Pilot Green Transport Fund

Final Report On
Trial of Electric Van for Construction Industry
(Chi Shing)

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Final Report
(Trial Period: 1 August 2012 – 31 July 2014)

Executive Summary

1 Introduction

1.1 The Pilot Green Transport Fund (the Fund) is set up to encourage transport operators to try out green and innovative transport technologies, contributing to better air quality and public health for Hong Kong. Chi Shing Transportation Company (Chi Shing) was approved under the Fund for trial of one electric van-type light goods vehicles for construction industry operation. Through the tendering procedures stipulated in the Subsidy Agreement Chi Shing entered into with the Government, Chi Shing procured one Micro-Vett Electric Doblo light goods vehicle (EV) for trial.

1.2 PolyU Technology and Consultancy Company Limited (PolyU) has been engaged by the Environmental Protection Department as an independent third party assessor to monitor the trial and evaluate the performance of the trial vehicle. A diesel vehicle (DV) providing similar services was assigned as the conventional vehicles for comparing with the EV.

1.3 This report summarizes the performance of the EV in the 24 months of the trial as compared with its conventional diesel counterpart.

2 Trial Vehicles

2.1 Key features of the EV and DV are shown in Appendix 1 and photos of the vehicles are shown in Appendix 2. These vehicles were used for transporting people and tools for handling pre-cast concrete structures at construction sites. The EV is designed to carry 425 kg payload. According to its manufacturer, the EV has a travel range of 190 km with its battery fully charged and air-conditioning off.

2.2 Chi Shing used a Land Rover Defender diesel light goods vehicle (DV) for comparison but its previous operations was carried out by the EV. During the trial period, the modes of operation of the two vehicles were very different and the data to be collected from the DV might not be suitable for comparison. As Chi Shing has maintained a detailed record of data on the maintenance and fuel consumption of the DV from May 2008 to August 2013, relevant extract from such data was used to compare with the data collected from the EV trial.

2.3 During the trial period, the EV was driven mainly from Wan Chai or Chi Shing's office in Yuen Long, visiting en route a number of work sites, including Kennedy Town, Ma On Shan and Yuen Long. The EV did not travel on fixed route.

2.4 In the first 12 months of the trial, the EV was mostly charged using public quick chargers at different locations to reduce charging time and avoid affecting its normal operation. The charging time was around one hour. It was occasionally charged using private standard chargers. The charging time was about seven hours. In late September 2012, Chi Shing set up one standard charger at its office at Mai Po, Yuen Long at its own cost. Since then, the EV was charged more frequently at Chi Shing's office. The EV was charged almost everyday when it was used. If it was required to cover a long journey in one day, it would be recharged two or three times to extend its travel range.

3 Trial Information

3.1 The trial started on 1 August 2012 and lasted for 24 months. Chi Shing was required to collect and provide trial information including the EV mileage reading before charging, amount of electricity consumed and time used in each charging, operation downtime due to charging, and cost and downtime associated with scheduled and unscheduled maintenance of the EV and the charging facilities. Similar historical data from the DV were also required. In addition to the cost information, reports on maintenance work, operational difficulties and opinions of the drivers and Chi Shing were collected to reflect any problems of the EV.

4 Findings of Trial

4.1 Operating Costs

4.1.1 Table 1 below summarizes the fuel cost data of the EV and DV. The fuel cost of the EV was significantly lower: $1.06/km (79%) lower than the DV.

Table 1: Average fuel economy and average fuel cost of each vehicle

		EV	**DV (historical)**
Total distance travelled / km		40,557	58,688
Average fuel economy /	(km/kWh)	4.13	
	(km/litre)		9.27 [1]
	(km/MJ)	1.15	0.257 [2]
Average fuel cost /($/km)		0.275	1.34

[1] Calculated from historical data based on estimated fuel consumption in the first two years of operation, and using average diesel fuel cost of $12.4 per litre

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

4.1.2 Table 2 below summarizes the total operating cost data of the EV and DV. During the trial period, the EV had five scheduled and two unscheduled maintenances with 51 days downtime. The record showed the DV had six scheduled maintenances with 24 days downtime during the first 24 months of its operation. Utilization rate of the EV was 93%, compared with 97% for the DV.

4.1.3 The first unscheduled maintenance of the EV involved battery balancing while the second one involved replacement of the gear box by one with an additional low gear to improve the EV's ability to start on and go up steep slopes. The first three scheduled maintenance involved battery balancing. The fourth and fifth ones involved maintenance work for annual examination.

4.1.4 Scheduled maintenance of EV was simpler than the DV. Unlike the DV, the EV does not need to replace filters or engine oil. If frequent visit to the supplier's workshop for battery balancing could be avoided, the EV might require fewer scheduled maintenance.

