Pilot Green Transport Fund

Final Report
On
Trial of Hybrid Light Goods Vehicle for Supermarket (AS Watson)

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(Trial Period: 1 June, 2013 – 31 May, 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 and innovative transport technologies, contributing to better air quality and public health for Hong Kong. The Fund has subsidized A.S.Watson Group (HK) Limited (AS Watson) to try one hybrid light goods vehicle for delivery service.

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 AS Watson to collect information for evaluating the performance of the hybrid light goods vehicle (HV) as compared with the diesel light goods vehicle (DV) which provided the same service in the same areas and 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 Final Report summarizes the performance of the HV for delivery service in the twenty four months of the trial as compared with their conventional counterpart.

2. Trial Vehicles

2.1. AS Watson procured one 5.5 tonnes GVW HINO 300 Series hybrid light goods vehicle (HV) of 4009 cc cylinder capacity for trial.

2.2. One 5.5 tonnes GVW Mitsubishi FUSO Canter diesel light goods vehicle (DV) of 3907 cc cyliner capacity was assigned for comparison with the HV. Although the DV was not equipped with air-conditioning, this was the only truck apart from the HV serving the same purpose in the same area. Therefore the DV is the only suitable conventional vehicle for comparison.

2.3. Key features and photos of the HV and DV are in Appendix 1 and 2 respectively.

3. Trial Information

3.1. The 24-month trial started on 1 June 2013. Both vehicles provided delivery services from the supermarket near the Discovery Bay pier to residential blocks on the hill side within Discovery Bay. The vehicles provide service every day from 7:30 am to 11:30 pm including Sundays and public holidays.

4. Findings of Trial

4.1 Operating Costs

4.1.1 During this twenty four month trial period, the HV travelled 30,772 km whereas the DV travelled 27,995 km. The performance of the HV and their average operating costs as compared with the DV in the twenty four months of the trial is summarized below:

Table 1: Average fuel economy and average fuel cost of trial vehicles

	Hybrid Light Goods Vehicle (with air-conditioning) HV	**Diesel Light Goods Vehicle (without air-conditioning) DV**
Average fuel economy	4.42 km/litre	4.56 km/litre
Average fuel cost[1]	$2.79 /km	$2.70 /km
Average total operating cost[1],[2]	$3.63 /km	$6.36 /km

[1] The market fuel price was used for calculation
[2] Including costs incurred from maintenance. AS Watson did not pay for the labour cost of the first two scheduled maintenances of the HV.

4.1.2 Given the HV had air-conditioning but the DV had not, the average fuel cost of HV was higher than its conventional counterpart by 3.6%. According to Hino, the air conditioner of the HV has a power of 1.3 - 2.6 kW. Assuming the HV has a 2.0 kW air conditioner and it operated maximum 12 hours daily (excluding 4 hours of breaks); the daily energy demand of the air conditioning would be 24 kWh. With the assumption of lower heating value of 36.13 MJ/litre for diesel fuel, 24 kWh daily energy demand would be equivalent to about 73 litres monthly fuel consumption. To remove the effect due to air conditioning, the monthly fuel consumption of the

HV is adjusted by subtracting the fuel consumption due to air conditioning. The fuel cost saving of the HV over the DV was then estimated to be 21%.

4.1.3 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 model could save about 15% fuel as compared with its diesel counterpart according to the calculation method approved by the Ministry of Land, Infrastructure, Transport and Tourism of Japan. Fuel economy depends on road condition. If it travels more in suburban areas or on highways, there would be less fuel saving because the energy recovered by the electric generator at start-stops is much reduced. It should be noted that the HV is a Hino make while the DV is a Mitsubishi make which has a different engine design, therefore the manufacturer's fuel saving information is less applicable to this case. It has been shown in above section that if we remove the effect due to air conditioning, the fuel cost saving of the HV over the DV is estimated to be 21%. This value is higher than that claimed by the manufacturer and could be attributed to the high vehicle age of the DV which might have lower fuel economy. In general, it is considered that the HV had better fuel economy than the DV.

