Pilot Green Transport Fund

Final Report On
Trial of Electric Light Buses for Hotel Guest Shuttle Service (Hotel ICON Limited)

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(Trial Period: 1 January 2017 – 31 December 2018)

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. Hotel ICON Limited (ICON) was approved under the Fund for trial of two electric light buses for hotel guest shuttle service. Through the tendering procedures stipulated in the Subsidy Agreement, ICON procured two Wuzhoulong electric light buses (EVs – EV-1 and EV-2) for trial. Both the EVs were registered as private light buses.

1.2 PolyU Technology and Consultancy Company Limited has been engaged by the Environmental Protection Department (EPD) as an independent third party assessor to monitor the trial and evaluate the performance of the trial vehicles as compared with their conventional counterparts. ICON originally hired two diesel buses for the same type of service. With the EVs in operation, the hiring services of the diesel vehicles were terminated. Therefore, historical data of the two formerly hired diesel buses (DVs – DV-1 and DV-2) were used for comparison purpose.

1.3 This Final Report summarizes the performance of the EVs in the 24-month trial as compared with historical data of the formerly hired DVs.

2. Trial Vehicles

2.1 Key features of the EVs, the charging facilities and the DVs are in Appendix 1 and photos of the EVs and charging facilities are in Appendix 2. The vehicles were used mainly for providing shuttle service to hotel guests from the hotel to Tsim Sha Tsui. Each EV had a seating capacity for 16 passengers. According to the manufacturer, each EV has a travel range of 180 km with fully charged batteries and the air conditioning off.

2.2 Both EVs were normally parked inside the hotel. ICON had set up two DC quick chargers, each of 48 kW capacity, to charge the batteries of the EVs as well as to record the electricity consumption of each EV. During the trial period, the EVs were only charged inside the hotel. Each EV was normally charged twice a day, including a long charge overnight and a topping up charge during day time.

3. Trial Information

3.1 The trial started on 1 January 2017 and lasted for 24 months. ICON was required to collect and provide trial information including the EV mileage reading before charging, amount of electricity consumed and time taken in each charging, and operation downtime due to charging, cost and downtime associated with scheduled and unscheduled maintenance of the EVs and the charging facilities. Historical data of the DVs were also required. In addition to the cost information, reports on maintenance work, operational difficulties and opinions of the drivers were collected to reflect any problems of the EVs.

4. Findings of Trial

4.1 The average fuel economy and cost statistics of the EVs and the DVs are summarized in Table 1. The average fuel costs of EV-1 and EV-2 were HK$2.57/km (75.5%) and HK$2.64/km (75.8%) lower than those of DV-1 and DV-2 respectively, with the fleet average fuel cost of the EVs HK$2.61/km (76%) lower than that of the DVs. However, the average total operating costs of EV-1 and EV-2 were HK$2.53/km (74.2%) and HK$1.2/km (34.5%) higher than those of DV-1 and DV-2 respectively. Compared with the DVs, the fleet average total operating cost for the EVs was higher by HK$1.86/km (54%) mainly due to the hiring cost of replacement vehicles during the EVs downtime.

Table 1: Key operation statistics of each vehicle (1 January 2017 to 31 December 2018)

		Electric light buses		**Diesel buses[1] (historical data)**	
		EV-1	**EV-2**	**DV-1**	**DV-2**
Total distance travelled (km)		53,692	54,056	86,629	76,847
Average fuel economy	km/kWh	1.368	1.359	-	-
	km/litre	-	-	3.72	3.65
	km/MJ	0.38	0.378	0.103[2]	0.101[2]
By vehicle type average fuel economy		1.36 km/kWh		3.69 km/litre	
Average fuel cost (HK$/km)		0.837	0.842	3.41	3.48
By vehicle type average fuel cost (HK$/km)		0.840		3.45	
Average total operating cost (HK$/km)		5.94	4.68	3.41	3.48
By vehicle type average total operating cost (HK$/km)		5.31		3.45	
Downtime/days[3]		168[4]	148[4]	63	50
By vehicle type average down time/days		158		56.5	

[1] Historical data from June 2014 to May 2016 were used for the DVs, fuel cost based on average market fuel prices of January 2017 to December 2018

[2] Assuming lower heating value of 36.13 MJ/litre for diesel fuel

[3] Downtime refers to the working days the vehicle was not in operation, which counted from the first day it stopped operation till the day it was discharged from the vehicle supplier to the operator.

