Pilot Green Transport Fund

Final Report On
Trial of Electric Van for Construction Industry
(Mak Hang Kei)

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Pilot Green Transport Fund
Trial of Electric Van for Construction Industry (Mak Hang Kei)

Final Report
(Trial Period: 1 December 2013 – 30 November 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. Mak Hang Kei (Hong Kong) Construction Limited (MHK) was approved under the Fund for trial of two electric van-type light goods vehicle with associated charging facilities for construction work. Through the tendering procedures stipulated in the Subsidy Agreement MHK entered into with the Government, MHK procured two Renault Kangoo Van Z.E. light goods vehicles (EV-1 and EV-2) for trial.

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 trial and evaluate the performance of the trial vehicles. MHK assigned two diesel light goods vehicles (DV-1 and DV-2) that provided similar services as the conventional vehicles for comparing with the two EVs.

1.3 This report summarizes the performance of the EVs in the 24-month trial as compared with their conventional diesel counterpart.

2. Trial Vehicles

2.1 Key features of the EVs and the DVs are shown in Appendix 1 and photos of the vehicles are shown in Appendix 2. These vehicles were used to transport staff, materials and tools for construction works. EV-1 and DV-1 served Sha Tin, Tai Po, Sai Kung and Tseung Kwan O. EV-2 and DV-2 served the Kowloon district. According to its manufacturer, each EV is designed to carry 650 kg payload. The EV has a designed travel range of 170 km per charge without air-conditioning.

2.2 MHK has set up at the site office two 13A electricity outlets to charge the battery of the EVs as well as watt-hour meters for each outlet to record the electricity consumption of each EV at its site office at Ma On Shan. Due to concerns about the EVs' driving range, the EVs were used occasionally for short trips only. Therefore, they were not charged every day. Both EVs were charged from 18:00 in the evening to 08:00 in the next morning when charging were required. The EVs were only charged at the site office. Photos of the charging facilities are in Appendix 2.

2.3 The Ma On Shan site started decommissioning in October 2014 after the project at the site was completed. Decommission work carried out at night disrupted frequently the site's power supply and charging of the EVs causing their low usage in October and November 2014. In December 2014, the EVs were deployed to a new site and have picked up usage since then.

3. Trial Information

3.1 The trial started on 1 December 2013 and lasted for 24 months. MHK 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 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 were collected to reflect any problems of the EVs.

4. Findings of Trial

4.1 Operating Costs

4.1.1 The average fuel economy and cost statistics of the EVs and the DVs are summarized in Table 1. The fuel costs comparisons are as follows: EV-1 $0.966/km (77%) lower than DV-1; EV-2 $0.968/km (77%) lower than DV-2.

Table 1: Key operation statistics of each vehicle

		Electric vans		**Diesel vans**	
		EV-1	**EV-2**	**DV-1**	**DV-2**
Total distance travelled/km		10,683	11,021	39,513	67,316
Average fuel economy/	(km/kWh)	4.29	4.30		
	(km/litre)			9.47	9.61
	(km/MJ)	1.19	1.19	0.262[1]	0.266[1]
Average fuel cost ($/km)		0.284	0.282	1.25	1.25

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

4.1.2 Table 2 summarizes the operating cost data of each vehicle. The total operating cost is $1.03/km for EV-1 and $1.01/km for EV-2. As compared with their DV counterparts, the total operating cost was lower by 48% for EV-1 and 41% for EV-2.

Table 2: Summary of all the costs and downtime of each vehicle

		EV-1	EV-2	DV-1	DV-2
Fuel cost/$		3,032	3,109	49,582	84,417
Maintenance cost/$		8,016	8,016	28,188	29,734
Other cost/$		0	0	0	0
Total operating cost/$		11,048	11,125	77,770	114,151
Average total operating cost/ ($/km)		1.03	1.01	1.97	1.70
Downtime/day[1]		8	8	10	10
By Vehicle type	Average total operating cost/ ($/km)	1.02		1.80	
	Average downtime/ day	8		10	

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

4.1.3 Apart from the fuel costs, the table also shows the average total operating costs which included maintenance costs and other indirect costs such as towing fee, vehicle replacement fee. The EVs and the DVs incurred only fuel and maintenance costs in this trial. The average total operating cost of the two EVs was $1.02/km. Compared with the DVs, the average total operating cost of the EVs was lower by 43%, given that MHK did not pay for the repair of the EVs which were still covered by warranty.

