informs Members of the latest progress of these measures and brief Members on the proposed additional measures.

ROADSIDE AIR QUALITY TREND

2. Major sources of air pollution in Hong Kong are marine, road transport and electricity generation. Key roadside air pollutants from vehicles are respirable suspended particulates (RSP), fine suspended particulates (FSP) and nitrogen dioxide (NO_2). The percentage contribution of the vehicle fleet to the total key air pollutant emissions in Hong Kong in 2016 is at **Annex A**.

3. Commercial vehicles, including goods vehicles, buses, light buses and taxis, account for about 20% of the total vehicle fleet in terms of number, but are key emission sources of air pollutants at the roadside, accounting for about 95% of the total vehicular emissions of RSP and nitrogen oxides (NOx) in Hong Kong (see **Annex B**). Hence, these vehicles have all along been a major target of the Government's measures to improve roadside air quality.

4. With the emission control measures on vehicles in recent years, roadside concentrations of key air pollutants have decreased by 28% to 32% from 2013 to 2017 (**Annex C**). Progress of on-going emission control measures are set out at **Annex D**. Despite these improvements, the annual roadside NO_2 concentration is still at a level twice its Air Quality Objectives (AQO)[1] and remains a key challenge, which the Government is committed to tackle.

[1] In 2017, annual average of NO_2 concentrations recorded at Causeway Bay, Central & Mong Kok roadside monitoring stations were 97, 80 and 81 $\mu g/m^3$ respectively. The annual AQO limit of NO_2 is $40\mu g/m^3$. Although most people do not stay at roadside for a long time, high roadside pollution level would have adverse health impact on those staying for long hours at roadside.

PROPOSED NEW ROADSIDE AIR QUALITY IMPROVEMENT INITIATIVES

5. The Government plans to introduce the following new initiatives to further reduce air pollutant emissions from vehicles. Some of these proposed initiatives can be implemented shortly and some would take longer time. We consulted the Advisory Council on the Environment (ACE) on 3 December 2018 and the Council supported the proposed initiatives.

Phasing Out Euro IV Diesel Commercial Vehicles (DCVs)

6. DCVs first registered from 1 February 2014 are subject to a service life limit of 15 years (see **Annex D**), and an incentive-cum-regulatory programme was launched in March 2014 to progressively phase out about 82 000 pre-Euro IV (i.e. pre-Euro, Euro I, Euro II, Euro III) DCVs by end 2019, with $11.4 billion set aside as ex-gratia payment.

7. As at end June 2018, 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 current phasing out programme by end 2019, the Government plans to progressively phase out Euro IV DCVs by end 2023.

8. Similar to the current phasing out programme, we propose to phase out these 40 000 odd Euro IV DCVs by batches on a mandatory basis and offer ex-gratia payment to vehicle owners who scrap and de-register their Euro IV DCVs by the specified deadlines. After the deadlines, the licences of the DCVs concerned will not be renewed. Vehicle first registration dates will be used for distinguishing Euro IV vehicles. We are working out the implementation details (e.g. deadlines, funding requirements) with reference to the current phasing out pre-Euro IV DCV programme and will consult the trade in due course. We aim to advise this Panel again in late 2019 /early 2020 after we have drawn up draft implementation details and consulted the trade. It is estimated that the new programme would reduce about 1 090 tonnes NOx and 60 tonnes RSP (about 13% and 17% of the total vehicular emissions respectively) by end 2025.

Trial of Retrofitting Euro IV and V Double-Deck Franchised Buses with Enhanced Selective Catalytic Reduction (SCR) Systems

9. Retrofitting existing diesel buses with emission reduction devices (such as catalytic reduction devices) is one of the effective ways to reduce emissions. As mentioned in **Annex D**, the Government spent $197 million in

retrofitting 1 030 Euro II and Euro III franchised buses with SCR devices by end 2017, upgrading their emission performance to Euro IV level or above.

10. There are at present about 3 900 Euro IV and Euro V double deck franchised buses, belonging to six dominant bus models[2], all of which are already equipped with SCR systems. With the advancement of engine technology and emission reduction devices, Euro VI buses emit 90% less NOx and 50% less RSP than Euro IV buses, and 80% less NOx and 50% less RSP than Euro V buses.

11. In order to reduce NOx emissions from the public buses, starting from mid-2017, the Transport of London (TfL) has been subsidising public bus operators to retrofit about 4 900 Euro IV and V buses with enhanced SCR systems to upgrade their NOx emission performance to the Euro VI level by end 2020. With reference to London's experience, we plan to subsidise around $38 million to conduct a 6-month trial (Trial) to retrofit about 60 Euro IV and V double-deck franchised buses of the dominant bus models with enhanced SCR systems so as to establish the technical feasibility of the retrofitting work in Hong Kong, and to confirm the emission reduction performance of the enhanced SCR systems from different suppliers under the local driving and operation conditions.

12. Relevant franchised bus companies (FBCs) have lent their support to the Trial. A Task Force comprising FBCs, Environmental Protection Department (EPD), Transport Department (TD), local experts would be set up shortly to draw up technical specifications and detailed arrangements for the Trial, and monitor and evaluate the operational performance and emission reduction performance of the buses retrofitted with the enhanced SCR systems. We intend to engage a few enhanced SCR suppliers to take part in the Trial, each to design suitable enhanced SCR systems for one or more of the dominant bus models. We expect the Trial would start in 2020 and be completed in 2021. The aim of the Trial is to be able to compile a list of qualified enhanced SCR suppliers and suitable specifications, for the future full scale retrofit of the dominant bus models[3].

13. Subject to the satisfactory outcome of the Trial, the Government intends to fully subsidise FBCs to retrofit about 3 900 eligible Euro IV and Euro V double-deck franchised buses with enhanced SCR systems, so as to bring their emission performance to Euro VI level. Assuming that the full

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[2] There are around 4 000 Euro IV and V double-deck franchised buses, and 3 942 of them belong to six dominant bus models. The number of the buses of these six models range from 90 to 2143. These six models are - *ADL Enviro500 11.3/12M, ADL Enviro500 12M, ADL Enviro400 10.5M, ADL Enviro500 TURBO 11.3/12.8M, Volvo B9TL Wright Body 12M, and Volvo B9TL6X2 11.3M*

[3] As the designs of the enhanced SCR systems are different in respect of different bus models, and it requires extensive time and effort to design, it would not be cost effective to retrofit models with only a small number of vehicles.

scale retrofit can be completed in 2024, we estimate that there would be a reduction of approximately 1 070 tonnes of NOx and 70 tonnes of RSP emissions (12% and 19% of the total vehicular emissions respectively) in 2025.

