Pilot Green Transport Fund

Final Report
On
Trial of Hybrid Light Bus for Green Minibus Service (Hong Kong Metropolitan Bus)

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(Trial Period: 1 January, 2014 – 31 December, 2015)

Executive Summary

1. Introduction

1.1 The Pilot Green Transport Fund (the Fund) is set up to encourage transport operators to try out green and innovative transport technologies, contributing to better air quality and public health for Hong Kong. The Fund has subsidized Hong Kong Metropolitan Bus Limited (HK Metropolitan) to trial one hybrid public light bus for green minibus service.

1.2 PolyU Technology and Consultancy Company Limited (PolyU) has been engaged by Environmental Protection Department as an independent third party assessor to monitor the trials and evaluate the operational performance of the trial vehicles. PolyU regularly visited HK Metropolitan to collect information for evaluating the performance of the hybrid public light bus (HV) as compared with the diesel public light bus (DV) which provided the same service in the same route. The information collected includes the said vehicles' operation data, fuel bills, maintenance records, reports on operation difficulties, and opinions of the HV drivers from survey questionnaires.

1.3 This Final Report summarizes the performance of the HV for passenger carriage service in the twenty-four months of the trial as compared with their conventional counterpart.

2. Trial Vehicles

2.1 HK Metropolitan procured one 16 seats Dongfeng Gemini EQ6700L5SHEVY hybrid public light bus of 7 tonnes gross vehicle weight (HV) for trial.

2.2 One Mitsubishi 16 seats diesel public light bus of 5.5 tonnes gross vehicle weight (DV) serving the same green minibus route with same road conditions was assigned for comparison with the HV.

2.3 Key features and photos of the HV and DV are in Appendices 1 and 2 respectively.

3. Trial Information

3.1 The 24-month trial started on 1 January 2014. Both vehicles provided green minibus services for route 69X plying between Cyberport and Causeway Bay. There is a climbing road section with a gradient of about 13% along this route in Pokfulam. The vehicles provide service every day from 6:30 am to 11:10 pm including Sundays and public holidays. Both vehicles might also be assigned to routes 69 (plying between Cyber Port and Tai Koo) and 69A (plying between Cyber Port and Aberdeen) according to operational need, the road conditions of these two routes are similar to route 69X.

4. Findings of Trial

4.1 Operating Costs

4.1.1 During this twenty-four-month trial period, the HV travelled 87,220 km whereas the DV travelled 211,368 km. The performance of the HV and its average operating cost as compared with the DV in the twenty four months of the trial is summarized below:

Table 1: Average fuel economy and average fuel cost of trial vehicles

	Hybrid Public Light Bus HV	**Diesel Public Light Bus DV**
Average fuel economy	4.33 km/litre	4.26 km/litre
Average fuel cost[1]	$2.66 /km	$2.77 /km

[1] The market fuel price was used for calculation
[2] Including costs incurred from maintenance

4.1.2 The average fuel cost of HV was lower than its conventional counterpart by 4.1%. According to supplier of the HV, the temperature of the batteries of the HV usually reached 50oC or above during the summer period, and the battery cooling system was not able to effectively lower down its temperature. While the battery management system limited the charging current when the batteries were under high temperature, the engines were still operating as usual to generate power. Therefore, the charging efficiency was lower at high temperature and the fuel economy of the HV was obviously lower in summer days. Besides, the vehicle operating conditions and the drivers' driving habit would have affected its fuel saving performance.

4.1.3 During the trial period, the HV had undergone eleven scheduled and sixty-four unscheduled maintenances. The HV had similar types of scheduled maintenance as that for the DV, such as checkup on the engine, replacement of lubrication oil and filter but required in addition the update on the battery management system and battery maintenance. As the HV was still under warranty, HK Metropolitan did not pay for the maintenance, the maintenance costs were included as a reference for comparison. The unscheduled maintenance actions were mainly due to malfunction of the battery management system, water seepage at the door and air conditioning system which required improved sealing, abnormal condition of the batteries and high temperature of the engine. The total maintenance cost for the HV in the 24 months' trial period was $ 62,775. The utilization rate of the HV was 68%, considerably lower than the 95% of the DV.

