

Pilot Green Transport Fund

Final Report On
Trial of Electric Single-deck Bus for Shuttle Service
(Sun Bus Limited)

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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 Single-deck Bus for Shuttle Service
(Sun Bus Limited)**

**Final Report
(Trial Period: 1 December 2017 – 30 November 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. Sun Bus Limited (Sun Bus) was approved under the Fund for trial of one electric single-deck bus for shuttle service.

1.2 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 vehicle. Sun Bus assigned a diesel single-deck bus (DV) providing similar services as the conventional vehicle for comparing with the EV.

1.3 This Final report summarizes the performance of EV in the 24 months of the trial as compared with its conventional diesel counterpart.

2 Trial Vehicle

2.1 Through the tendering procedures stipulated in the Subsidy Agreement Sun Bus entered into with the Government, Sun Bus procured a Shandong Yixing Feiyan electric single-deck bus (EV) for trial.

2.2 Key features and photos of the EV, DV and charging facility are in Appendix 1 and Appendix 2, respectively. The vehicles were used mainly for providing shuttle service to KMB staff and clients around KMB Lai Chi Kok Depot, Hing Wah Street West, Yuet Lun Street and KMB Mei Foo Office. According to the EV manufacturer, the EV model has a travel range of 250 km with its battery fully charged.

2.3 Sun Bus had set up one dedicated DC quick charger, with output capacity of 100kW/700V/143A DC, for the EV at KMB Lai Chi Kwok depot. The EV was normally charged overnight.

3 Trial Information

3.1 The EV started trial on January 2016, but it failed to operate soon. It was handed back to the manufacturer for repair and returned to normal operation in November 2017. Thus, the trial was considered to start on 1 December 2017 and lasted for 24 months. Sun Bus 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 EV and the

charging facility. Similar set of data from the DV was also required. In addition to the cost information, reports on maintenance work, operational difficulties and opinions of the driver and Sun Bus were collected and provided to reflect any problems of the EV.

4. Findings of Trial

4.1 Table 1 below summarizes the operational statistical data of EV and DV. Average total operating cost of the EV was about HK\$6.09/km (81%) lower than that of the DV. The average fuel cost of the EV is HK\$5.6/km (80%) lower than that of the DV.

Table 1: Total operating costs (December 2017 – November 2019)

		EV	DV
Total mileage (km)		43,690	111,915
Average fuel economy	(km/kWh)	0.80	-
	(km/litre)	-	1.97
	(km/MJ)	0.22	0.05 ^[1]
Average fuel cost (HK\$/km) ^[2]		1.44	7.04
Average total operating cost (HK\$/km)		1.44	7.53
Downtime (working day) ^[3] ^[4]		127	88

[1] Assuming lower heating value of 36.13 MJ/litre for diesel fuel.

[2] The market fuel price was used 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 There were 3 scheduled maintenances and 21 unscheduled maintenances for the EV while the DV had 1 scheduled maintenance and 16 unscheduled maintenances in this reporting period. The scheduled and unscheduled maintenances had led to 127 days and 88 days of operational downtime for the EV and the DV respectively. There were 730 working days in this reporting period, the utilization rates of EV and the DV were 83% and 88% respectively.

4.3 The EV driver felt that the EV was quieter and more environmentally friendly compared to the DV. However, the EV driver expressed that he was not satisfied with the steering wheel because it was heavier than the DV when turning.

4.4 Sun Bus expressed that repairing the EV was inconvenient and the capacity of EV battery were not enough for their daily operations. Due to the license issues, the EV could not be driven on highways and the EV could only serve in a short distance. Since Sun Bus could not have recruited a EV driver to drive the EV since July 2019, the EV was idle from July to Sep 2019 and Nov 2019. In general, Sun bus and the driver were not satisfied with the performance of EV.

4.5 To eliminate the effect of seasonal fluctuations, 12-month moving averages were used to evaluate the trend of the EV's fuel economy. The fuel economy varied from 0.8 to 0.84 km/kWh for EV. During the trial period, the variation in fuel economy of EV was minor and hence there was no indication that the fuel economy and the batteries had deteriorated.

4.6 The carbon dioxide equivalent (CO_{2e}) emissions from the EV and the DV were 29,979 kg and 60,759 kg, respectively, and hence there was an emission reduction of 30,780 kg CO_{2e}, which was about 51% reduction, in the trial.

