Pilot Green Transport Fund

Final Report
On
Trial of Hybrid Medium Goods Vehicles for Transportation of Recycling Materials
(On Mei Tak Environmental Technology Limited)

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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. On Mei Tak Environmental Technology Limited (On Mei Tak) was approved under the Fund for trial of three hybrid medium goods vehicles for transportation of recycling materials. Through the tendering procedures stipulated in the Agreement, On Mei Tak 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 trial and evaluate the operational performance of the trial vehicles. PolyU regularly visited On Mei Tak 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 include 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, i.e. the DVs.

2. Trial Vehicles

2.1 On Mei Tak procured three Mitsubishi Fuso Canter Eco Hybrid medium goods vehicles (HV-1, HV-2 and HV-3) of 7,500 kg gross vehicle weight (GVW) and 2,998 cc cylinder capacity each for trial. The HVs were used for transportation of recycling materials.

2.2 Three diesel medium goods vehicles (DV-1, DV-2 and DV-3) were assigned for comparison with the three HVs. DV-1 was a Nissan make of 10,400 kg GVW and 7,684 cc cylinder capacity. DV-2 was a Hino make of 10,400 kg GVW and 7,961 cc cylinder capacity. DV-3 was a Isuzu make of 9,000 kg GVW and 5,193 cc cylinder capacity.

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. All HVs and DVs were stationed in a car park on Kwai Wo Street, which was nearby On Mei Tak's company office in Kwai Fong. On Mei Tak could only find a control vehicle (i.e. DV-1) that operated in the same service areas with HV-1 but not for the other two. Despite operating in different service areas, DV-2 and DV-3 were still considered acceptable control vehicles for HV-2 and HV-3 because the road conditions of their routes were similar to those of HV-2 and HV-3. The vehicles provided service from Monday to Saturday according to the daily plan. The vehicles would not stop working on gazetted holidays except the Lunar New Year holidays, in other words, the vehicles operated six full days per week (from 8 a.m. to 6 p.m.).

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 5%, 29% and 15% 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)	59,838	50,110	71,908	72,308	57,537	55,166
Average fuel economy (km/litre)	4.66	4.71	5.18	4.43	3.35	4.35
Average fuel cost ($/km) [1]	2.66	2.64	2.40	2.81	3.71	2.83

[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 travel in urban areas at an average speed of 20 km/h with frequent start-stops. If they travel 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 HV's electric generator at start-stops is much reduced. In the trial, all the HVs and DVs travelled partly in suburban and on highways, so the fuel saving should lie between 12% and 20%. As a result, an average fuel saving of 17% was achieved which was slightly less than the manufacturer's claim. On the other hand, it should be noted that the HVs were Mitsubishi make while the DVs were of different makes which had different engine designs. Therefore it is not completely a direct comparison.

4.1.3 During the trial period, HV-1 had four scheduled maintenances and four unscheduled maintenances. Three unscheduled maintenances were due to failure of air conditioning system, oil pump and battery, and out of lubricating oil. The remaining unscheduled maintenance was due to malfunctioning of the engine. The total maintenance cost was $12,926. HV-2 had five scheduled maintenances and one unscheduled maintenance. The unscheduled maintenance was caused by the malfunction of the front vehicle lamp which was unrelated to the vehicle's performance, so the cost was excluded from the calculation. The total maintenance cost was $16,426. HV-3 had five scheduled maintenances and three unscheduled maintenances. The three unscheduled maintenances were due to failure of air conditioning system, malfunction of the brake lamp and red alert indicator lamp. The total maintenance cost was $19,968. It should be noted that in the first two scheduled maintenances 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%, 99% 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 and maintenance costs in this trial. The average total operating costs of HV-1, HV-2 and HV-3 were 4%, 35% and 27% 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			**Conventional Vehicles**		
	HV-1	**HV-2**	**HV-3**	**DV-1**	**DV-2**	**DV-3**
Total operating cost ($)[1] [2]	172,088.5	148,680.3	192,529.8	216,268.7	261,913.5	203,692.6
Average total operating cost ($/km)	2.88	2.97	2.68	2.99	4.55	3.69
Downtime (working days) [3]	58	9	17	3	18	24

[1] The labor cost was waived in the first two scheduled maintenances 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 that 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, On Mei Tak was satisfied with the performance of the HVs. On Mei Tak 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 are used to evaluate the trend of the HVs' fuel economy. For HV-1, the fuel economy varied from 4.02 km/litre

to 5.35 km/litre. For HV-2, the fuel economy varied from 4.35 km/litre to 5.09 km/litre. For HV-3, the fuel economy varied from 4.93 km/litre to 5.55 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 CO2 equivalent emissions from HV-1, HV-2 and HV-3 were 33,881 kg, 28,109 kg and 36,641 kg respectively, while that from using conventional vehicles would be 35,627 kg, 39,457 kg and 43,620 kg respectively. Therefore, there is a total reduction of 20,073 kg (17%) CO2 equivalent 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. For the former, the HVs saved 17% fuel on average compared with the DVs. The fuel saving is slightly less than the best fuel saving performance claimed by the manufacturer (i.e. 20%) as the HVs travelled partly in suburban areas and on highways. It should be noted that the HVs were Mitsubishi make while the DVs were of different makes which had different engine designs. Therefore it is not completely a direct comparison. Nevertheless, the HVs in general have better fuel economy than 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. Generally speaking, the drivers were satisfied with the performance of the HVs.

