

Pilot Green Transport Fund

Final Report

On

Trial of Single-deck Electric Bus for Coach Hiring Service
(Tai On Investment Limited)

(8 November 2021)

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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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Trial of Single-deck Electric Bus for Coach Hiring Service
(Tai On Investment Limited)**

**Final Report
(Trial Period: 1 September 2019 – 31 August 2021)**

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. Tai On Investment Limited (Tai On) was approved under the Fund for trial of one single-deck electric bus for coach hiring service. Through the tendering procedures stipulated in the Subsidy Agreement signed with the Government, Tai On procured one BYD C9R single-deck electric bus (EV) for trial.

1.2 The PolyU Technology and Consultancy Company Limited 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. Tai On assigned a single-deck diesel bus (DV) providing same service as the conventional counterpart for comparison.

1.3 Due to Tai On's commercial decision, an original conventional counterpart – Isuzu single-deck diesel bus (DV1) ceased to provide shuttle bus service on 11 October 2019. Tai On has assigned a Scania single-deck diesel bus (DV2) to replace DV1 as the conventional counterpart for comparing with the EV since 30 October 2019. Tai On was required to record all the operational data of the trial and conventional vehicles during the trial for comparison purpose.

1.4 This Final Report summarizes the performance of the EV in the 24 months of the trial as compared with the DV.

2. Trial and Conventional Vehicles

2.1 The trial EV, BYD C9R single-deck electric bus, has a gross vehicle weight (GVW) of 18,000 kg capable of carrying a driver and 65 passengers, and it is equipped with a 324 kWh lithium iron phosphate battery pack. It has a driving range of 250 km with air-conditioning off. No designated driver was assigned to drive the EV.

2.2 Tai On assigned an Isuzu single-deck diesel bus (DV1) which has a GVW of 14,800 kg capable of carrying a driver and 66 passengers and a cylinder capacity of 7,790 c.c. for comparison purpose. DV1 was in operation from 1 September 2019 to 10 October 2019, but ceased to provide service thereafter. Tai On assigned a Scania single-deck diesel bus (DV2) with a GVW of 16,000 kg capable of carrying a driver and 65 passengers and a cylinder capacity of 9,290 c.c. to replace DV1 for comparison with the EV from 30 October 2019 to 30 October 2020. However, due to the COVID-19 pandemic which affected the business of

Tai On, the DV2 had also stopped operation since 31 October 2020.

2.3 The vehicles were mainly used to provide shuttle bus service for Next Digital Limited for 24 hours every day. The service route was a fixed round-trip route. From hours 06:50 to 24:00, they provided service between Tseung Kwan O Industrial Estate and the Tiu Keng Leng MTR station; while from hours 00:00 to 06:15, they provided service between Tseung Kwan O Industrial Estate and Tseung Kwan O, Kwun Tong and Mong Kok. From 8 July 2021, Next Digital Limited had ceased operation and the shuttle bus service was also stopped, therefore the EV also stopped operation from 8 July 2021 till end of the trial (55 days in total).

2.4 Tai On used a 80 kW, 3-phase AC quick charging facility to charge the EV and it takes around 4 ~ 5 hours for fully charging the EV. Key features of the EV, charging facility and the DV are in Appendix 1 and their photos are shown in Appendix 2.

3. Trial Information

3.1 The trial commenced on 1 September 2019 and lasted for 24 months. Tai On 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 maintenances of the EV and charging facility. A 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 drivers and Tai On were collected and provided to reflect any problems of the EV.

4. Findings of Trial

4.1 Table 1 summarizes the statistical data of the EV and the DV.

Table 1: Key operation statistics of each vehicle (1 September 2019 – 31 August 2021)

		EV ^[1]	DV ^[2]
Total mileage (km)		141,887	126,262
Average daily mileage (km/working day)		212	313
Average fuel economy	(km/kWh)	1.01	-
	(km/litre)	-	3.64
	(km/MJ)	0.28	0.10 ^[3]
Average fuel cost (HK\$/km) ^[4]		1.19	3.93
Average total operating cost per km (HK\$/km)		1.34	4.05
Downtime (working day) ^[5]		8	4

^[1] Due to Tai On's business operation arrangement, the EV had not provided service from 8 July 2021 to 31 August 2021 (totally 55 days).

^[2] Due to the COVID-19 pandemic which affected the business of Tai On, the DV stopped operation on 31 October 2020. The results were evaluated based on the operation data of the DV from 1 September 2019 to 30 October 2020.

^[3] Assuming lower heating value of 36.13 MJ/litre for diesel fuel.

^[4] The market fuel price was used for calculation.

^[5] Downtime refers to the equivalent number of working days in which 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 During the 24 months of the trial, the total mileage and the average daily mileage of the EV were 141,887 km and 212 km/day, respectively while those of the DV were 126,262 km and 313 km/day, respectively. The average fuel cost of the EV was HK\$2.74/km (about 70%) lower than that of the DV. The average total operating cost of the EV was HK\$2.71/km (about 67%) lower than that of the DV.

