

# **Pilot Green Transport Fund**

## **Final Report On Trial of Electric Light Goods Vehicles for Construction Industry (Geotech Engineering Limited)**

(4 November 2020)

PREPARED BY:

Dr. Joe K.W. LO  
Mr. Bruce ORGAN

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. Joe K.W. LO (Team Leader)**

Centre Manager

Jockey Club Heavy Vehicle Emissions Testing and Research Centre

Hong Kong Institute of Vocational Education (Tsing Yi)

**Mr. Bruce ORGAN (Team Member)**

Emission Manager

Jockey Club Heavy Vehicle Emissions Testing and Research Centre

Hong Kong Institute of Vocational Education (Tsing Yi)

**Pilot Green Transport Fund  
Trial of Electric Light Goods Vehicles for Construction Industry  
(Geotech Engineering Limited)**

**Final Report  
(Trial Period: 1 August 2014 – 31 July 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 and innovative transport technologies, contributing to better air quality and public health for Hong Kong. Geotech Engineering Limited (GE) was approved under the Fund for trial of two electric light goods vehicles for transporting materials, tools and staff for construction projects. Through the tendering procedures stipulated in the Subsidy Agreement, GE procured two Renault Kangoo Z.E. electric light goods vehicles (EVs) 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. GE assigned two diesel light goods vehicles (DVs) providing the same type of service as the conventional vehicles for comparing with the 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 and Conventional Vehicles**

2.1 GE procured two Renault Kangoo EVs (EV-1 and EV-2) which have a gross vehicle weight of 2,300 kg and a maximum payload of 650 kg. They have a driving range of 170 km with its batteries fully charged and air conditioning turned off. The EVs were mainly charged overnight after work. GE has set up two dedicated 20A chargers for the EVs at its office carpark. EV-1 was often charged at its driver's home in Fanling at night using a 13A outlet; EV-2 was parked and charged at GE office every night. GE assigned two DVs (DV-1 and DV-2) with gross vehicle weights of 3200 kg and 2800 kg respectively as the conventional vehicles for comparing with the EVs.

2.2 Key features of the EVs, DVs and charging facilities are shown in Appendix 1 and their photos are shown in Appendix 2.

### 3. Trial Information

3.1 The trial commenced on the 1 August 2014 and lasted for 24 months. GE was required to collect and provide trial information including the EVs mileage reading before charging, amount of electricity consumed and time used in each charging, downtime due to charging and maintenance records associated with scheduled and unscheduled maintenance of the EVs and the charging facility. 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 GE were collected to reflect any problems of the EVs.

### 4. Findings of Trial

#### 4.1 Operating Costs

4.1 Table 1 summarizes the key operation statistics of the EVs and DVs. The fleet average fuel cost of the EVs was HK\$1.02/km (82%) lower than that of the DVs while the fleet average total operating costs of the EVs were HK\$1.02/km (78%) lower than that of the DVs.

Table 1: Key operating statistic of each vehicle (August 2014 – July 2016)

		EV-1	EV-2	DV-1	DV-2
Total mileage (km)		28,330	27,858	56,782	36,917
Average fuel economy	(km/kWh)	5.02	4.97	-	-
	(km/litre)	-	-	8.01	9.88
	(km/MJ) <sup>[1]</sup>	1.39	1.38	0.22	0.27
Average fuel cost (HK\$/km) <sup>[2]</sup>		0.23	0.23	1.37	1.14
Fleet average fuel cost (HK\$/km) <sup>[2]</sup>		0.23		1.25	
Average total operating cost (HK\$/km) <sup>[2]</sup>		0.32	0.25	1.48	1.14
Fleet average total operating cost (HK\$/km) <sup>[2]</sup>		0.29		1.31	
Downtime (working day) <sup>[3][4]</sup>		3	1	2	0

<sup>[1]</sup> Assuming lower heating value of 36.13MJ/litre for diesel

<sup>[2]</sup> The market rates of fuel and electricity consumption were adopted for calculation.

<sup>[3]</sup> Downtime refers to the equivalent number of working days in which the vehicle is not in operation due to charging, and the period that the vehicle is not in operation due to maintenance, counting from the first day it stops operation till the day it is returned to the operator.

<sup>[4]</sup> Maintenance due to incidents unrelated to the performance of the vehicle were not included for comparison.

4.2 During the trial period, EV-1 and EV-2 each had one scheduled maintenance and DV-1 had two scheduled maintenances while DV-2 had no scheduled maintenance. There was one unscheduled maintenance for EV-1, while EV-2, DV-1 and DV-2 had no unscheduled maintenance. These led to 3 days, 1 day and 2 days of operational downtime for EV-1, EV-2 and DV-1 respectively. The utilization rates of EV-1, EV-2, DV-1 and DV-2 were about 99%, 100%, 100% and 100% respectively.

