Pilot Green Transport Fund

Final Report on Trial of Hybrid Light Goods Vehicles for Logistics Service (Kwai Bon)

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(Trial Period: 1 December 2012 – 30 November 2014)

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. Kwai Bon Transportation Limited (Kwai Bon) was approved under the Fund for trial of three hybrid light goods vehicles for logistics service. Through the tendering procedures stipulated in the Agreement, Kwai Bon procured three Mitsubishi FUSO Canter Eco Hybrid light goods vehicles (HVs) for trial.

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 Kwai Bon to collect information for evaluating the performance of the hybrid light goods vehicles (HVs) as compared with the diesel light goods vehicles (DVs), which provided the same service in similar areas or with similar road conditions. The information collected includes the said vehicles' operation data, refueling amount, maintenance records, reports on operation difficulties, and opinions of the HV drivers from survey questionnaires.

1.3 This report summarizes the performance of the HVs in the 24-month trial as compared with their conventional counterparts.

2 Trial Vehicles

2.1 Kwai Bon procured three 5.5 tonnes GVW Mitsubishi FUSO Canter Eco Hybrid light goods vehicles (HV-1, HV-2 and HV-3) of 2988 cc cylinder capacity for trial. The HVs were used for providing goods pickup and delivery services to and from the airport for its client.

2.2 Three 5.5 tonnes GVW Mitsubishi FUSO Canter diesel light goods vehicles (DV-1, DV-2 and DV-3) of 4899 cc cylinder capacity and of similar service areas or with similar road conditions were assigned for comparison with the three HVs.

2.3 Key features and photos of the HVs and DVs are in Appendices 1 and 2 respectively.

3 Trial Information

3.1 The 24-month trial started on 1 December 2012. HV-1, HV-2 and HV-3 were stationed at Tsuen Wan, Yuen Long, and Chai Wan respectively. DV-1 and DV-3 were stationed at Chai Wan and DV-2 was stationed at Sai Wan. Kwai Bon could only identify DV-3 that operates on the same route as HV-3 but not for the other two HVs. Despite operating in different routes, DV-1 and DV-2 are still considered acceptable conventional counterparts for HV-1 and HV-2 because they are relatively new and their routes are similar to those of HV-1 and HV-2. The vehicles provide service from Monday to Saturday according to the daily plan. Normally, the vehicles departed three times daily, at 6:00 am, 12:00 noon and 2:00 pm. Each trip takes about 40 minutes to complete. On Saturdays, the vehicles may have fewer trips.

4 Findings of Trial

4.1 Operating Costs

4.1.1 Table 1 below summarizes the fuel cost data of the HVs and the DVs. The average fuel costs of HV-1, HV-2 and HV-3 were lower than their conventional counterparts by 7%, 16% and 18% respectively.

Table 1: Key operation statistics of each vehicle

	Hybrid Light Goods Vehicle			**Diesel Light Goods Vehicle**		
	HV-1	**HV-2**	**HV-3**	**DV-1**	**DV-2**	**DV-3**
Total distance travelled (km)	68,803	83,537	131,786	87,481	65,493	112,205
Average fuel economy (km/litre)	5.83	6.12	6.34	5.40	5.16	5.22
Average fuel cost ($/km) [1]	2.16	2.05	1.98	2.33	2.44	2.40

[1] The market fuel price was used for calculation

4.1.2 In fact, the vehicle operating conditions and the drivers' driving habit would affect its fuel saving performance. According to the manufacturer's information, the trial vehicle could save up to about 20% fuel per km as compared with its diesel counterpart if it travels in urban areas at an average speed of 20 km/h with frequent start-stops. If it travels in suburban areas or on highways at an average speed of 44 km/h, the fuel saving performance would however be reduced to about 12% because the energy recovered by the electric generator at start-stops is much reduced. All the HVs, as well as the DVs, travelled mostly on suburban and highways, and hence the trial HVs were unable to achieve the best fuel saving performance according to the manufacturer because of less start-stops to recover the energy by the electric generator as compared to traveling in urban areas. HV-3 had higher fuel saving than that claimed by the manufacturer, this might be due to the fact that DV-3 was not that economical on fuel because it was nine years older than HV-3. The HVs in general have better fuel economy than the DVs. The HVs saved an average of 14% of fuel when traveling on suburban and highways as compared to the DVs.