Tightening the Emission Standards of First Registered Motorcycles (MCs), Light Buses (Design Weight of more than 3.5 tonnes) and Buses (Design Weight of not more than 9 tonnes)

14. It has been the Government's standing policy to tighten the emission standards of motor vehicles upon first registration, with reference to the international developments and the supply of compliant vehicles to Hong Kong. The Air Pollution Control (Vehicle Design Standards) (Emission) (Amendment) Regulation 2017 was passed in the Legislative Council (LegCo) in April 2017 to tighten the statutory emission standards for various classes of vehicles as set out in the table below –

Vehicle Class	**Commencement Date**	
	Euro 6b On Board Diagnostic (OBD)[4] Euro 6-1[5]	***Euro 6c OBD Euro 6-2[6]***
Private Car (petrol) and Taxi	1 July 2017	1 September 2019
Light bus and Goods Vehicle (both of design weight not more than 3.5 tonnes)	1 January 2018	1 September 2020
	Euro VI OBD Phase A/B[5]	***Euro VI OBD Phase C[6]***
Bus (design weight more than 9 tonnes) and Goods Vehicle (design weight more than 3.5 tonnes)	1 October 2018	1 April 2019
	California LEV III	
Diesel private cars	1 October 2017	

15. In view of the current adequate supply of Euro 4 compliant MC models and the latest projection of supply of Euro VI compliant light bus and bus models, we recommend –

[4] On Board Diagnostic (OBD) as defined in European Commission Regulation 582/2011 is "a system on board a vehicle or connected to an engine which has the capability of detecting malfunctions, and, if applicable, of indicating their occurrence by means of an alert system, of identifying the likely area of malfunction by means of information stored in computer memory, and of communicating that information off-board".

[5] The initial phase of the tightening involve the introduction of more stringent emission standards in the certification emission test as well as other requirements such as new testing procedures for heavy duty vehicles, more comprehensive checking on emissions by the On Board Diagnostic (OBD) system, etc.

[6] The subsequent phases mainly involve the tightening in stages of the requirements for the OBD system.

(a) tightening the emission standards of first registered MCs to Euro 4, in second half of 2020 ; and
(b) tightening the emission standards of first registered light buses (design weight of more than 3.5 tonnes) and buses (design weight of not more than 9 tonnes) to Euro VI, OBD Phase C, starting from early 2021.

16. For motor tricycles, as the current supply of Euro 4 compliant models in the local market is still insufficient, we will continue to keep in view the supply of Euro 4 compliant motor tricycles for assessing the feasibility of tightening the relevant emission standards in future.

17. The proposed new emission standards will be implemented through amending the Air Pollution Control (Vehicle Design Standards) (Emission) Regulations, Cap 311J. Justifications for the proposals in paragraph 15(a) and (b) are set out below.

Motorcycles (MCs)

18. MCs are the most significant source of Volatile Organic Compounds (VOC) of the vehicle fleet. In 2016, the 50 900 MCs (7% of total vehicle fleet) accounted for 3 100 tonnes of total VOC (65% of total VOC from the vehicle fleet).

19. The European Union (EU), Japan and Taiwan have already implemented Euro 4 or equivalent emission standards in 2017 and the Mainland will also implement China 4 standards (equivalent to Euro 4 standards) from July 2019. In comparison with Euro 3 counterparts, Euro 4 petrol MCs emit about 60% less NOx and about 50% less total hydrocarbon (including VOC) from the tailpipes (see **Annex E**). The EU has also introduced control on evaporative emission of VOC and requirements for OBD system to further reduce their emissions.

20. Following the implementation of Euro 4 or equivalent emission standards for MCs in other places, there are now in Hong Kong about 140 Euro 4 compliant MC models type-approved by the TD. As can be seen from the first registration figures in 2017 and 2018 (up to end October), Euro 4 MCs are becoming more popular over the last two years -

	2017		2018 (up to end Oct)	
	No. of MC first registered (imported through authorized dealers)	No. of MC applications approved based on Certificate of Conformity through parallel importers [note]	No. of MC first registered (imported through authorized dealers)	No. of MC applications approved based on Certificate of Conformity through parallel importers [note]
Euro 3	2 334 (56%)	65	1 213 (38%)	25
Euro 4	1 819 (44%)	112	2 006 (62%)	139
Total	4 153	177	3 219	164

Note: The figures include those applications approved based on Certificate of Conformity (C.O.C.) but exclude applications approved based on local emission test results, as the test reports concerned only certified whether the MCs met Euro 3 standard and did not provide information on whether they met Euro 4. There were 1 216 and 843 MC applications approved in 2017 and 2018 (up to end October) respectively based on local emission test results.

21. Considering the adequate local supply of Euro 4 compliant MC models, we propose to tighten the emission standards of first registered MC to Euro 4 from the second half of 2020.

22. In August and September 2018, EPD consulted the MC supplier trade (i.e. authorised MC dealers and parallel-import MC suppliers) on the proposal above. All authorised MC dealers, which supply the majority of MCs, did not object to the proposal. However, the parallel-import MC suppliers strongly objected to the proposal as they indicated difficulty to source parallel-import MCs from other places that could meet the Euro 4 standards in 2020. They requested that the implementation date be deferred by a few years to allow adequate time for them to prepare for the tightening of the standards. We consider their request not justifiable because (a) Europe, Japan and Taiwan have already implemented Euro 4 or equivalent emission standards for MCs and their brands are most popular in Hong Kong[7]; (b) there are now about 140 type approved Euro 4 compliant models and more are expected to come; and (c) in any case, the period from now to the proposed implementation date in 2020 should be adequate for them to map out their business corresponding plans to cope with the proposals.

Light buses (design weight of more than 3.5 tonnes) and buses (design weight of not more than 9 tonnes)

23. The EU has been implementing Euro VI emission standards since 2013. Compared with Euro V counterparts, Euro VI heavy duty diesel vehicles emit about 80% less NOx and 50% less RSP (**Annex E**).

[7] Most popular MC brands in Hong Kong are from Europe, Japan and Taiwan. Their market share of first registered MCs in 2017 and 2018 were over 90%.

24. As at end September 2018, there were 2 843 registered buses[8] (design weight of not more than 9 tonnes), which all run on diesel, and 7 523 registered light buses[8] (design weight of more than 3.5 tonnes), around 59% of which (4 450) run on liquefied petroleum gas (LPG) and 41% (3 073) on diesel.

25. Currently, there are 4 Euro VI diesel light bus models (design weight of more than 3.5 tonnes) and 3 Euro VI diesel bus models (design weight of not more than 9 tonnes) type-approved by TD. The two major suppliers of bus (design weight of not more than 9 tonnes) accounting for over 90% of market share[9] have advised EPD that Euro VI OBD Phase C or above bus model (design weight of not more than 9 tonnes) would be available to Hong Kong by January 2021. The two major suppliers of light bus (design weight of more than 3.5 tonnes) accounting for over 90% of market share[10] have also advised EPD that Euro VI OBD Phase C or above light bus model (design weight of more than 3.5 tonnes) would be available to Hong Kong by January 2021. In addition, we understand from other vehicle suppliers that they have plans to introduce Euro VI OBD Phase C compliant light bus and bus models to Hong Kong, hence it is anticipated that there should be adequate Euro VI OBD Phase C compliant models by early 2021.