4.3 GE has designated one driver for each of the EVs. The drivers found no problem in operating the EVs and felt the EVs were quiet and environment-friendly. However, the drivers consistently expressed disappointment with the EVs' driving range. EV-1 had to shorten its journey due to low battery level although the scheduled distance was within the driving range

quoted by the manufacturer. The drivers were always concerned about the driving range of the EVs.

4.4 Overall, GE agreed that using EVs was good in general because it provided a greener and quieter environment compared to using DVs. They were however concerned that the EVs had a limited driving range and the time taken to recharge the batteries was too long.

4.5 To eliminate the effect of seasonal fluctuations, 12-month moving averages were used to evaluate the trend of EVs' fuel economies. The fuel economy of EV-1 varied between 4.52 and 5.23 km/kWh and that of EV-2 varied between 4.85 and 5.18 km/kWh (i.e. about 14% and 6% variation respectively). There was a slight decrease in charging capacity of the EV batteries during the trial period.

4.6 The carbon dioxide equivalent (CO<sub>2e</sub>) emission from EV-1 was 3,229 kg and that from EV-2 was 3,078 kg while that from DV-1 was 9,580 kg and that from DV-2 was 7,637 kg. Hence, there was a reduction for EV-1 of 6,350 kg (66%) CO<sub>2e</sub> emission and a reduction for EV-2 of 4,559 kg (60%) CO<sub>2e</sub> emission. Overall, there was a reduction of 10,910 kg (63%) CO<sub>2e</sub> emission by using the EVs in the trial.

## 5 Summary

5.1 The drivers found no problem in operating the EVs and felt they were quiet and environment-friendly. However, the drivers consistently expressed disappointment with the EVs' driving range. EV-1 had to shorten its journey due to low battery level although the scheduled distance was within the driving range quoted by the manufacturer. GE was generally satisfied with the EVs' performance although they were concerned about the limited driving range and time taken to recharge the batteries.

5.2 The utilization rates of EV-1, EV-2, DV-1 and DV-2 were about 99%, 100%, 100% and 100% respectively. However, the usages of the EVs were on the low side as reflected by the difference in the total mileages between the EVs (28,330 km and 27,858 km, i.e. 48 and 47 km on average per working day) and the DVs (56,782 km and 36,917 km, i.e. 96 and 63 km on average per working day) in the trial. There was a slight decrease in charging capacity of the EV batteries during the trial period.

5.3 The fleet average fuel cost of the EVs was HK\$1.02/km (82%) lower than that of the DVs. Taking into account the maintenance costs, the average total operating cost of the EVs was HK\$1.02/km (78%) lower than that of the DVs. The CO<sub>2e</sub> emission from the EVs was 10,910 kg (63%) lower than that from the DVs in the trial.

## Appendix 1: Key Features of Vehicles and Charging Facilities

### 1. Trial EVs

<b>Registration Mark</b>	<b>ST1106 (EV-1) &amp; ST2263 (EV-2)</b>
Make:	Renault
Model:	Kangoo Z.E.
Class:	Light goods vehicle
Gross vehicle weight:	2300 kg
Seating capacity:	driver + 4 passengers
Rated power:	44 kW
Driving 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 20A)
Payload:	650 kg
Year of manufacture:	2014

### 2. EV charging facilities

Charging Standard:	IEC62196
Charging Mode:	Single Phase 20A

### 3. DVs for comparison

<b>Registration Mark</b>	<b>FW783 (DV-1)</b>
Make:	Hyundai
Model:	H1
Class:	Light goods vehicle
Seating capacity:	5 seats
Gross vehicle weight:	3230 kg
Engine capacity:	2497 c.c.
Year of manufacture:	2014

<b>Registration Mark</b>	<b>MU3769 (DV-2)</b>
Make:	Toyota
Model:	Hi-Ace
Class:	Light goods vehicle
Seating capacity:	5 seats
Gross vehicle weight:	2800 kg
Engine capacity:	2982 c.c.
Year of manufacture:	2007

## Appendix 2: Photos of Vehicles and Charging Facilities

### 1. Trial EVs and charging facilities



Front view of EV-1



Rear view of EV-1



Right side view of EV-1



Left side view of EV-1



EV charger of EV-1



Electricity meter of EV-1



Front view of EV-2



Rear view of EV-2



Right side view of EV-2



Left side view of EV-2



EV charger of EV-2



Electricity meter of EV-2

2. DVs for comparison

	
<p>Front view of DV-1</p>	<p>Rear view of DV-1</p>
	
<p>Right side view of DV-1</p>	<p>Left side view of DV-1</p>



Front view of DV-2



Rear view of DV-2



Right side view DV-2



Left side view of DV-2