Pilot Green Transport Fund

Final Report On
Trial of Hybrid Light Bus
for Red Public Light Bus Service
(Leung Sick Chiu)

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Final Report
(Trial Period: 1 May 2018 – 30 April 2020)

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. Leung Sick Chiu was approved under the Fund for trial of one diesel-electric hybrid light bus (HV) for red public light bus 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. Leung Sick Chiu assigned a liquefied petroleum gas (LPG) light bus (GV) providing similar public service as the conventional vehicle for comparing with the HV.

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

2 Trial and Conventional Vehicles

2.1 Through the tendering procedures stipulated in the Agreement, Leung Sick Chiu procured a GMI Gemini GM6700GAREEV diesel-electric hybrid light bus (HV) for trial.

2.2 Key features of the HV and the GV are in Appendix 1 and photos of the vehicles are in Appendix 2. The vehicles were used to provide red public light bus service for the route serving between Sau Mau Ping and Jordan Road. According to the HV's manufacturer, the HV had a gross vehicle weight of 7,000 kg and a cylinder capacity of 2,776 cc.

3 Trial Information

3.1 The trial started on 1 May 2018 and lasted for 24 months. Leung Sick Chiu was required to collect and provide trial information including the HV odometer reading before refueling, the date of refueling, the refueled amount, cost and operation downtime associated with scheduled and unscheduled maintenance of the HV. A similar set of data from the GV was also required. In addition to the cost information, reports on maintenance work, operational difficulties and opinions of the drivers and Leung Sick Chiu were collected to reflect any problems of the HV.

4. Findings of Trial

4.1 Table 1 summarizes the statistical data of the HV and the GV. The average fuel economy of the HV was 0.021 km/MJ (20%) higher than that of the GV. However, the average total operating cost of the HV was HK$1.84/km (117%) higher than that of the GV. The average fuel cost of HV was HK$1.72/km (126%) higher than that of the GV. It was because the HV and the GV consumed diesel and LPG respectively, and the average unit price of diesel was higher than that of the LPG by about 315%.

Table 1: Key operation statistics of each vehicle (May 2018 to April 2020)

		HV	**GV**
Total mileage (km)		88,848	207,988
Fuel cost (HK$) [1]		273,283	282,343
Average fuel economy	(km/litre)	4.54	2.50
	(km/MJ)	0.126 [4]	0.105 [5]
Average fuel cost (HK$/km)		3.08	1.36
Average total operating cost (HK$/km)		3.41	1.57
Downtime (working day) [2] [3]		60	40

[1] The market rate was adopted for calculation.
[2] 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.
[3] Maintenance due to incidents unrelated to the performance of the vehicle was not included for comparison.
[4] Assuming lower heating value of 36.13 MJ/litre for diesel fuel.
[5] Assuming lower heating value of 23.67 MJ/litre for LPG fuel.

4.2 During the 24 months of the trial, there were 4 scheduled maintenances and 21 unscheduled maintenances for the HV, resulting in 60 working days of downtime. For the GV, there were 1 scheduled maintenance and 23 unscheduled maintenances, resulting in 40 working days of downtime. During the 731 working days of the trial period, the utilization rates of the HV and the GV were 92% and 95% respectively.

4.3 Leung Sick Chiu had a designated driver for each shift of the HV. The drivers felt that the HV produced less air pollutants. Although the HV ran quietly when it was not charging, it was noisy while charging. The night-shift driver expressed that he did not want to use HV anymore. He was complained by passengers because of the noisy engine which made him unable to hear passengers notifying him to get off the HV at the next station. The situation has been reported to the manufacturer and mitigation measures, such as filling in engine compartment with sound absorbing materials and slightly adjusting the engine power, were taken to tackle the battery box noise problem. However, the drivers expressed that the noise problem was not significantly improved after the mitigation measures. In addition, the day-shift driver expressed that the HV had comparatively less power for going uphill and at start-up.

4.4 Passengers had varied opinions on the HV. Some passengers felt that the HV emitted less air pollutants and improved the roadside air quality. They liked the HV and supported on replacing the existing conventional light buses with hybrid light buses. However, there were also some passengers expressing dissatisfaction with the HV, especially the noise from the charging process and comparatively less power.

