

Pilot Green Transport Fund

Final Report On
Trial of Electric Light Goods Vehicles
for Airport Operation
(Airport Authority Hong Kong)

(17 June 2020)

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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 Light Goods Vehicles for Airport Operation
(Airport Authority Hong Kong)**

**Final Report
(Trial Period: 1 December 2014 – 30 November 2016)**

Executive Summary

1. Introduction

1.1 The Pilot Green Transport Fund (the Fund) is set up to encourage transport operators to try out green innovative transport technologies, contributing to better air quality and public health for Hong Kong. Airport Authority Hong Kong (AAHK) was approved under the Fund for trial of three electric light goods vehicles (hereafter called EVs) for airport operation. Through the tendering procedures stipulated in the Subsidy Agreement, AAHK procured three Renault Kangoo Z.E. electric light goods vehicles for trial.

1.2 The Hong Kong Institute of Vocational Education (Tsing Yi) 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. Three petrol light goods vehicles providing similar services were assigned as the conventional counterparts for comparing with the three EVs.

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

2. Trial Vehicles

2.1 AAHK procured three Renault Kangoo Z.E. electric light goods vehicles (namely EV-1, EV-2 & EV-3) and each has a gross vehicle weight (GVW) of 2,300 kg and 22 kWh battery capacity for trial. The EVs were mainly used for supporting the on-call services in airport. AAHK has not applied subsidy for installation of EV facilities, but uses the existing charging facilities located in airport area. The EVs were regularly charged overnight or when not in service, and were stationed at the AAHK facilities at the Hong Kong International Airport (HKIA).

2.2 Three Nissan URVAN 2.5L petrol light goods vehicles (namely PV-1, PV-2 and PV-3) with a gross vehicle weight (GVW) of 3,100 kg each were assigned for comparison with the three EVs in this trial.

2.3 Key features of the EVs and the PVs are shown in Appendix 1 and photos of the vehicles and the existing charging facilities are shown in Appendix 2.

3. Trial Information

3.1 The trial started on 1 December 2014 and lasted for 24 months. AAHK 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, downtime due to charging cost and operation downtime associated with scheduled and unscheduled maintenance of the EVs. Similar monthly 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 AAHK were collected to reflect any problems of the EVs.

4. Findings of Trial

4.1 The following table summarizes the key operation statistics of each vehicle in the trial. The average fuel costs of EV-1, EV-2 and EV-3 were HK\$2.62/km (about 90%), HK\$2.21/km (about 89%) and HK\$2.85/km (about 90%) lower than PV-1, PV-2 and PV-3, respectively and the fleet average fuel cost of the EVs was HK\$2.56/km (about 91%) lower than the PVs. The average total operating costs of EV-1, EV-2 and EV-3 were HK\$2.47/km (about 80%), HK\$2.23/km (about 72%) and HK\$3.75/km (about 76%) lower than PV-1, PV-2 and PV-3, respectively and the fleet average total operating cost of the EVs was about HK\$2.82/km (about 76%) lower than that of the PVs.

Table 1: Key operation statistics of each vehicle (December 2014 to November 2016)

	EVs			PVs			
	EV-1	EV-2	EV-3	PV-1	PV-2	PV-3	
Total distance traveled (km)	10,782	6,102	4,139	18,621	11,759	18,121	
Average daily distance traveled (km)	21.5	12.2	8.3	37.2	23.5	36.2	
Average fuel economy ^[1]	(km/kWh)	4.09	4.14	3.73	-	-	-
	(km/litre)	-	-	-	5.09	5.85	4.66
	(km/MJ)	1.14	1.15	1.04	0.16 ^[1]	0.18 ^[1]	0.15 ^[1]
Average fuel cost (HK\$/km) ^[2]	0.28	0.27	0.30	2.90	2.48	3.15	
Fleet average fuel cost (HK\$/km)	0.28			2.84			
Average total operating cost (HK\$/km)	0.62	0.87	1.19	3.09	3.10	4.94	
Fleet average total operating cost (HK\$/km)	0.89			3.87			
Downtime (working day) ^{[3][4]}	3	3	3	5	20	26	

^[1] Assuming lower heating value of 32 MJ/liter for petrol fuel

^[2] The market fuel price was used for calculation

^[3] Downtime refers to the period the vehicle is not in operation, which counted from the first day it stops operation till it is returned to the operator

^[4] Maintenance due to incidents unrelated to the performance of the vehicle was not included for comparison.

