Pilot Green Transport Fund

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

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(Trial Period: 1 February 2013 – 31 January 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 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 medium goods vehicles for beverage delivery. Through the tendering procedures stipulated in the Agreement, Swire procured three Mitsubishi Fuso Canter Eco Hybrid medium goods vehicles (HVs) for trial.

1.2 PolyU Technology and Consultancy Company Limited (PolyU) has been engaged by the 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 HVs as compared with the diesel medium 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, fuel bills, 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, i.e. the DVs.

2. Trial Vehicles

2.1 Swire procured three Mitsubishi Fuso Canter Eco Hybrid medium goods vehicles (HV-1, HV-2 and HV-3) of 7500kg gross vehicle weight (GVW) and 2998 cc cylinder capacity for trial. Only HV-1 is equipped with a tail lift. The HVs were used for delivering beverages to retail stores and supermarkets.

2.2 Three Mitsubishi FUSO Canter diesel medium goods vehicles (DV-1, DV-2 and DV-3) of 9000kg GVW and 4899 cc cylinder capacity 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 February 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 costs of HV-1, HV-2 and HV-3 were lower than those of their conventional counterparts by 31%, 26% and 12% respectively.

Table 1: Key operation statistics of each vehicle

	Hybrid Medium Goods Vehicle			**Diesel Medium Goods Vehicle**		
	HV-1	**HV-2**	**HV-3**	**DV-1**	**DV-2**	**DV-3**
Total distance travelled (km)	34,484	29,011	41,281	28,694	22,516	40,082
Average fuel economy (km/litre)	5.71	4.64	5.59	3.97	3.42	4.88
Average fuel cost ($/km) [1]	2.18	2.70	2.23	3.14	3.64	2.54

[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 both of them travelled in urban areas at an average speed of 20 km/h with frequent start-stops. If they travelled in suburban areas or on highways at an average speed of 44 km/h, the fuel saving performance would be reduced to about 12% because the energy recovered by the HV's electric generator at start-stops were much reduced. In this trial, both the HVs and the DVs travelled partly in suburban areas and on highways, the fuel saving should be no more than 20%. However, an average fuel saving of 24% was achieved. A possible explanation is that the HVs have lower GVW than the DVs, resulting in higher fuel saving than expected.

4.1.3 During the report period, HV-1 had undergone five scheduled maintenances and one unscheduled maintenance due to the leakage of lubricating oil. The total maintenance cost was $17,041. HV-2 had undergone four scheduled maintenances and three unscheduled maintenances.

One of the unscheduled maintenances was due to damage of door lock which was unrelated to the performance of HV-2 and therefore was not included in comparison. The other two unscheduled maintenances were due to lack of lubricating oil and failure of the air flow sensor. The total maintenance cost was $9,589. HV-3 had undergone four scheduled maintenances and three unscheduled maintenances. The three unscheduled maintenances were due to lack of lubricating oil, remote control circuit failure and failure in starting the engine. The total maintenance cost was $ 14,423. It should be noted that in the first two scheduled maintenances of each HV, 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 97%, 97% and 93% respectively

4.1.4 Table 2 below summarizes the operating costs of the HVs and the DVs. The average total operating cost includes maintenance costs and other indirect costs such as towing fee and vehicle replacement fee. The HVs and the DVs incurred only fuel, maintenance and towing fees in this trial. The average total operating costs of HV-1, HV-2 and HV-3 were 36%, 42% and 26% lower than those of DV-1, DV-2 and DV-3 respectively.

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

	Hybrid Vehicles (HV)			**Conventional Vehicles (DV)**		
	HV-1	**HV-2**	**HV-3**	**DV-1**	**DV-2**	**DV-3**
Total operating cost ($)[1] [2]	92,239.9	87,801.1	106,288.5	119,810.9	117,117.9	139,489.1
Average total operating cost ($/km)	2.67	3.03	2.57	4.18	5.20	3.48
Downtime (working days) [3]	17	16	43	16	17	17

[1] The labor cost was waived in the first two scheduled maintenances of HVs 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, as well as 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 when 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 was good because it could provide a greener environment.

4.2.3 To remove the effect of seasonal fluctuations, 12-month moving averages were used to evaluate the trend of each HV's fuel economy. For HV-1, the fuel economy varied from 5.66 km/litre to 6.02 km/litre. For HV-2, the fuel economy varied from 4.59 km/litre to 4.82 km/litre. For HV-3, the fuel economy varied from 5.51 km/litre to 6.02 km/litre. Although there was a slight decrease in fuel economy for HV-2 over the trial period, there was no indication of deterioration in fuel economy for the other two HVs. It appeared 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 carbon dioxide (CO_2) emissions from HV-1, HV-2 and HV-3 were 15,947 kg, 16,517 kg and 19,489 kg respectively, while the emissions from the DVs were 22,932 kg, 22,422 kg and 22,350 kg respectively. Therefore, HV-1, HV-2 and HV-3 achieved 30%, 26% and 13% CO_2 emission reduction respectively in the trial.

