

## Case Study

### B20 BIODIESEL (TALLOW DERIVED)



#### TRIAL SUMMARY

	Fuel benefit (L/100 km)	GHG benefit (g/km CO <sub>2</sub> -e)	Economic benefit (\$/100 km)
<p>This trial sought to quantify the differences in fuel consumption associated with the use of B20 relative to the use of conventional diesel fuel for heavy vehicle operation.</p> <p>The trial involved the comparison of fuel consumption under diesel (before) and B20 (after) operation in eight linehaul vehicles operating in regional Victoria and New South Wales.</p> <p>The results revealed a small fuel consumption benefit in the order of 0.5% which is not considered to be statistically valid. Nonetheless, the results did not give rise to an increased fuel consumption rate, which had been expected owing to the lower energy density of B20 relative to diesel.</p>	0.688 ↑	246.9 ↑	1.81 ↑

↑ performance better 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 a biodiesel trial conducted under the program in 2011.

#### 1 BIODIESEL FUELS

Biodiesel is the name given to ester-based oxygenated fuels that can be derived from a variety of sources including agricultural crops, animal fats and used cooking oils. Developments in biodiesel production technology suggest that future feedstocks could include diverse sources such as algae and woody feedstocks.

Biodiesel can be used in neat form (B100) or, more often, as a blend with conventional petroleum-based diesel. Typical blends in Australia include 5% biodiesel (B5) and 20% biodiesel (B20).

Some concern has been expressed over the sustainability of some feedstocks such as palm oil. It is understood that the global biofuel

industry is developing a sustainability protocol intended to ensure only sustainable feedstocks are considered for future biodiesel production.

Biodiesel fuel blends are often promoted as a means of delivering GHG emissions relative to the use of conventional petroleum-based diesel. There is, however, considerable uncertainty about the economic and emissions benefits of biodiesel blends. In particular it has been suggested that any emissions benefit per unit use of the fuel is likely to be negated as the lower energy density of the fuel means that a greater volume of fuel is required to complete the same vehicle task.

In addition, some members of the heavy vehicle fleet community have expressed concern about past operational problems associated with significant variations in the quality of biodiesel. It is worth noting, however, that many of these trials were completed prior to the establishment of a formal fuel quality standard for biodiesel in Australia.

## 2 TRIAL OBJECTIVE

The objective of this trial was to quantify the actual increase in fuel consumption (if any) of a B20 biodiesel truck relative to a conventional diesel truck.

Pure biodiesel typically has an energy content of 34.6 MJ/L, compared with 38.6 MJ/L for conventional diesel. When blended to create a B20 blend, the resultant energy density penalty of B20 was calculated to be in the order of 2%.

A secondary objective of the trial was to assess the economic, operational and emissions performance of B20 (tallow-derived) for linehaul operations, relative to conventional diesel fuel.

## 3 METHODOLOGY

### DATA COLLECTION

This trial sought to conduct an in-field assessment of a B20 blend of biodiesel (tallow-derived) in eight linehaul vehicles operating in regional Victoria and New South Wales.

The vehicles were initially operated on conventional diesel fuel (123 days in total) in order to derive a fuel consumption baseline for comparison purposes. B20 was then substituted in the same set of vehicles and fuel consumption data was collected (324 days in total).

During the trial period, data loggers were used to collate drive cycle data on the vehicle drive cycles to ensure validity of the before and after comparison. The data collected by the loggers included:

- **FUEL CONSUMPTION:** total fuel consumed in a daily period.
- **FUEL ECONOMY:** daily fuel economy (km/L).
- **DISTANCE:** kilometres travelled.
- **IDLE TIME:** time spent at idle.
- **ENGINE LOAD:** percentage of time spent at a given engine load.

- **AVERAGE SPEED:** average speed (km/h).
- **STOPS:** number of stops per kilometre travelled.

### DATA ANALYSIS

Key descriptors considered in this analysis included average vehicle speed, drive fuel economy and engine load. The data was used to compare the operating characteristics of the vehicle under conventional diesel operation with B20 operation to ensure that the comparison was valid. Any fuel consumption data collected during periods where significant variation in vehicle driving characteristics was observed was excluded from the analysis. The diesel baseline figures were then compared with the B20 biodiesel figures (Section 4).

Comparison of vehicle operation was made by considering two duty cycle descriptors: engine load and average vehicle speed. Engine load is a measure of how hard the engine is working and is affected by factors such as operating speed, acceleration rates, vehicle payload, transmission design, weather conditions and driver behaviour.

Comparison of the engine load profiles for the diesel and B20 operation is presented in Figure 1. These results show good correlation between the operation of the vehicles on diesel and B20, suggesting that direct comparison of the fuel consumption figures derived in the trial is valid.

Average speed was used as a further check of the validity of the fuel consumption comparison. As shown in Figure 2, comparison of the speed profiles for both diesel and B20 operation are closely matched. Analysis of both duty cycle descriptors revealed that the direct comparison of the fuel consumption figures derived under the trial is valid.

