Pilot Green Transport Fund

Final Report On
Trial of Single-deck Electric Buses for Resident Shuttle Service
(Kwoon Chung Motors Company Limited)

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Pilot Green Transport Fund
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Kwoon Chung Motors Company Limited

Final Report
(Trial Period: 1 June 2015 to 31 May 2017)

Executive Summary

1 Introduction

1.1 The Pilot Green Transport Fund (the Fund) is set up to encourage transport operators to try out green innovative transport technologies, contributing to better air quality and public health for Hong Kong. Once a fund application is approved, the successful applicant is required to sign a Subsidy Agreement (the Agreement) with the Government and conduct the trial of the innovative green technology in accordance with the approval conditions stipulated in the Agreement. The successful applicant is also required to provide a conventional counterpart to compare with the green innovative technology under trial. Kwoon Chung Motors Company Limited (Kwoon Chung) was approved under the Fund for trial of two single-deck electric buses (EVs) for resident shuttle service.

1.2 The Hong Kong Institute Vocational Education (Tsing Yi) has been engaged by the Environmental Protection Department as an independent third party assessor to monitor the trial and evaluate the performance of the EVs. Kwoon Chung assigned one single-deck diesel bus (DV) providing the same service as the conventional vehicle for comparing with the EVs.

1.3 This Final report summarizes the performance of the EVs in the 24 months of the trial as compared with their conventional counterpart.

2 Trial and Conventional Vehicles

2.1 Through the tendering procedures stipulated in the Subsidy Agreement, Kwoon Chung procured two Wuzhoulong single-deck electric buses (EV-1 and EV-2) which have a gross vehicle weight (GVW) of 17,000 kg and 100 kW rated power for trial. The EVs were used to provide resident shuttle service for Kingswood Villas in Tin Shui Wai.

2.2 One MAN single-deck diesel bus (i.e. DV) with GVW of 17,100 kg was assigned for comparison with the EVs in this trial. The DV was also used to provide resident shuttle service for Kingswood Villas.

2.3 Key features of the EVs, DV and charging facilities are shown in Appendix 1 and their photo are shown in Appendix 2.

3 Trial Information

3.1 The trial started on 1 June 2015 and lasted for 24 months. Kwoon Chung was required to collect and provide trial information including the EV's mileage reading at recharging, date of recharging and recharge amount, costs and operation downtime associated with scheduled and unscheduled maintenances of the EVs. Similar set of monthly data from the DV was also required. In addition to the cost information, reports on maintenance work, operational difficulties and opinions of the drivers and Kwoon Chung were collected to reflect any problems of the EVs. The service hours of the EVs and DV were from 6:30am to 24:00 on Monday to Sunday and public holidays.

4 Findings of Trial

4.1 Table 1 below summarizes the key operating statistics of EVs and DV. The fleet average fuel cost of the EVs was HK$ 2.22 (71%) lower than that of the DV while the fleet average total operating cost of the EVs was HK$ 2.22 (71%) lower than that of the DV.

Table 1: Total operating costs (June 2015 – May 2017)

		EV-1	**EV-2**	**DV**
Total mileage (km)		147,179	125,770	416,757
Average Fuel economy	(km/kWh)	1.23	1.24	-
	(km/litre)	-	-	3.47
	(km/MJ)	0.34	0.34	0.10 [4]
Average Fuel cost (HK$)[1]		0.92	0.91	3.14
Fleet average fuel cost (HK$/km) [1]		0.92		3.14
Average total operating cost (HK$/km)[3]		0.92	0.91	3.14
Fleet average total operating cost (HK$/km)		0.92		3.14
Downtime (working day) [2] [3]		127	116	12

[1] The market rates were adopted for calculation.

[2] Downtime refers to the equivalent number of working days in which the vehicle is not in operation due to charging, and the period the vehicle is not in operation due to maintenance, counting from the first day it stops operation till the day it is returned to the operator.

[3] Maintenance due to incident unrelated to the performance of the vehicle was not included for comparison.

[4] Assuming lower heating value of 36.13 MJ/litre for diesel fuel**.**

4.2 During the trial period, there was no scheduled maintenance for the EV-1 and charging facilities. Both EV-2 and the DV had two scheduled maintenances, leading to 8 and 12 days of operational downtime respectively. In addition, there were 22, 27, 9 and 11 unscheduled maintenances for EV-1, EV-2, the Charger No. 1 and Charger No. 2 respectively, leading to 95 and 99 days of operational downtime for EV-1 and EV-2 due to EV breakdown and 32 and 9 days of operational downtime for EV-1 and EV-2 due to charger breakdown. There was no unscheduled maintenance for the DV. There were 731 working days in the trial period. The utilization rates of EV-1, EV2 and DV were 83%, 84% and 98% respectively.