26. EPD has consulted the light bus and bus trade and relevant vehicle suppliers[11] in November 2018. Light bus and bus suppliers as well as operators had no objection to our proposal provided that there would be adequate supply of Euro VI OBD Phase C compliant vehicles before the effective date of the new emission standards. In addition, operators requested the Government to regularly monitor the actual supply of Euro VI compliant vehicle models and make necessary adjustments to the implementation schedule of the new standards in case the supply of Euro VI OBD Phase C light buses (design weight of more than 3.5 tonnes) and buses (design weight of not more than 9 tonnes) could not be able to meet the market needs by early 2021. Some light bus operators pointed out that the dealers and they might need time to solve teething problem of the new Euro VI OBD Phase C model, which would be supplied to Hong Kong in early 2021, and requested us to take note of this when setting the implementation date. Some vehicle suppliers indicated that Euro VI OBD Phase C models had been ready to supply Hong Kong, and welcomed the proposal to be launched as early as practicable. Taking into account the views of the stakeholders, we propose to tighten the

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8 excluding electric vehicles

9 based on the first registered buses in 2017 and 2018

10 based on the first registered light buses in 2017 and 2018

11 including the Hong Kong Motor Traders Association (MTA), which comprises local representatives of major motor vehicle manufacturers; the Automotive Council of European Chamber of Commerce in Hong Kong (EuroCham), which comprises representatives of European vehicle manufacturers, and the Hong Kong Bus Suppliers Association (HKBSA), which comprises local bus suppliers.

emission standards of first registered light buses (design weight of more than 3.5 tonnes) and buses (design weight of not more than 9 tonnes) to Euro VI OBD Phase C in early 2021. We will continue to monitor the supply of compliant vehicle models during the legislative amendment process.

27. For LPG light buses, the sole LPG light bus supplier has indicated that it has decided to cease the production and supply of LPG light buses in the future. It is highly unlikely that there will be supply of LPG light buses from other vehicle suppliers. Notwithstanding this, we also propose to tighten the emission standards for newly registered LPG light buses to Euro VI OBD Phase C in early 2021 in case there is supply of LPG light buses in future.

28. If the proposals on MCs, light buses and buses go ahead as planned above, it is estimated that there would be a reduction of approximately 290 tonnes of NOx, 11 tonnes of RSP and 1 290 tonnes of total VOC emissions (4%, 3% and 29% of total vehicular emissions) in 2025.

Environmental Benefits

29. It is estimated that, if the above new initiatives [12] are fully implemented as proposed, the overall annual average of NO_2 concentrations and FSP concentrations at the three roadside air quality monitoring stations could reduce by 19 ug/m^3 and 3 ug/m^3 respectively in 2025.

<u>Review of the Scope of the Pilot Green Transport Fund (PGTF)</u>

30. At present, the PGTF subsidise local trials of green innovative transport technologies that stand a good chance of coping with the operational requirements of the local transport trades and could be adopted by the relevant trades for wider use upon successful trials. Public transport sectors, charitable/non-profit making organisations providing services to their clients, and operators of goods vehicles (including special purpose vehicles) are eligible to apply. According to the PGTF trial results (**Annex D**), most of green commercial vehicles are yet to become popular as their technologies still need to be developed and are yet to fully meet the operational requirements of the local transport trades. The Government considers that we should continue to encourage trials of those green innovative transport technologies in order to incentivise vehicle suppliers to introduce more green commercial vehicles that may suit our local operational requirements, through the PGTF. Separately,

[12] Measures include phasing out about 40 000 Euro IV DCVs, retrofitting about 3 900 eligible Euro IV and Euro V double-deck franchised buses with enhanced SCR systems, and tightening the Emission Standards of First Registered Motorcycles, Light Buses (Design Weight of more than 3.5 tonnes) and Buses (Design Weight of not more than 9 tonnes)

the results of the PGTF trials have also shown that some technologies, such as electric light goods vehicles (van-type) (e-LGVs), could meet the operational requirements of some transport sectors as evidenced by the willingness of more transport operators to try out e-LGVs under the PGTF. In this regard, it is considered necessary to explore means to facilitate the transport trades' wider use of those green innovative transport technologies that have been proved to be relatively mature and suitable for adoption locally, with a view to further improving roadside air quality and reducing carbon emissions.

31. EPD intends to conduct the review of the PGTF along the following directions:

(i) Whilst the current conditions for approving subsidy for the PGTF trials (i.e. trials of technologies that stand a good chance of coping with the local operational requirements and will be adopted by the relevant transport sectors for wider use upon successful trial) should be retained, we would review if improvements could be made in various areas including the subsidy scope, applicants' eligibility, subsidy levels, limits on the number of applications for each type of technologies, conditions for receiving the subsidy, etc.

(ii) The review should also explore means to encourage wider use of technologies that have been proved by the trials to be relatively mature and suitable for adoption locally, e.g. whether subsidy should be provided to the trades for purchasing the products without the requirement for conducting a trial. We also need to map out the specifications and criteria for implementation.

32. The EPD will commence the review as soon as possible and aim to complete it in 2019. The EPD will consult the Panel after formulating relevant proposals.

Promoting Use of New Energy Vehicles

33. To further reduce emissions of air pollutants from private cars, the Government will continue to encourage the public to use new energy vehicles in the hope that all newly registered private cars in Hong Kong will ultimately become new energy vehicles in the long run. As the first step, we may consider ceasing the first registration of diesel private cars subject to consultation with stakeholders. Similarly, we will also consider whether the first registration of diesel motor cycles should be ceased.

ADVICE SOUGHT

34. Members are invited to note the progress made in improving the roadside air quality and comment on the new roadside air quality improvement proposals.

Environment Bureau/Environmental Protection Department

December 2018

Annex A

Contribution of Vehicle Emissions to the Total Air Pollutant Emissions in Hong Kong in 2016

Pollutants	Contribution of Vehicle Emissions to Total Emissions
RSP	10%
FSP	11%
NO_x	18%

Annex B

Hong Kong Air Pollutant Emission Inventory 2016 - Road Transport

2016 Road Transport Emissions (Note)						
Use	**Fuel**	**Vehicle Class**	**Number of Vehicles**	**RSP**	**FSP**	**NOx**
				Tonne (%)		
Non-commercial	**Diesel**	Private Car	7,200	<5 (1%)	<5 (1%)	20 (0%)
		Total (Diesel)	**7,200**	**<5 (1%)**	**<5 (1%)**	**20 (0%)**
	Petrol	Private Car	524,000	20 (5%)	20 (5%)	430(3%)
		Motor Cycle	50,900	<5 (1%)	<5 (1%)	140 (1%)
		Total (Petrol)	**575,000**	**30 (6%)**	**20 (6%)**	**570 (4%)**
	Total (Non-commercial)		**582,000**	**30 (7%)**	**30 (7%)**	**590 (4%)**
Commercial	**Diesel**	Light Goods Vehicle	70,100	80 (18%)	70 (18%)	2,400 (15%)
		Medium or Heavy Goods Vehicle	42,600	150 (37%)	140 (37%)	4,800 (29%)
		Public Light Bus	1,200	40 (9%)	40 (9%)	370 (2%)
		Private Light Bus	2,700	<5 (1%)	<5 (1%)	120 (1%)
		Franchised bus	5,900	70 (18%)	70 (18%)	3,200 (20%)
		Non-Franchised Public/Private Bus	8,000	40 (10%)	40 (10%)	1,400 (8%)
		Total (Diesel)	**131,000**	**390 (93%)**	**360 (93%)**	**12,200 (75%)**
	Petrol	Light Goods Vehicle	1,700	<5 (0%)	<5 (0%)	8 (0%)
		Private Light Bus	410	<5 (0%)	<5 (0%)	<5 (0%)
		Taxi	10	<5 (0%)	<5 (0%)	<5 (0%)
		Total (Petrol)	**2,100**	**<5 (0%)**	**<5 (0%)**	**10 (0%)**
	LPG	Public Light Bus	3,100	<5 (0%)	<5 (0%)	380 (2%)
		Private Light Bus	1,100	<5 (0%)	<5 (0%)	10 (0%)
		Taxi	18,300	<5 (0%)	<5 (0%)	3,000 (19%)
		Total (LPG)	**22,500**	<5 (0%)	<5 (0%)	3,400 (21%)
	Total (Commercial)		**155,000**	**390 (93%)**	**360 (93%)**	**15,600 (96%)**
Total			**737,000**	**420 (100%)**	**380 (100%)**	**16,200 (100%)**