4.2 During the trial period, EV-1, EV-2 and EV-3 had one scheduled maintenance each for regular checkup resulting in 3 working days of operation downtime per EV. There was no unscheduled maintenance for the EVs. PV-1 had one scheduled maintenance resulting in 4 days of operation downtime but no unscheduled maintenance related to the vehicle performance. PV-2 had one scheduled maintenance resulting in 20 working days of downtime but no unscheduled maintenance required. PV-3 did not have scheduled maintenance but had four unscheduled maintenances related to vehicle performance with the total of 26 working days of operation downtime during the trial period. Utilization rates of the EV-1, EV-2 & EV-3 were all 99.4% and that of PV-1, PV-2 and PV-3 were 99%, 96% and 95%, respectively.

4.3 The drivers found no problem in operating the EVs and felt the EVs were quiet and environment-friendly. There was no difficulty in charging the EVs since a sufficient number of charging points were available in the airport. Since the EVs were normally driven on flat roads, the EV drivers did not have any comment on the EV performance about slope-climbing.

4.4 AAHK expressed that the driving range of the EVs limited their servicing area. They would consider expanding their operating area outside the Airport boundary if the EVs could provide longer driving ranges. AAHK also suggested that the long charging time should be improved so that the daily duty time of EVs would be extended to cover the night duty shift as they would like to have the flexibility to allocate service roster for the EVs just like the other conventional vehicles in the fleet.

4.5 To eliminate the effect of seasonal fluctuations, 12-month moving averages were used to evaluate the trend of the EVs' fuel economy. The fuel economies varied from 4.09 to 4.33 km/kWh for EV-1, 4.03 to 4.48 km/kWh for EV-2 and 3.55 to 3.88 km/kWh for EV-3. During the 24-month trial period, the variation in fuel economy of the EVs is minor and there is no indication that the fuel economy and the batteries have deteriorated during the trial period.

4.6 The carbon dioxide equivalent (CO_{2e}) emissions from the EV-1, EV-2 and EV-3 were 1,431 kg, 803 kg and 602 kg, respectively, while those from PV-1, PV-2 and PV-3 were 5,795 kg, 2,825 kg and 2,405 kg, respectively. Hence there is a reduction of 4,364 kg (about 75%), 2,022 kg (about 72%) and 1,803 kg (about 75%) CO_{2e} emission for EV-1, EV-2 and EV-3 in the trial. The total reduction of CO_{2e} is 8,189 kg (about 74% on average) by using EVs in the trial.

5 Summary

5.1 The drivers found no problem in operating the EVs and felt the EVs were quiet and environment-friendly. The utilization rates of the EVs were all 99.4% and those of PV-1, PV-2 and PV-3 were 99%, 96% and 95% respectively.

5.2 However, the usage of the EVs was on the lower side as reflected by the difference in the total mileage travelled between the EVs and PVs: EV-1 (10,782 km i.e. an average of 21.5 km/day), EV-2 (6,102 km i.e. an average of 12.2 km/day), EV-3 (4,139 km i.e. an average of 8.3 km/day), PV-1 (18,621 km, i.e. an average of 36.2 km/day), PV-2 (11,759 km, i.e. an average of 24.4 km/day) and PV-3 (18,121 km, i.e. an average of 36.2 km/day).

5.3 The EVs incurred a lower fleet average fuel cost of HK\$2.56/km (about 91%) compared to that of the PVs. Taking into account maintenance costs, the fleet average total operating cost of the EVs was HK\$2.82/km (about 76%) lower than that of the PVs. There is a reduction of 4,364 kg (about 75%), 2,022 kg (about 72%) and 1,803 kg (about 75%) CO_{2e} emission for EV-1, EV-2 and EV-3 in the trial and the total reduction of CO_{2e} was 8,189 kg (about 74% on average) by using EVs in the trial.