4.1.4 Besides fuel cost, maintenance cost and other costs associated with breakdowns, such as replacement of components and parts, were also accounted for in calculating the total operating cost. It should be noted that the direct maintenance costs of the HV were included for reference as it was still under warranty. The average total operating cost per kilometer of HV was 3.4% lower than DV.

Table 2: Average total operating cost and downtime of each vehicle

	Hybrid Public Light Bus	**Diesel Public Light Bus**
Total operating cost/$	295,146 [1]	739,740
Average total operating cost/($/km)	3.38	3.50
Downtime/working days[2]	230	38

[1] The HV was still under warranty. Although HK Metropolitan did not pay for the maintenance, the cost due to maintenance is included for reference

[2] Downtime refers to the period the vehicle is not in operation, which counted from the first day it stops operation till the day it is returned to the operator.

4.2 Performance and Reliability

4.2.1 HK Metropolitan had two designated drivers for the HV in the first six months and one designated driver in the remaining eighteen months. They had the same opinions on the operation and performance of the HV in the survey. Both drivers found no problem in operating the vehicle except that it was more difficult to steer round a tight turning in the first six months.

The steering was improved after the vehicle manufacturer replaced the steering assembly. They however felt that the HV was noisy when the engine was operating to recharge the battery about every fifteen minutes. The passengers opined that the air was clean inside the HV but they also felt that the HV was noisy when the engine was operating and it was less powerful on hill climbing especially for gradient of 13% at Pukfulam Road. According to the supplier of the HV, the HV has a higher maximum output than a conventional public light bus, but it was set to operate at a lower power. Besides, they estimate that the absence of grunting noise of a diesel engine also contributed to the feeling of being less powerful.

4.2.2 Overall, HK Metropolitan had reservation in using hybrid vehicle extensively because the utilization rate of the HV was low which adversely affected the public light bus service. Besides, they also opined that the HV could not save fuel compared to a conventional diesel light bus.

4.2.3 To remove the effect of seasonal fluctuations, 12-month moving averages are used to evaluate the trend of the vehicles' fuel economy. The results show a narrow variation from 4.37 km/l to 4.49 km/l for the HV. There was no indication of fuel economy deterioration during the trial period.

5. Summary of Findings

5.1 The HV had a marginally better fuel economy than the DV. On an average, the HV had a 4.1% fuel cost saving as compared to the DV. Including the maintenance costs, the average total operating cost of the HV was 3.4% lower than the DV.

5.2 The HV drivers had no problem in operating the vehicle except that it was more difficult to steer round a tight turning in the first six months. The steering was improved after the vehicle manufacturer replaced the steering assembly. They however felt that the HV was noisy when the engine was operating to recharge the battery. The passengers opined that the air was clean inside the HV but they also felt that the HV was noisy when the engine was operating and it was less powerful than the DV on hill climbing.

5.3 The HV had frequent maintenance which caused a downtime of 230 days out of the 730 days in the twenty-four months' trial period. The utilization rate of the HV was 68%, considerably lower than that 95% for the DV.

Appendix 1: Key Features of Vehicles

1. Trial HV

Registration Mark:	**SH8307 (HV)**
Make:	Dongfeng
Model:	Gemini EQ6700L5SHEVY
Class:	Public light bus
Gross vehicle weight:	7,000 kg
Seating Capacity:	driver + 16 passengers
Rated Power:	150 kW
Maximum speed:	100 km/h
Battery type:	Lithium iron phosphate battery
Year of manufacture:	2013

2. DV used for comparison

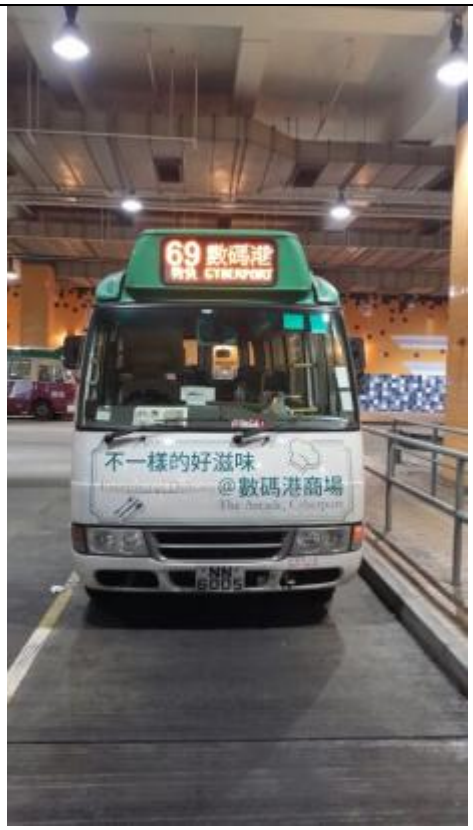
Registration Mark:	**NN6005 (DV)**
Make:	Mitsubishi Fuso
Model:	BE63DGRMDA
Class:	Public light bus
Gross vehicle weight:	5500 kg
Seating Capacity:	driver + 16 passengers
Cylinder capacity:	4899 cc
Year of manufacture:	2008

