# Pilot Green Transport Fund

# Final Report
# On
# Trial of Hybrid Medium Goods Vehicles for Logistics Service
# (Kerry Distribution (Hong Kong) Limited)

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**Pilot Green Transport Fund**
**Trial of Hybrid Medium Goods Vehicles for Logistics Service**
**(Kerry Distribution (Hong Kong) Limited)**

**Final Report**
**(Trial Period: 1 April 2013 – 31 March 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. Kerry Distribution (Hong Kong) Limited (Kerry) was approved under the Fund for trial of three hybrid medium goods vehicles for logistics service. Through the tendering procedures stipulated in the Agreement, Kerry 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 Kerry to collect information for evaluating the performance of the hybrid medium goods vehicles (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, 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 Kerry 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 2,988 cc cylinder capacity for trial. The HVs were used for providing road freight services.

2.2 Three 9,000 kg GVW Mitsubishi Fuso Canter diesel medium goods vehicles (DV-1, DV-2 and DV-3) of 4,899 cc cylinder capacity and of same service areas were assigned for comparison with the three HVs. In the second year, because of the routes changes in two of them (DV-2 and DV-3) which made them no longer suitable for comparsion with the respective HV-2 and HV-3,

they were replaced by two 9,000 kg GVW Isuzu diesel medium goods vehicles of 4,751 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 April 2013. All the HVs and DVs were stationed at Kerry Cargo Centre in Kwai Chung. Each HV shares the same service areas with its diesel counterpart. The vehicles provide service from Monday to Saturday and the number of working hours per day was twelve.

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 those of their conventional counterparts by 11%, 29% and 32% 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) | 54,342 | 50,052 | 85,022 | 90,253 | 65,477 | 73,574 |
| Average fuel economy (km/litre) | 5.90 | 6.69 | 6.87 | 5.19 | 4.77 | 4.66 |
| Average fuel cost ($/km) [1] | 2.09 | 1.84 | 1.79 | 2.36 | 2.58 | 2.62 |

[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 this trial, all the HVs and the DVs travelled partly in suburban and on highways, the fuel saving should be less than 20%. However, some of the HVs in this trial achieved higher fuel saving than the manufacturer's claim. A possible explanation is that the HVs have a lower GVW than the DVs, resulting in a higher fuel saving than expected. On the whole, the three HVs achieved an average fuel saving of 24%.

4.1.3 During the trial period, HV-1 had undergone six scheduled maintenances and one unscheduled maintenance due to oil leakage in the tail lift hydraulic system. The cause of the unscheduled maintenance was unrelated to the performance of the vehicle, therefore it was not included for comparing the performance of the HV with its diesel counterpart. The total maintenance cost was $40,012. HV-2 had undergone seven scheduled maintenances and one unscheduled maintenance due to a malfunction of the anti-theft system. The total maintenance cost was $36,053. HV-3 had undergone eight scheduled maintenances and three unscheduled maintenances due to a failure in starting the engine, a malfunction of the anti-theft system and detachment of rivets in the loading compartment of the vehicle. The total maintenance cost was $41,217. 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 97%, 98% 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 cost in this trial. The average total operating costs of HV-1, HV-2 and HV-3 were 7%, 23% and 29% 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 ($) [1] [2] | 153,667.9 | 128,098.9 | 193,342.8 | 272,171.3 | 217,112.9 | 235,157.4 |
| Average total operating cost ($/km) | 2.83 | 2.56 | 2.27 | 3.02 | 3.32 | 3.20 |
| Downtime (working days) [3] | 15 | 11 | 15 | 23 | 14 | 12 |

[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 when going uphill as compared with the DVs.

4.2.2 Overall, Kerry agreed that using hybrid vehicle was good because it could help improve the roadside air quality. However, Kerry opined that the maintenance of the HVs was not easier or cheaper than those of the DVs.

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 5.67 km/litre to 6.18 km/litre. For HV-2, the fuel economy varied from 6.60 km/litre to 6.82 km/litre. For HV-3, the fuel economy varied from 6.74 km/litre to 7.04 km/litre. Although there was a slight decrease of fuel economy for HV-1, there is no indication of deteriorating fuel economy for HV-2 and HV-3. 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 $CO_2$ equivalent emissions from HV-1, HV-2 and HV-3 were 24,307 kg, 19,747 kg and 32,677 kg respectively, while that from using conventional vehicles would be 27,636 kg, 27,695 kg and 48,155 kg respectively. Therefore, there is a total reduction of 26,754 kg (26%) $CO_2$ equivalent emission (12%, 29% and 32% reduction for HV-1, HV-2 and HV-3 respectively) in the trial, with an average reduction of 24% $CO_2$ equivalent emission.

## 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, all the HVs were not expected to achieve the best fuel saving performance (20%) 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, some of the HVs in this trial achieved higher fuel saving than the manufacturer's claim. On the whole, the three HVs eventually achieved an average fuel saving of 24% which is better than the manufacturer's claim possibly due to lower GVW than the DVs.

5.2 The HV drivers reflected that it took time to familiarize with the operation of the HVs. After familiarization with the vehicles, they had no problem in the operation but reflected that the HVs had slower response and less power when going uphill as compared with the DVs.

5.3 The HVs had regular scheduled maintenance similar to the DVs. Out of the 594 working days in the 24-month trial period, HV-1, HV-2 and HV-3 had lost 15, 11, and 15 days respectively and the utilization rates of HV-1, HV-2 and HV-3 were 97%, 98% and 97% respectively.

