Pilot Green Transport Fund

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

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

Final Report
(Trial Period: 1 March 2012 – 28 February 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. TNT Express Worldwide (HK) Limited (TNT) was approved under the Fund for trial of two electric van-type light goods vehicles for courier service industry. Through the tendering procedures stipulated in the Subsidy Agreement TNT entered into with the Government, TNT procured two Smith Edison Panel Vans (EVs) 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 vehicles. Two diesel vehicles (DVs) providing similar services were assigned as the conventional vehicles for comparing with the two EVs.

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

2 Trial Vehicles

2.1 Key features of the EVs and DVs are shown in Appendix 1 and photos of the vehicles are shown in Appendix 2. They are referred to as EV-1, EV-2, DV-1 and DV-2 in this report. These vehicles were used for courier service. EV-1 and DV-1 were parked in TNT's Kowloon Bay depot, providing service to Ngau Tau Kok, Kowloon Bay and Kwun Tong areas. EV-2 and DV-2 were parked at TNT's Kwai Fong depot, providing service to Tai Kok Tsui, Shum Shui Po, Shek Kip Mei, Cheung Sha Wan and Lai Chi Kok areas. According to the design of the EVs, their maximum payload is limited to 1,115 kg. According to the manufacturer, the model has a travel range of 120 km with its battery fully charged and air-conditioning off.

2.2 TNT has set up two 32-ampere outlets, one in normal use and the other as spare for contingency, with electricity consumption meter at each of the two depots to charge the batteries of the EVs. It takes about 8 hours to fully charge the batteries. The EVs were only charged at their respective depots. According to the routes of the EVs, day to day usage of the vehicles for providing the courier service in the two service areas of the trial is generally less than 25 km for EV-1 and 70 km for EV-2. As the driving range of the EVs after fully charged would meet TNT's daily usage, the charging was normally scheduled to be carried out at their off-duty time, mainly at nighttime. Due to the difference in their daily mileage, EV-2 was charged almost on a daily basis while EV-1 was charged once every 2 or 3 days.

2.3 Two Toyota Hiace diesel vans (DV-1 and DV-2), each has a gross vehicle weight of 2,800 kg and a payload of about 1,000 kg from TNT of similar service areas were assigned for comparison with the two EVs.

3 Trial Information

3.1 The trial started on 1 March 2012 and lasted for 24 months. TNT was required to collect and provide trial information including the EV mileage reading before charging, amount of electricity consumed in each charging, charging time and operation downtime due to charging. EV monthly operation data included distance travelled, electricity consumed, electricity cost, cost and downtime associated with scheduled and unscheduled maintenance of the EVs and the charging facilities. Similar monthly 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 TNT were collected to reflect any problems of the EVs.

4 Findings of Trial

4.1 Operating Costs

4.1.1 Table 1 below summarizes the fuel cost data of the EVs and DVs. The fuel cost savings were as follows: EV-1 $1.23/km (56%) lower than DV-1; and EV-2 $0.87/km (61%) lower than DV-2. This shows that the EVs have a significant fuel saving than DVs. The average fuel economy for the vans (EV-2 and DV-2) from Kwai Fong depot was significantly better than those vans (EV-1 & DV-1) from Kowloon Bay depot, better by 71% and 52% for EV and DV respectively. This difference could be attributed to the heavier cargo load of EV-1 and DV-1 as well as more frequent stops in their service areas.

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

		Electric vans		Diesel vans	
		EV-1	**EV-2**	**DV-1**	**DV-2**
Average fuel economy	(km/kWh)	1.14	1.95		
	(km/litre)			5.61	8.55
	(km/MJ)	0.32	0.54	0.16[1]	0.24[1]
Average fuel cost /($/km)		0.97	0.57	2.20	1.44

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

4.1.2 Table 2 below summarizes the operating cost data of the EVs and DVs. During the trial period, both EVs had one scheduled maintenance each. EV-1 did not have any unscheduled maintenance but EV-2 had six breakdowns and one accident that required repairs by the vehicle supplier. As for the DVs, each had three scheduled and two unscheduled maintenances. There was insignificant downtime for EV-1 and the two DVs while EV-2 had 172 days of downtime, mainly due to the breakdowns. Utilization rates of EV-1 and EV-2 were nearly 100% and 71%, respectively, as compared with nearly 100% for both DVs.

4.1.3 The frequent breakdown of EV-2 in the trial involved mainly failure of braking and battery charging systems. The EV supplier and local service agent had taken excessively long time to rectify the problems, leading to very long downtime, despite the actual repair time required was within a couple of days, and hence it incurred high replacement vehicle rental costs.

4.1.4 Scheduled maintenance of EVs was simpler than DVs since the DVs required replacement of filters and engine oil and passing the smoke test, all of which were not required for the EVs. Reviewing the unscheduled maintenance history of the EVs, it could not be deduced that the EVs are unreliable since almost all incidents occurred in EV-2 could be due to the quality problem of the individual vehicle instead of design defect or limitation of the technology.

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 total operating cost is $1.22/km for EV-1 and $3.10/km for EV-2 which had additional costs incurred by the vehicle breakdown. As compared with their DV counterpart from the same depot, the total operating cost for EV-1 was lower by 53%. However, the total operating cost for EV-2 was 88% more than DV-2 due to the vehicle breakdown.

Table 2 Average total operating cost and downtime of each vehicle

		Electric vans		Diesel vans	
		EV-1	**EV-2**	**DV-1**	**DV-2**
Average total operating cost /($/km)		1.22	3.10	2.61	1.65
By vehicle type	average total operating cost /($/km)	2.16		2.13	
	average downtime[1] /day	86.5		3.5	

[1] Downtime refers to the working days in the period the vehicle is not in operation, which is counted from the first day it stops operation till the day it is discharged from the vehicle supplier to the operator

4.2 Performance and Reliability

4.2.1 The two EV drivers had no problem in operating the EVs but found they did not have enough power to go uphill (maximum of about 8% and 10% gradient for the two service areas).