4.3 Kwoon Chung designated one driver for each EV. The drivers found no problem in operating the EVs and felt the EVs were quiet and environment-friendly. However, the drivers found that the EVs were not powerful enough when driving uphill on steep roads. The passengers supported replacing the existing conventional buses with electric buses, and expressed that the EVs were more environment-friendly than the DV. However, some of the passengers felt that the EVs were noisy as compared with the DV.

4.4 Kwoon Chung was not satisfied with the performance of the EVs since they lost too much time for unscheduled maintenances. For example, the battery, charging & air-conditioning systems were unstable and did not function well.

4.5 To eliminate the effect of seasonal fluctuations, 12-month moving averages were used to evaluate the trend of the fuel economies of the EVs. The fuel economy varied from 1.22 to 1.23 km/kWh (i.e., about 1% variation) for EV-1 and from 1.23 to 1.26 km/kWh (i.e., about 3% variation) for EV-2. During the 24-month trial period, there was no significant variation in the fuel economy of each EV.

4.6 The carbon dioxide equivalent (CO_2e) emissions from the EV-1 and EV-2 were 63,917 kg and 54,384 kg, respectively, while the comparable emission from the DV for the same distances travelled as each EV were 111,883 kg for EV-1 and 95,609 kg for EV-2. Hence there was a reduction of 47,966 kg (about 43%) and 41,224 kg (about 43%) CO_2e emission for EV-1 and EV-2 in the trial.

5. Summary

5.1 The drivers found no problem in operating the EVs and felt the EVs were quiet and environment-friendly. However, the drivers found that the EVs were not powerful enough when driving uphill on steep roads. The passengers supported replacing the existing conventional buses with electric buses, and expressed that the EVs were more environment-friendly than the DVs. However, some of the passengers felt that the EVs were noisy as compared with the DV.

5.2 Kwoon Chung was not satisfied with the performance of the EVs since too much time was lost for unscheduled maintenances. For example, the battery, charging & air-conditioning systems were unstable and did not function well. Kwoon Chung opined that the EVs could not meet its daily operational requirements due to the maintenance issues.

5.3 The utilisation rates of EV-1, EV-2 and the DV were 83%, 84% and 98% respectively. The usage of the EVs was on the low side as reflected in the difference in the total mileages between the EVs (147,179 km and 125,770 km, i.e. 287 and 228 km on average per working day) and the DV (416,757 km, i.e. 570 km on average per working day) in the trial. During the trial period, the variation in the fuel economies of the EVs was not significant.

5.4 The fleet average fuel cost of the EVs was HK$2.22/km (71%) lower than that of the DV. Taking into account the maintenance costs, the fleet average total operating cost of the EVs was HK$2.22/km (71%) lower than that of the DV. The total CO_2e emission from the EVs was 89,190 kg (43% on average) lower than that from the DV during the trial period.

Appendix 1: Key Features of Vehicles and Charging Facilities Involved in the Trial

1. Trial EVs

Registration Mark	**TJ 1089 (EV-1) & EF8710 (EV-2)**
Model:	Wuzhoulong FDG6110EV2
Vehicle Class:	Public bus
Gross Vehicle Weight:	17,000 kg
Seating Capacity:	Driver + 49 passengers
Rated Power:	100 kW
Travel Range:	200 km (air-conditioning on)
Maximum Speed:	over 80 km/h
Battery Type:	Lithium Iron Phosphate battery
Battery Capacity:	242 kWh
Year of manufacture:	2015

2. EV charging facilities

Charging Standard:	IEC62196
Charging Mode:	Three Phase 32A

3. DV for comparison

Registration Mark	**RM5618**
Make:	MAN
Model:	18.360H0CL/R
Class:	Public Bus
Seating capacity:	Driver + 47 passengers
Gross vehicle weight:	17,100 kg
Year of manufacture:	2011

Appendix 2: Photos of Vehicles and Charging Facilities

1. EV-1

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<tr><td>Front view of EV-1</td><td>Rear view of EV-1</td></tr>
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<tr><td>Left side view of EV-1</td><td>Right side view of EV-1</td></tr>
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2. EV-2

	
Front view of EV-2	Rear view of EV-2
	
Left side view of EV-2	Right side view of EV-2

3. EV charging facilities

Charging Stations – front view

Charging Stations – front view close up

Charging Stations – Power Meter

4. DV for comparison

	
Front view of DV	Rear view of DV
	
Right side view DV	Left side view of DV