4.5 Leung Sick Chiu claimed that the performance of the HV did not meet the operational requirements and too much maintenance was conducted for the HV. On the other hand, Leung Sick Chiu expressed that the HV emitted less air pollutants and improved the roadside air quality. In general, Leung Sick Chiu and the drivers were not satisfied with the performance of the HV.

4.6 To eliminate the effect of seasonal fluctuations, 12-month moving averages were used to evaluate the trend of the HV fuel economy. In the 24 months of the trial, it was shown that the fuel economy was stable (between 4.39 km/litre and 4.65 km/litre). The engine of the HV was still in normal working conditions and the fuel economy could be maintained through proper maintenance.

4.7 Based on the total distance travelled by the HV in the trial, the carbon dioxide equivalent (CO_2e) emission from the HV was 54,255 kg while that from the GV was 59,855 kg. Hence, the HV had a lower CO_2e emission than the GV for 5,600 kg (about 9%) in the trial.

5. Summary

5.1 The drivers felt that the HV produced less air pollutants. Although it ran quietly when it was not charging, it was noisy while charging. The situation has been reported to the manufacturer and mitigation measures were taken to tackle the battery box noise problem. However, the drivers expressed that the noise problem was not significantly improved after the mitigation measures. Also, the day-shift driver expressed that the HV had comparatively less power for going uphill and at start-up. In general, Leung Sick Chiu and the drivers were not satisfied with the performance of the HV.

5.2 Passengers had varied opinions on the HV. Some passengers felt that the HV emitted less air pollutants and improved the roadside air quality. However, there were also some passengers expressing dissatisfaction with the HV, especially the noise from the charging process and comparatively less power.

5.3 The average fuel economy of the HV was 0.021 km/MJ (20%) higher than that of the GV. As the average unit price of diesel was much higher than that of LPG (about 315%), it resulted in a higher average fuel cost of the HV than that of the GV by HK$1.72/km (126%). The average total operating cost of the HV was also higher than that of the GV by HK$1.84/km (117%). The utilization rates of the HV and the GV were 92% and 95% respectively.

5.4 The CO_2e emission from the HV was 54,255 kg while that from the GV was 59,855 kg. Hence, the HV had a lower CO_2e emission than the GV for 5,600 kg (about 9%) in the trial.

5.5 No deterioration in the performance of the HV was observed during the trial period.

Appendix 1: Key Features of Vehicles

1. Trial HV

Registration Mark	**EN9248**
Make:	GMI
Model (code):	Gemini GM6700GAREEV
Class:	Public Light Bus
Gross vehicle weight:	7,000 kg
Seating capacity:	Driver + 19 passengers
Engine capacity:	2,776 c.c.
Battery Type:	Lithium iron phosphate
Year of manufacture:	2017

2. GV for comparison

Registration Mark	**KK8931 (Starting from May 2018 to January 2020)**
Make:	Toyota
Model:	BZB40RZCMSCYY
Class:	Public Light Bus
Gross vehicle weight:	4,000 kg
Seating capacity:	Driver + 16 passengers
Engine capacity:	4,104 c.c.
Year of manufacture:	2004

Registration Mark	**LV6110 (Starting from February 2020 to April 2020)**
Make:	Toyota
Model:	BZB40RZCMSCYY
Class:	Public Light Bus
Gross vehicle weight:	4,000 kg
Seating capacity:	Driver + 16 passengers
Engine capacity:	4,104 c.c.
Year of manufacture:	2005

Appendix 2: Photos of Vehicles

1. Trial HV

	
Front view of HV	Rear view of HV
	
Left side view of HV	Right side view of HV

2. GV for comparison

KK8931 (Starting from May 2018 to January 2020)

	
Front view of GV (KK8931)	Rear view of GV (KK8931)
	
Left Side view of GV (KK8931)	Right Side view of GV (KK8931)

LV6110 (Starting from February 2020 to April 2020)

	
Front view of GV (LV6110)	Rear view of GV (LV6110)
	
Left side view of GV (LV6110)	Right side view of GV (LV6110)