5. Summary of Findings

5.1 The vehicle operating conditions and the driver's driving habit would affect the fuel saving performance of a hybrid vehicle. For the former, all the HVs were not expected to achieve the best fuel saving performance claimed by the manufacturer because they had not always travelled in urban areas where frequent starts and stops allowed, but sometimes travelled in suburban areas and on highways. However, they eventually achieved the fuel saving (24% on average) better than the manufacturer's claim (20%) due to lower GVW than the DVs.

5.2 The 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 travelling at low speed. They reflected that the HVs lacked power when going uphill as compared with the DVs. According to the supplier, one of the factors leading to the feeling of being less powerful is that the HVs have a less powerful engine than the DVs.

5.3 The HVs had regular scheduled maintenance similar to the DVs. There were 591 working days in the 24-month trial period and HV-1, HV-2 and HV-3 had lost 17, 16, and 43 days, respectively. The utilization rates of HV-1, HV-2 and HV-3 were 97%, 97% and 93% respectively.

5.4 Although there was a slight decrease in fuel economy for HV-2 over the trial period, there was no indication of deterioration in fuel economy for the other two HVs.

Appendix 1: Key Features of Vehicles

1. Hybrid Medium Goods Vehicles under trial (HV)

Registration Mark:	**RV9394 (HV-1)**
Make:	Mitsubishi Fuso
Model:	Canter Eco Hybrid FEB74GR3SDAG
Class:	Medium goods vehicle
Gross vehicle weight:	7,500 kg
Seating Capacity:	3 (include driver)
Cylinder Capacity:	2998 cc
Year of manufacture:	2012

Registration Mark:	**RW4275 (HV-2)**
Make:	Mitsubishi Fuso
Model:	Canter Eco Hybrid FEB74GR3SDAG
Class:	Medium goods vehicle
Gross vehicle weight:	7,500 kg
Seating Capacity:	3 (include driver)
Cylinder Capacity:	2998 cc
Year of manufacture:	2012

Registration Mark:	**RW4280 (HV-3)**
Make:	Mitsubishi Fuso
Model:	Canter Eco Hybrid FEB74GR3SDAG
Class:	Medium goods vehicle
Gross vehicle weight:	7,500 kg
Seating Capacity:	3 (include driver)
Cylinder Capacity:	2998 cc
Year of manufacture:	2012

2. Diesel Medium Goods Vehicles used for comparison (DV)

Registration Mark:	**MZ9320 (DV-1)**
Make:	Mitsubishi Fuso
Model:	Canter Double Cab (Euro 4) FE85DGWSRDA
Class:	Medium goods vehicle
Gross vehicle weight:	9000 kg
Seating Capacity:	6 (include driver)
Cylinder capacity:	4899 cc
Year of manufacture:	2007

Registration Mark:	**NM541 (DV-2)**
Make:	Mitsubishi Fuso
Model:	Canter Double Cab (Euro 4) FE85DGWSRDAA
Class:	Medium goods vehicle
Gross vehicle weight:	9000 kg
Seating Capacity:	6 (include driver)
Cylinder capacity:	4899 cc
Year of manufacture:	2008

Registration Mark:	**NA7299 (DV-3)**
Make:	Mitsubishi Fuso
Model:	Canter (Euro 4) FE85DGZSRDA
Class:	Medium goods vehicle
Gross vehicle weight:	9000 kg
Seating Capacity:	3 (include driver)
Cylinder capacity:	4899 cc
Year of manufacture:	2007

Appendix 2: Photos of Vehicles

1. Hybrid Medium Goods Vehicles under trial (HV)

	
Hybrid Vehicle HV-1 (RV9394) (front view)	Hybrid Vehicle HV-1 (RV9394) (end view)
	
Hybrid Vehicle HV-1 (RV9394) (side view)	Hybrid Vehicle HV-1 (RV9394) (side view)
	
Hybrid Vehicle HV-2 (RW4275) (front view)	Hybrid Vehicle HV-2 (RW4275) (end view)

	
Hybrid Vehicle HV-2 (RW4275) (side view)	Hybrid Vehicle HV-2 (RW4275) (side view)
	
Hybrid Vehicle HV-3 (RW4280) (front view)	Hybrid Vehicle HV-3 (RW4280) (end view)
	
Hybrid Vehicle HV-3 (RW4280) (side view)	Hybrid Vehicle HV-3 (RW4280) (side view)

2. Diesel Medium Goods Vehicles for Comparison (DV)

	
Diesel Vehicle DV-1 (MZ9320) (front view)	Diesel Vehicle DV-1 (MZ9320) (end view)
	
Diesel Vehicle DV-1 (MZ9320) (side view)	Diesel Vehicle DV-1 (MZ9320) (side view)
	
Diesel Vehicle DV-2 (NM541) (front view)	Diesel Vehicle DV-2 (NM541) (end view)

	
Diesel Vehicle DV-2 (NM541) (side view)	Diesel Vehicle DV-2 (NM541) (side view)
	
Diesel Vehicle DV-3 (NA7299) (front view)	Diesel Vehicle DV-3 (NA7299) (end view)
	
Diesel Vehicle DV-3 (NA7299) (side view)	Diesel Vehicle DV-3 (NA7299) (side view)