Appendix 2: Photos of Vehicles

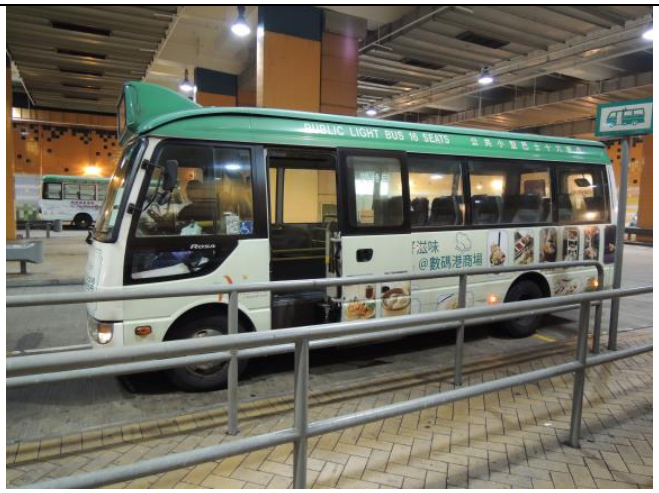
1. Trial HV

	
HV (SH8307) (front view)	HV (SH8307) (side view)
	
HV (SH8307) (side view)	HV (SH8307) (end view)

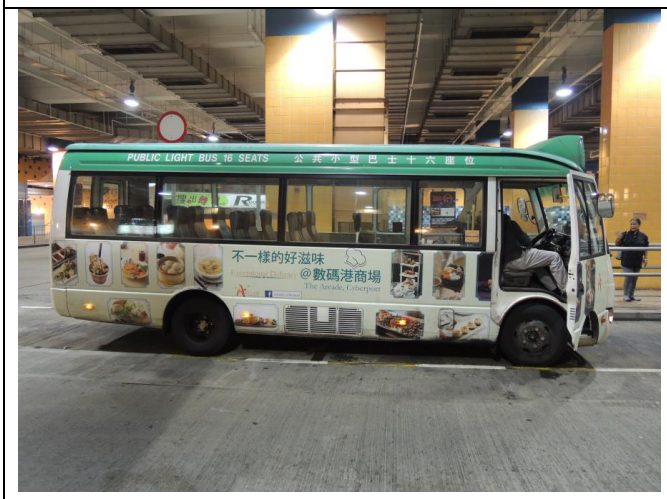
2. DV used for comparison



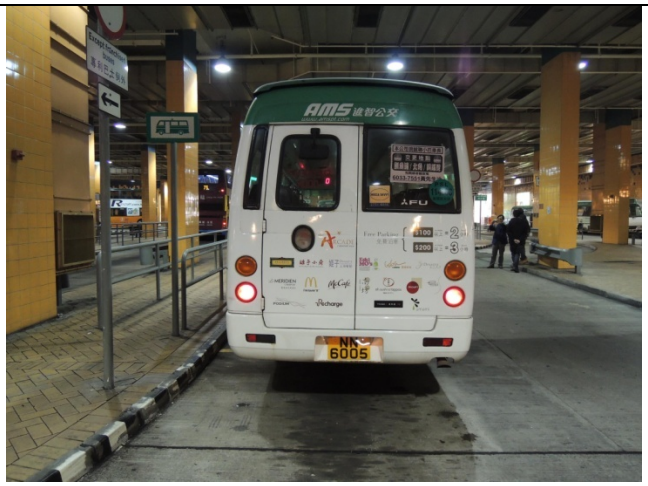
DV(NN6005) (front view)



DV(NN6005) (side view)



DV(NN6005) (side view)



DV(NN6005) (end view)