## 4 RESULTS

Comparison of the fuel efficiency figures (Figure 3) revealed a significant level of variation in comparative results, with the fuel efficiency associated with B20 operation varying from 5% higher, to 35% lower. Of the eight trucks monitored under the trial, three demonstrated a B20 fuel economy benefit, two showed similar fuel economy to that of diesel, and three revealed a higher fuel consumption with B20 operation.

Statistically, the average variation in fuel economy was a 5.1% benefit under biodiesel operation, but a median benefit of 1.6%.

Further analysis revealed that a major source of the variation appeared to be a high variation in the data derived from one of the trial vehicles (i.e. Vehicle 4 in Figure 3). Exclusion of this vehicle revealed that the fuel efficiency difference between B20 and diesel operation was less than 0.5%.

## 5 CONCLUSION

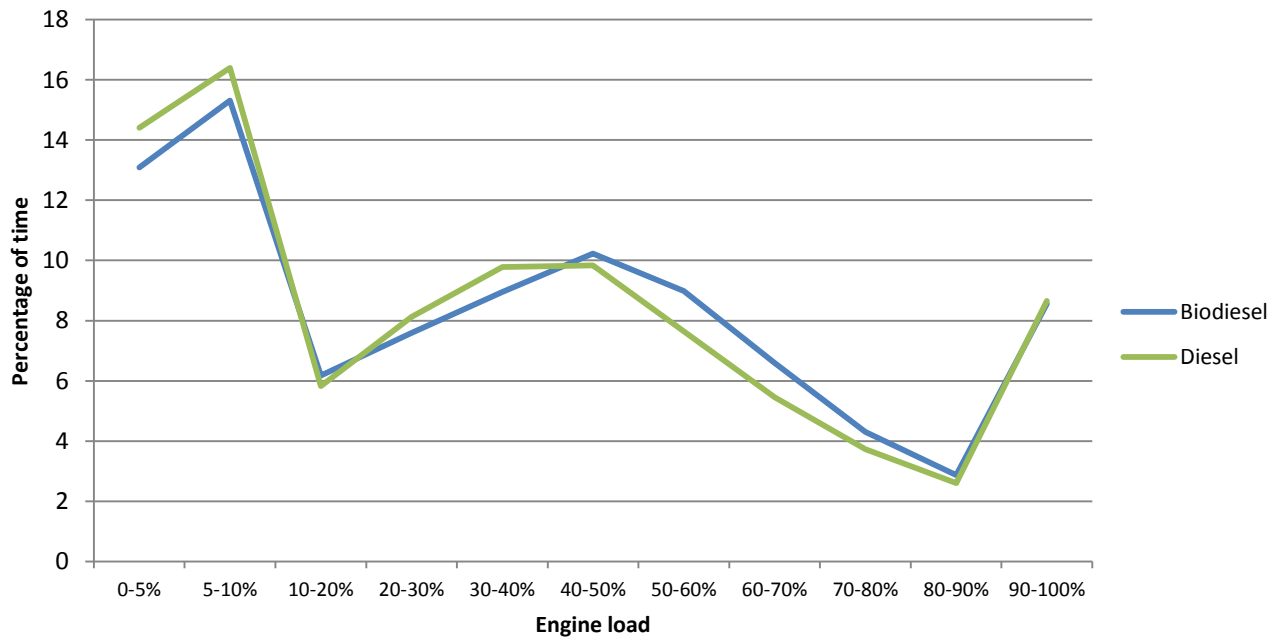
There appears to be no consistent correlation between fuel type and fuel efficiency. Although there has historically been some concern that the reduced energy content of biodiesel blended fuels results in a fuel efficiency penalty, this has not been supported by the results of this trial.

Given that international and Australian carbon accounting protocols consider biofuels to burn with near zero tailpipe emissions (3.4 kg CO<sub>2</sub>-e/GJ versus 69.9 kg CO<sub>2</sub>-e/GJ for conventional diesel), a vehicle running on a B20 blend of biodiesel can be expected to achieve a GHG emissions reduction of close to 20% at the tailpipe.

