

## Case Study

### HYBRID TECHNOLOGY

(General Freight LPUD)



#### TRIAL SUMMARY

The objective of this trial was to assess the economic, operational and emissions performance of a hybrid electric vehicle relative to a conventional diesel vehicle. The comparison was conducted for two local pick-up and delivery vehicles operating in the Sydney metropolitan area.	Fuel benefit (L/100 km)	GHG benefit (g/km CO <sub>2</sub> -e)	Economic benefit (\$/100 km)
	21% ↑ (saving 6.66 L/100 km)	21% ↑ (saving 179.35 gCO <sub>2</sub> e/km)	21% ↑ (saving \$9.32/100 km)

↑ performance better than conventional vehicle  
↓ performance worse than conventional vehicle

The *Green Truck Partnership* is designed to be a forum for the objective evaluation of the merits of clean vehicle technologies and fuels by heavy vehicle operators. This report discusses the results of hybrid technology trial conducted under the program in 2012.

#### 1 HYBRID VEHICLE TECHNOLOGIES

A hybrid vehicle uses two or more power sources. The most common form of hybrid is one that combines an internal combustion engine (powered by petrol or diesel fuel) with an electric motor powered by on-board batteries.

The principal benefit of a hybrid vehicle is the fuel that can be saved through electric vehicle operation.

The energy used by the electric motor is drawn from an on-board battery pack that is charged by the operation of the internal combustion engine and by the kinetic energy recovered from the operation of the braking system.

The principal fuel efficiency benefit comes from the recovery of energy from the braking system which is then used to reduce overall fuel consumption.

Accordingly, hybrid vehicle technologies deliver the greatest benefit when used in urban stop-

start applications where the opportunity for capturing braking energy is highest (as opposed to highway haul applications where high speed and lack of braking operation minimises the opportunity for energy recovery).

The principal downside of a hybrid vehicle relates to its higher capital cost relative to conventional ICE technologies. Consequently, the pure economic case for investment in this technology is generally only warranted where the quantum of fuel savings over the life of the vehicle exceeds the incremental capital cost of vehicle purchase.

A hybrid vehicle is also a little heavier than a conventional vehicle owing to the need to accommodate two power systems, as well as two energy storage systems (battery pack and fuel tank). As a consequence, the use of hybrid vehicles for weight-constrained freight operation will typically result in a payload penalty.

Consequently, the real-world merits of substituting a hybrid truck for a conventional ICE truck will be a factor of the intended application of the vehicle.

## 2 TRIAL OBJECTIVE

The objective of this trial was to assess the economic and environmental performance of a hybrid truck (relative to a conventional diesel vehicle) used in a local pick-up and delivery application in a metropolitan area.

## 3 METHODOLOGY

### DATA COLLECTION

The trial involved an in-field assessment of a hybrid local pick-up and delivery vehicle relative to an equivalently configured diesel vehicle. The vehicles were simultaneously operated on like routes in the Sydney metropolitan region over a four-week period.

In order to ensure that the operation of the two vehicles was directly comparable, data loggers were fitted to each vehicle to capture key descriptors of vehicle operation. Specifically, information was collected in relation to:

- **IDLE TIME:** time spent at idle.
- **AVERAGE SPEED:** average speed (km/h).
- **STOPPING INTENSITY:** number of stops per kilometre travelled.

Owing to the nature of the vehicles being trialled, instantaneous fuel consumption data could not be captured. As a result, daily fuel consumption data was provided by the participating fleet and aggregated with the drive cycle data for each day of the trial period.

### DATA ANALYSIS

The first stage of the analysis involved validating the fuel consumption comparison between both vehicles. This involved comparing the daily operation of both vehicles using the three drive cycle descriptors (i.e. average speed, idle time and stopping intensity) and exclusion of daily fuel

consumption data where the drive cycles were assessed as being too dissimilar for comparison.

