Pilot Green Transport Fund

Final Report
On
Trial of Hybrid Light Goods Vehicles (Non-van type) for Beverage Delivery
(Hong Kong Yakult Company Limited)

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(Trial Period: 1 May, 2016 – 30 April, 2018)

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. The Fund has subsidized Hong Kong Yakult Company Limited (Yakult) to try three hybrid light goods vehicles (non-van type) for beverage delivery service.

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. The assessor regularly visited Yakult to collect information for evaluating the performance of the hybrid light goods vehicles (non-van type) (HVs) as compared with the conventional counterparts 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 HVs for beverage delivery service in the 24 months trial as compared with their conventional diesel counterparts, i.e., CVs.

2. Trial Vehicles

2.1 Yakult procured three Mitsubishi FUSO hybrid light goods vehicles of 5,500 kg gross vehicle weight (HV-1, HV-2 and HV-3) of 2,998 cc cylinder capacity for trial.

2.2 Three 5,500 kg GVW diesel light good vehicles (one Hino, 4,009 cc (CV-1); two Isuzu, 5193 cc cylinder capacity (CV-2, CV-3)) were assigned for comparison with the HVs. All vehicles were equipped with air-conditioning and freezer.

2.3 Key features and photos of the HVs and CVs are in Appendix 1 and 2 respectively.

3. Trial Information

3.1 The 24-month trial started on 1 May 2016. Two pairs of vehicles (HV-1/CV-1; HV-2/CV-2) delivered products from Kwun Tong depot to Kowloon and Hong Kong Island areas while the third pair of vehicles (HV-3/CV-3) delivered products from Fotan depot to New Territories and Kowloon. HV-1 and HV-3 were redeployed to Mongkok / Yaumatei areas and Sham Shui Po / Cheung Sha Wan areas respectively from October 2017. There is no fixed route. The vehicles provided service from Monday to Saturday (08:00 to 17:00 hours) excluding Sundays and public holidays.

4. Findings of Trial

4.1 Operating Costs

4.1.1 Table 1 shows a summary of the total operating costs incurred for each vehicle. The average total operating cost of HV-1, HV-2 and HV-3 were about 8.1%, 6.8% and 12.7% lower than those of CV-1, CV-2 and CV-3, respectively. The overall average total operating cost of three HVs was about 9.1% (HK$0.39/km) lower than that of the CVs.

Table 1: Operating costs of each vehicle

	Hybrid Vehicles			**Conventional Vehicles**		
	HV-1	**HV-2**	**HV-3**	**CV-1**	**CV-2**	**CV-3**
Fuel cost (HK$) [1]	64,956	68,312	75,166	63,130	90,779	87,963
Maintenance cost (HK$) [2] [3]	10,071	10,071	10,071	4,255	5,500	9,725
Other cost (HK$)	0	0	0	0	0	0
Average fuel economy (km/litre)	3.59	3.22	3.67	3.07	2.78	3.11
Average fuel cost (HK$/km) [1]	3.27	3.66	3.21	3.84	4.25	3.79
Average total operating cost (HK$/km)	3.78	4.20	3.64	4.10	4.51	4.21
Average total operating cost per km by vehicle type (HK$/km)	3.88			4.27		
Downtime (working day) [4]	4	4	5	3	5	4

[1] The market fuel price was used for calculation.

[2] The HV was under warranty, the labour cost was waived and only the parts to be replaced were charged.

[3] Maintenance due to incident not related to the performance of the vehicle was not included for comparing the performance.

[4] Downtime refers to working days that the vehicle is not in operation, which counted from the first day it stops operation till the day it is returned to the operator.

4.1.2 The average fuel cost of HV-1, HV-2 and HV-3 were lower than that of CV-1, CV-2 and CV-3 by 15%, 14% and 15%, respectively.

4.2 Operating Cost Benefits

4.2.1 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 the maintenance cost of the HVs did not include labour cost as the vehicles were still under warranty, the labour cost was waived and only the parts to be replaced were charged. The average total operating cost of the HVs was about 9% lower than the CVs.

4.2.2 During the 24-months trial period, there was one scheduled maintenance for all hybrid vehicles involving thorough examination and maintenance for the annual renewal of vehicle license as well as one unscheduled maintenance for HV-1 and HV-2. HV-1 was involved with a minor collision into other vehicle and HV-2 had a minor maintenance on the braking system. These two maintenances were unrelated to its performance. For CVs, each vehicle had a scheduled thorough examination and maintenance for the annual renewal of vehicle license. There was no unscheduled maintenance for all the three CVs. Out of the 590 wording days in the trial, there was 4 days, 4 days and 5 days downtime for HV-1, HV-2 and HV-3, respectively while CV-1, CV-2 and CV-3 had 3 days, 5 days and 4 days downtime, respectively excluding those downtime un-related to the vehicle performance. The utilization rate was 99.3%, 99.3% and 99.2% for HV-1, HV-2 and HV-3 and 99.5%, 99.2% and 99.3% for CV-1, CV-2 and CV-3, respectively.