Note:
- The number less than 5 is represented by "<5", the number of 5 to 10 is rounded to the nearest integer, the number greater than 10 and 1,000 is rounded to the nearest ten, the number greater than 1,000 to 10,000 is rounded to the nearest hundred, and the number of greater than 10,000 is rounded to three significant figures.
- Number of vehicles are the number of licensed vehicles (including government vehicles) in 2016.

Annex C

Roadside Concentrations of Key Air Pollutants (from 2013 to 2017)

Pollutants	Roadside Concentrations (μg/m^3)					% Difference
	2013	2014	2015	2016	2017	2017 vs 2013
RSP	57	50	45	38	39	-32%
FSP	37	32	30	26	26	-30%
NO_2	120	102	99	82	86	-28%

Annex D

Progress of On-going Emission Control Initiatives on Vehicles

Phasing Out Pre-Euro IV Diesel Commercial Vehicles

1. The Government launched an incentive-cum-regulatory scheme in March 2014[1] to progressively phase out pre-Euro IV (i.e. pre-Euro, Euro I, Euro II, Euro III) diesel commercial vehicles (DCVs) before 2020 with $11.4 billion set aside as ex-gratia payment to assist the affected vehicle owners. According to the Air Pollution Control (Air Pollutant Emission) (Controlled Vehicles) Regulation, Cap. 311X (the Regulation), the following are retirement deadlines for pre-Euro IV DCVs, after which the licences of the DCVs concerned will not be renewed –

Emission Design Standard of DCVs	Retirement deadlines
Pre-Euro	December 31, 2015
Euro I	December 31, 2016
Euro II	December 31, 2017
Euro III	December 31, 2019

2. To facilitate timely replacement of DCVs in the long run, the Regulation also stipulates a service life limit of 15 years for DCVs first-registered on or after 1 February 2014.

3. As at 31 October 2018, about 65 600 DCVs (about 80% of the eligible vehicles) were scrapped with an approved ex-gratia payment amounting to about $8.8 billion. Detailed information of DCVs scrapped under the scheme is at **Appendix I to Annex D**[2].

[1] There were about 82 000 pre-Euro IV DCVs (including goods vehicles, light buses and non-franchised buses) at the time. In 2013, pre-Euro IV DCVs accounted for more than 85% and 70% of the RSP and NOx emissions respectively of the DCV fleet.

[2] Since the Regulation came into effect, exemptions were granted for 26 pre-Euro IV DCVs to extend the retirement deadline in accordance with Section 6 of the Regulation. Section 6 of the Regulation provided that the EPD may exempt a vehicle from the application of the Regulation for not more than 1 year if it is satisfied that exceptional circumstances make it impractical or unreasonable for a controlled vehicle to comply with this Regulation.

Retrofitting Selective Catalytic Reduction (SCR) Devices on Euro II and III Franchised Buses

4. Franchised bus companies (FBCs) are required to replace franchised buses before they reached 18 years old. Over the past few years, the Government fully subsidised the FBCs to retrofit eligible Euro II and III franchised buses[3] with SCR devices to reduce their emissions, thereby upgrading their emission performance to that of Euro IV or above level. The retrofit programme was completed by the end of 2017 under which 1 030 Euro II and Euro III franchised buses were retrofitted with SCR devices. The total expenditure was $197 million.

Franchised Bus Low Emission Zones (FBLEZs)

5. In the busy corridors in Central, Causeway Bay and Mong Kok, franchised buses could account for up to 40% of the traffic flow. Setting up FBLEZs by restricting access to low emission franchised buses could bring improvement to the roadside air quality not only within the FBLEZs, but also the districts that the low emission buses will ply. As such, the Government has set up FBLEZs in three busy corridors in these three areas on 31 December 2015. FBCs are required to deploy low emission buses (i.e. buses meeting Euro IV or higher emission standards or Euro II and III buses retrofitted with SCR devices and diesel particulate filters) to routes running through the FBLEZs. At present, more than 99%[4] of the buses passing through the FBLEZs are low emission buses.

6. As there are more and more Euro V or Euro VI buses in the franchised bus fleet, the Government is now discussing with FBCs on the tightening of the requirement of the FBLEZs with a view to requiring FBCs to deploy buses meeting Euro V and above standards in the FBLEZs as soon as practicable.

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[3] All pre-Euro and Euro I buses have already retired.

[4] In case of unexpected service disruptions due to traffic congestion, vehicle breakdowns, traffic accidents and ad-hoc trips etc., the FBCs may need to deploy non-low emission buses to ply the FBLEZs occasionally in order to maintain normal bus services. However, these exceptional cases will be reduced further with the FBCs acquiring more environmental friendly buses into their bus fleet. We envisage that the deployment of non-low emission buses to the FBLEZs under these exceptional cases will be further reduced.

Trial of Single-Deck Electric Franchised Buses

7. Electric buses do not have exhaust emissions. Replacing conventional franchised buses with electric buses can improve roadside air quality. The Government provided $180 million to fully subsidise the FBCs (including Kowloon Motor Bus Company (1933) Limited (KMB), Long Win Bus Company Limited (LWB), Citybus Limited (CTB), New World First Bus Services Limited (NWFB) and New Lantao Bus Company (1973) Limited (NLB)) to acquire 36 single-deck electric buses (including 28 battery-electric buses and eight supercapacitor buses) for conducting a two-year trial to test out their performance, reliability as well as economic feasibility in local conditions. To monitor and assess the operational efficiency and performance of electric buses, a Task Force, comprising representatives from the relevant FBCs, Environmental Protection Department (EPD), Transport Department (TD), as well as local academics was set up.