4.1.5 Apart from the fuel costs, the table also shows the average total operating costs which include maintenance costs and other indirect costs such as towing fee, vehicle replacement fee. The EV and DV incurred only fuel and maintenance costs in this trial. The average total operating cost is $0.426/km for the EV and $1.58/km for the DV. As compared with the DV, the total operating cost for the EV was lower by 73%, given that Chi Shing did not pay for the repair of the EV which was still covered by warranty.

Table 2: Total operating cost and downtime of each vehicle

	EV	**DV (historical)**
Total operating cost/$	17,262	92,799 [1]
Average total operating cost/($/km)	0.426	1.58
Downtime/working days [2]	51	24

[1] Calculated from historical data based on estimated fuel consumption in the first two years of operation, and using average diesel fuel cost of $12.4 per litre

[2] 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.

4.2 Performance and Reliability

4.2.1 The EV drivers had no problem in operating the EV and had no adverse comments on the EV.

4.2.2 Since Chi Shing mostly relied on public chargers at the beginning of the trial, the EV battery was not properly balanced. Thus, battery balancing was carried out frequently at the EV supplier's workshop. After Chi Shing has installed a standard charger at its office, the EV was mainly charged using the charger and balancing at the supplier's workshop was no longer needed.

4.2.3 Overall, Chi Shing agreed that using electric vehicle is good because it can provide a greener and quiet environment as well as much lower fuel cost. However, Chi Shing expressed the following concerns:

(i) the travel range is relatively short;

(ii) at this stage, there is insufficient information to estimate the EV's future maintenance cost after the warranty expires; and

(iii) the cost of EV is high.

4.2.4 To remove the effect of seasonal fluctuations, 12-month moving averages are used to evaluate the trend of the EV's fuel economy. The results show a significant improvement in fuel economy of the EV, from 3.88 km/kWh for the first twelve months to 4.67 km/kWh for the last twelve months. This could be due to the adaptation of the drivers' driving techniques to suit the EV.

4.2.5 The charged amount could reach the rated value even in the last few months of the trial. There is no indication that the battery has deteriorated resulting in lower charge amount.

5 Summary

5.1 The trial showed that the EV had lower fuel cost as compared with its conventional diesel counterpart, with a saving of $1.06/km or 79%. The total operating cost for the EV was 73% lower than the DV, given that Chi Shing did not pay for the repair of the EV which was still covered by warranty.

5.2 The EV drivers found no problem in operating the EV. The operation of the EV was smooth despite having two unscheduled and five scheduled maintenances, most of them involved battery balancing at the EV supplier's workshop in the twelve months of the trial. As a result, the EV total downtime was 51 days in the 24-months period and its utilization rate was 93%. On the other hand, the DV's utilization rate was 97%.

5.3 The average fuel economy of the EV showed a general increase with time. From the first 12-month average to the final 12-month average, the fuel economy increased from 3.88 km/kWh to 4.67 km/kWh, an increase of 20%. The trial showed that the performance of the EV and its batteries was stable over the trial period.

5.4 The trial showed that under local operating conditions where air-conditioning is essential, the Micro-Vett Electric Doblo could meet the user's daily mileage requirements with multiple charging using public quick chargers. Moreover, the EV was able to perform as required.

Appendix 1: Key Features of Vehicles Involved in the Trial

1. Trial EV

Licence Plate No. RM4064

Make:	Micro-Vett
Model:	Electric Doblo
Class:	Light goods vehicle
Gross vehicle weight:	2,510 kg
Seating capacity:	driver + 4 passengers
Rated power:	40 kW
Travel range:	190 km (air-conditioning off)
Maximum speed:	110 km/h
Battery material:	lithium-polymer
Battery capacity:	44.4 kWh
Charging time:	standard charge, 9kW, 100% full, approx. 7 hours quick charge, CHAdeMO 1.5C, 80% full, approx. 40 minutes
Payload:	about 425 kg

2. DV used for comparison

License Plate No. NL1405

Make:	Land Rover
Model:	Defender 110 S/W (E)
Class:	Light goods vehicle
Gross vehicle weight:	3,050 kg
Cylinder capacity:	2,402 cc
Payload:	about 850 kg
Year of manufacture:	2008

Appendix 2: Photos of Vehicles and Charging Facilities

1. Trial Electric Vehicle and Charging Facilities

	
Micro-Vett Electric Doblo light goods vehicle (RM4064)	Meters on Dashboard of EV
	
Portable Watt-hour meter for recording charge amount	Charging facilities at Chi Shing's office in Yuen Long

2. Diesel Vehicle for Comparison

	
Land Rover Defender Diesel light goods vehicle (NL1405)	