[4] Maintenance due to traffic accident of the vehicle was not included for comparing the performance of the vehicles

4.2 Scheduled maintenance of the EVs and the DVs involved scheduled inspections and annual examinations. There were only two scheduled maintenances for each of the EVs.

4.3 However, EV-1 and EV-2 had 26 and 23 unscheduled maintenances respectively, in the 24 months of the trial period. From June 2014 to May 2016, DV-1 had 11 scheduled and 17 unscheduled maintenances while DV-2 had 9 scheduled and 13 unscheduled maintenances. During the trial period, there was no maintenance cost involved for all the EVs and DVs because the EVs were still under warranty while the rental fee of the DVs included the maintenance costs.

4.4 Apart from the maintenance cost, other indirect costs may include towing fee, vehicle replacement fee and cost of operation downtime due to charging and maintenance of the EVs. In this trial, the EVs incurred vehicle replacement costs during their downtime. The vehicle replacement costs involved were HK$274,000 for EV-1 and HK$207,700 for EV-2. The average total operating costs of EV-1 and EV-2 were HK$2.53/km (74.2%) and HK$1.2/km (34.5%) higher than those of DV-1 and DV-2 respectively. Thus, the fleet average total operating cost of the EVs was 54% higher than that of the DVs.

4.5 EV-1 and EV-2 had 168 days and 148 days of downtime respectively, with utilization rates of 77% and 79.7% respectively. DV-1 and DV-2 had 63 days and 50 days of downtime respectively, with utilization rates of 91.4% and 93.2% respectively. The lower utilization rates of the EVs were due to the frequent and long unscheduled maintenances.

4.6 Although the drivers agreed that the EVs emitted less pollutants and the air was cleaner inside the vehicle, they expressed that the EVs had comparatively less power for climbing uphill than the DVs and they also reported various operational difficulties in each month, involving problems with air-conditioning, doors, battery charging, braking, gear shifting, etc. Because of these operational difficulties, the drivers reported that the operation of the EVs was problematic and the performance of the EVs was deteriorating. They also felt that the mileage for each charge was not sufficient for daily operation with air-conditioning on especially on busy days, and the EVs were not quieter than the DVs. Therefore, they did not like driving the EVs and would not recommend the EVs to other drivers.

4.7 The feedbacks from the passengers were in general on the positive side. They felt that the air was cleaner inside the vehicle, and the vehicle emitted less polluted exhaust and could help improve roadside air quality. However, some passengers had reservation on supporting replacing all existing vehicles with EVs and did not feel that the EVs were quieter.

4.8 Overall, ICON agreed that using electric vehicle is good because it can provide a greener environment. However, ICON felt that the performance of the EVs under this trial did not meet their operational requirements. Moreover, the EVs did not help save their operational cost. They were not easier and cheaper to maintain than the DVs and the performance of the EVs was deteriorating. Therefore, ICON had reservation in encouraging other transport operators to try out the EVs under this trial and had reservation in replacing all existing conventional vehicles with EVs under trial.

4.9 To remove the effect of seasonal fluctuations, 12-month moving averages were used to evaluate the trend of the vehicles' fuel economy. For the EVs, the 12-month moving average fuel economy of EV-1 dropped by 8% while that of EV-2 dropped by 6% over the trial period. In both cases, there is indication of slight deteriorating fuel economy during the trial period.

4.10 During the trial period, there were frequent problems with the charging system such that there were problems in charging the battery packs of the EVs properly. Besides, there was no signification deterioration in the battery packs during the trial period.

