

**Pilot Green Transport Fund**

**Final Report On**  
**Trial of Electric Light Goods Vehicle**  
**for Building Services**  
**(Lung Wai Air-conditioner and**  
**Electrical Engineering Co.)**

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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 Vehicle for Building Services (Lung Wai Air-conditioner and Electrical Engineering Co.)**

#### **Final Report (Trial Period: 1 August 2016 – 31 July 2018)**

## **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. Lung Wai Air-conditioner and Electrical Engineering Co. (Lung Wai) was approved under the Fund for trial of one electric light goods vehicle for building services. Through the tendering procedure stipulated in the Subsidy Agreement, Lung Wai procured one Renault Kangoo Van Z.E. (hereafter called EV) for trial.

1.2 PolyU Technology and Consultancy Company Limited (PTeC) has been engaged by the Environmental Protection Department (EPD) as an independent third party assessor (the Assessor) to monitor the trial and evaluate the performance of the trial vehicle as compared with its conventional counterpart. Lung Wai assigned a Nissan diesel light goods vehicle (hereafter called DV) providing the same type of services as the conventional counterpart for comparison.

1.3 This Final Report summarises the performance of the EV in the 24-month trial as compared with its conventional counterpart, i.e. the DV.

### **2. Trial Vehicles**

2.1 The trial vehicle (EV) – Renault Kangoo Van Z.E. has a gross vehicle weight of 2,260 kg capable of carrying a driver with four passengers and goods. It has a 22 kWh lithium-ion battery pack. According to its manufacturer, the EV has a driving range of 170 km with air-conditioning off and no load after full charging. The maximum payload is 650 kg. A Nissan 2,953 c.c. URVAN 3.0 diesel LGV (DV) is assigned as conventional counterpart for comparison in this trial. Key features and photos of the EV and the DV are shown in Appendix 1 and Appendix 2, respectively. The vehicles were used mainly for transportation of tools for building services from Lung Wai's workshop in Jordan, Kowloon, to nearby regions in Kowloon and the New Territories. Day-to-day travel for providing such service was less than 10 km for the EV.

2.2 The EV was charged using 13-ampere charger, either at Lung Wai's workshop during day time or at the carpark of Domain Mall in Yau Tong during night time.

### **3. Trial Information**

3.1 The trial started on 1 August 2016 and lasted for 24 months. Lung Wai was required to collect and provide trial information including the EV daily operation data and maintenance records. EV daily operation data include mileage reading before charging, amount of electricity

consumed and time taken in each charging, and operation downtime due to charging. Maintenance records include cost and downtime associated with scheduled and unscheduled maintenance of the EV. Similar data were also required from the DV. In addition to the cost information, reports on maintenance work and operational difficulties, and opinions of the driver were collected to reflect any problems of the EV.

#### 4. Findings of Trial

##### 4.1 Operating Costs

4.1.1 Table 1 below shows all costs of each vehicle in the trial period. The average fuel cost of the EV was HK\$1.23/km (i.e., about 83%) lower than that of the DV. During the trial period, the EV had three scheduled maintenances and one unscheduled maintenance while the DV had two scheduled maintenances but no unscheduled maintenance. Compared with the DV, the average total operating cost of the EV was HK\$0.57/km (i.e., about 30%) higher. The higher average total operating of the EV is due to the cost of the general maintenance and the low mileage of the EV during the trial period. The utilization rates were about 98% and 99% for the EV and the DV, respectively.

Table 1: Summary of all the costs of each vehicle (1 Aug 2016 – 31 July 2018)

		<b>EV</b>	<b>DV</b>
Total distance traveled (km)		3,719	39,474
Average daily distance travelled (km / day)		6.4	67
Fuel cost (HK\$)		918.2	58,248
Average fuel economy	(km/kWh)	4.59	-
	(km/litre)	-	8.24
	(km/MJ)	1.28	0.23 <sup>[1]</sup>
Average fuel cost (HK\$/km)		0.25 <sup>[2]</sup>	1.48 <sup>[3]</sup>
Maintenance cost <sup>[4]</sup> (HK\$)		8,172	15,385
Other cost		0	0
Total operating cost (HK\$)		9,090	73,633
Average total operating cost (HK\$/km)		2.44	1.87
Downtime <sup>[5]</sup> (working days)		13	6

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

<sup>[2]</sup> Electricity bill is not available; electricity cost is taken as HK\$1.13/kWh from 2016 to 2018 and HK\$1.154/kWh in 2018.