4.2.2 Overall, TNT agreed that using electric vehicle is good, which can provide a greener and quiet environment as well as much lower fuel cost. However, TNT expressed the following concerns about the EVs under trial:

(i) they had lower performance on climbing up steep roads;

(ii) they exceeded the vehicle height limits of some car parks which limited their usage;

(iii) the capacity of the batteries limited the EVs to shorter trips;

(iv) inadequate support from local agent of the EVs on maintenance and repair; and

(v) battery life of one of the vehicle was suspected to have deteriorated.

4.2.3 To remove the effect of seasonal fluctuations, a 12-month moving average is used to evaluate the trend of the fuel economy for the EVs and DVs. The results show a general decrease of fuel economy with time for the EVs: a reduction of 10.5% for EV-1 and about 4% for EV-2 throughout the trial period. For both EVs, the drop in fuel economy is consistent and could be a concern in long term use of EVs. However, no obvious change in fuel economy has been observed for the DVs.

4.2.4 For each EV, the peak charge amount in each of the last six months of the trial period was compared with that one year before. There is no indication that the charge amount has dropped arising from deterioration of the charging system for the two EVs.

5 Summary

5.1 The average fuel economy of EV-1 and EV-2 was 1.14 km/kWh and 1.95 kWh. Indeed, the fuel economy or driving range is affected by various factors such as driving behaviour, road gradient, traffic condition, air-conditioning load and cargo load.

5.2 The total operating cost for EV-1 was 53% lower than DV-1. However, the total operating cost for EV-2 was 88% more than DV-2. This is caused mainly by the frequent breakdown of EV-2 due to mainly the failure of braking and battery charging systems which increased the maintenance cost significantly. The average fuel cost of the EVs was 58% lower than the DVs. The saving in fuel cost is still small, compared with the much higher capital cost of the EVs and their associated charging facilities than DVs.

5.3 EV-1, DV-1 and DV-2 had comparable utilization rates, close to 100%. EV-2, due to the breakdowns encountered during the trial, showed significantly lower utilization rate of around 71%.

5.4 The fuel economy of EVs expressed in km/kWh had dropped （4% - 10%）over the trial period. Similar analysis was conducted for the DVs but no obvious change in fuel economy has been observed in their case.

5.5 The trial showed that under local operating conditions where air-conditioning is essential, the EVs are suitable for use with short daily mileage. The vehicle manufacturer should, however, provide adequate technical support to the EVs to avoid excessive downtime for repair and maintenance.

Appendix 1: Key Features of Vehicles Involved in the Trial

1. Trial HVs

Registration Mark:	**RE6810 and RE 6805**
Make:	Smith
Model:	Smith Edison Panel Van
Class:	Light goods vehicle
Gross vehicle weight:	3500 kg
Payload:	1115 kg
Seating Capacity:	driver + 2 passengers
Rated Power:	23.5 kW
Travel range:	120 km on full charge and air-conditioning off on flat road conditions
Maximum speed:	80 km/h
Battery material:	Lithium ion
Batteries capacity:	36 kWhr
Charging time:	8 hours with max. charging current of 16A
Year of manufacture:	2010

2. DVs used for comparison

Registration Mark:	**MR5653**
Make:	Toyota
Model:	KDH200RSSMDY
Class:	Light goods vehicle
Gross vehicle weight:	2.8 tonnes
Payload:	about 1000 kg
Seating Capacity:	driver + 2 passengers
Cylinder capacity:	2494 cc
Year of manufacture:	2006

Registration Mark:	**NR2383**
Make:	Toyota
Model:	KDH201RSSMDY
Class:	Light goods vehicle
Gross vehicle weight:	2.8 tonnes
Payload:	about 1000 kg
Seating Capacity:	driver + 2 passengers
Cylinder capacity:	2982 cc
Year of manufacture:	2008

Appendix 2: Photos of Vehicles and Charging Facilities

1. Trial Electric Vans and Charging Facilities

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<tr><td> 
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<tr><td>Smith Panel Van</td><td></td></tr>
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<tr><td>Electric Van (RE6810) at Kowloon Bay Depot</td><td>Electric Van (RE6805) at Kwai Fong Depot</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Batteries of the electric vans</td><td>Meters on dashboard of EV</td></tr>
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	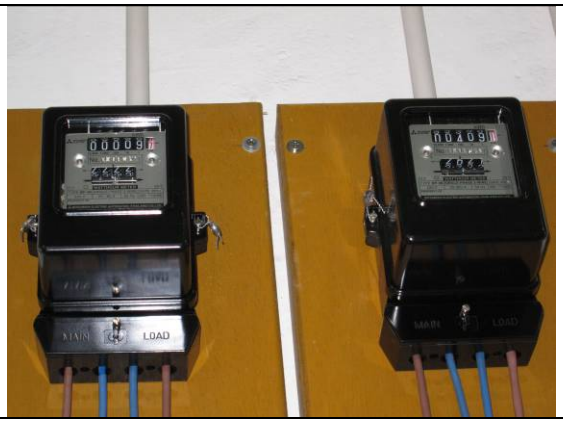
EV charging from the charging socket	Watthour meters at charging station

2. Diesel Vans for Comparison

	
Toyota Hiace diesel vans	
	
Diesel vans (MR5653) at Kowloon Bay Depot	Diesel vans (NR2383) at Kwai Fong Depot