Pilot Green Transport Fund

Final Report On
Trial of Electric Light Goods Vehicles
for Construction Industry
(Kum Shing (K.F.) Construction Company Limited)

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Pilot Green Transport Fund
Trial of Electric Light Goods Vehicles for Construction Industry
(Kum Shing (K.F.) Construction Company Limited)

Final Report
(Trial Period: 1 October 2017 - 30 September 2019)

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. Kum Shing (K.F.) Construction Company Limited (Kum Shing) was approved under the Fund for trial of three electric light goods vehicles (hereafter called EVs) for transporting equipment to and from the construction sites in Kowloon and the New Territories. Through the tendering procedures stipulated in the Subsidy Agreement signed with the Government, Kum Shing procured three EVs - Nissan e-NV200 electric light goods vehicles (EV-1, EV-2 and EV-3) for trial.

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 green innovative technology. Three Nissan diesel light goods vehicles (DVs) serving the same purpose were assigned as the conventional counterparts for comparing with the three EVs.

1.2 This Final Report summarizes the performance of the EVs in the twenty-four months of the trial as compared with their conventional counterparts.

2 Trial Vehicles

2.1 Key features of the EVs, DVs and charging facilities are in Appendix 1 and photos of the vehicles and charging facilities are in Appendix 2. The vehicles were used for transporting equipment for their sites in Kowloon and New Territories. EV-1 and DV-1 served the sites in Tai Po, Tuen Mun and Tseung Kwan O; EV-2 and DV-2 served the sites in Tsuen Wan and Kwai Tsing; EV-3 and DV-3 both served the sites in Tuen Mun and Tsing Yi. According to the EV's manufacturer, the EV model's maximum payload is 650 kg and it has a travel range of 165 km with its batteries fully charged and air-conditioning off.

2.2 Kum Shing has set up one dedicated 13A, one dedicated 32A and one dedicated 125A chargers for EVs at its car park in To Kwa Wan office. The EVs were charged regularly after work. For a long journey, the EV driver would stop at a charging point to top up the battery during lunch time or at the time without any assigned duties even if the battery capacity was far from being depleted.

3 Trial Information

3.1 The trial commenced on 1 October 2017 and lasted for 24 months. Kum Shing was required to collect and provide trial information including the EV mileage reading before charging, amount of electricity consumed in each charging, time taken for charging, operation downtime due to charging, cost and downtime associated with scheduled and unscheduled maintenance of the EVs and the charging facilities. Similar sets of 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 Kum Shing were collected and provided to reflect any problems of the EVs.

4. Findings of Trial

4.1 Table 1 summarizes the statistical data of the EVs and the DVs. The fleet average fuel cost of all three EVs was HK$1.33/km (84%) lower than that of the three DVs. Including the maintenance costs, the fleet average total operating costs of the three EVs was HK$1.46/km (85%) lower than that of the three DVs.

Table 1: Key operation statistics of each vehicle (October 2017 to September 2019)

		EVs			**DVs**		
		EV-1	**EV-2**	**EV-3**	**DV-1**	**DV-2**	**DV-3**
Total mileage (km)		12,860	17,663	10,374	32,895	46,295	31,092
Average fuel economy	(km/kWh)	4.60	4.62	4.56	-	-	-
	(km/litre)	-	-	-	9.08	8.50	8.28
	(km/MJ) [1]	1.28	1.28	1.27	0.25	0.24	0.23
Average fuel cost (HK$/km) [2]		0.25	0.25	0.26	1.50	1.60	1.65
Fleet average fuel cost (HK$/km)		0.25			1.58		
Average total operating cost (HK$/km)		0.25	0.25	0.26	1.50	1.99	1.65
Fleet average total operating cost (HK$/km)		0.25			1.71		
Downtime (working day) [3] [4]		0	0	2	0	2	0

[1] Assuming lower heating value of 36.13MJ/litre for diesel fuel.
[2] The market rate was adopted for calculation.
[3] 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] Maintenance due to incidents unrelated to the performance of the vehicle was not included for comparison.

4.2 During the 24 months of trial, EV-3 and DV-2 had one scheduled maintenance each, resulting in a downtime of 2 working days. There was no scheduled maintenance for EV-1, EV-2, DV-1 and DV-3.