<sup>[3]</sup> The market fuel price was used for calculation

<sup>[4]</sup> Maintenance not related to the performance of the vehicle was not included for comparing the performance of the vehicles.

<sup>[5]</sup> Downtime refers to the equivalent number of working days in which the vehicle is not in operation due to charging, and the period 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.

##### 4.2 Performance and Reliability

4.2.1 The driver of the EV had no problem in operating the EV. He agreed that the EV was quieter and emitted less pollutants, but the power of the vehicle was not good on uphill driving. Besides, the driving range on a full charge with air conditioning and the payload of EV were limited and he needed to plan trips well and could only drive to the working locations close to the office or workshop. Thus, he used the EV less and only for short trips; but used the DV as much as possible, leading to the low total mileage of the EV.

4.2.2 Overall, Lung Wai agreed that using EV is good because it can provide a greener and quiet environment as well as its much lower fuel cost. However, Lung Wai does not have plan to replace its existing conventional vehicle with electric vehicle because electric vehicle is not able to meet his operational need (i.e. limited driving range on a full charge with air conditioning) and there is uncertainty in maintenance and total operation cost in long run. Lung Wai lacked confidence in using the EV for long trips due to limited battery capacity, therefore, the DV was used significantly more than the EV, in particular for long trips. During the trial, Lung Wai was repeatedly reminded to use the EV more often for longer trips but Lung Wai did not respond to the request owing to lack of confidence.

4.2.3 To remove the effect of seasonal fluctuations, 12-month moving averages were used to evaluate the trend of the EV's fuel economy. For the EV, the 12-month moving average varied from 4.45 km/kWh to 4.78 km/kWh, indicating that the fuel economy had a minor variation during the trial period.

4.2.4 The EV was not charged on a daily basis and the charged amount was less than 10 kWh most of the time, which is much below the battery capacity of 22 kWh. There was no indication that there was deterioration in the capacity of the batteries.

4.2.5 In the trial period, the CO<sub>2</sub> equivalent (CO<sub>2</sub>e) emissions from the EV and the DV were 420 kg and 1,251 kg respectively, and hence there was a reduction of 831 kg CO<sub>2</sub>e, which is about 66% reduction with the replacement of DV by EV in the trial.

## 5. Summary

5.1 The trial showed that the EV had lower average fuel cost as compared with its conventional diesel counterpart, with a saving of HK\$1.23/km or 83%. However, the average total operating cost for the EV was HK\$0.57/km (i.e., about 30%) higher than that of the DV. The higher total operating per km of the EV is due to the cost of the general maintenances and the low mileage of the EV during the trial period.

5.2 The EV driver had no problem in operating the EV for short trips and the operation of the EV was smooth. In the trial period, the EV involved three scheduled maintenances and one unscheduled maintenance, with utilization rate of 98%.

5.3 The 12-month moving average indicates that there was no deterioration in fuel economy in the trial period. Also, there was no indication of deterioration in the charge capacity of the batteries.

5.4 The trial results showed that under local operating conditions where air-conditioning is essential, the Renault Kangoo Van Z.E. light goods vehicle could meet Lung Wai's daily mileage requirements for short trips only. Moreover, the EV did not cause any problem to the driver during the trial period and was able to perform as required. However, Lung Wai would not replace its existing conventional vehicle with electric vehicle because electric vehicle meets his operational need for short trips only (i.e. limited driving range on a full charge with air conditioning) and there is uncertainty in maintenance and total operation cost in long run.

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

### **1. Trial EV**

<b>Registration mark</b>	<b>UD6608</b>
Make:	Renault
Model:	Kangoo Van Z.E.
Class:	Light goods vehicle
Gross vehicle weight:	2,260 kg
Seating capacity:	driver + 4 passengers
Rated power:	44 kW max.
Travel range:	170 km (air-conditioning off and no load)
Maximum speed:	130 km/h
Battery material:	lithium-ion
Battery capacity:	22 kWh
Charging time:	10 hours (13A)
Year of manufacture:	2016

### **2. Diesel Vehicle Used for Comparison**

<b>Registration mark</b>	<b>MR8157</b>
Make:	Nissan
Model:	URVAN 3.0 DIESEL HPV
Class:	Light Goods Vehicle
Gross vehicle weight:	3,300 kg
Seating Capacity:	driver + 5 passengers
Cylinder capacity:	2,953 cc
Year of manufacture:	2006

## Appendix 2: Photos of Vehicles

### 1. Trial Electric Van



EV – front view



EV –end view



EV – side view 1



EV – side view 2

### 2. Diesel Vehicle for Comparison



DV : front view