4.1.4 During the trial period, each EV had three scheduled maintenance but no unscheduled maintenance, DV-1 had two scheduled maintenance and eight unscheduled maintenance, DV-2 had two scheduled maintenance and nine unscheduled maintenance. The downtime was 8 days for each EV and 10 days for each DV. Utilization rates were 98.6% for the EVs and 98.3% for the DVs.

4.1.5 Scheduled maintenance of EVs was simpler than the DVs since the latter required replacement of filters and engine oil and passing the smoke test.

4.2 Performance and Reliability

4.2.1 The drivers of the two EVs had no problem in operating the EVs and were satisfied with their performance. However, both drivers opined that the travel range was too short for normal operation and therefore the EVs were only used infrequently and mostly for short journeys.

4.2.2 Overall, MHK agreed that using electric vehicle is good because it can provide a greener and quiet environment as well as its much lower fuel cost. However, MHK would not replace all its existing conventional vehicles with the green vehicles because there was concern about the maintenance cost of the EVs.

4.2.3 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 varied narrowly from 4.41 to 4.16 km/kWh for EV-1 and from 4.39 to 4.18 km/kWh for EV-2. There is a very slight drop in fuel economy of the EVs over the trial period, but the variation is very narrow that deterioration in fuel economy is insignificant for both EVs.

4.2.4 For both EVs, the monthly peak charge amount in the last six months of the trial period was slight lower than that in the last six months of the first year of the trial period. It is an indication that the charge amount has dropped. This might be a result of deterioration in the charging capacity of the battery.

4.2.5 The equivalent CO_2 emissions from the EVs and the DVs are 3,000 kg and 6,306 kg, respectively. Result indicated a reduction of 3,306 kg (52.4%) CO_2 emission throughout the trial.

5. Summary

5.1 The trial showed that the EVs had lower fuel cost as compared with their conventional diesel counterparts, with an average saving of $0.967/km or 77%. The total operating cost for the EVs was 43% lower than the DVs, given that MHK did not pay for the repair cost of the EVs which were still covered by warranty.

5.2 The EV drivers found no problem in operating the EVs. The operation of the EVs was smooth. Utilization rates were 98.6% for the EVs and 98.3% for the DVs.

5.3 There is no indication that the fuel economy has significant deterioration in the trial period but there could be deterioration in the charging capacity of the battery.

5.4 The trial showed that under local operating conditions where air-conditioning is essential, the Renault Kangoo Van Z.E. could meet the user's daily mileage requirements, for short trips, using in-house charging facilities.

Appendix 1: Key Features of the Vehicles Involved in the Trial

1. Trial EVs

Registration Mark:	**KN370 & MZ950**
Make:	Renault
Model:	Kangoo Van Z.E.
Class:	Light goods vehicle
Gross vehicle weight:	2.3 tonnes
Payload:	650 kg
Seating capacity:	driver + 4 passengers
Rated power:	44 kW max.
Travel range:	air-conditioning off, no load: 170 km
Maximum speed:	130 km/h
Battery material:	lithium-ion
Battery capacity:	22 kWh
Charging time:	10 hours [13A]

2. DVs used for comparison

Registration Mark:	**MN4098**	**NB1102**
Make:	Toyota	Toyota
Model[1]:	KDH200RSSPDY	KDH201RSSMDY
Class:	Light goods vehicles	Light goods vehicles
Gross vehicle weight:	2.8 tonnes	2.8 tonnes
Payload:	850 kg	850 kg
Seating Capacity:	driver + 5 passengers	driver + 5 passengers
Cylinder capacity:	2,494 cc	2,982 cc
Year of manufacture:	2006	2007

[1] Both are also commonly known as Hiace

Appendix 2: Photos of Vehicles and Charging Facilities

1. Trial EVs and Charging Facilities

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<tr><td>EV-1 – front view</td><td>EV-1 – end view</td></tr>
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<tr><td>EV-1 – side view</td><td>Watt-hour meter of EV-1’s charging facility</td></tr>
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EV-2 – front view	EV-2 – end view
	
EV-2 – side view	Watt-hour meter of EV-2's charging facility
	
Charging station for the EVs	

2. DVs for Comparison

	
DV-1	DV-2