4.1.4 Besides fuel costs, maintenance cost and other costs associated with breakdowns, such as replacement of components and parts, were also accounted for in calculating the total operating cost. It should be noted that in the first two scheduled maintenance of the hybrid vehicle, the labour cost was waived and only the parts to be replaced were charged. The total operating cost of HV with the air conditioning on was 43% lower than the 21-year old DV.

4.1.5 During the report period, the HV had undergone nine scheduled and seven unscheduled maintenances. Some maintenance actions were unrelated to the performance of HV and were not included for comparison with the DV. The total maintenance cost was $25,915. The utilization rate of HV was 95%, which was similar to the DV (93%).

4.2 Performance and Reliability

4.2.1 The HV drivers liked the HV as it was air-conditioned while the diesel vehicle was not, but reflected that the HVs had less power in going uphill as compared with the DV, they also reflected that the response time for acceleration of this vehicle was not as quick as the diesel one.

4.2.2 AS Watson agreed that the HV met all the operational requirements and the maintenance of the HV might be easier and cheaper compared to the conventional DV. They were not certain to replace all the DVs in their fleet with the HV as they did not perceive a noticeable fuel saving of the HV.

4.2.3 To remove the effect of seasonal fluctuations, 12-month moving averages are used to evaluate the trend of the HV's fuel economy. It is shown that there is no indication of deteriorating fuel economy. It appears that the engine of the HV was still in normal working conditions and the fuel economy could be maintained through proper maintenance.

4.2.4 The equivalent CO2 emissions from the HV was 19,322 kg, while that from using conventional vehicle would be 18,709 kg. Therefore, there is a slight increase of 613 kg CO2 emission in the trial because HV had air conditioning while DV had not. Had HV turned off air conditioning, there would have been a reduction of 4,042 kg (18%) CO2 emission compared to conventional vehicle in the trial.

5. Conclusion

5.1 The vehicle operating conditions and the drivers' driving habit would affect the fuel saving performance of the hybrid vehicle. The HV with the air conditioning had 3.6% higher fuel cost as compared to the DV without air conditioning. To remove the effect due to air-conditioning, the fuel consumption due to air conditioning operation was estimated and deducted from the total fuel consumed by the HV and the fuel saving was found to be 21%. Therefore, it is considered that the HV in general had better fuel economy than the DV.

5.2 The HV drivers reflected that they preferred operate the vehicle because the HV had air-conditioning. However, all of them reflected that the HV responded slower than the DV and was less powerful than conventional truck when driving upslope. According to the supplier, this is because the processor in the HV at the ECO driving mode controls the optimum power output in order to achieve higher fuel efficiency, and in turn giving a feeling to driver that the vehicle is less powerful. The HV can give the driver a more powerful feeling when driving out of the ECO mode.

5.3 AS Watson agreed that the HV met all the operational requirements and the maintenance of the HV might be easier and cheaper compared to the conventional DV. They were not certain to replace all the DVs in their fleet with the HV as they did not perceive a noticeable fuel saving of the HV.

5.4 The HV had regular scheduled maintenance similar to the DV. The HV had little failure out of the 730 working days in the twenty four month trial period, the HV lost 37 days only and the utilization rate of the HV was 95%, which was similar to the DV.

5.5 No deterioration in the performance of the HV was observed from the reported data.

Appendix 1: Key Features of Vehicles

1. Trial HV

Registration Mark:	**RZ6963 (HV)**
Make:	Hino
Model:	Hino 300 Series Hybrid
Class:	Light goods vehicle
Gross vehicle weight:	5500 kg
Seating Capacity:	driver + 2 passengers
Cylinder capacity:	4009 cc
Year of manufacture:	2013

2. DV used for comparison

Registration Mark:	**GD1360 (DV)**
Make:	Mitsubishi
Model:	CANTER FE439E
Class:	Light goods vehicle
Gross vehicle weight:	5500 kg
Seating Capacity:	driver + 2 passengers
Cylinder capacity:	3907 cc
Year of manufacture:	1994

Appendix 2: Photos of the Trial Vehicle

1. Trial HV

	
HV (RZ6963) (front view)	HV (RZ6963) (side)
	
HV (RZ6963) (end view)	HV (RZ6963) (side)

2. DV used for comparison

	
DV(GD1360) (front view)	DV(GD1360) (side view)