8. At present, 26 battery-electric buses and four supercapacitor buses have commenced operation. The remaining two battery-electric buses of NLB are under re-tendering process, and are expected to commence operation by the end of 2019 at the earliest. Besides, four more supercapacitor buses of KMB will commence operation in the first quarter and the second quarter of 2019 respectively. The details are set out below –

	BYD Battery-electric Buses	Great Dragon Battery-electric Buses	Youngman Supercapacitor Buses
No. of Buses	21	5	4[Note]
Manufacturer	BYD Auto Industry Company Limited	Great Dragon International Corporation Limited	China Youngman Automobile Group Company Limited
Passenger Carrying Capacity	**14 KMB/LWB buses**: 70 (including 35 seats) **5 CTB/NWFB buses**: 68 (including 31 seats) **2 NLB buses**: 71(including 31 seats)	**CTB/NWFB:** 64 (including 35 seats)	**KMB:** 72 (including 35 seats)
Battery Capacity	324kWh	315kWh	53kWh
Power and Charging Requirement	380V/126A (AC)	700V/100A (DC)	750V/200A (DC)

Note The remaining four are also from China Youngman Automobile Group Company Limited

9. The five ***battery-electric buses*** of CTB and NWFB manufactured by BYD Auto Industry Company Limited (BYD), were the first batch of buses, commencing operation by the end of 2015. At the initial stage of trial, there were various incidents of the battery-electric buses, including excessive regenerative braking torque affecting the braking performance of electric buses in rainy weather that led to suspension of the trial to conduct thorough maintenance and checking. The Task Force finally decided to extend the trial for five months to make up the downtime for rectification of the problems. The trial of five BYD battery-electric buses completed in May 2018.

10. FBCs advised that the driving performance of battery-electric buses was comparable with that of the conventional diesel buses, but they were different from the conventional diesel buses in terms of vehicle operation and characteristics. The trial results of the five BYD battery-electric buses showed that the bus availability (excluding outage unrelated to malfunctions of the buses) was 77.3%, which was slightly lower than the conventional diesel buses of 88.3%.

11. In terms of driving range, the information of BYD showed that the driving range of battery-electric buses after a full charge could reach 250 km. The trial results of CTB/NWFB showed that the electricity consumption per kilometer under the operational mode of hilly terrains in Hong Kong and high demand on air-conditioning is higher than that in other places[5] and the situation is even worse in hot and humid summer. The average driving range of the five BYD battery-electric buses was about 190 km. In the months with high ambient temperature, the driving range could decrease to about 150 km, which is far lower than the daily mileage requirement of general public buses for 200 to 300 km. The preliminary trial results showed that the remaining 21 battery-electric buses in operation encountered the same problem of limited driving range. EPD together with the FBCs and manufacturers are exploring the possibility of increasing the battery efficiency to enhance the driving range and identifying suitable routes with their operational conditions which could cope with the limited driving range.

12. The above trial results of CTB/NWFB have preliminarily indicated

[5] The average electricity consumption in Hong Kong is 1.36 kWh per kilometer, which is higher than the single-deck battery-electric buses in Shenzhen of average 1 kWh per kilometer, i.e. about 30% more.

that the wider use of single-deck battery-electric buses in Hong Kong will hinge on –

(a) whether the battery capacity of single-deck battery-electric bus could be substantially increased enabling it to travel about 300 km a day after a full charge; and/or
(b) whether there is adequate space for installation of charging facilities at the termini or public transport interchanges for top-up charging of the single-deck battery-electric buses in daytime taking into account mode of charging in daytime and high operation frequency of buses in Hong Kong.

13. As for the ***supercapacitor buses***, the first batch of two commenced the trial in late March 2017 and the operation has been satisfactory so far. However, there was unstable operation of supercapacitors under high temperature in summer. In this connection, the bus supplier adjusted the supercapacitor system to enhance the vehicle stability in summer. Two more supercapacitor buses commenced operation in November 2018. KMB will continue to work with the bus supplier on the performance of supercapacitor buses to ensure that the buses are in stable operation.

14. Further details of the trial and operational performance of the ebuses under trial are in **Appendix II to Annex D**. We will continue to monitor the performance of the electric buses on trial.

Strengthened Emission Control of Petrol and Liquefied Petroleum Gas (LPG) Vehicles

15. Poorly maintained petrol and LPG vehicles could emit carbon monoxide, hydrocarbons and NOx up to ten times their normal levels. After providing $80 million to help some 17 000 LPG and petrol taxis and light buses to replace their worn-out catalytic converters and oxygen sensors, the Government strengthened the emission control for these two types of vehicles since September 2014. Through deploying portable roadside remote sensing equipment, gross emitters in the petrol and LPG vehicle fleet are identified. The vehicle owners concerned are required to fix the vehicles' excessive emission problems and have the vehicles tested at a designated vehicle emission testing centre within 12 working days from issue of an Emission Testing Notice (ETN), to confirm rectification of the vehicle's excessive

emission problems. If the vehicles fail to pass the emission tests, their licences may be cancelled.

16. As at the end of October 2018, some 2.7 million petrol and LPG vehicle counts have been screened and about 15 000 ETNs issued, amongst which about 500 licences of vehicles failed to fulfil the emission test requirement within the prescribed period.

17. EPD has progressively increased the deployment of roadside remote sensors from previously up to three locations to currently up to five locations per day in 2018. About 720 000 vehicle counts were screened and about 4 700 ETNs were issued in the first ten months of 2018, which were about 30% and 60% more than those in 2017 respectively. According to the data gathered so far, the gross emitters in the petrol fleet have reduced from about 10% in 2014 to current 5%, and those in LPG vehicle fleet from about 80% to 20%. We will continue to monitor the emission level of the vehicle fleet to work out future plans of deploying roadside remote sensors.

Pilot Green Transport Fund (PGTF)

18. The Government has put in place a $300 million PGTF since March 2011 to encourage the public transport sectors (including taxi, public light bus, bus and ferry), goods vehicle operators and charitable/non-profit making organisations to try out green innovative transport technologies. Recipients of the PGTF will have to record the trial data for evaluating the performance of the transport technologies concerned and to share with their peers the trial experience so as to promote a wider use of technologies that have been trialed with satisfactory results.

19. As at the end of October 2018, PGTF approved 135 trials with a total subsidy of about $138 million, involving electric commercial vehicles (e-CVs) (including light goods vehicles (van type), medium goods vehicles (tractor), single-deck buses, light buses and taxis), hybrid commercial vehicles (including light goods vehicles (non-van type), medium goods vehicles, single-deck buses and light buses), solar air-conditioning system for bus, electric inverter air conditioning system for bus, diesel-electric propulsion system for ferry and seawater scrubber for ferry. A total of 67 trials have been completed for 42 electric light goods vehicles (van type), eight single-deck electric buses, three electric taxis, 25 hybrid light goods vehicles (non-van type), 14 hybrid medium goods vehicles, five hybrid light buses, one

solar air-conditioning system for bus, two electric inverter air conditioning systems for buses, one diesel-electric propulsion system for ferry and one seawater scrubber for ferry. A total of 57 trial reports have been uploaded to the dedicated website of PGTF for public information. The key findings on trials so far on vehicles are set out below.