4.1.3 During the trial period, HV-1 had five scheduled maintenance and four unscheduled maintenance. Three unscheduled maintenance were due to minor car accidents, the cause of which were unrelated to the performance of the vehicle. Therefore, the three unscheduled maintenance were not included for comparing the performance of the HVs with the diesel counterparts. The remaining unscheduled maintenance was due to a failure in starting the engine. The total maintenance cost was $7,006.7. HV-2 had five scheduled maintenance and two unscheduled maintenance. One unscheduled maintenance was caused by a broken round car mirror which was unrelated to the vehicle's performance, the cost was excluded from the calculation. The remaining unscheduled maintenance was due to the exhaustion of the battery. The total maintenance cost was $9,485.7. HV-3 had undergone eight scheduled maintenance and two unscheduled maintenance. One unscheduled maintenance was due to failure of lighting and was not included for comparison. The remaining unscheduled maintenance was due to leakage of the water tank. The total maintenance cost was $9868.7. It should be noted that in the first two scheduled maintenance of the hybrid vehicles, the labour cost was waived and only the parts to be replaced were charged. The utilization rate of HV-1, HV-2 and HV-3 were 94%, 98% and 97% respectively.

4.1.4 Table 2 below summarizes the operating cost data of the HVs and the DVs. The average total operating costs include maintenance costs and other indirect costs such as towing fee, vehicle replacement fee. The HVs and the DVs incurred only fuel, maintenance and towing fees in this trial. The average total operating cost of HV-1, HV-2 and HV-3 were 7%, 16% and 18% lower than DV-1, DV-2 and DV-3 respectively.

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

	Hybrid Vehicles			**Conventional Vehicles**		
	HV-1	**HV-2**	**HV-3**	**DV-1**	**DV-2**	**DV-3**
Total operating cost ($) [1] [2]	155,325.4	180,725.6	271,129.3	219,640.3	196,596.7	287,709.7
Average total operating cost ($/km)	2.26	2.17	2.06	2.51	3.00	2.57
Downtime (working days) [3]	33 days	13 days	17 days	14 days	19 days	16 days

[1] The labor cost was waived in the first two scheduled maintenance and only the parts to be replaced were charged.

[2] Cost of maintenance due to incident not related to the performance of the vehicle or major overhauls, exceptional incidents due to the old age of the vehicle were excluded in comparison

[3] Downtime refers to the period the vehicle is not in operation, which is counted from the first day it stopped operation till the day it returned to operation

4.2 Performance and Reliability

4.2.1 The HV drivers had no problem in operating the HVs but reflected that the HVs had slower response and less power in going uphill as compared with the DVs.

4.2.2 Overall, Kwai Bon was satisfied with the performance of the HVs. Kwai Bon agreed that using hybrid vehicle is good because it can provide a greener environment.

4.2.3 To remove the effect of seasonal fluctuations, 12-month moving averages are used to evaluate the trend of the HVs' fuel economy. For HV-1, the fuel economy varied from 5.65 km/litre to 5.84 km/litre. For HV-2, the fuel economy varied from 5.89 km/litre to 6.31 km/litre. For HV-3, the fuel economy varied from 6.25 km/litre to 6.39 km/litre. There is no indication of deteriorating fuel economy. It appears that the engines of the HVs were still in normal working conditions and the fuel economy could be maintained through proper maintenance.

5 Summary of Findings

5.1 The vehicle operating conditions and the drivers' driving habit would affect the fuel saving performance of the hybrid vehicles. All the trial HVs travelled mostly on suburban and highways, and hence they were unable to achieve the best fuel saving performance according to the manufacturer. Nevertheless, the HVs in general have better fuel economy than the DVs. The HVs saved an average of 14% of fuel when traveling on suburban and highways as compared to the DVs.