5. Summary

5.1 The EV driver had no problem in operating the EV. However, he was not satisfied with the steering wheel because it was heavier than that of the DV when turning. Sun Bus expressed that repairing the EV was inconvenient and the capacity of EV battery were not enough for their daily operations. In general, Sun Bus and the driver were not satisfied with the performance of EV.

5.2 The utilization rates of EV and DV were 83% and 88% respectively. However, the usage of the EV was on the low side as reflected by the difference in the total mileage travelled between the EV (43,690 km, i.e. 72 km on average per working day) and the DV (111,915 km, i.e. 169 km on average per working day) in the 24 months of trial.

5.3 The trial showed that the EV had a lower average fuel cost as compared with its conventional diesel counterpart, with a saving of HK\$5.6/km (80%). The average total operating cost of the EV was about HK\$6.09/km (81%) lower than that of the DV. Also, the EV had about 51% CO_{2e} emission less than the DV.

5.4 At present, the price of EV is higher than that of its conventional vehicle. The accumulated fuel saving may not be able to offset the higher EV 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 the EV will be affordable to the transport trade in future.

Appendix 1: Key Features of Vehicles and Charging Facility

1. Trial EV

Registration Mark	TT5187
Make:	Shandong Yixing Elect. Auto Ltd.
Model:	Feiyan
Class:	Public Bus
Gross vehicle weight:	18 tonnes
Seating capacity:	50 (including driver)
Rated Power:	150 kW
Travel Range:	not less than 250 km (air-conditioning on)
Maximum speed:	over 70 km/h
Battery Type:	Lithium Iron Phosphate Battery
Battery Capacity:	360 kWh
Year of manufacture:	2014

2. DV for comparison

Registration Mark	PS2754 (from December 2017 to May 2018)*
Make:	Man
Model:	18.290HOCL/R
Class:	Public Bus
Seating capacity:	51 (including driver)
Gross vehicle weight:	16 tonnes
Engine capacity:	6871 c.c.
Year of manufacture:	2011

3. DV for comparison (starting from June 2018)

Registration Mark	TE1389
Make:	DAEWOO
Model:	BH117L
Class:	Public Bus
Seating capacity:	50 (including driver)
Gross vehicle weight:	16 tonnes
Engine capacity:	7640 c.c.
Year of manufacture:	2014

* The DV with registration mark PS2754 experienced high temperature problem in May 2018. Thus, it had been replaced by DV with registration mark TE1389 in June 2018.

4. Charging Facility

Charging Station 20A	
Charging Standard:	GB/T 17626.2-1998
Charging Mode:	100kW/700V / 143A, DC

Appendix 2: Photos of Vehicles and Charging Facility

1. Trial EV

	
Front view of EV	Rear view of EV
	
Left side view of EV	Right side view of EV

2. DV for comparison

(i) PS2754 (from December 2017 to May 2018)

 A front-facing view of a green and white MAN bus, license plate PS 2754, parked in a lot. The bus has a large windshield and a MAN logo on the front. A timestamp '2017-12-01 11:07' is visible in the bottom right corner.	 A rear-facing view of the same green and white MAN bus, license plate PS 2754. The rear features a large window, a MAN logo, and a 'Star Bus' emblem. A timestamp '2017-12-01 11:07' is visible in the bottom right corner.
<p>Front view of DV (PS2754)</p>	<p>Rear view of DV (PS2754)</p>
 A side profile view of the green and white MAN bus, license plate PS 2754, parked on a street. The bus has orange and green decorative graphics on its side. A timestamp '2017-12-01 11:07' is visible in the bottom right corner.	 A side profile view of the green and white MAN bus, license plate PS 2754, parked on a street. The bus has orange and green decorative graphics on its side. A timestamp '2017-12-01 11:07' is visible in the bottom right corner.
<p>Left side view of DV (PS2754)</p>	<p>Right side view of DV (PS2754)</p>

(ii) TE1389 (starting from June 2018)



Front view of DV (TE1389)



Rear view of DV (TE1389)





Left side view of DV (TE1389)



Right side view of DV (TE1389)

3. Charging Facility

	
20A Charging Station for EV	Electricity Meter