

Pilot Green Transport Fund

Final Report On Trial of Electric Van for Emergency Vehicle Rescue Service (HKAA)

(28 December 2015)

PREPARED BY:

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

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

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 Van for Emergency Vehicle Rescue Service (HKAA)**

**Final Report
(Trial Period: 1 October 2012 – 30 September 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. The Hong Kong Automobile Association (HKAA) was approved under the Fund for trial of one electric van-type light goods vehicle for emergency vehicle rescue service. Through the tendering procedures stipulated in the Subsidy Agreement HKAA entered into with the Government, HKAA 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. HKAA initially assigned a Daihatsu petrol vehicle providing similar services as the conventional vehicle for comparing with the EV. It was subsequently scrapped and replaced by a Mazda petrol vehicle for the comparison. These petrol vehicles are referred to as the PVs in this report.

1.3 This report summarizes the performance of the EV in the 24-month trial as compared with its conventional petrol counterparts.

2 Trial Vehicles

2.1 Key features of the EV and the PVs are shown in Appendix 1 and photos of the vehicles are shown in Appendix 2. These vehicles provided 24-hour emergency vehicle rescue service throughout Hong Kong all year round, responding to 10-20 service requests every day. 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 HKAA has two depots, one in Yau Ma Tei and one in Wan Chai. It has set up at each depot a 20A electricity outlet to charge the battery of the EV as well as a Watt-hour meter to record the related electricity consumption. It takes about 8 hours to charge the EV's battery from 0 to 100% full. It can also be charged using CHAdeMO quick chargers – there are 12 such quick chargers in Hong Kong – to top up to 80% within 40 minutes. Once fully charged, the travel range of the EV could meet HKAA's daily use. Thus the EV was charged only once from mid-night to 08:00 in the morning for 8 hours from Monday to Friday and from mid-night on Saturday to mid-night on Sunday for 24 hours. The 24-hour charging is required for battery balancing to maintain the battery performance. During the trial period, the EV was stationed at the Yau Ma Tei depot and was only charged there. The charging facility at Wan Chai serves as a backup in case the EV's battery needs topping up whilst in Hong Kong Island. Photos of the charging facilities are in Appendix 2.

2.3 HKAA initially assigned a Daihatsu 1,499 c.c. 5-seater petrol private car that provided similar service as the EV's conventional counterpart for comparison. The Daihatsu PV was subsequently scrapped in January 2013 because of its frequent problems and high repair cost. It was replaced by a Mazda 1,324 c.c. 5-seater petrol private car for comparison with the EV.

3 Trial Information

3.1 The trial started on 1 October 2012 and lasted for 24 months. HKAA 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 data from the PVs were also required. In addition to the cost information, reports on maintenance work, operational difficulties and opinions of the drivers and HKAA 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 the PVs. The fuel cost of the EV was significantly lower: \$1.48/km (79%) lower than the PVs.

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

		EV	PVs
Total distance travelled / km		24,744	9,037
Average fuel economy /	(km/kWh)	2.91	
	(km/litre)		9.04
	(km/MJ)	0.808	0.283 ^[1]
Average fuel cost /(\$/km)		0.393	1.87

[1] Assuming lower heating value of 32 MJ/litre for petrol

4.1.2 Table 2 below summarizes the operating cost data of the EV and the PVs. During the trial period, the EV had three scheduled and two unscheduled maintenances with 75 days downtime. The PVs had one scheduled and one unscheduled maintenance with 6 days downtime. Utilization rate of the EV was 90%, compared with 99% for the PVs.

4.1.3 The first unscheduled maintenance of the EV was caused by the failure of a component of the battery management system. The second unscheduled maintenance involved the replacement of a failed AC/DC charging unit on the EV. The first scheduled maintenance involved mainly battery balancing. The second and third ones involved maintenance work for annual examinations. The first PV had one unscheduled maintenance to replace its exhaust pipe and silencer. The second PV had one scheduled maintenance which involved maintenance work for annual examination.

4.1.4 Scheduled maintenance of the EV was simpler than the PVs since the latter required replacement of filters and engine oil. The relatively long downtime of the EV was caused by the unscheduled AC/DC charging unit replacement. The replacement parts took a long time to arrive.

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 the PVs incurred only fuel and maintenance costs in this trial. The average total operating cost is \$0.890/km for the EV and \$2.65/km for the PVs. As compared with the PVs, the average total operating cost for the EV was lower by 66%, given that HKAA did not pay for the repair of the EV which was still covered by warranty.

Table 2: Average total operating cost and downtime of each vehicle

	EV	PVs
Total operating cost/\$	22,021	23,917
Average total operating cost/(\$/km)	0.890	2.65
Downtime/working days ^[1]	75	6

[1] 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 Overall, HKAA agreed that using electric vehicle is good because it can provide a greener and quiet environment as well as incurring much lower fuel cost.

4.2.3 To remove the effect of seasonal fluctuations, 12-month moving averages are used to evaluate the trend of the vehicles' fuel economy. The results show a narrow variation from 2.89 km/kWh to 2.94 km/kWh for the EV. For the PVs, it varied from 8.83 km/L to 10.0 km/L. In both cases, there is no indication of fuel economy deterioration during the trial period.

4.2.4 For the EV, the peak charge amount in each of the last three months of the trial period was similar to the peak amounts found twelve months before. 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 petrol counterparts, with a saving of \$1.48/km or 79%. The total operating cost for the EV was 66% lower than the PVs, given that HKAA 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 maintenances. However, a spare part took a long time to arrive causing the EV significant downtime. As a result, the EV total downtime was 75 days in the 24-months period and its utilization rate was only 90%. On the other hand, the PVs utilization rate was almost 100%.

5.3 The average fuel economy of all vehicles involved hardly changed during the trial. For the EV, the stable fuel economy is another indication that its battery has not deteriorated.

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 using in-house charging facilities. Moreover, the EV did not cause any problem to the drivers during the trial period and was able to perform as required.

Appendix 1: Key Features of Vehicles Involved in the Trial

1. Trial Electric Van

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. Petrol Vehicles Used for Comparison

MJ7790 (October 2012 – January 2013)

Make:	Daihatsu
Model:	G303RG-GPNE
Class:	Private Car
Gross vehicle weight:	N.A.
Payload:	N.A.
Seating Capacity:	driver + 4 passengers
Cylinder capacity:	1,499 cc
Year of manufacture:	1997

HX7212 (since February 2013)

Make:	Mazda
Model:	DEMIO 1.3 5DR 'M'
Class:	Private Car
Gross vehicle weight:	N.A.
Payload:	N.A.
Seating Capacity:	driver + 4 passengers
Cylinder capacity:	1,324 cc
Year of manufacture:	1998

Appendix 2: Photos of Vehicles and Charging Facilities

1. Trial Electric Van and Charging Facility

	
<p>Front view of trial EV</p>	<p>Rear view of trial EV</p>
	
<p>Charging station at Yau Ma Tei</p>	<p>Watt-hour meter</p>
	
<p>Meters on dashboard of EV</p>	

2. Petrol Vehicles for Comparison



Daihatsu petrol vehicle (October 2012 – January 2013)



Mazda petrol vehicle (February 2013 onwards)