(i) Electric Commercial Vehicles

20. e-CVs under trial could save 31% to 91% of their energy cost on an individual vehicle basis compared with their conventional counterparts. Results of the trials have reflected that high production cost, limited service life, long charging time and low energy density of batteries are the key constraints for e-CVs to become popular. The hilly terrain in Hong Kong and the need to have air-conditioning during summer also reduce the driving range of e-CVs. As a result, the existing e-CV technologies are yet to be able to cope with the operational needs of local taxis, light buses and single-deck buses. All the 3 electric taxis that were once trialed under PGTF have been re-registered as private cars because taxis generally run almost a whole day and under normal operation cannot spare four-hours a day for charging. Electric light buses and electric single-deck buses have also experienced similar problems. The electric light buses trialed under PGTF, after a full charge which takes four hours, could only sustain a driving range of 180 km which is lower than the daily mileage of a typical public light bus. In the case of the single-deck electric buses under trial, the driving range varies from 200 km to 280 km after a full charge which takes as long as four hours.

21. In comparison, electric light goods vehicles (e-LGVs) (van type) are more likely to gain popularity and are suitable for operators who require relatively lower daily mileage and payload because batteries of these vehicles can be topped up outside operation hours. However, e-LGVs might not be suitable for transport trades requiring higher mileage and payload. With the advancement of e-LGV technology, we would expect more e-LGV models with higher driving range and payload, as well as competitive price, will be introduced to Hong Kong in future[6].

[6] Two brands tested under PGTF are going to introduce new e-LGV models with more promising driving performance. Compared with the old models, the driving ranges of the two new models increases by 59% (from 170 km to 270 km) and 92% (from 165 km to 317 km) respectively. The payloads of these new models are some 650 kg and 630 kg respectively which are lower than the payload of a typical conventional diesel light goods vehicle (van type) (some 850 kg). As advised by one of the vendors of the two brands, the battery warranty of its new model will be extended from 5

(ii) Hybrid Commercial Vehicles

22. Higher fuel economy is the major merit of hybrid vehicles over their conventional counterparts, thereby reducing roadside emission and operational cost. However, the actual fuel economy of a hybrid vehicle depends on the operation modes. A route requiring frequent start-stop will harness better the hybrid drive-train. If a route is dominated by highway driving, a hybrid vehicle can hardly outperform its conventional counterpart in fuel economy. For this reason, the trial results found that the hybrid goods vehicles' incurred fuel saving ranging from 3% to 32% as compared with their conventional counterparts whilst the corresponding figure for the hybrid light buses was not more than 4%. The latter had a poorer fuel economy performance which might be caused by inadequate cooling for their batteries.

(iii) Other Technologies

23. The trial of a solar air-conditioning system for bus was also completed with the result indicating a 10% fuel cost saving. Also, the preliminary result of an electric inverter air-conditioning system for bus indicated a 17% fuel cost saving.

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years or 100 000 km to 8 years or 160 000 km, but it will cost less than the old model. Furthermore, there is a new brand of e-LGVs recently entering into the market. Its vendor advised that the two e-LGV models of this new brand could also have driving range up to 350 km and 400 km respectively with a payload not lower than 870 kg which is more or less the same as that of a typical conventional diesel light goods vehicle.

Appendix I to Annex D

Phasing Out Pre-Euro IV DCVs

Number of Applications for Ex-gratia Payment (by emission standards and vehicle types) (as at 31 October 2018)

Vehicle Types	No. of applications for ex-gratia payment (take-up rate)					No. of applications approved	Total no. of eligible DCVs
	Pre-Euro	Euro I	Euro II	Euro III	Total		
Light goods vehicles	8,748 (89.8%)	10,188 (96.4%)	10,503 (98.5%)	8,924 (50.9%)	38,363 (79.1%)	38,064	48,499
Medium goods vehicles	6,477 (90.2%)	2,241 (92.9%)	6,038 (98.9%)	5,520 (57.1%)	20,276 (80.0%)	20,146	25,358
Heavy goods vehicles	657 (96.6%)	311 (99.4%)	778 (99.2%)	274 (53.4%)	2,020 (88.2%)	2,014	2,290
Public light buses	15 (100.0%)	283 (99.0%)	497 (97.1%)	93 (23.0%)	888 (72.9%)	875	1,218
Private light buses	297 (94.6%)	334 (93.6%)	394 (97.5%)	72 (36.9%)	1,097 (86.4%)	1,085	1,270
Non-franchised buses	168 (94.4%)	124 (94.7%)	547 (91.9%)	2,164 (82.9%)	3,003 (85.4%)	2,976	3,515
Total	16,362 (90.3%)	13,481 (95.8%)	18,757 (98.4%)	17,047 (55.2%)	65,647 (79.9%)	65,160	82,150

Note: Issue of vehicle licences to pre-Euro, Euro I and Euro II DCVs have been stopped since 2016, 2017 and 2018 respectively. As at 1 November 2018, all pre-Euro and Euro I DCVs have been phased out; and 17 eligible Euro II DCVs still had valid licences. These remaining Euro II DCVs will not be allowed to run on the road after the expiry of their vehicle licences.

Appendix II to Annex D

Trial of Single-deck Electric Franchised Buses

Table 1: Information of single-deck electric buses which commenced / completed the trials and the corresponding charging facilities (as at 31 May 2018)

Number, model, manufacturer and origin of buses	**Day of commencement of trial**	**Service route [origin and destination]**	**Location of charging facilities**	**Number of charging facilities and its site area (including parking space)**	**Information of electricity storage device and charging requirement**	**Monthly average number of on-road breakdowns[i] and bus availability (%)[ii]**
KMB						
4 supercapacitor buses Model: JNP6122UC Manufacturer: China Youngman Automobile Group Company Limited (Youngman) Origin: China	Trials commenced in phases in March 2017 and November 2018	284 (4 buses) [Sha Tin Central - Ravana Garden (Circular)] Total distance of 5.7 km	Sha Tin Central Bus Terminus (for top up charging during operation)	2 (about 49 m^2 each)	750 V／200 A (DC) Supercapacitor capacity of 53 kWh About 20 minutes for a full charge	0.11 time(s) 53.4%
			Shatin Depot (for overnight charging)	2 (one of them is under preparation) (about 49 m^2 each)		

Notes:

[i] Breakdowns only include failure of passenger-carrying buses which necessitate passenger evacuation except those owing to accidents.

[ii] The outages unrelated to malfunctions (including inspections for Certificate of Road Worthiness/Certificate of Fitness, monthly inspections, routine maintenance/checking, cleaning, etc.) are excluded.

