

Pilot Green Transport Fund

Final Report On Trial of Hybrid Light Bus for Green Public Light Bus Service (Multi Logistics 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 Hybrid Light Bus for Green Public Light Bus Service
(Multi Logistics Limited)**

**Final Report
(Trial Period: 1 April 2018 – 31 March 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. Multi Logistics Limited (Multi Logistics) was approved under the Fund for trial of one diesel-electric hybrid light bus (HV) for green 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. Multi Logistics assigned a liquefied petroleum gas (LPG) public light bus (GV) providing similar 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 compares with its conventional counterpart.

2. Trial Vehicles

2.1 Through the tendering procedures stipulated in the Agreement, Multi Logistics procured one 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 respectively. The vehicles were used to provide green public light bus service for route no. 86, serving between Kai Tak Cruise Terminal and Telford Gardens in Kowloon Bay. 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 April 2018 and lasted for 24 months. Multi Logistics 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 driver and Multi Logistics were collected and provided 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 total operating cost of the HV was HK\$1.61/km (91%) higher than that of the GV. The average fuel cost of HV was HK\$1.66/km (114%) higher than that of the GV. It is 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 313%.

Table 1: Key operation statistics of each vehicle (April 2018 – March 2020)

| | | HV | GV |
|--|------------|----------------------|----------------------|
| Total mileage (km) | | 119,457 | 141,834 |
| Fuel cost (HK\$) ^[1] | | 370,937 | 205,542 |
| Average fuel economy | (km/litre) | 4.53 | 2.35 |
| | (km/MJ) | 0.125 ^[4] | 0.099 ^[5] |
| Average fuel cost (HK\$/km) | | 3.11 | 1.45 |
| Average total operating cost (HK\$/km) | | 3.38 | 1.77 |
| Downtime (working day) ^{[2][3]} | | 60 | 27 |

[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 26 and 35 scheduled maintenances for the HV and GV respectively, resulting in downtime of 24 and 22 working days. Also, there were 20 and 5 unscheduled maintenances for the HV and GV respectively, resulting in downtime of 60 and 27 working days. There were 731 working days in the reporting period, the utilization rates of the HV and the GV were 92% and 96% respectively.

4.3 The driver expressed that the HV ran quieter than the GV when it was not charging, but it was noisy during charging and sometimes he even could not hear passengers notifying him to get off the HV at the next station. Also, the driver felt that the HV had comparatively lower acceleration rate, especially during uphill and sometime even on flat road. However, the driver expressed he encountered less difficulties in driving the HV when the trial went on, and the manufacturer had helped tackle the noise problem. He started to like driving the HV.

4.4 Passengers had different 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 vehicles by hybrid vehicles. However, there were also some passengers expressing dissatisfaction with the HV, especially the noise from the charging process and comparatively less power of the HV. Therefore, they didn't like the HV.

4.5 Multi Logistics claimed that the performance of the HV met the operational requirements and the HV could help improve the roadside air quality, therefore they would encourage other public light bus operators to try out the hybrid light bus and believed that HV could continuously provide public light bus services for a long time.

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 is shown that the fuel economy was stable (between 4.48 km/litre and 4.67 km/litre). It appears that 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 73,108 kg while that from the GV was 85,613 kg. Hence there was an emission reduction of 12,505 kg CO_{2e} (about 15%) in the trial.

5 Summary

5.1 The driver shared the view that the HV ran quieter than the GV when it was not charging, but it was noisy during charging. Also, the driver felt that the HV had comparatively lower acceleration rate, especially during uphill and sometime even on flat road. However, the driver expressed he encountered less difficulties in driving the HV when the trial went on, and the manufacturer had helped tackle the noise problem. He started to like driving the HV. In general, Multi Logistics and the driver were moderately satisfied with the performance of the HV.

5.2 Passengers had different 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 of the HV.

5.3 The average unit price of diesel was much higher than that of LPG (about 313%), resulting in a higher average fuel cost of the HV than that of the GV by HK\$1.66/km (114%). The average total operating cost of the HV was HK\$1.61/km (91%) higher than that of the GV. The utilization rates of the HV and the GV were 92% and 96% respectively.

5.4 The CO_{2e} emission from the HV was 73,108 kg while that from the GV was 85,613 kg. Hence there was an emission reduction of 12,505 kg CO_{2e} (about 15%) 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

| | |
|-----------------------|------------------------|
| Make: | GMI |
| Model: | 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

| | |
|--------------------------|------------------------|
| Registration Mark | SS992 |
| Make: | Toyota |
| Model: | Coaster LPG SWB |
| Class: | Public Light Bus |
| Gross vehicle weight: | 4,800 kg |
| Seating capacity: | Driver + 16 passengers |
| Engine capacity: | 4,104 c.c. |
| Year of manufacture: | 2016 |

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

| | |
|---|--|
|  <p>A front view of a white and yellow bus with a green roof. The destination sign above the windshield reads 'KOWLOON BAY CRUISE TERMINAL' and '九龍灣郵輪碼頭'. The route number '86' is displayed. The license plate is 'SS 992'. A banner across the front reads '同舟共濟 齊心抗疫' (同舟共濟 齊心抗疫). A timestamp '2020-05-13 11:12:00' is visible in the bottom left corner.</p> |  <p>A rear view of the same bus. The license plate is 'SS 992'. A large advertisement on the back features three people's faces. A timestamp '2020-05-13 11:12:30' is visible in the bottom left corner.</p> |
| <p>Front view of GV</p> | <p>Rear view of GV</p> |
|  <p>A left side view of the bus. The license plate is 'SS 992'. A timestamp '2020-05-13 11:12:20' is visible in the bottom left corner.</p> |  <p>A right side view of the bus. The license plate is 'SS 992'. A timestamp '2020-05-13 11:12:07' is visible in the bottom left corner.</p> |
| <p>Left side View of GV</p> | <p>Right side View of GV</p> |