Australian Government
Department of Resources Energy and Tourism

Energy Efficiency Opportunities

Energy Efficiency Assessment ***Case Study***

BUNKER FREIGHT LINES

Bunker Freight Lines agreed to participate as a trial company in the Australian Government's Energy Efficiency Opportunities program in 2006. The company has been aware of energy management issues for over a decade and has been involved in the Australian Government's Greenhouse Challenge program since 1998. However, Bunker believes that the Energy Efficiency Opportunities program has helped them take energy management to another level by encouraging the company to implement more rigorous energy data collection, analysis and management systems. This is driving improvements in fuel efficiency through new technologies and innovations in fleet maintenance which have the potential to generate significant cost savings.

"The trial has been great. Its made us think about things we haven't thought of before. We all get a bit comfortable that we are doing things the right way, but when someone challenges you, you start thinking in a different way ... we've only touched the tip of the iceberg. Greenhouse Challenge took us one step; now the Energy Efficiency Opportunities program has moved us another step along the road of greater energy efficiency. It has made us think more laterally about how, when and where we use energy and about measuring it more effectively and accurately".

Val Gomez, National Workshop Manager, Bunker Freight Lines

The company saw the trial as an opportunity to look for further opportunities to improve energy use and for the business to share their experiences with others in the industry. This case study describes the assessment process and some of the projects which are being implemented or investigated.

BUSINESS BENEFITS ACHIEVED SO FAR

Bunker conducted an assessment of its prime movers and identified 32 energy efficiency opportunities which have a payback of 4 years or better. Eight of these opportunities have been investigated and collectively offer the potential to:

- **deliver potential savings of at least $4,415,000 for a one-off investment of $2,586,000 - a simple payback of 7 months;**
- **reduce fuel consumption by at least 12%;**
- **reduce greenhouse gas emissions by at least 13% or 9,800 tonnes of CO_2 equivalent per year; and**
- **improve the company's capacity to analyse what influences fuel consumption and quantify the potential savings of energy efficiency opportunities through an improved data collection system.**

In addition, these opportunities will generate non-energy benefits such as:

- **reduced consumption of lubricating oil from the use of LPG-assisted fuel, generating less oil waste and saving labour and oil costs; and**
- **improved tyre longevity from the use of nitrogen-filled tyres.**

About the company

Bunker Freight Lines is privately owned and the largest sub-contract trucking company in Australia. It hauls trailers loaded by national freight forwarders. The company is based in Melbourne and also operates depots in Sydney, Adelaide, Brisbane and Perth. It has a workforce of 305, including 225 drivers. Its 127 prime movers travel around 38.6 million kilometres per year. Since 1998, Bunker has continuously increased the proportion of its freight carried by B-Doubles and road trains.

Energy use at Bunker Freight Lines

Fuel is Bunker's highest operating cost followed by wages and tyres. Each year its trucks consume approximately 22 million litres of diesel fuel and generate 72,862 tonnes of carbon dioxide. Diesel fuel accounts for 99.6% of the company's total energy consumption of 0.78 PJ/year and around 30% of operating costs. Fuel efficiency is therefore the largest single opportunity for the company to reduce operating costs and so increase competitiveness.

The assessment process

Corporate leadership

Bunker is a leader in the transport sector and has pursued innovation in partnership with its major suppliers who manufacture prime movers, engines, trailers, tyres and fuel. This innovation has included:

- working closely with Detroit Diesel on the introduction of electronic engines within Australia;
- testing with major oil companies the introduction of new oil blends;
- piloting aerodynamic kits such as air tabs and trailer skirts;
- comprehensive testing of new fuel saving devices;
- testing and introducing new improved standards of trailer wiring loom configurations with Australian manufacturers;
- making overall internal improvements in safety, maintenance and operations; and
- developing and implementing a vehicle tracking system to manage fleet logistics and overall diesel fuel consumption.

The project team

To ensure the effectiveness of the trial assessment the management team appointed Val Gomez, National Workshop Manager as their energy champion and also provided a full time assistant to assist with the management and implementation of future energy efficiency projects and programs. The trial was managed by Val Gomez and undertaken with the support of Energy Efficiency Opportunities staff and an external energy consultant.