Number, model, manufacturer and origin of buses	Day of commencement of trial	Service route [origin and destination]	Location of charging facilities	Number of charging facilities and its site area (including parking space)	Information of electricity storage device and charging requirement	Monthly average number of on-road breakdowns and bus availability (%)
KMB						
10 battery-electric buses Model: K9R Manufacturer: BYD Auto Industry Company Limited (BYD) Origin: China	10 battery-electric buses commenced the trials in phases between July 2017 and September 2018. The current routes are different from the initial ones [iii].	6C (2 buses) [Mei Foo - Kowloon City Ferry Pier] 10.2 km both for departure and return	Lai Chi Kok Bus Maintenance Depot Yuet Lun Street Depot (Both depots support Routes 6C, 35A and 42A)	4 (about 44 m^2 each) 2 (about 44 m^2 each)	380 V ／126A (AC) Lithium iron phosphate battery Battery capacity of 324 kWh About 4 hours for a full charge	0 time(s) 86.4%
		35A (2 buses) [Tsim Sha Tsui East - On Yam] 15.1 km both for departure and return				0 time(s) 82.7%
		42A (2 buses) [Jordan (To Wah Road) - Cheung Hang] 14.6 km for departure from Cheung Hang 14.4 km for departure from Jordan				0 time(s) 84%
		5C (2 buses) [Star Ferry Pier - Tsz Wan Shan (Central)] 10.8 km for departure	Kowloon Bay Bus Maintenance Depot	4 (about 44 m^2 each)		0.1 time(s) 59%

Number, model, manufacturer and origin of buses	Day of commencement of trial	Service route [origin and destination]	Location of charging facilities	Number of charging facilities and its site area (including parking space)	Information of electricity storage device and charging requirement	Monthly average number of on-road breakdowns and bus availability (%)
		from Tsz Wan Shan 11.2 km for departure from Star Ferry Pier				
		603 (2 buses) [Ping Tin - Central (Central Ferry Piers)] 16.2 km for departure from Ping Tin 18.1 km for departure from Central				0 time(s) 83.6%

Notes:
[iii] Starting from 28 September 2018, the trial routes are adjusted. The current routes are 7M [Lok Fu – Chuk Yuen Estate (Circular)], 203C [Tai Hang Tung – Tsim Sha Tsui East (Mody Road)], 11D [Lok Fu – Kwun Tong Ferry] and 43M [Kwai Fong Station – Cheung Ching (Circular)].

Number, model, manufacturer and origin of buses	**Day of commencement of trial**	**Service route [origin and destination]**	**Location of charging facilities**	**Number of charging facilities and its site area (including parking space)**	**Information of electricity storage device and charging requirement**	**Monthly average number of on-road breakdowns and bus availability (%)**
LWB						
4 battery-electric buses Model: K9R Manufacturer: BYD Origin: China	July 2017	S64 (2 buses) [Tung Chung (Yat Tung Estate Public Transport Terminus) - Airport (Passenger Terminal Building) (Circular)] Total distance of 22.5 km	Siu Ho Wan Bus Maintenance Depot	4 (about 44 m^2 each)	380 V ／126A (AC) Lithium iron phosphate battery Battery capacity of 324 kWh About 4 hours for a full charge	0 time(s) 79.3%
	February 2018	E31 (2 buses) [Tung Chung (Yat Tung Estate Public Transport Terminus) - Tsuen Wan (Discovery Park Bus Terminus)] 33.9 km for departure from Tsuen Wan 33.5 km for departure from Tung Chung				0 time(s) 51.5%

Number, model, manufacturer and origin of buses	**Day of commencement of trial**	**Service route [origin and destination]**	**Location of charging facilities**	**Number of charging facilities and its site area (including parking space)**	**Information of electricity storage device and charging requirement**	**Monthly average number of on-road breakdowns and bus availability (%)**
CTB						
6 battery-electric buses Model: K9R (3 buses) Manufacturer: BYD Origin: China ---------- Model: LS-130-116 (3 buses) Manufacturer: Great Dragon International Corporation Limited (Great Dragon) Origin: China	The trial of 3 BYD buses commenced in December 2015 and completed in May 2018. 3 Great Dragon buses commenced the trial in June 2017. The current routes are different from the initial ones [iv].	11 (1 BYD and 1 Great Dragon) [Central (Central Ferry Piers) - Jardine's Lookout (Circular)] Total distance of 15.7 km	Chai Wan Depot	BYD: 3 (about 70 m^2 each) Great Dragon: 3 (about 70 m^2 each)	BYD: 380 V ／ 126A (AC) Lithium iron phosphate battery Battery capacity of 324 kWh About 4 hours for a full charge --------- Great Dragon: 700 V ／ 100A (DC) Lithium iron phosphate battery Battery capacity of 315 kWh About 4 hours for a full charge	BYD: 0.56 time(s) 75.9% Great Dragon: 0.75 time(s) 61.4%
		12 (1 BYD and 1 Great Dragon) [Central (Central Ferry Piers) - Robinson Road (Circular)] Total distance of 7.5 km				BYD: 0.04 time(s) 73.4% Great Dragon: 0.25 time(s) 69.9%
		25A (1 BYD and 1 Great Dragon) [Wan Chai (Hong Kong Convention & Exhibition Centre Extension) - Braemar Hill (Circular)] Total distance of 11.4 km				BYD: 0.6 time(s) 77.5% Great Dragon: 0.5 time(s) 61.8%

Notes:

[iv] Starting from 1 July 2018, Great Dragon battery-electric bus running on Route 12 is deployed to Route 25A.

Number, model, manufacturer and origin of buses	**Day of commencement of trial**	**Service route [origin and destination]**	**Location of charging facilities**	**Number of charging facilities and its site area (including parking space)**	**Information of electricity storage device and charging requirement**	**Monthly average number of on-road breakdowns and bus availability (%)**
NWFB						
4 battery-electric buses Model: K9R (2 buses) Manufacturer: BYD Origin: China ---------- Model: LS-130-116 (2 buses) Manufacturer: Great Dragon International Corporation Limited (Great Dragon) Origin: China	The trial of 2 BYD buses commenced in December 2015 and completed in May 2018. 2 Great Dragon buses commenced the trial in June 2017. The current routes are different from the initial ones[v].	78 (1 BYD and 1 Great Dragon) [Wong Chuk Hang Station - Wah Kwai Estate (Circular)] Total distance of 8.9 km	Wong Chuk Hang Depot	BYD: 1 (about 70 m^2 each) Great Dragon: 1 (about 70 m^2 each)	BYD: 380 V ／ 126A (AC) Lithium iron phosphate battery Battery capacity of 324 kWh About 4 hours for a full charge --------- Great Dragon: 700 V ／ 100A (DC) Lithium iron phosphate battery Battery capacity of 315 kWh About 4 hours for a full charge	BYD: 0.16 time(s) 82.4% Great Dragon: 0.42 time(s) 47.8%
		81 (1 BYD and 1 Great Dragon) [Lai Tak Tsuen - Chai Wan (Hing Wah Estate)] 11.2 km for departure from Lai Tak Tsuen 10.5 km for departure from Hing Wah Estate	Chong Fu Road Depot	BYD: 1 (about 70 m^2 each) Great Dragon: 1 (about 70 m^2 each)		BYD: 0.4 time(s) 77.3% Great Dragon: 1.17 time(s) 32.2%

[v] Starting from 1 July 2018, Great Dragon battery-electric bus running on Route 81 is deployed to Route 78.

