Pilot Green Transport Fund

Final Report On
Trial of Electric Vans for Courier Service (FedEx)

(23 January 2016)

PREPARED BY:

Dr. C.S. Cheung
Dr. W.T. Hung
Dr. D.W. Yuen

List of Monitoring and Evaluation Team Members

Dr. C.S. Cheung (Team Leader)
Professor
Department of Mechanical Engineering
The Hong Kong Polytechnic University

Dr. W.T. Hung (Deputy Team Leader)
Associate Professor
Department of Civil and Environmental Engineering
The Hong Kong Polytechnic University

Dr. D.W. Yuen (Project Administrator)
Teaching Fellow
Department of Mechanical Engineering
The Hong Kong Polytechnic University

Pilot Green Transport Fund
Trial of Electric Vans for Courier Service (FedEx)

Final Report
(Trial Period: 1 April 2013 – 31 March 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 and innovative transport technologies, contributing to better air quality and public health for Hong Kong. Federal Express (Hong Kong) Limited (FedEx) was approved under the Fund for trial of three electric van-type light goods vehicles for courier service with the associated charging facilities. Through the tendering procedures stipulated in the Subsidy Agreement FedEx entered into with the Government, FedEx procured three Smith Edison Panel Vans (EVs) for trial.

1.2 PolyU Technology and Consultancy Company Limited has been engaged by the Environmental Protection Department as an independent third party assessor to monitor the trials and evaluate the performance of the green and innovative transport technologies under trial as compared with their conventional counterparts. Three diesel vehicles (DVs) providing similar services were assigned as the conventional vehicles for comparing with the three EVs.

1.3 This report summarizes the performance of the EVs in the twenty four months of the trial and compares them with their conventional counterparts.

2 Trial Vehicles

2.1 Key features of the EVs and DVs are in Appendix 1 and photos of the vehicles are in Appendix 2. They are referred to as EV-1, EV-2, EV-3, DV-1, DV-2 and DV-3 in this report. These vehicles were used for courier service. EV-1 and DV-1 served Tai Wai industrial and residential areas. EV-2 and DV-2 served the Hong Kong Science Park and the Chinese University of Hong Kong. EV-3 and DV-3 served the densely populated areas of Sha Tin. In general, EV-1 and DV-1 stopped less frequently than EV-2 and DV-2. EV-3 and DV-3 made the shortest daily journeys. The maximum payload of these EVs is limited to 1,115 kg. According to the manufacturer, each EV has a travel range of 120 km with its batteries fully charged and air-conditioning off.

2.2 FedEx has set up at the Shek Mun depot three 32A electricity outlets to charge the batteries of the EVs. It takes about 8 hours to charge the batteries from 0 to 100%. The EVs were only charged at the depot. The driver of EV-2 charged the vehicle twice a day: at lunch time and overnight after business hours. EV-1 and EV-3 were mostly charged overnight only.

3 Trial Information

3.1 The trial started on 1 April 2013 and would last 24 months. FedEx was required to collect and provide trial information including the EV mileage reading before charging, amount electricity consumed and time used 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. Similar data from the DVs were also required. In addition to the cost information, reports on maintenance work, operational difficulties and opinions of the drivers and FedEx were collected to reflect any problems of the EVs.

3.2 Average daily mileage was about 26 km for EV-1; 45 km for EV-2 and 16 km for EV-3 excluding the downtimes. The longest journey the EVs has travelled between recharging was 76 km (EV-3). The extended downtimes of EV-2 and EV-3 were owing to the very long time required for the vehicle manufacturer to maintain minor vehicle damages.

3.3 The following table summarizes the statistical data of the EVs and DVs. The fuel cost savings were as follows: EV-1 $1.30/km (64%) lower than DV-1; EV-2 $2.67/km (77%) lower than DV-2 and EV-3 $0.93/km (52%) lower than DV-3.

Table 1: Key operation statistics of each vehicle (April 2013 to March 2015)

		Electric vans			**Diesel vans**		
		EV-1	**EV-2**	**EV-3**	**DV-1**	**DV-2**	**DV-3**
Total distance travelled/km		18,425	26,565	7,860	23,230	21,594	25,784
Average fuel economy/	(km/kWh)	1.60	1.47	1.37			
	(km/litre)				6.03	3.57	6.93
	(km/MJ)	0.444	0.408	0.381	0.167 [1]	0.099 [1]	0.192 [1]
Average fuel cost/($/km)		0.739	0.793	0.867	2.04	3.46	1.80
Average total operating cost/($/km)		1.86	1.74	2.83	3.25	4.83	2.23
By vehicle type	average total operating cost/($/km)	2.14			3.44		
	average downtime [2] /day	133 [3]			17		

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

[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 discharged from the vehicle supplier to the operator.