4.3 The three DVs had one unscheduled maintenance each, but they were not included in the comparison as they were unrelated to the vehicle performance. There was no unscheduled maintenance for EV-1, EV-2 and EV-3.

4.4 The utilization rates of EV-1, EV-2, DV-1 and DV-3 were 100%, while those of EV-3 and DV-2 were 99.7% in the 24-month trial period.

4.5 To remove the effect of seasonal fluctuations, 12-month moving averages of fuel economy are used to evaluate the trend of each EV's fuel economy. The 12-month moving average fuel economy of the EV-1 varied from 4.02 to 5.31 km/kWh (about 24% drop). EV-2 varied from 4.41 to 4.89 km/kWh (about 10% fluctuation) and EV-3 varied from 4.19 to 5.05 km/kWh (about 17% fluctuation). It can be observed that the fuel economy of EV-1 had a steady fall whilst the other two did not during the trial period.

4.6 The carbon dioxide equivalent (CO_2e) emission reduction from EV-1 compared to DV-1 on same mileage (12,860 km) was 2,312 kg (around 60%). The CO_2e emission from EV-2 compared to DV-2 on same mileage (17,663 km) was 3,542 kg (around 63%), and that from EV-3 compared to DV-3 on same mileage (10,374 km) was 2,154 kg (around 63%). In this trial, the total reduction of CO_2e emission from the three EVs compared to the three DVs was 8,008 kg (around 62% on average).

5. Summary

5.1 All EV drivers had no problem in operating the EVs and felt that the EVs were quieter and more environmentally friendly compared to the DVs. Also, the EV drivers expressed that the EVs had no significant degradation in performance. However, the service area of the EVs was limited due to the capacity of the batteries. Kum Shing and the drivers needed to plan the driving route ahead, and find the locations of charging stations before they use the EVs in case they need top-up charging outside.

5.2 The utilization rates of EV-3 and DV-2 were both 99.7%, while all the other EVs and DVs were 100%. The fleet average fuel cost of the three EVs was HK$1.33/km (84%) lower than that of the three DVs. Including the maintenance costs, the fleet average total operating cost of the EVs was HK$1.46/km (85%) lower than that of the DVs. Also, compared with the three EVs, the three DVs had a total reduction of 8,008 kg CO_2e emission (around 62% on average) in this trial period. It shows that the impact of electric vehicle technology on saving fuel and operating costs and reducing CO_2e emission were obvious.

5.3 At present, the price of EV is much higher than that of conventional vehicle, the accumulated fuel cost saving may not be able to offset the higher vehicle cost within a few years of operation. Since 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 and Charging Facilities

1. Trial EVs

(a) EV-1

Registration Mark	**UP912**
Make:	Nissan
Model:	e-NV200
Class:	Light Goods Vehicle
Gross vehicle weight:	2,250 kg
Seating capacity:	Driver + 4 passengers
Rated Power:	80 kW
Travel range:	165 km (air conditioning off)
Maximum speed:	over 120 km/h
Battery Type:	Lithium-ion
Battery capacity:	24 kWh
Year of manufacture:	2015

(b) EV-2

Registration Mark	**UP1304**
Make:	Nissan
Model:	e-NV200
Class:	Light Goods Vehicle
Gross vehicle weight:	2, 250 kg
Seating capacity:	Driver + 4 passengers
Rated Power:	80 kW
Travel range:	165 km (air conditioning off)
Maximum speed:	over 120 km/h
Battery Type:	Lithium-ion
Battery capacity:	24 kWh
Year of manufacture:	2015

(c) EV-3

Registration Mark	**UM9271**
Make:	Nissan
Model:	e-NV200
Class:	Light Goods Vehicle
Gross vehicle weight:	2,250 kg
Seating capacity:	Driver + 4 passengers
Rated Power:	80 kW
Travel range:	165 km (air conditioning off)
Maximum speed:	over 120 km/h
Battery Type:	Lithium-ion
Battery capacity:	24 kWh
Year of manufacture:	2015

2. Charging Facilities

(a) Charging Station 13A (not applied for subsidy under the Fund)