5.2 The HV drivers reflected that they had to adjust their driving habits in the first month but after familiarization with the vehicle, they had no problem in its operation. However, all of them reflected that the HVs responded slower than the DVs and were less powerful than the DVs when driving upslope. According to the supplier, one of the factors contributing to the feeling of being less powerful is that the HVs have a less powerful engine than conventional ones.

5.3 The HVs had regular scheduled maintenance similar to the DVs. The HVs seldom had any failure and out of the 599 working days in the 24 month trial period, HV-1, HV-2 and HV-3 had lost 33, 13, and 17 days and the utilization rate were 94%, 98% and 97% respectively.

5.4 No deterioration in the performance of the HVs was observed from the reported data.

Appendix 1: Key Features of Vehicles

1. Trial HV

Registration Mark:	**RT2725 (HV-1)**
Make:	Mitsubishi Fuso
Model:	Canter Eco Hybrid FEB74GR3SDAC
Class:	Light goods vehicle
Gross vehicle weight:	5500 kg
Seating Capacity:	driver + 2 passengers
Cylinder Capacity:	2998 cc
Year of manufacture:	2012

Registration Mark:	**RT9714 (HV-2)**
Make:	Mitsubishi Fuso
Model:	Canter Eco Hybrid FEB74GR3SDAC
Class:	Light goods vehicle
Gross vehicle weight:	5500 kg
Seating Capacity:	driver + 2 passengers
Cylinder Capacity:	2998 cc
Year of manufacture:	2012

Registration Mark:	**RU1898 (HV-3)**
Make:	Mitsubishi Fuso
Model:	Canter Eco Hybrid FEB74GR3SDAC
Class:	Light goods vehicle
Gross vehicle weight:	5500 kg
Seating Capacity:	driver + 2 passengers
Cylinder Capacity:	2998 cc
Year of manufacture:	2012

2. DV used for comparison

Registration Mark:	**RE405 (DV-1)**
Make:	Mitsubishi Fuso
Model:	Canter 5.5t FE83DGZSRDAA
Class:	Light goods vehicle
Gross vehicle weight:	5500 kg
Seating Capacity:	driver + 2 passengers
Cylinder capacity:	4899 cc
Year of manufacture:	2011

Registration Mark:	**PM6020 (DV-2)**
Make:	Mitsubishi Fuso
Model:	Canter 5.5t FE83DGZSRDAA
Class:	Light goods vehicle
Gross vehicle weight:	5500 kg
Seating Capacity:	driver + 2 passengers
Cylinder capacity:	4899 cc
Year of manufacture:	2010

Registration Mark:	**LE694 (DV-3)**
Make:	Mitsubishi Fuso
Model:	Canter 5.5t FE639F6SRDAA
Class:	Light goods vehicle
Gross vehicle weight:	5500 kg
Seating Capacity:	driver + 2 passengers
Cylinder capacity:	3907 cc
Year of manufacture:	2003

Appendix 2: Photos of Vehicles

1. Trial HVs

	
HV-1 (RT2725) (front view)	HV-1 (RT2725) (end view)
	
HV-1 (RT2725) (side view)	HV-1 (RT2725) (side view)
	
HV-2 (RT9714) (front view)	HV-2 (RT9714) (end view)

	
HV-2 (RT9714) (side view)	HV-2 (RT9714) (side view)
	
HV-3 (RU1898) (front view)	HV-3 (RU1898) (end view)
	
HV-3 (RU1898) (side view)	HV-3 (RU1898) (side view)

2. DVs used for Comparison

	
DV-1 (RE405) (front view)	DV-1 (RE405) (end view)
	
DV-1 (RE405) (side view)	DV-1 (RE405) (side view)
	
DV-2 (PM6020) (front view)	DV-2 (PM6020) (end view)

	
DV-2 (PM6020) (side view)	DV-2 (PM6020) (side view)
	
DV-3 (LE694) (front view)	DV-3 (LE694) (end view)
	
DV-3 (LE694) (side view)	DV-3 (LE694) (side view)