

**Pilot Green Transport Fund**

**Final Report**

**On**

**Trial of Electric Buses for KITEC and MTR Kowloon  
Bay Station Shuttle Service (Trademart)**

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The Monitoring and Evaluation Team's views expressed in this report do not necessarily reflect the views of the Environmental Protection Department, HKSAR.

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**Pilot Green Transport Fund**  
**Trial of Electric Buses for KITEC and MTR Kowloon Bay Station Shuttle Service**  
**(Trademart)**

**Final Report**  
**(Trial Period: 1 November 2013 – 31 October 2015)**

**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. International Trademart Company Limited (Trademart) was approved under the Fund for trial of two electric private buses for shuttle service with the associated charging facilities. Through the tendering procedures stipulated in the Subsidy Agreement, Trademart procured two Shandong Yixing Feiyan electric single-deck buses for trial. They are referred to as EV-1 and EV-2, collectively as EVs, in this report.

1.2 PolyU Technology and Consultancy Company Limited (PolyU) has been engaged by the Environmental Protection Department (EPD) as an independent third-party assessor to monitor the trials and evaluate the performance of the green innovative transport technologies under trial as compared with their conventional counterparts. In this trial, Trademart assigned one diesel single-deck vehicle (DV) providing similar services as the conventional vehicle for comparing with the two EVs. The information collected includes the said vehicles' operation data, fuel bills, maintenance records, reports on operation difficulties, and opinions of the EV drivers from survey questionnaires.

1.3 This Final Report summarizes the performance of the EVs in the 24-month trial as compared with their conventional counterpart, i.e. the DV.

2. Trial Vehicles

2.1 Trademart procured two Shandong Yixing electric buses (EV-1 and EV-2) with each of 17 tonnes gross vehicle weight (GVW) for trial. These vehicles provided shuttle service between MTR Kowloon Bay Station and Kowloon Bay International Trade and Exhibition Centre (KITEC). Each EV can carry a maximum of 45 passengers. According to the manufacturer, each EV has a travel range of 280 km with its batteries fully charged and air-conditioning on. Trademart also assigned a 17 tonnes GVW diesel bus (DV) of 11,970 c.c engine capacity servicing the same route for comparison. Throughout the trial period, the DV had been changed twice, in early February 2015 and August 2015 respectively due to change of bus operator and retirement of corresponding DV. No matter how, Trademart still provided similar DV for comparison.

2.2 Trademart had set up two dedicated 125 kW chargers to charge the batteries of individual EV under trial. The chargers are situated at KITEC car park, B1 level. It takes about 4-5 hours to fully charge the batteries. The EVs were only charged at this charging station overnight, from around 2300 to 0400 daily. Given that the EVs travel around 120 km/day, it is unable to examine whether EVs under this trial could travel 280km with its batteries fully charged and air-conditioning on as stated by the manufacturer.

2.3 Key features and photos of the EVs and DV(s) are in Appendices 1 and 2 respectively.

### 3. Trial Information

3.1 The 24-month trial started on 1 November 2013. EVs provide shuttle service connecting KITEC and MTR Kowloon Bay Station. The vehicles provide daily service, including Sundays and public holidays, and the number of working hours per day was around fourteen.

### 4. Findings of Trial

#### 4.1 Operating Costs

4.1.1 Table 1 below summarizes the statistical data of the EVs and DV. The average fuel cost of the EVs was about \$5.47/km (76%) lower than that of the DV.

Table 1: Key operational statistics of each vehicle (from November 2013 to October 2015)

		Electric Buses		Diesel Bus
		EV-1	EV-2	DV
Total mileage/km		36,992	87,884	65,071
Average fuel economy/	(km/kWh)	0.622	0.643	
	(km/litre)			1.62
Average fuel cost/(\$/km)		1.77	1.71	7.21
Total operating cost/\$		207,581	439,714	539,694
Average total operating cost/(\$/km)		5.61	5.00	8.29
By vehicle type	average total operating cost/(\$/km)	5.18		8.29
	average downtime <sup>[1]</sup> /day	345 <sup>[2]</sup>		129.5

<sup>[1]</sup> Downtime refers to the period the vehicle is not in operation, which counted from the first day it stops operation till the day it is returned to the operator.

<sup>[2]</sup> Prolonged downtime of EV-1 due to a fire accident in late September 2014 which made EV-1 unable to resume trial afterward.

4.1.2 EV-1 broke down in late September 2014 and was towed to the supplier's service centre. It caught fire en route and has since been taken out of the service. Investigation showed that the fire was unrelated to the vehicle being an EV, it is merely an accident.

4.1.3 Apart from the fuel costs, Table 1 also shows that average total operating cost which may include maintenance fee and other indirect costs such as towing fee, vehicle replacement fee, etc. Average total operating cost of the two EVs was \$ 5.18/km, about 38% lower than that of the DV. The cost for hiring replacement buses is not included in this report because KITEC provided incomplete data in this area.

4.1.4 The two EVs had average downtime of 345 days while the DV had 129.5 days downtime in the 24-month trial period. The utilization rate of EV-1 and EV-2 were 33% and 72% respectively and that of DV was 82%. The EVs were plagued by a number of problems that led to frequent maintenance. The major ones were the large temperature difference among the battery compartments, battery management system fault and front axle suspension failure. However, during the trial period, about 50% of the EVs' total maintenance downtime was unrelated to their electric drive systems; they were related to temperature sensor, brake, air compressor, axle balance and body works instead. The low utilization rate of EV-1 is because EV-1 was damaged due to fire accident and could not resume operation. Had only the service 11 months been considered, the utilization rate of EV-1 would be 72%, same as EV-2.