As shown in Figure 1 and Figure 2, a comparison of the speed profiles for both vehicles revealed a strong level of correlation. The stopping intensity for both vehicles also shows a strong correlation, which suggests the vehicles were undertaking similar routes (Figure 3). Accordingly, the study team concluded that the operation of the two vehicles was very similar and that direct comparison of the fuel consumption of the two vehicles was valid (i.e. there were no significant differences in duty cycle that would affect fuel consumption, and any observed differences were likely to be almost solely related to differences in the vehicle technologies).

Following data validation, the fuel consumption of the two vehicles was compared. The results are summarised in Section 4.

## 4 RESULTS

Comparison of the fuel consumption of both vehicles revealed that the hybrid vehicle delivered a fuel efficiency benefit of 21% relative to the conventional diesel vehicle.

This result equates to a GHG emissions benefit of 21% in favour of the hybrid vehicle, which is equivalent to a net reduction in GHG emissions of 179.35 g/km.

## 5 CONCLUSION

The findings of this trial suggest that the use of a hybrid vehicle in an urban local pick-up and delivery application will likely deliver a fuel cost benefit of approximately 21%. At current fuel costs (i.e. August 2012), this benefit equates to a net saving of approximately \$9.32 per 100 km, as shown in Figure 4.

It is worth noting that the economic performance of this technology cannot be considered on the

basis of fuel savings alone. Ideally, the assessment should be conducted on a whole-of-vehicle-life basis. Essentially, the net economic outcome will be a factor of the incremental capital cost of the vehicle and the total number of kilometres travelled by the vehicle over its life.