5.4 The 12-month moving average fuel economy figures suggest that the variation in fuel economy of the EVs is minor and there is no indication that the fuel economy and the batteries have deteriorated during the trial period.

5.5 At present, the price of electric vehicle is higher than that of a conventional vehicle, so the accumulated fuel cost saving cost may not be able to offset the higher vehicle cost shortly. However, electric vehicle market is expanding and electric vehicle technology is improving, the price difference between electric vehicle and conventional vehicle is narrowing down and more affordable to the transport trade.

Appendix 1: Key Features of Vehicles Involved in the Trial

1. Trial EVs

a) EV-1

Registration Mark	SW 8837
Make:	Renault
Model:	Kangoo Z.E.
Class:	Light goods vehicle
Gross vehicle weight:	2,300 kg
Seating capacity:	driver + 4 passengers
Rated power:	44 kW
Travel range:	170 km (air-conditioning off)
Maximum speed:	130 km/h
Battery material:	Lithium ion
Batteries capacity:	22 kWh
Charging time:	8 hours (Max. current 16A)
Payload:	650kg
Year of manufacture:	2014

b) EV-2

Registration Mark	SW 8969
Make:	Renault
Model:	Kangoo Z.E.
Class:	Light goods vehicle
Gross vehicle weight:	2,300 kg
Seating capacity:	driver + 4 passengers
Rated power:	44 kW
Travel range:	170 km (air-conditioning off)
Maximum speed:	130 km/h
Battery material:	Lithium ion
Batteries capacity:	22 kWh
Charging time:	8 hours (Max. current 16A)
Payload:	650kg
Year of manufacture:	2014

c) EV-3

Registration Mark	SW 9881
Make:	Renault
Model:	Kangoo Z.E.
Class:	Light goods vehicle
Gross vehicle weight:	2,300 kg
Seating capacity:	driver + 4 passengers
Rated power:	44 kW
Travel range:	170 km (air-conditioning off)
Maximum speed:	130 km/h
Battery material:	Lithium ion
Batteries capacity:	22 kWh
Charging time:	8 hours (Max. current 16A)
Payload:	650kg
Year of manufacture:	2014

2. PVs for comparison

a) PV-1

Registration Mark	NE 2804
Make:	NISSAN
Model:	URVAN 2.5L Petrol
Class:	Light goods vehicle
Seating capacity:	driver + 5 passengers
Gross vehicle weight:	3,100 kg
Engine capacity:	2488 c.c.
Year of manufacture:	2007

b) PV-2

Registration Mark	NR 6597
Make:	NISSAN
Model:	URVAN 2.5L Petrol
Class:	Light goods vehicle
Seating capacity:	driver + 5 passengers
Gross vehicle weight:	3,100 kg
Engine capacity:	2488 c.c.
Year of manufacture:	2008

c) PV-3

Registration Mark	NT 917
Make:	NISSAN
Model:	URVAN 2.5L Petrol
Class:	Light goods vehicle
Seating capacity:	driver + 5 passengers
Gross vehicle weight:	3,100 kg
Engine capacity:	2488 c.c.
Year of manufacture:	2009

Appendix 2: Photos of Vehicles and the Existing Charging Facilities

1. Trial EVs and charging facilities

a) EV-1



Front View of EV-1



Rear View of EV-1



Left Side View of EV-1



Right Side View of EV-1

b) EV-2



Front View of EV-2



Rear View of EV-2



Left Side View of EV-2



Right Side View of EV-2

c) EV-3



Front View of EV-3



Rear View of EV-3



Left Side View of EV-3



Right Side View of EV-3

d) Charging Facilities



Charging Station



Charging Point

2. PVs for comparison

a) PV-1



NE 2804 – front view



NE 2804 – rear view



NE 2804 – side view 1



NE 2804 – side view 2

b) PV-2



NR 6597 – front view



NR 6597 – rear view



NR 6597 – side view 1



NR 6597 – side view 2

c) PV-3



NT 917- front view



NT 917 - rear view



NT 917 - side view 1



NT 917- side view 2