4.11 The carbon dioxide (CO_2) equivalent emissions from the EVs and the DVs were 40,300 kg and 81,073 kg respectively, hence there was a total reduction of 40,773 kg, which was about 50% reduction, CO_2 equivalent emission in the trial.

5. Summary

5.1 In the 24 months of the trial, the average daily mileages of EV-1 and EV-2 were 96 km and 98 km respectively. While the average daily mileages of DV-1 and DV-2 were 130 km and 113 km, which were higher than those of the EVs.

5.2 The trial showed that the EVs had lower fuel cost as compared with their conventional diesel counterparts, with an average fuel saving of HK$2.61/km or 76%. However, the average total operating cost for the EVs was 54% higher than that of the DVs, due to the frequent breakdown of the EVs which incurred a large amount of vehicle replacement costs. Utilization rates were 77% and 79.7% for EV-1 and EV-2 respectively, and 91.4% and 93.2% for DV-1 and DV-2 respectively.

5.3 There was a total reduction of 40,773 kg, which was about 50% reduction, CO_2 equivalent emission in the trial.

5.4 There was indication that the fuel economy had slightly deteriorated in the trial period but deterioration in the charging capacity of the battery could not be judged due to frequent breakdown of the charging system and due to the relatively low amount of electricity charged each time.

5.5 The EV drivers reflected having problems in operating the EVs and the operation of the EVs was not smooth. They reported various operational difficulties in each month, involving problems

with air-conditioning, doors, battery charging, braking, gear shifting, etc. The passengers felt that the air was cleaner inside the vehicle and the vehicle emitted less polluted exhaust and could help improve roadside air quality. However, some passengers had reservation on supporting replacing all existing vehicles with electric vehicles and did not feel that the EVs under trial were quieter than the DVs.

5.6 The trial showed that under ICON's operating conditions where air-conditioning was essential, the Wuzhoulong electric light buses could not meet ICON's daily mileage requirements. The frequent breakdowns and excessive downtime were not acceptable to ICON. The manufacturer of the EVs should provide better technical support to its electric light buses to avoid excessive downtime for repair and maintenance.

Appendix 1: Key Features of Vehicles and Charging Facilities

1. Trial EVs

Registration Mark	**EV-1: ICON 7 (formerly UD2682),** **EV-2: ICON 5 (formerly UD4401)**
Make:	Wuzhoulong
Model:	FDG6700EVG
Class:	Private light bus
Gross vehicle weight:	7,000 kg
Capacity:	Driver + 16 passengers
Rated power:	45 kW
Travel range:	over 180 km
Maximum speed:	over 80 km/h
Battery material:	Lithium-ion battery
Batteries capacity:	101 kWh
Charging time:	~ 4-5 hours
Year of manufacture:	2015

2. DVs used for comparison

Registration Mark	**DV-1: GF7792**	**DV-2: MA9168**
Make:	Toyota	Toyota
Model:	XZB59RZEMQY5	BB59RZEMQZ5
Class:	Public bus	Public bus
Gross vehicle weight:	5,600 kg	5,300 kg
Seating capacity:	Driver + 23 passengers	Driver + 23 passengers
Cylinder Capacity:	4009 c.c.	4104 c.c.
Year of manufacture:	2007	2005

3. Charging Facilities

Make:	XU JI Power Co., Ltd
Model:	EVQC 31 Quick charging system
Output:	400VDC/ 120A
Charging standard:	GB/T 20234

Appendix 2: Photos of Vehicles and Charging Facilities

Trial EVs and Charging Facilities

	
EV-1 front view	EV-1 end view
	
EV-1 side view 1	EV-1 side view 2
	
EV-2 front view	EV-2 end view

	
EV-2 side view 1	EV-2 side view 2
	
AC/DC converter installed in baggage room on ground floor (serve charger at ground floor)	Battery charger (with charging cable) installed at ground floor
	
Complete set battery charger installed in basement floor for charging the EVs	