Number, model, manufacturer and origin of buses	**Day of commencement of trial**	**Service route [origin and destination]**	**Location of charging facilities**	**Number of charging facilities and its site area (including parking space)**	**Information of electricity storage device and charging requirement**	**Monthly average number of on-road breakdowns and bus availability (%)**
NLB						
2 battery-electric buses Model: K9R (for 2 buses) Manufacturer: BYD Origin: China	The trial commenced in July 2018	38 (2 buses) [Tung Chung (Yat Tung Estate Public Transport Interchange) - Tung Chung Station Bus Terminus (Circular)] Total distance of 4.2 km	Yat Tung Estate Public Transport Interchange	2 (about 37 m^2 each)	BYD: 380 V ／ 126A (AC) Lithium iron phosphate battery Battery capacity of 324 kWh About 4 hours for a full charge	Not applicable (As at the end of the statistical period, i.e. 31 May 2018, the two battery-electric were not yet put into service)

Table 2: Summary of the trial of electric buses (up to 31 May 2018)

Franchised bus company/ Type of electric bus/ Manufacturer	No. of buses undergoing or completed the trial (No. of buses under trial)	(a) Total mileage (km) [i]	(b) Average Energy Consumption Rate (kWh/km)	(c) Emission Benefit (NOx / PM10) [ii] (g/km)	(d) Average Electricity Cost ($/km)	(e) Average No. of On-Road Breakdowns / Month	(f) Bus Availability (%)	(g) Projected driving range [iii] (km)
KMB Supercapacitor Buses / Youngman	2 (8)	42 300	2.19	NOx: 2.59 PM10: 0.11	2.67	0.11	53.4%	19
KMB/LWB Battery-electric buses / BYD	14 (14)	70 600	1.26		1.50	0.01	75.2%	206
CTB/NWFB Battery-electric buses / BYD [iv]	5 (5)	362 100	1.36		1.77	0.35	77.3%	191
CTB/NWFB Battery-electric buses / Great Dragon	5 (5)	63 900	1.89		2.34	0.62	54.6%	117
NLB Battery-electric buses / BYD [v]	0 (2)	Not Applicable						
NLB Battery-electric buses [vi]	0 (2)							

Notes:

[i] From trial commencement to the end of May 2018

[ii] NOx- Nitrogen oxides; PM10- Respirable suspended particulates

It is assumed that electric buses replaced the Euro V single-deck diesel buses running on the same routes to reduce the emissions. Emission from the power companies for the use of electric buses is not counted

[iii] The projected driving range is calculated from usable battery capacity (80% of the highest battery capacity for Youngman and BYD, and 70% of the highest battery capacity for Great Dragon as recommended by the manufacturers) divided by average energy consumption rate

[iv] The trial completed in May 2018

[v] The trial commenced in July 2018

[vi] Undergoing re-tender process

Annex E

Effective Dates of Emission Standards in Hong Kong and their Emission Limits by Vehicle Classes

<table>
<tr><th rowspan="3">Design Weight (DW)</th><th rowspan="3">Vehicle Class</th><th rowspan="3">Effective Date of Prevailing Standards</th><th rowspan="3">Prevailing Emission Standards</th><th colspan="8">Emission Limits</th></tr>
<tr><th colspan="2">NOx</th><th colspan="2">VOC （HC）</th><th colspan="2">Particulate Matter</th><th colspan="2">Particle No.</th></tr>
<tr><th>Euro V</th><th>Euro VI</th><th>Euro V</th><th>Euro VI</th><th>Euro V</th><th>Euro VI</th><th>Euro V</th><th>Euro VI</th></tr>
<tr><td rowspan="4">Not more than 3.5 tonnes</td><td>Private Car (Petrol)</td><td rowspan="2">1 July 2017</td><td rowspan="5">Euro VI</td><td rowspan="2">60*
(mg/km)</td><td rowspan="2">60*
(mg/km)</td><td rowspan="2">100*
(mg/km)</td><td rowspan="2">100*
(mg/km)</td><td rowspan="2">4.5*^
(mg/km)</td><td rowspan="2">4.5*^
(mg/km)</td><td rowspan="2">Not Applicable</td><td rowspan="2">$6x10^{11}$*^
(#/km)</td></tr>
<tr><td>Taxi</td></tr>
<tr><td>Light Bus</td><td rowspan="2">1 January 2018</td><td rowspan="2">280#
(mg/km)</td><td rowspan="2">125#
(mg/km)</td><td rowspan="2" colspan="2">Not Applicable</td><td rowspan="2">4.5#
(mg/km)</td><td rowspan="2">4.5#
(mg/km)</td><td rowspan="2">$6x10^{11}$#
(#/km)</td><td rowspan="2">$6x10^{11}$#
(#/km)</td></tr>
<tr><td>Goods Vehicle</td></tr>
<tr><td rowspan="2">More than 3.5 tonnes</td><td>Goods Vehicle</td><td rowspan="2">1 October 2018</td><td rowspan="2">2,000#
(mg/kWh)</td><td rowspan="2">400#
(mg/kWh)</td><td rowspan="2">460#
(mg/kWh)</td><td rowspan="2">130#
(mg/kWh)</td><td rowspan="2">20#
(mg/kWh)</td><td rowspan="2">10#
(mg/kWh)</td><td rowspan="2">Not Applicable</td><td rowspan="2">$8x10^{11}$#
(#/kWh)</td></tr>
<tr><td>Bus (DW more than 9 tonnes)</td></tr>
<tr><td rowspan="2">More than 3.5 tonnes</td><td rowspan="2">Light Bus</td><td rowspan="3">1 June 2012</td><td rowspan="3">Euro V</td><td rowspan="3">2,000#
(mg/kWh)</td><td rowspan="3">400#
(mg/kWh)</td><td rowspan="3">460#
(mg/kWh)</td><td rowspan="3">130#
(mg/kWh)</td><td rowspan="3">20#
(mg/kWh)</td><td rowspan="3">10#
(mg/kWh)</td><td rowspan="3">Not Applicable</td><td rowspan="3">$8x10^{11}$#
(#/kWh)</td></tr>
<tr><td>Not more than 9 tonnes</td><td>Bus</td></tr>
<tr><td colspan="4"></td><td>Euro 3</td><td>Euro 4</td><td>Euro 3</td><td>Euro 4</td><td>Euro 3</td><td>Euro 4</td><td>Euro 3</td><td>Euro 4</td></tr>
<tr><td>Not Applicable</td><td>Motorcycle (Petrol)</td><td>1 January 2007</td><td>Euro 3</td><td>170/
220*@
(mg/km)</td><td>70/
90*@
(mg/km)</td><td>750/
330*@
(mg/km)</td><td>380/
170*@
(mg/km)</td><td colspan="2">Not Applicable</td><td colspan="2">Not Applicable</td></tr>
<tr><td>Not Applicable</td><td>Motorcycle (Diesel)</td><td>1 January 2007</td><td>Euro 3</td><td>170/
220#@
(mg/km)</td><td>300#
(mg/km)</td><td>750/
330#@
(mg/km)</td><td>100#
(mg/km)</td><td>Not Applicable</td><td>80#
(mg/km)</td><td colspan="2">Not Applicable</td></tr>
<tr><td>Not Applicable</td><td>Motor Tricycle</td><td>1 January 2007</td><td>Euro 3§</td><td>400*
(mg/km)</td><td>70/
90*@
(mg/km)</td><td>1500*
(mg/km)</td><td>380/
170*@
(mg/km)</td><td colspan="2">Not Applicable</td><td colspan="2">Not Applicable</td></tr>
</table>

Note:
Compression Ignition Engine
^ Applies only to Direct Injection Engine
* Positive Ignition Engine
@According to Vehicle Maximum Speed
§ Tightening to Euro 4 as soon as practicable subject to the supply of Euro 4 compliant motor tricycles