4.3 In this trial, the utilization rates of the EV and DV were 98.8% and 99.0%, respectively.

4.4 To remove the effect of seasonal fluctuations, the 12-month moving average were used to evaluate the trend of the EV's fuel economy. The 12-month moving average fuel economy varied narrowly from 0.99 to 1.04 km/kWh. There was no sign of deterioration in fuel economy over the trial period.

4.5 Based on the total mileage of the EV and the fuel economy of the DV, the equivalent carbon dioxide (CO₂e) emission from the DV could be estimated for comparison purpose. The CO₂e emissions from the EV and DV were 55,644 kg and 102,866 kg, respectively and hence the EV emitted 47,222 kg CO₂e (about 46%) less than the DV in this trial.

4.6 The operation of the EV was smooth. The EV drivers had no problem in operating the EV and considered it was clean and quiet. Both the drivers and Tai On were satisfied with the EV performance. Passengers were also satisfied with or had no comment on its performance.

5. Summary

5.1 In this trial, the average daily mileages of the EV and the DV were 212 km and 313 km, respectively.

5.2 The EV had lower fuel cost than the DV, with an average fuel cost saving of about 70%. Accounting the maintenance costs incurred for both the EV and the DV, the average total operating cost saving of the EV was about 67% lower than that of the DV.

5.3 The utilization rates of the EV and the DV were 98.8% and 99.0%, respectively. In the trial period, there was no sign of deterioration in fuel economy of the EV.

5.4 Compared with the DV, there was about 46% CO₂e emission reduction by using the EV.

5.5 The drivers had no problem in operating the EV and considered it was clean and quiet. Passengers were also satisfied with or had no comment on its performance. Tai On was also satisfied with the EV performance in general.

5.6 As electric bus market is expanding and the technology is improving, the price difference between the EV and its conventional counterpart is narrowing down. Electric buses will be more affordable to the transport trade.

Appendix 1: Key Features of Vehicles and Charging Facility

1. Trial EV and Charging Facility

(a) EV

Registration mark	WG4658
Make:	BYD
Model:	C9R
Class:	Public bus
Gross vehicle weight:	18,000 kg
Seating capacity:	driver + 65 passengers
Rated power:	300 kW
Travel range:	250 km (air conditioning off)
Maximum speed:	100 km/h
Battery material:	Lithium iron phosphate
Battery capacity:	324 kWh
Year of manufacture:	2018

(b) Charging Facility

Make:	BYD
Model:	EVA080KG/01
Power:	80 kW, 3-phase AC
Charging standard:	GB/T 20234.2
Weight:	30 kg
Year of manufacture:	2018

2. DV Used for Comparison

	1 Sep 2019 to 10 Oct 2019	30 Oct 2019 to 30 Oct 2020
Registration mark:	DV1: UM8716 ^[1]	DV2: SS5402 ^[2]
Make:	Isuzu	Scania
Model:	LT434PF-6S-V	K280IB4X2NB
Class:	Public bus	Public bus
Gross vehicle weight:	14,800 kg	16,000 kg
Seating capacity:	Driver + 66 passengers	Driver + 65 passengers
Cylinder capacity:	7,790 cc	9,290 cc
Year of manufacture:	2015	2013

^[1] DV1 (UM8716) provided shuttle bus service from 1 Sep 2019 to 10 Oct 2019 only.

^[2] Due to Tai On's business decision, DV1 (UM8716) ceased to provide shuttle bus service on 11 Oct 2019 and was replaced by DV2 (SS5402) on 30 Oct 2019. However, due to the COVID-19 pandemic which affected the business of Tai On, the DV2 stopped operation on 31 October 2020.

Appendix 2: Photos of Vehicles and Charging Facility

1. Trial EV and Charging Facility



Front view of the EV



Rear view of the EV



Left side view of the EV



Right side view of the EV



80 kW, 3-phase AC quick charging facility

2. DV for Comparison

DV1: UM8716 (1 Sep 2019 to 10 Oct 2019)

 A front-facing view of a white Isuzu bus with purple floral decorations. The license plate is UM 8716. The word 'ISUZU' is visible on the front grille.	 A rear-facing view of the same white Isuzu bus with purple floral decorations. The license plate is UM 8716. The word 'ISUZU' is visible on the rear panel.
<p>Front view of DV1</p>	<p>Rear view of DV1</p>
 A side view of the white Isuzu bus from the left side, showing purple floral decorations and a purple stripe along the roofline.	 A side view of the white Isuzu bus from the right side, showing purple floral decorations and a purple stripe along the roofline.
<p>Left side view of DV1</p>	<p>Right side view of DV1</p>

DV2: SS5402 (from 30 Oct 2019 to 31 Oct 2020)



Front view of DV2



Rear view of DV2



Left side view of DV2



Right side view of DV2