4.3 Performance and Reliability

4.3.1 Yakult had designated drivers for the HVs. The drivers found no problem in operating the HVs and in general felt the HVs were clean and less polluted. However, they reflected that the HVs responded slower and less powerful than CVs especially driving upslope. The drivers of HV-1 and HV-2 very often used manual gear to supersede the automatic gear change especially in hill climbing operation. The first driver of HV-3 reflected that the vehicle rolled back at uphill-start especially on rainy days; he was not satisfied in driving this vehicle. HV-1 had engine warning light on occasionally especially on uphill operation in May 2017. After switching the service areas and drivers of HV-1 and HV-3 in October 2017, the drivers had no complaint on the two HVs.

4.3.2 Yakult was satisfied with the HVs in general and would consider replacing the entire vehicle fleet with greener vehicles including HVs in the future.

4.3.3 To remove the effect of seasonal fluctuations, 12-month moving averages are used to evaluate the trend of the HV's fuel economy. The results show that fuel economy of the HVs fluctuated slightly over the 24-month trial period. HV-1 and HV-3 were re-deployed in October 2017 and had different drivers in the middle of the trial period leading to deviations. It appears that the engines of the HVs were still in normal working conditions and the fuel economy could be maintained through proper maintenance.

4.3.4 The CO_2 equivalent (CO_2e) emissions from HV-1, HV-2 and HV-3 were 15,325 kg, 16,062 kg and 17,683 kg, respectively while that from using the conventional vehicles would be 17,912 kg, 18,600 kg and 20,839 kg respectively. There was thus a total reduction of 8,281 kg CO_2 equivalent emission (ie, around 14.4%) in the trial by using HVs as compared with CVs.

5. Summary of Findings

5.1 The three HVs had a better fuel economy than the three CVs. The average fuel cost of HV-1, HV-2 and HV-3 were lower than that of CV-1, CV-2 and CV-3 by about 15%, 14% and 15%, respectively. Including the maintenance costs, the overall average total operating cost of the HVs was 9% lower than that of the CVs. There was a total of 8,281 kg CO_2e reduction (i.e., 14.4%) by using HVs during the 24-month trial period as compared with CVs.

5.2 The three HVs and the three CVs had one scheduled annual examination and maintenance each for renewal of vehicle license in the 24-month trial period. All vehicles had no unscheduled maintenance (excluding maintenances unrelated to vehicle performance). Out of the 590 working days in the 24-month trial period, there was 4 days, 4 days and 5 days downtime for HV-1, HV-2 and HV-3 respectively while CV-1, CV-2 and CV-3 had 3 days, 5 days and 4 days downtime respectively excluding those downtime un-related to the vehicle performance. The utilization rate was therefore 99.3%, 99.3% and 99.2% for HV-1, HV-2 and HV-3 and 99.5%, 99.2% and 99.3% for CV-1, CV-2 and CV-3, respectively.

5.3 No deterioration in the performance of the HVs was observed during the trial period.

5.4 The drivers of the HVs had no problem in operating the vehicle except that the HVs responded slower than the CVs and had less powerful than the CVs especially when driving upslope. The fund recipient, Yakult was satisfied with the HVs and will consider replace the entire vehicle fleet with green vehicles including HV.

Appendix 1: Key Features of Vehicles

1. Trial HVs

Registration Mark:	**UA9307 (HV-1), UB305 (HV-2) and UA8824 (HV-3)**
Make:	Mitsubishi FUSO
Model:	FEB74ER3SDAL
Class:	Light goods vehicle (non-van type)
Gross vehicle weight:	5,500 kg
Seating Capacity:	driver + 2 passengers
Cylinder capacity:	2,998 cc
Year of manufacture:	2015 (HV-2) and 2016 (HV-1 and HV-3)

2. CVs used for comparison

Registration Mark:	**TW4991 (CV-1)**
Make:	HINO
Model:	300 SERIES XZU720R-HKTQS3
Class:	Light goods vehicle (non-van type)
Gross vehicle weight:	5,500 kg
Seating Capacity:	driver + 2 passengers
Cylinder capacity:	4,009 cc
Year of manufacture:	2015

Registration Mark:	**NF2706 (CV-2)**
Make:	ISUZU
Model:	NPR75GJM
Class:	Light goods vehicle (non-van type)
Gross vehicle weight:	5,500 kg
Seating Capacity:	driver + 2 passengers
Cylinder capacity:	5,193 cc
Year of manufacture:	2007

Registration Mark:	**SR6664 (CV-3)**
Make:	ISUZU
Model:	NPR75FH-V
Class:	Light goods vehicle (non-van type)
Gross vehicle weight:	5,500 kg
Seating Capacity:	driver + 2 passengers
Cylinder capacity:	5,193 cc
Year of manufacture:	2014

Appendix 2: Photos of the Trial Vehicles

1. Trial HVs

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Front view of HV-1, UA9307</td><td>Side view of HV-1</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Side view of HV-1</td><td>Rear view of HV-1</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Front view of HV-2, UB305</td><td>Side view of HV-2</td></tr>
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Side view of HV-2	Rear view of HV-2
	
Front view of HV-3, UA8824	Side view of HV-3
	
Side view of HV-3	Rear view of HV-3

2. CVs used for comparison

	
Front view of CV-1, TW4991	Side view of CV-1
	
Front view of CV-2, NF2706	Side view of CV-2
	
Front view of CV-3, SR6664	Side view of CV-3