## 4.2 Performance and Reliability

4.2.1 Trademart has designated two drivers for each vehicle. The drivers of EV-1 and EV-2 consistently expressed satisfaction with the operation and performance of the vehicles. All drivers found no problem in operating the EVs and felt the EVs were quieter and had larger torque than their diesel counterparts. The latter was obvious when going uphill or pulling away from traffic light.

4.2.2 Overall, Trademart agreed that, in general, using electric vehicle was good because it provided a greener and quieter environment compared with the diesel vehicle. However, Trademart was not satisfied with the unexpected downtimes of the two EVs owing to the battery, charging facilities as well as other problems throughout the trial period.

4.2.3 To remove the effect of seasonal fluctuations, 12-month moving average is used to remove the seasonal effect and evaluate the trend of the EVs' fuel economy. The average fuel economy was 0.63 km/kWh for the EVs. From the available operational data, it can only be concluded that the fuel economy of the EV-1 showed a gentle trend of deterioration but EV-2 did not have a discernible trend of deterioration.

4.2.4 The equivalent CO<sub>2</sub> emission from EV-1 and EV-2 were 37,928 kg (11 out of 24 months) and 81,743 kg respectively while that from the correspondence DV was 63,220 kg and 150,196 kg respectively. Therefore, there was a total reduction of 25,292 kg (40%) for EV-1 and 68,453 kg (46 %) for EV-2 CO<sub>2</sub> emission in the trial.

## 5. Summary of Findings

5.1 The EVs provided shuttle service between MTR Kowloon Bay Station and Kowloon Bay International Trade and Exhibition Centre, and travelled around 120 km/day with air-conditioning on. The average total operating cost of the EVs – including the nominal maintenance costs that were waived because the EVs were still under warranty – was 38% (\$ 3.11/km) less than that of the DV. Their utilization rates were comparable to the DV, 72% vs 82%. The fuel cost of the EVs was nearly 76% lower than that of the DV, which is rather a significant reduction.

5.2 There was a total reduction of 93,745 kg (44%) CO<sub>2</sub> emission. The fuel economy and thus the travel range are affected by various factors such as driving behaviour, road gradient, traffic condition and air-conditioning load. There was a gentle deterioration in fuel economy for EV-1 but no discernible trend of deterioration for EV-2 in the 24-months trial period.

5.3 Majority of the passengers felt that the EVs were green and emitted no air pollutant. They would like to see all vehicles changed to EVs. The drivers of the EVs did not have problems in operating the vehicles. They felt the EVs were quieter and had larger torque than the DV. Overall, Trademart agreed that, in general, using electric vehicle is good because it provides a greener and quieter environment compared with the diesel vehicle. However, Trademart was not prepared to replace the entire bus fleet with the electric vehicles due to unexpected downtimes owing to different problems encountered throughout the trial period.

5.4 The trial showed that Yixing electric single-deck buses could be used in shuttle bus operations. If the downtime could be shortened, more operators would be willing to use this electric vehicle.

## Appendix 1: Key Features of Vehicles

### 1. Electric bus under trial (EVs)

<b>Registration Mark:</b>	<b>SF8209, SF8306</b>
Make:	Shandong Yixing
Model:	Feiyan
Class:	Private bus
Gross vehicle weight:	17 tonnes
Seating capacity:	46 (include driver)
Rated power:	150 kW
Travel range:	280 km (air-conditioning on)
Maximum speed:	over 70 km/h
Battery material:	Lithium iron phosphate
Batteries capacity:	360 kWh
Charging time:	4 hours (using 125 kW charger)

### 2. Diesel bus used for comparison (DV)

<b>Registration Mark:</b>	<b>SG5650 (1 November 2013 to January 2015)</b>
Make:	MAN
Model:	18.310HOCL/R
Class:	Private bus
Gross vehicle weight:	17 tonnes
Seating capacity:	50 (include driver)
Engine capacity:	11970 c.c.
Year of manufacture:	2010

<b>Registration Mark:</b>	<b>TD4198 (February 2015 to July 2015)</b>
Make:	Daewoo
Model:	BH117L
Class:	Private bus
Gross vehicle weight:	N/A
Seating capacity:	50 (include driver)
Engine capacity:	7640 c.c.
Year of manufacture:	2014

<b>Registration Mark:</b>	<b>PN6833 (August 2015 to October 2015)</b>
Make:	MAN
Model:	18.360HOCL/R
Class:	Private bus
Gross vehicle weight:	16 tonnes
Seating capacity:	50 (include driver)
Engine capacity:	10518 c.c.
Year of manufacture:	2010

### 3. Charging System

Charging system model:	Titans
Charger power:	125kW
Charging rate:	Fast

## Appendix 2: Photos of Vehicles and Charging Facilities

### 1. Trial Electric Buses and Charging Facilities



EV-1 (SF8209) – front view



EV-1 (SF8209) – end view



EV-1 (SF8209) – side view 1



EV-1 (SF8209) – side view 2



EV-1 – Charging station



EV-2 (SF8306) – front view



EV-2 (SF8306) – end view



EV-2 (SF8306) – side view 1



EV-2 (SF8306) – side view 2



EV-2 – Charging station

2. Diesel Bus for Comparison



DV (SG5650) – front view



DV (TD4198) – front view



DV (PN6833) – front view