5.4 Although HV-1 showed a slight decrease in fuel economy, there is no indication of deteriorating fuel economy for HV-2 and HV-3.

5.5 The three HVs had a total reduction of $CO_2$ equivalent emission of 26,754 kg, which was around 26%, in the trial. The average reduction is 24%.

## Appendix 1: Key Features of Vehicles

### 1. Trial HV

| | |
|---|---|
| **Registration Mark:** | **RW5120 (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: | 2998 cc |
| Year of manufacture: | 2012 |

| | |
|---|---|
| **Registration Mark:** | **RW5185 (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: | 2998 cc |
| Year of manufacture: | 2012 |

| | |
|---|---|
| **Registration Mark:** | **RW6258 (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: | 2998 cc |
| Year of manufacture: | 2012 |

## 2. DV used for comparison

| | |
|---|---|
| **Registration Mark:** | **NF6306 (DV-1)** |
| Make: | Mitsubishi Fuso |
| Model: | Canter FE85DGZSRDA |
| Class: | Medium goods vehicle |
| Gross vehicle weight: | 9000 kg |
| Seating Capacity: | 2 |
| Cylinder capacity: | 4899 cc |
| Year of manufacture: | 2007 |

| | |
|---|---|
| **Registration Mark:** | **PW3240 (DV-2) (from April 2013 to April 2014)** |
| Make: | Mitsubishi Fuso |
| Model: | Canter FE85DGZSRDAA |
| Class: | Medium goods vehicle |
| Gross vehicle weight: | 9000 kg |
| Seating Capacity: | 2 |
| Cylinder capacity: | 4899 cc |
| Year of manufacture: | 2008 |

| | |
|---|---|
| **Registration Mark:** | **ME7299 (DV-2) (from May 2014 to March 2015)** |
| Make: | Isuzu |
| Model: | NQR7OPU-5NMF |
| Class: | Medium goods vehicle |
| Gross vehicle weight: | 9000 kg |
| Seating Capacity: | 2 |
| Cylinder capacity: | 4751 cc |
| Year of manufacture: | 2005 |

| | |
|---|---|
| **Registration Mark:** | **PW3372 (DV-3) (from April 2013 to April 2014)** |
| Make: | Mitsubishi Fuso |
| Model: | Canter FE85DGZSRDA |
| Class: | Medium goods vehicle |
| Gross vehicle weight: | 9000 kg |
| Seating Capacity: | 2 |
| Cylinder capacity: | 4899 cc |
| Year of manufacture: | 2007 |

| | |
|---|---|
| **Registration Mark:** | **MF2573 (DV-3) (from May 2014 to March 2015)** |
| Make: | Isuzu |
| Model: | NQR7OPU-5NMF |
| Class: | Medium goods vehicle |
| Gross vehicle weight: | 9000 kg |
| Seating Capacity: | 2 |
| Cylinder capacity: | 4751 cc |
| Year of manufacture: | 2005 |

## Appendix 2: Photos of Vehicles

### 1. Trial HVs

<table>
<tr><td> 
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<tr><td>HV-1 (RW5120) (front view)</td><td>HV-1 (RW5120) (end view)</td></tr>
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<tr><td>HV-1 (RW5120) (side view)</td><td>HV-1 (RW5120) (side view)</td></tr>
<tr><td> 
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<tr><td>HV-2 (RW5185) (front view)</td><td>HV-2 (RW5185) (end view)</td></tr>
</table>

| | |
|---|---|
|  |  |
| HV-2 (RW5185) (side view) | HV-2 (RW5185) (side view) |
|  |  |
| HV-3 (RW6258) (front view) | HV-3 (RW6258) (end view) |
|  |  |
| HV-3 (RW6258) (side view) | HV-3 (RW6258) (side view) |

## 2. DVs used for comparison

| | |
|---|---|
|  |  |
| DV-1 (NF6306) (front view) | DV-1 (NF6306) (end view) |
|  |  |
| DV-1 (NF6306) (side view) | DV-1 (NF6306) (side view) |
|  |  |
| DV-2 (PW3240) (front view)<br>(from April 2013 to April 2014) | DV-2 (PW3240) (end view)<br>(from April 2013 to April 2014) |

| | |
|---|---|
|  |  |
| DV-2 (PW3240) (side view)<br>(from April 2013 to April 2014) | DV-2 (PW3240) (side view)<br>(from April 2013 to April 2014) |
|  |  |
| DV-2 (ME7299) (front view)<br>(from May 2014 to March 2015) | DV-2 (ME7299) (end view)<br>(from May 2014 to March 2015) |
|  |  |
| DV-2 (ME7299) (side view)<br>(from May 2014 to March 2015) | DV-2 (ME7299) (side view)<br>(from May 2014 to March 2015) |

| | |
|---|---|
|  |  |
| DV-3 (PW3372) (front view)<br>(from April 2013 to April 2014) | DV-3 (PW3372) (end view)<br>(from April 2013 to April 2014) |
|  |  |
| DV-3 (PW3372) (side view)<br>(from April 2013 to April 2014) | DV-3 (PW3372) (side view)<br>(from April 2013 to April 2014) |
|  |  |
| DV-3 (MF2573) (front view)<br>(from May 2014 to March 2015) | DV-3 (MF2573) (end view)<br>(from May 2014 to March 2015) |

| | |
|---|---|
|  |  |
| DV-3 (MF2573) (side view)<br>(from May 2014 to March 2015) | DV-3 (MF2573) (side view)<br>(from May 2014 to March 2015) |