

Pilot Green Transport Fund

Final Report On
Trial of Electric Vans on Campus
(CUHK)

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

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**Pilot Green Transport Fund
Trial of Electric Vans on Campus (CUHK)**

**Final Report
(Trial Period: 1 October 2013 – 30 September 2015 for EV-1
and 1 February 2014 – 31 January 2016 for EV-2)**

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 Chinese University of Hong Kong (CUHK) was approved under the Fund for trial of two electric van-type light goods vehicles to provide goods transportation service for its departments and faculties. Through the tendering procedures stipulated in the Agreement, CUHK procured one Renault Kangoo Van Z.E. (EV-1) and one Mitsubishi Minicab MiEV (EV-2) 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. CUHK 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. The originally assigned DV-2 (MD4962) had retired in March 2015 and was replaced by another diesel light goods vehicle (TE9811) for the trial.

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

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 by Estates Management Office to provide transportation and goods delivery services within the campus. Day-to-day travel for providing such service was generally less than 100 km for each EV. EV-1 has a payload of 650 kg while that of EV-2 is 350 kg. EV-1 has a design travel range of 170 km per charge without air-conditioning while EV-2 has a design travel range of 150 km per charge without air-conditioning – according to its manufacturer. However, all EVs under trial were operated with air-conditioning, even in the winter, both for cooling and for avoiding moisture appearing on the windscreen. The performances data as reported here were based on operation of EVs with air-conditioning.

2.2 CUHK has set up inside the campus two 13A electricity outlets to charge the batteries of the EVs as well as watt-hour meters for each outlet to record the electricity consumption of each EV. The EVs were charged inside the campus only during the trial period. Due to the low daily mileage, both EVs were not charged every day. Both EVs were usually charged at night time to the next morning when charging was required. EV-1 needs about 10 hours to charge from empty to full. EV-2 having a smaller battery needs about 7 hours only. Photos of the charging facilities are in Appendix 2.

3. Trial Information

3.1 The trial started on 1 October 2013 for EV-1 and 1 February 2014 for EV-2 and lasted for 24 months for each vehicle. CUHK 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 recorded. In addition to the cost information, reports on maintenance work, operational difficulties, opinions of the drivers and recipient (CUHK) 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 \$1.40/km (84%) lower than DV-1; EV-2 \$1.62/km (88%) 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		11,382	9,107	20,974	37,241
Average fuel economy/	(km/kWh)	3.67	4.60		
	(km/litre)			7.16	6.41
	(km/MJ)	1.02	1.28	0.20 ^[1]	0.18 ^[1]
Average fuel cost (\$/km)		0.26	0.21	1.66	1.83

^[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 \$1.15/km for EV-1 and \$1.12/km for EV-2. As compared with their DV counterparts, the total operating cost was lower by 38% for EV-1 and 39% for EV-2.

Table 2: Summary of all the costs and downtime

		EV-1	EV-2	DV-1	DV-2
Fuel cost/\$		3,003	1,943	34,947	68,248
Maintenance cost/\$ ^[1]		10,035	8,220	4,136	0
Other cost/\$		0	0	0	0
Total operating cost/\$		13,038	10,163	39,083	68,248
Average total operating cost/ (\$/km)		1.15	1.12	1.86	1.83
Downtime/day ^[2]		19	54	18	4
By Vehicle type	Average total operating cost/ (\$/km)	1.13		1.84	
	Average downtime/ day	37		11	

^[1] The local service agents charged CUHK for routine inspection of the EVs once every 6 month/5000 km.

^[2] 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 and vehicle replacement fee. Both the EVs and the DVs incurred only fuel and maintenance costs in this trial. The average total operating cost of the two EVs was \$1.13/km. Compared with the DVs, the average total operating cost of the EVs was lower by 39%, given that CUHK did not pay for the repair cost of the EVs which were still covered by warranty.

4.1.4 During the trial period, EV-1 had three (3) scheduled and one (1) unscheduled maintenance, with 11 and 8 days of downtime, respectively. The scheduled maintenances were for routine inspection by the service agent and for annual inspection. The unscheduled maintenance was caused by water accumulation on the floor of the passenger seat. EV-2 had four (4) scheduled and one (1) unscheduled maintenance, with 25 and 29 days of downtime, respectively. The scheduled maintenances were for routine inspection by the service agent and for annual inspection. The unscheduled maintenance was for replacement of damaged charging cable and parts. DV-1 had two (2) scheduled and one (1) unscheduled maintenance, with 18 days of downtime while DV-2 had one (1) schedule maintenance, with 4 days downtime but no unscheduled maintenance.