5.3 The HVs had regular scheduled maintenance and seldom had any failure. Out of the 620 working days in the 24-month trial period, HV-1, HV-2 and HV-3 had lost 58, 9, and 17 days and the utilization rates were 91%, 99% 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 equivalent emission in the trial was 20,073 kg, which was about 17%.

Appendix 1: Key Features of Vehicles

1. Trial HV

Registration Mark	**RV8182 (HV-1)**
Make:	Mitsubishi Fuso
Model:	Canter Eco Hybrid FEB74GR3SDAG
Class:	Medium goods vehicle
Gross vehicle weight:	7,500 kg
Seating Capacity:	2
Cylinder Capacity:	2,998 cc
Year of manufacture:	2012

Registration Mark	**RV7005 (HV-2)**
Make:	Mitsubishi Fuso
Model:	Canter Eco Hybrid FEB74GR3SDAG
Class:	Medium goods vehicle
Gross vehicle weight:	7,500 kg
Seating Capacity:	2
Cylinder Capacity:	2,998 cc
Year of manufacture:	2012

Registration Mark	**RV9805 (HV-3)**
Make:	Mitsubishi Fuso
Model:	Canter Eco Hybrid FEB74GR3SDAG
Class:	Medium goods vehicle
Gross vehicle weight:	7,500 kg
Seating Capacity:	2
Cylinder Capacity:	2,998 cc
Year of manufacture:	2012

2. DV used for comparison

Registration Mark	**PP5760 (DV-1)**
Make:	Nissan
Model:	MKB37BLHRA
Class:	Medium goods vehicle
Gross vehicle weight:	10,400 kg
Seating Capacity:	2
Cylinder capacity:	7,684 cc
Year of manufacture:	2007

Registration Mark	**KC9342 (DV-2)**
Make:	Hino
Model:	FD2JLKA
Class:	Medium goods vehicle
Gross vehicle weight:	10,400 kg
Seating Capacity:	2
Cylinder capacity:	7,961 cc
Year of manufacture:	2001

Registration Mark	**PN2139 (DV-3)**
Make:	Isuzu
Model:	NQR75PNM
Class:	Medium goods vehicle
Gross vehicle weight:	9,000 kg
Seating Capacity:	2
Cylinder capacity:	5,193 cc
Year of manufacture:	2007

Appendix 2: Photos of Vehicles

1. Trial HVs

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<tr><td>Hybrid Vehicle HV-1 (RV8182) (front view)</td><td>Hybrid Vehicle HV-1 (RV8182) (end view)</td></tr>
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<tr><td>Hybrid Vehicle HV-1 (RV8182) (side view)</td><td>Hybrid Vehicle HV-1 (RV8182) (side view)</td></tr>
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<tr><td>Hybrid Vehicle HV-2 (RV7005) (front view)</td><td>Hybrid Vehicle HV-2 (RV7005) (end view)</td></tr>
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Hybrid Vehicle HV-2 (RV7005) (side view)	Hybrid Vehicle HV-2 (RV7005) (side view)
	
Hybrid Vehicle HV-3 (RV9805) (front view)	Hybrid Vehicle HV-3 (RV9805) (end view)
	
Hybrid Vehicle HV-3 (RV9805) (side view)	Hybrid Vehicle HV-3 (RV9805) (side view)

2. DVs used for comparison

	
Diesel Vehicle DV-1 (PP5760) (front view)	Diesel Vehicle DV-1 (PP5760) (end view)
	
Diesel Vehicle DV-1 (PP5760) (side view)	Diesel Vehicle DV-1 (PP5760) (side view)
	
Diesel Vehicle DV-2 (KC9342) (front view)	Diesel Vehicle DV-2 (KC9342) (end view)

	
Diesel Vehicle DV-2 (KC9342) (side view)	Diesel Vehicle DV-2 (KC9342) (side view)
	
Diesel Vehicle DV-3 (PN2139) (front view)	Diesel Vehicle DV-3 (PN2139) (end view)
	
Diesel Vehicle DV-3 (PN2139) (side view)	Diesel Vehicle DV-3 (PN2139) (side view)