Data collection

Bunker records energy use data to track and manage fuel consumption, costs and greenhouse gas emissions. 'Trip sheets' are used to record details of the driver, all refuelling on the trip, odometer readings at the start and finish of the trip, and details of the trailers attached. Refuelling data is also captured from RFID (radio frequency identification) tags for depot refuelling and from fuel supplier data files for 'on the road' purchases. This data is fed into the vehicle fuel database, allowing calculation of each vehicle's total distance, total fuel use, cost, and average fuel economy. A management report for all vehicles is produced monthly and on an annual basis to manage and report on fleet fuel economy.

In preparation for the opportunities workshop (outlined below), a background paper was prepared by the consultant to provide an overview of current energy use and applications. The purpose of the background paper was:

- to make information and viewpoints from a range of people available to all the participants in the workshop;
- to present and understand data on benchmarking (energy use per unit of production), energy consumption, the cost of energy to the business and overall operating efficiency;
- to provide energy perspectives on performance data beyond the usual analysis conducted with the existing vehicle tracking system; and
- to provide a preliminary list of 39 potential energy saving ideas to kick-start discussion at the workshop.

A typical example of a B-Double vehicle. These vehicles are monitored to optimise truck performance and minimise fuel consumption.

The data analysed in the background paper included:

- trends in average fuel economy for the entire fleet and for each truck and trailer combination, i.e. trucks, single trailers, B-Doubles and road trains **(Figure 1)**; and
- the 'transport task' (million pallets carried multiplied by the number of kilometres travelled) over time and in relation to fuel consumption.

The background paper also asked a number of questions to tease out further information and to gain a better understanding of the data collected by Bunker. Some of these questions included:

- what is the transport task (pallets/km)?
- how is data collected now?
- how is the data collated?
- how is the data reported, analysed and used?
- does the analysis of the data give an accurate picture?

- does the analysis tell the whole story about where energy is used?
- does the company have enough accurate, timely, relevant data to manage energy consumption, costs and efficiency?

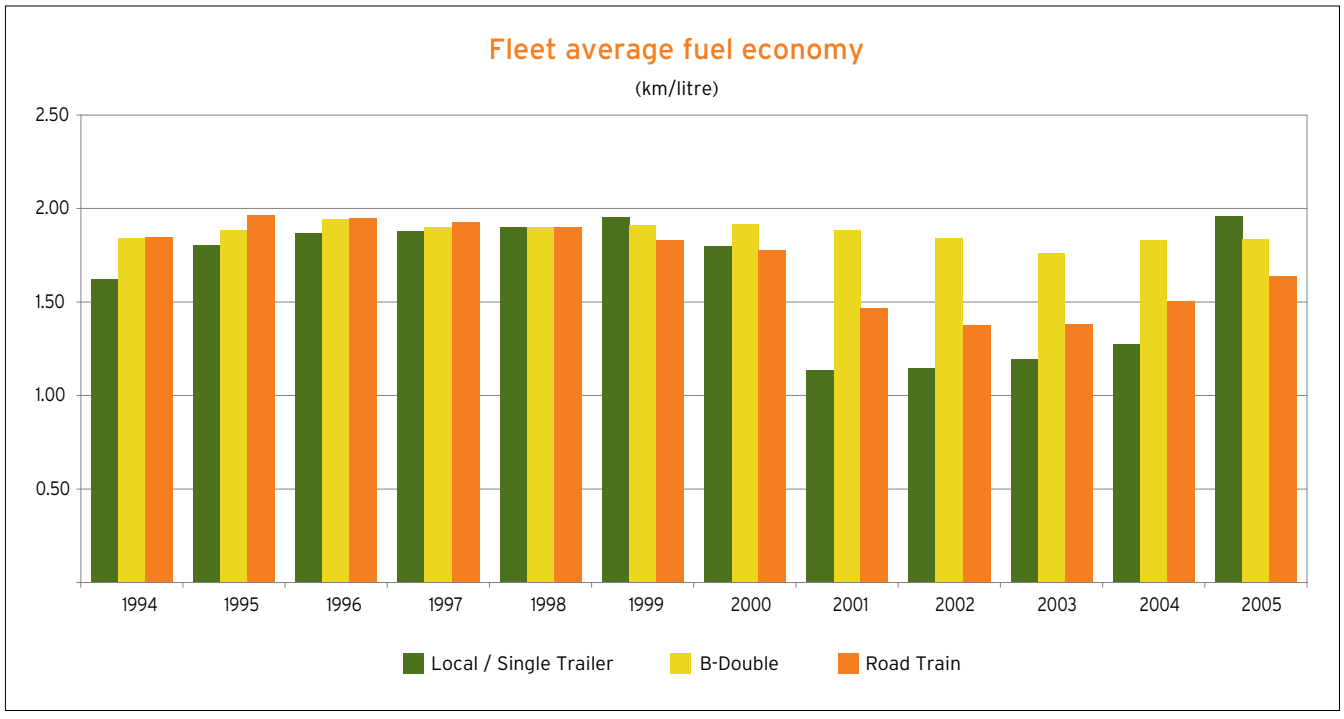
These questions helped to shift the thinking at Bunker about how data was collected and analysed, and how a better system could support business improvement processes.