4.1.5 Scheduled maintenance of EVs was simpler than the DVs since the latter required replacement of filters, engine oil and passing the smoke test. The relatively long downtime of the EVs was caused by regular scheduled maintenance demanded by the EV suppliers. For EV-2, the relatively long downtime was also caused by the long time taken for the replacement of a new charging cable.

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, they opined that the travel range was too short and it took long time for charging.

4.2.2 Overall, CUHK 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, CUHK would not replace all its existing conventional vehicles with the green vehicles because it was not easier and cheaper to maintain the EVs and it took longer time for vehicle maintenance.

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 averages indicate that no deterioration in fuel economy was found in either EV.

4.2.4 For EV-1, the monthly peak charge amount of the battery pack 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. There are two possible reasons to that. First, it might be a result of deterioration in the charging capacity of the battery. Second, it might be associated with low usage of EV-1 in the last six months of the trial (monthly mileage of 139 km to 271 km), thus each time the topping up amount was not that high. For EV-2, there is no indication that there was deterioration in the charging capacity of the batteries.

4.2.5 The total equivalent CO₂ emissions from the EVs and the DVs are 3,094 kg and 8,344 kg, respectively, indicating a reduction of 5,250 kg or 63% CO₂ emission throughout the trial period.

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 \$1.53/km or 86%. The total operating cost for the EVs was 39% lower than the DVs, given that CUHK did not pay for the repair of the EVs which were still covered by warranty.

5.2 The EV drivers found no problem in operating the EVs but the travel range was relatively short and it took long time for charging. Utilization rates were 95% for the EVs and 98% for the DVs.

5.3 There is no indication that the fuel economies of the EVs have deteriorated in the trial period. In regard to the battery charging capacity, there is no indication of deterioration for EV-2 but there might be deterioration for EV-1.

5.4 The trial showed that under CUHK' operating conditions where there is hilly terrain, the EVs could meet the user's daily travel requirements using in-house charging facilities.

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

1. Trial EVs

Registration Mark:	SC3326 (EV-1)	SL2845 (EV-2)
Make:	Renault	Mitsubishi
Model:	Kangoo Van Z.E.	Minicab MiEV
Class:	Light goods vehicle	Light goods vehicle
Gross vehicle weight:	2.3 tonnes	1.66 tonnes
Payload:	650 kg	350 kg
Seating capacity:	driver + 4 passengers	driver + 1 passenger
Rated power:	44 kW max.	25 kW max.
Travel range:	air-conditioning off, no load: 170 km	air-conditioning off, no load: 150 km
Maximum speed:	130 km/h	130 km/h
Battery material:	lithium-ion	lithium-ion
Battery capacity:	22 kWh	16 kWh
Charging time:	10 hours [13A]	7 hours [13A]

2. DVs used for comparison

Registration Mark:	MX8911 (DV-1)	MD4962 (DV-2(a))
Make:	Isuzu	Toyota
Model:	TFR86HD	KDH200RSSMDY (Hiace)
Class:	Light goods vehicle	Light goods vehicle
Gross vehicle weight:	2.85 tonnes	2.80 tonnes
Payload:	600 kg	850 kg
Seating capacity:	driver + 4 passengers	driver + 5 passengers
Cylinder capacity:	2,499 cc	2,494 cc
Year of Manufacture:	2007	2005

Registration Mark:	TE9811 (DV-2(b))
Make:	Toyota
Model:	Hiace diesel LWB
Class:	Light goods vehicle
Gross vehicle weight:	2.80 tonnes
Payload:	850 kg
Seating capacity:	driver + 5 passengers
Cylinder capacity:	2,982 cc
Year of Manufacture:	2015

Appendix 2: Photos of Vehicles and Charging Facilities

1. Trial EVs and Charging Facilities



EV-1 – front view



EV-1 – end view



EV-1 – side view



Watt-hour meter of EV-1's charging facility



EV-2 – front view



EV-2 – end view



EV-2 – side view



Watt-hour meter of EV-2's charging facility

2. DVs for Comparison



DV-1 – front view



DV-2(a) – front view



DV-2(b) – front view