Pilot Green Transport Fund

Interim Report On
Trial of Solar Air-conditioning System for Shuttle Bus (Hong Kong Science and Technology Parks)

(2 July 2015)

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(Hong Kong Science and Technology Parks)

Interim Report
(Trial Period: 1 April 2014 – 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 and innovative transport technologies, contributing to better air quality and public health for Hong Kong. HK Science and Technology Parks Corporation (HKSTPC) was approved under the Fund for trial of one unit of Solar Air-conditioning System (SAS) on a shuttle bus. The SAS was expected to lower the fuel consumption of the bus. Through the tendering procedures stipulated in the Subsidy Agreement HKSTPC entered into with the Government, HKSTPC appointed Green Power Industry Ltd to install one SAS on a new diesel private bus (this new vehicle is referred to as SAV in this report) for trial.

1.2 The SAV replaced another diesel private bus equipped with a conventional air-conditioning (a/c) system (this replaced vehicle is referred to as CAV in this report). The CAV is the only conventional vehicle of the same class as the SAV that HKSTPC has. Thus historical data of the CAV, from January to December 2013, would be used in this report to compare with data collected from the SAV.

1.3 PolyU Technology and Consultancy Company Limited has been engaged by the Environmental Protection Department as an independent third party assessor to monitor the trial and evaluate the performance of the trial vehicles.

1.4 This Interim Report summarizes the performance of the SAV in the first twelve months of the trial as an indirect comparison between the SAS and the conventional a/c system.

2 Trial Product and Related Vehicles

2.1 Flexible solar panels, with peak power of 1,320W, are part of the SAS and were installed on the roof of the SAV to supplement the energy needed by an electric compressor of the SAS. The CAV had a conventional a/c compressor mechanically driven by the vehicle's engine.

2.2 Key features of the SAS, SAV and CAV are in Appendix 1 and photos of the SAV are in Appendix 2. The vehicles provided scheduled shuttle services between Hong Kong Science Park and Inno Centre at Kowloon Tong at different times. Average daily mileage is about 300 km.

3 Trial Information

3.1 The trial has started on 1 April 2014 and will last for 24 months. HKSTPC was required to collect and provide trial information including the SAV operation data and maintenance records. SAV operation data include distance travelled, amount and cost of diesel fuel consumed and ambient and cabin temperatures. Maintenance records include cost and downtime associated with scheduled and unscheduled maintenance of the SAV related to the performance of the SAS. Similar data are also required from the CAV. In addition to the cost information, reports on maintenance work, operational difficulties and opinions of the driver were collected to reflect any problems of the SAS.

3.2 The following table summarizes the statistical data of the SAV and CAV. The fuel cost of the SAV was $0.18/km (10%) lower than the CAV. Apart from the different data collection periods, the SAV is heavier, has a newer and smaller engine compared with the CAV. While the age and size of engines may affect fuel economy, the gross vehicle weight of the SAV is probably more important here since it is almost 40% heavier. All factors considered, the SAV's better fuel economy is significant but its cause is difficult to ascertain.

Table 1: Key operation statistics of each vehicle, April 2014 – March 2015

		SAV [1]	**CAV (historical data)**
Total mileage/km		79,582	73,046
Average fuel economy/	(km/litre)	7.21	6.51
	(km/MJ) [2]	0.2	0.18
Average fuel cost $/km		1.69	1.87 [3]
Average total operating cost /($/km)		1.69	1.87 [4]
Downtime – a/c system related [5] /day		3 (SAS downtime 26 days)	- [4]

[1] May 2014 data not used because SAS was not in operation

[2] Assuming lower heating value of 36.13 MJ/litre for diesel fuel

[3] Calculated using the unit price of diesel used by the SAV in corresponding months

[4] CAV maintenance information unavailable but the vehicle was in service in all but a few days in the corresponding period

[5] Downtime refers to the period the vehicle is not in operation, which counted from the first day it stops operation till the day it is returned to the operator

3.3 Apart from the maintenance cost, other indirect costs may include towing fee, vehicle replacement fee and cost of operation downtime due to charging and maintenance of the SAV. The SAS started having problem on 30 April 2014 and was not in operation until it was repaired at the end of May 2014. It caused the SAV to have one unscheduled maintenance with three days downtime. A replacement bus was provided by the SAS supplier during these three days free of charge.

3.4 Utilization rate was 99% for the SAV and about 92% for the SAS. Although maintenance record of the CAV was not available, estimating from its historical operation data, its utilization rate was close to 100%.

3.5 On average, the SAV's cabin highest temperature in the summer months (June-October) was about 7 oC lower than the maximum daily temperature at the Hong Kong Observatory.

4 Summary

4.1 The average fuel cost of the SAV was 10% ($0.18/km) less than the CAV. Utilization rate was close to 100% for both vehicles and about 92% for the SAS.

4.2 The driver of the SAV had no problem in operating the SAS and was satisfied with its performance. He did not receive any complaint from the passengers regarding the SAS.

4.3 A passenger opinion survey was conducted with 10 passengers per month starting from September 2014. In general, feedbacks from the passengers on the SAS were positive.

4.4 Feedbacks from HKSTPC are also positive except that it is not sure if the SAS helps save operational cost and therefore not sure if all existing conventional product will be replaced with the green product.

Appendix 1: Key Features of the Trial Product and Vehicles Involved

1. Solar Air-conditioning System (SAS)

Supplier:	Green Power Industry Ltd
Solar panel type:	Monocrystalline silicon, flexible based
Solar cell efficiency:	21.1%
Solar panel total output:	Max. peak power 1,320W
System controller:	Max. power point tracking, 24V
Electric compressor:	2.12 kW, 24V, brushless DC motor
Additional battery:	210 Ah
Additional Alternator:	110 A

2. Diesel Bus with the SAS

Make:	Mitsubishi Fuso
Model:	BE641JRMDA
Class:	Private Bus
Gross vehicle weight:	7.3 tonnes
Seating capacity:	Driver + 29 passengers
Cylinder Capacity:	2,998 c.c.
Year of manufacture:	2013

3. Diesel Bus with Conventional A/C System for Comparison

Make:	Toyota
Model:	BB59RZEMQZ5
Class:	Private Bus
Gross vehicle weight:	5.3 tonnes
Seating capacity:	Driver + 28 passengers
Cylinder Capacity:	4,104 c.c.
Year of manufacture:	2001

Appendix 2: Photos of Diesel Private Bus (SAV) with SAS

	
SAV – front view	SAV – end view
	
SAV – side view 1	SAV – side view 2
	
Solar panel, part of the SAS, on SAV roof	SAV – odometer