(b) Charging Station 32A

Charging Standard: IEC 61851
Charging Mode: 220V / 32A, AC (Mode 3)

(c) Charging Station 125A

Charging Standard: IEC 62262
Charging Mode: 50-500V / 125A, DC (Mode 4)

3. DVs for comparison

(a) DV-1

Registration Mark	**RN465**
Make:	Nissan
Model:	URVAN
Class:	Light Goods Vehicle
Seating capacity:	Driver + 5 passengers
Gross vehicle weight:	3,300 kg
Engine capacity:	2,953 c.c.
Year of manufacture:	2012

(b) DV-2

Registration Mark	**RB2428**
Make:	Nissan
Model:	URVAN
Class:	Light Goods Vehicle
Seating capacity:	Driver + 5 passengers
Gross vehicle weight:	3,300 kg
Engine capacity:	2,953 c.c.
Year of manufacture:	2011

(c) DV-3

Registration Mark	**PN3222**
Make:	Nissan
Model:	URVAN
Class:	Light Goods Vehicle
Seating capacity:	Driver + 5 passengers
Gross vehicle weight:	3,300 kg
Engine capacity:	2,953 c.c.
Year of manufacture:	2010

Appendix 2: Photos of Vehicles and Charging Facilities

1. Trial EVs

(a) EV-1

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<tr><td>Front view of EV-1</td><td>Rear view of EV-1</td></tr>
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<tr><td>Left Side view of EV-1</td><td>Right Side view of EV-1</td></tr>
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(b) EV-2

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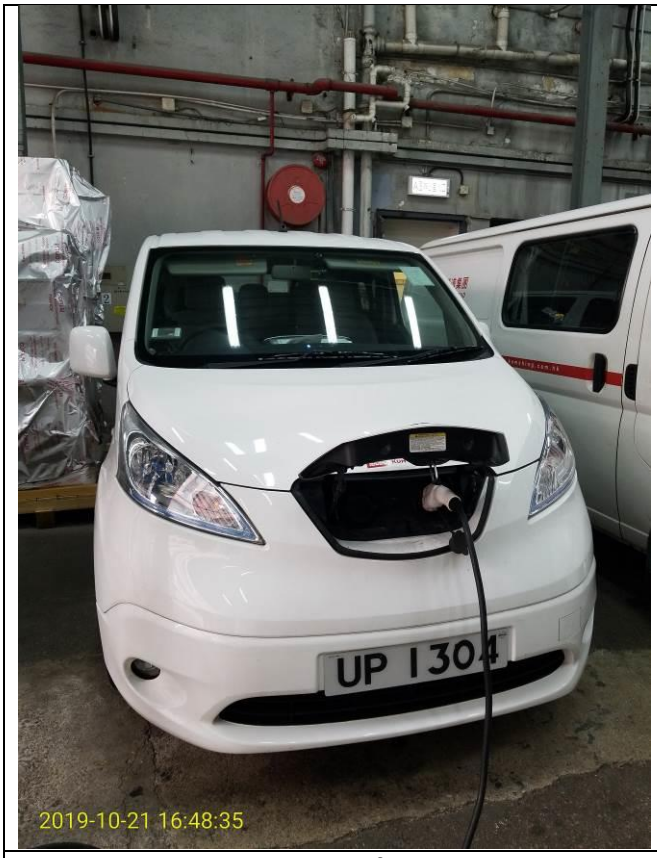
<tr><td> 
</td><td> 
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<tr><td>Front view of EV-2</td><td>Rear view of EV-2</td></tr>
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<tr><td>Left Side view of EV-2</td><td>Right Side view of EV-2</td></tr>
</table>

(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

2. Charging Facilities

	
(a) Charging Station 13A	Electricity Meter
	
(b) Charging Station 32A	Electricity Meter
	
(c) Charging Station 125A	Electricity Meter

3. DVs for comparison

(a) DV-1

	
Front view of DV-1	Rear view of DV-1
	
Left Side view of DV-1	Right Side view of DV-1

(b) DV-2

	
Front view of DV-2	Rear view of DV-2
	
Left Side view of DV-2	Right Side view of DV-2

(c) DV-3

	
Front view of DV-3	Rear view of DV-3
	
Left Side view of DV-3	Right Side view of DV-3