Pilot Green Transport Fund

Final Report
On
Trial of Hybrid Light Goods Vehicles for Beverage Delivery (Swire)

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(Trial Period: 1 January 2013 – 31 December 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. Swire Beverages Limited (Swire) was approved under the Fund for trial of three hybrid light goods vehicles for beverage delivery. Through the tendering procedures stipulated in the Agreement, Swire 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 Swire 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-months trial as compared with their conventional counterparts.

2. Trial Vehicles

2.1 Swire 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 delivering beverages to retail stores and supermarkets.

2.2 Three 5.5 tonnes GVW diesel light goods vehicles (DV-1, DV-2 and DV-3) were assigned for comparison with the three HVs. Only DV-2 was a Mitsubishi make while DV-1 was an Isuzu make and DV-3 was a Hino make. The cylinder capacity of DV-1, DV-2 and DV-3 are 5193 cc, 4899 cc and 4009 cc respectively.

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 January 2013. Both HVs and DVs are stationed at the depot of Swire Coca-Cola building in Sha Tin. The vehicles operate from Monday to Saturday according to the daily plan and it was reported by Swire that the service routes were random in their designated service areas.

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 cost of HV-1, HV-2 and HV-3 were lower than their conventional counterparts by 20%, 9% and 13% 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)	38,205	37,924	35,911	53,533	44,465	55,220
Average fuel economy (km/litre)	6.16	5.95	5.40	4.94	5.38	4.68
Average fuel cost ($/km) [1]	2.03	2.10	2.31	2.53	2.32	2.67

[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 partly 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. It should also be noted that the HVs are Mitsubishi make while DV-1 and DV-3 are of different make which have different engine design, therefore the manufacturer's fuel saving information is less applicable to HV-1 and HV-2 against their conventional counterparts. 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 two unscheduled maintenance. One unscheduled maintenance was due to the abnormal status of the gearbox indicator and the other was due to overheat and breakdown of braking system. The total maintenance cost was $23,991. HV-2 had five scheduled maintenance and five unscheduled maintenance. Two of the unscheduled maintenance were due to minor car accident, the cause of which is unrelated to the performance of HV-2 and therefore was not included for comparing the performance of HV-2 with its counterpart. Another maintenance was a repair of the door which was also unrelated to the performance of the vehicle, it was excluded from the comparison. The other two were due to the abnormal turn on of the service light and loss of lubricating oil. The total maintenance cost was $18,250. HV-3 had four scheduled maintenance and three unscheduled maintenance. The three unscheduled maintenance were due to the abnormal turn on of the engine light indicator, overheated lubricating oil and abnormal status of panel indicator. The total maintenance cost was $12,283. 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 rates of HV-1, HV-2 and HV-3 were 91%, 97% 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 18%, 23% 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 ($)[1] [2]	101,442.2	98,024.1	95,261.2	162,317.1	151,018.3	179,074.0
Average total operating cost ($/km)	2.66	2.58	2.65	3.03	3.40	3.24
Downtime (working days) [3]	51	15	15	17	55	19

[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 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, Swire was satisfied with the performance of the HVs. Swire 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 5.80 km/litre to 6.97 km/litre. For HV-2, the fuel economy varied from 5.80 km/litre to 6.01 km/litre. For HV-3, the fuel economy varied from 5.35 km/litre to 5.66 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.

4.2.4 The equivalent CO2 emissions from HV-1, HV-2 and HV-3 were 17,208 kg, 17,677 kg and 18,450 kg respectively, while that from using conventional vehicles would be 21,441 kg, 19,543 kg and 21,273 kg respectively. Therefore there is a total reduction of 8,922 kg CO2 emission in the trial.

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 partly 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 it took time to familiarize with the operation of the HVs, especially in the automatic switch of gear ratio when going uphill or when the vehicle was travelling at low speed. They reflected that the HVs lacked power in going uphill as compared with the DVs. 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 592 working days in the 24-month trial period, HV-1, HV-2 and HV-3 had lost 51, 15, and 15 days and the utilization rates of HV-1, HV-2 and HV-3 were 91%, 97% and 97% respectively.

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

5.5 The total reduction of CO2 emission in the trial was 8,922 kg.

Appendix 1: Key Features of Vehicles

1. Trial HV

Registration Mark RU6760, RU9333, RV320 (HV-1, HV-2 and HV-3)

Make:	Mitsubishi Fuso
Model:	Canter Eco Hybrid FEB74GR3SDAC
Class:	Light goods vehicle
Gross vehicle weight:	5500 kg
Seating Capacity:	2
Cylinder Capacity:	2998 cc
Year of manufacture:	2012

2. DV used for comparison

Registration Mark PL3221 (DV-1)

Make:	Isuzu
Model:	NPR75HJW-V
Class:	Light goods vehicle
Gross vehicle weight:	5500 kg
Seating Capacity:	5
Cylinder capacity:	5193 cc
Year of manufacture:	2010

Registration Mark NC7307 (DV-2)

Make:	Mitsubishi Fuso
Model:	FE83DEZSRDA
Class:	Light goods vehicle
Gross vehicle weight:	5500 kg
Seating Capacity:	2
Cylinder capacity:	4899 cc
Year of manufacture:	2007

Registration Mark NM6790 (DV-3)

Make:	HINO
Model:	XZU415RQKFQD3
Class:	Light goods vehicle
Gross vehicle weight:	5500 kg
Seating Capacity:	5
Cylinder capacity:	4009 cc
Year of manufacture:	2008

Appendix 2: Photos of Vehicles

1. Trial HVs

	
HV-1 (RU6760) (front view)	HV-1 (RU6760) (end view)
	
HV-1 (RU6760) (side view)	HV-1 (RU6760) (side view)
	
HV-2 (RU9333) (front view)	HV-2 (RU9333) (end view)

	
HV-2 (RU9333) (side view)	HV-2 (RU9333) (side view)
	
HV-3 (RV320) (front view)	HV-3 (RV320) (end view)
	
HV-3 (RV320) (side view)	HV-3 (RV320) (side view)

2. DVs used for comparison

	
DV-1 (PL3221) (front view)	DV-1 (PL3221) (end view)
	
DV-1 (PL3221) (side view)	DV-1 (PL3221) (side view)
	
DV-2 (NC7307) (front view)	DV-2 (NC7307) (end view)

	
DV-2 (NC7307) (side view)	DV-2 (NC7307) (side view)
	
DV-3 (NM6790) (front view)	DV-3 (NM6790) (end view)
	
DV-3 (NM6790) (side view)	DV-3 (NM6790) (side view)