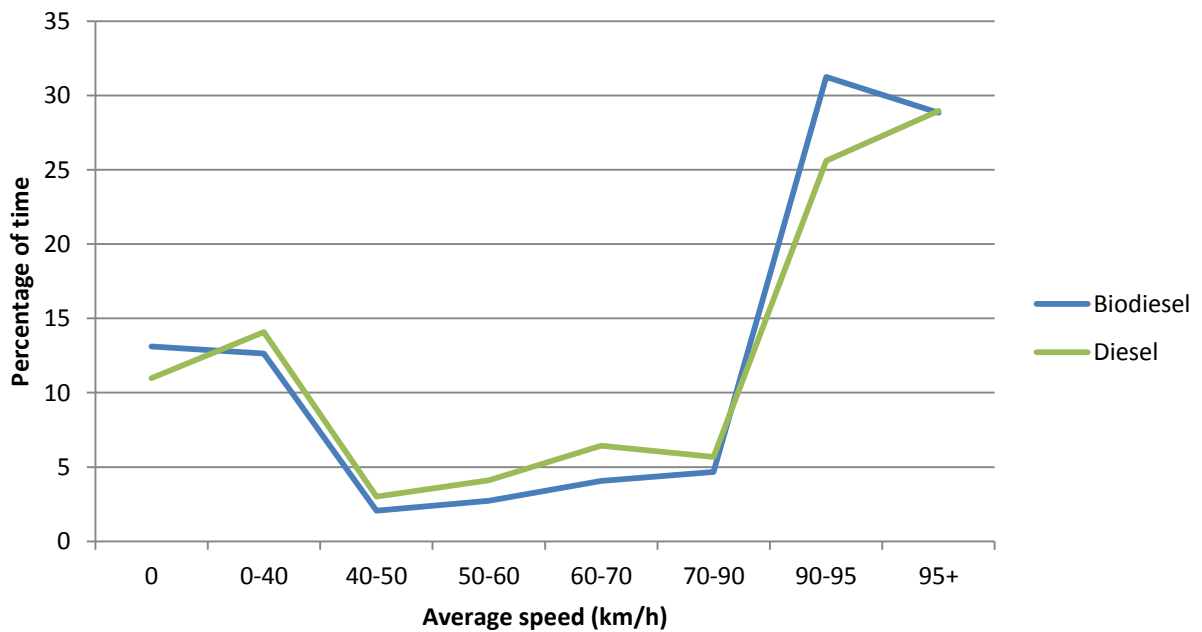
It should be noted that while the trial indicates the opportunity for significant GHG emissions benefit when considered on a tailpipe basis, the life cycle emissions of the assessed fuels were not considered or compared. As a consequence, consideration should be given to the life cycle emissions of biofuels if the fuel is to be adopted as a means of delivering GHG reductions compared with conventional diesel operation.

A number of biofuel feedstocks have attracted considerable negative attention due to their impacts on water, land use, food supply and potential upstream emissions. It is therefore recommended that the source of biodiesel is also carefully considered before implementing biodiesel within a fleet. When possible, consideration should be given to the feedstock in light of the sustainability protocol being developed by the Biodiesel Association of Australia (in partnership with international authorities).

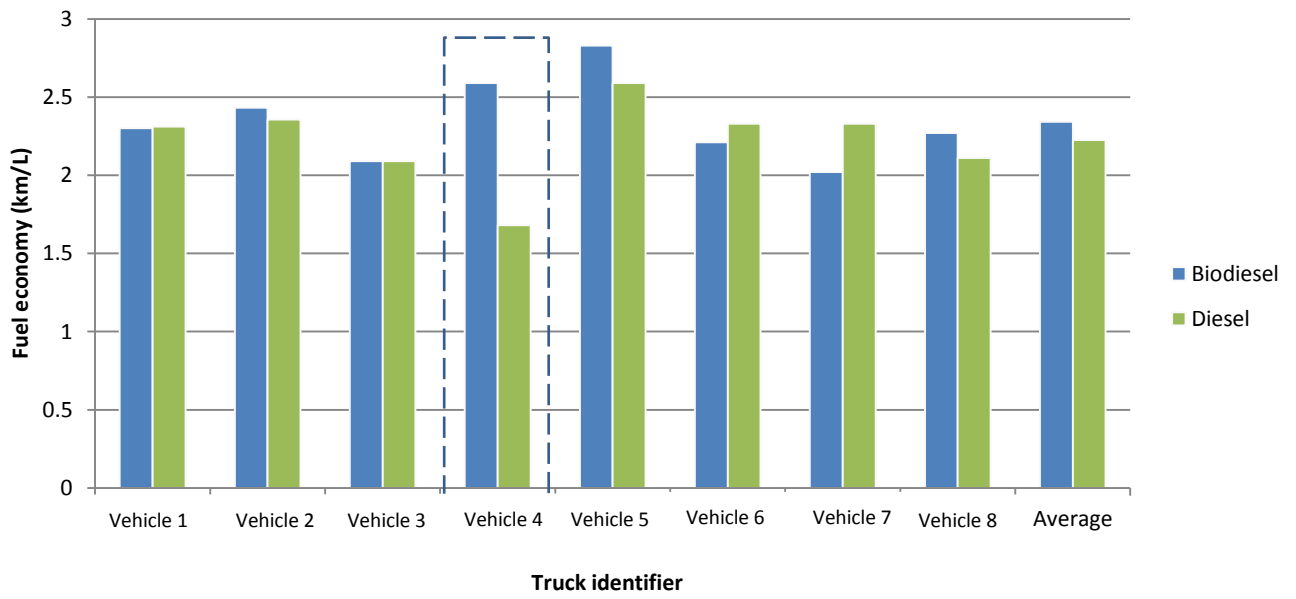
**Figure 1**  
Comparison of vehicle engine load  
across baseline and trial periods




**Figure 2**  
Comparison of vehicle average speed  
across baseline and trial periods



**Figure 3**  
**Diesel and B20 fuel efficiency results**



 outlying performance