Figure 1

Comparison of vehicle average speed across the trial period

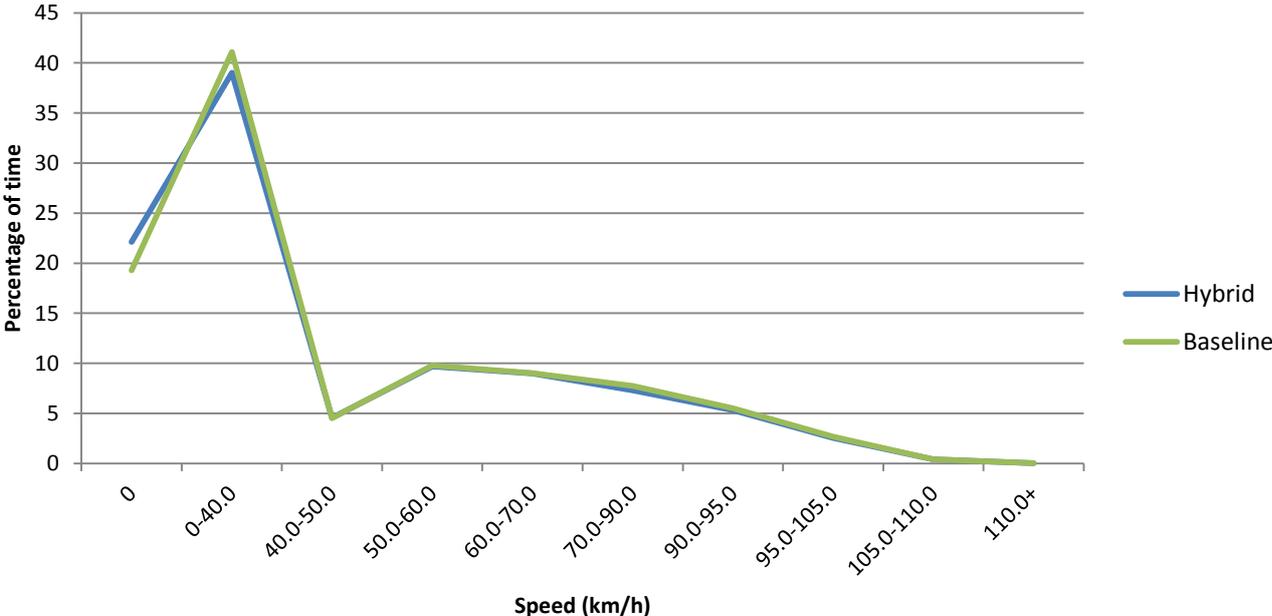


Figure 2

Comparison of hybrid and diesel baseline average speed across the trial period

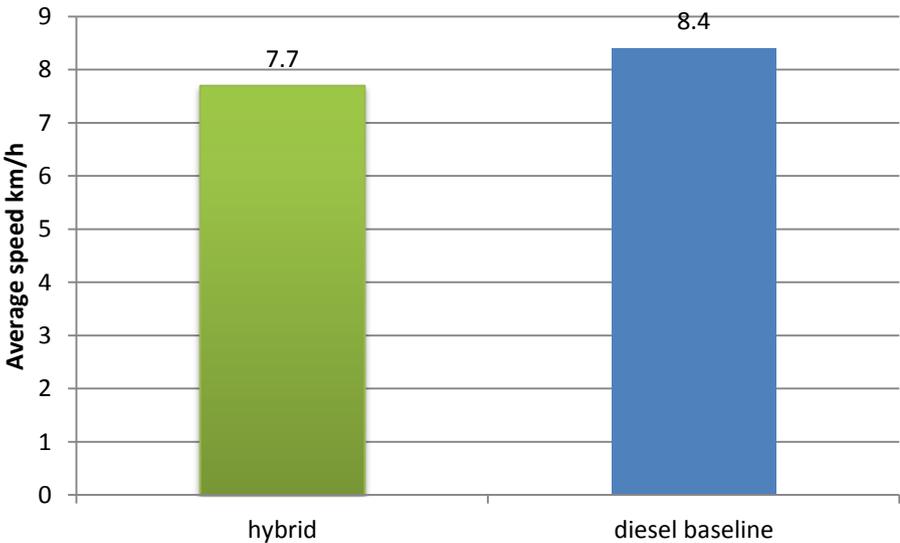


Figure 3

**Comparison of hybrid and diesel  
stopping intensity (stops per km)**

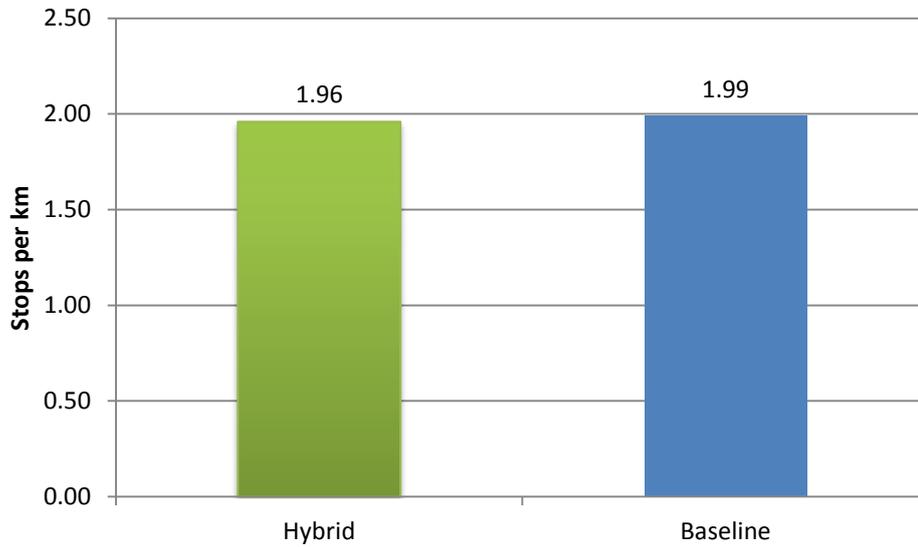


Figure 4

**Comparison of hybrid and diesel  
baseline economic benefit (\$ per 100 km)**