[3] If excluding the slow response downtimes in repairing the EVs owing to minor crashes which were unrelated to the vehicle performance, EV-2 had downtime of 17 days and EV-3 had 11 days; the average downtime for EVs would then be 13 days.

3.4 Apart from the fuel costs, the table also shows that average total operating cost which may include other indirect costs such as towing fee, vehicle replacement fee. In this report, the EVs and DVs incurred fuel and the maintenance expenses. FedEx has appointed a local maintenance contractor in order to obtain better services for the EVs and paid for many maintenance items. The maintenance cost of the EVs was quite high, at least half the total operating cost in terms of per km travelled.

3.5 The utilization rates in brackets show what it would be if these slow response downtime in repairing the EVs owing to minor crashes which were unrelated to the vehicle performance was set aside which showed the utilization rates would be similar for the two types of vehicles: EV-1, 98%; DV-1, 97%; EV-2, 81% (97%); DV-2, 98%; EV-3, 54% (98%); DV-3, 97%.

4 Summary

4.1 The average fuel cost of EVs was 67% ($1.63/km) less than the DVs. The average total operating costs of EVs was 38% ($1.30/km) less than the DVs. Excluding these downtimes unrelated to the vehicle performance, the utilization rates of the two types of vehicles were comparable, close to 100%.

4.2 The drivers of the EVs did not have problems in operating the vehicles and were in general satisfied with the performance of the vehicles. However, they felt that the hill-climbing ability of the EVs was poor and the EVs were not accelerating as quickly as the DVs which have manual gear. The EV-1 driver was generally satisfied with the performance of the vehicle and found no deterioration in its performance or travel range. The EV-2 driver was less satisfied with the performance of the vehicle and felt its performance and travel range deteriorating. At the beginning of the trial, he was disappointed with EV-2 because its 12V battery was completely drained and it could not start. The cause of failure was not identified. Noting the 12V battery might fail, the EV-2 driver has been carrying a back-up battery in EV-2 just in case. He also recharged EV-2 both at lunch time and overnight while EV-1 and EV-3 were charged mostly overnight only. All drivers of the EVs were worried about possible malfunction of their 12V battery. They also found the EVs' maximum speed of 80 km/h rather low. Nonetheless, the charging frequency as well as average fuel economy of the EVs did not indicate any deterioration in their performance or their traction batteries. In fact, the fuel economy of two EVs improved gradually over the 24 month trial period probably because the drivers have adapted their driving techniques to suit the EVs. Overall, FedEx agreed that, in general, using electric vehicle is good because it provides a greener and quieter environment compared with the diesel vehicle. However, FedEx was not satisfied with the aftersales service from the vehicle supplier since (1) it took around a few months each time to repair small damages on the vehicles, putting the vehicles out of service for extended periods unnecessarily; (2) two out of the three EVs had to replace their 12V batteries, some times more than once, soon after delivery. FedEx was not certain if the EVs were easier or cheaper to run.

4.3 The trial showed that Smith Edison Panel Vans could be used in operations that required short daily travels. The vehicle manufacturer needed to provide better support to the EVs to avoid excessive downtime caused by vehicles waiting for repair.

Appendix 1: Key Features of Vehicles Involved in the Trials

1. Trial EVs

Registration Mark:	**RV7930, RV7172 & RV6790**
Make:	Smith
Model:	Edison Panel Van
Class:	Light goods vehicle
Gross vehicle weight:	3.5 tonnes
Payload:	1.115 tonnes
Seating capacity:	driver + 2 passengers
Rated power:	23.5 kW
Travel range:	120 km (air-conditioning off, on flat road)
Maximum speed:	80 km/h
Battery material:	Lithium ion
Battery capacity:	36kWh
Charging time:	8 hours (32A)

2. DVs used for comparison

Registration Mark:	**LZ5211**	**PV4749**	**JZ6102**
Make:	Isuzu	Isuzu	Mercedes Benz
Model:	NKR77E-13M	NPR75HHE-V	313CDI
Class:	Light goods vehicle	Light goods vehicle	Light goods vehicle
Cylinder capacity:	2,999 cc	5,193 cc	2,151 cc
Gross vehicle weight:	5.3 tonnes	5.5 tonnes	3.5 tonnes
Payload:	1.5 tonnes	1.0 tonne	1.0 tonne
Year of manufacture:	2005	2011	2001

Appendix 2: Photos of Vehicles and Charging Facilities

1. Trial Electric Vehicle and Charging Facilities

<table>
<tr><td> 
</td><td></td></tr>
<tr><td>EV-1</td><td></td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>EV-2</td><td>EV-3</td></tr>
<tr><td> 
</td><td>  </td></tr>
<tr><td>Batteries of EV</td><td>Meters on dashboard of EV</td></tr>
</table>

	
EV charging from the charging socket	Watt-hour meter at charging station

2. Diesel Vehicles for Comparison

	
DV- 1	
	
DV-2	DV-3