Opportunities identification workshop

A professionally facilitated workshop was held at Bunker on 15 November 2006 with representatives from senior management, operations and administration at Bunker, the Australian Trucking Association and Department of Resources, Energy and Tourism staff. The aim was to review the energy use data in the background paper and to brainstorm ideas for energy saving initiatives.

The data presented at the workshop created a lively discussion about Bunker's current data collection and analysis process, its adequacy, and how meaningful the 'km/litre' measurement was. The analysis highlighted the fact that apparent fuel economy had declined in recent years.

Figure 1



Source: Bunker Freight Lines' vehicle fuel database

Figure 1 shows Bunker Freight Lines' average fuel economy for its Single Trailer, B-Double and Road Train vehicle configurations from 1994 to 2005. The figure shows that there was a reduction in fuel economy, especially for road trains and local / single trailers in the years 2001 through to the end of 2004.

This issue was discussed at length at the workshop in an attempt to identify causes and potential solutions. During this period, Bunker purchased a triple road train business which operated from Adelaide to Darwin. The purchased fleet was a

mixture of mainly older vehicles of various makes and engine configurations which had historically been managed as a small family business. It was identified that there was a lack of effective maintenance schedules and procedures. Through the analysis, it was confirmed that the fuel economy of these vehicles was at best '1 litre of fuel per kilometre travelled' and at worst '0.7 of a litre of fuel per kilometre travelled'. Integration of these vehicles into the Bunker Freight Lines fleet accounted for the majority of the reduction in fuel efficiency for road trains within the period identified in Figure 1.

It was noted during the workshop that B-Triple and road trains have restrictions on where they are able to operate. These restrictions make it necessary to operate smaller single trailer vehicles to deliver freight into cities. For example, if Bunker wants to move freight from Perth to Sydney via a B-Triple or road train, the road train would need to stop at Dubbo and single trailers would need to take the load into Sydney. These additional movements had a major impact on the overall efficiency of the local / single trailers as demonstrated in Figure 1.

The data also raised other questions about:

- the impact of Euro II and Euro III engines which reduce engine emissions but also reduce fuel efficiency;
- the relative performance of different tractor-trailer configurations;
- the unexplained variation in fuel economy between vehicles;
- how Bunker could improve its existing systems; and,
- the way the company measures vehicle performance to gain a better understanding and identify further efficiency benefits and opportunities.

During the workshop the preliminary list of energy efficiency ideas was expanded and refined to a total of 51. A priority number between '1' and '10' was allocated to each one, with '10' allocated to the highest priority ideas. Also, in response to the discussion held during the workshop, it was identified that a plan to improve fuel efficiency needed to be developed and implemented. This plan included:

- identifying and analysing key issues when implementing a truck replacement program such as fuel efficiency, cost of maintenance, and environmental impact;
- setting all existing trucks to manufacturer recommendations including adjusting horsepower and fuel flow;
- servicing all vehicles to company fleet specification and requirements; and
- replacing over time the most inefficient fleet with new fleet.

Detailed investigation

Following the workshop, preliminary investigation was undertaken for those ideas which were allocated a priority of 5 (out of 10) or higher.

Of the 51 ideas which were identified during the assessment process, 19 had payback periods clearly in excess of 4 years. Of the remaining 32 projects,

the following six projects were fully investigated during the course of the trial, considered to be viable and will be implemented:

- servicing and replacement of road trains;
- improved data collection and monitoring;
- recapping tyres;
- intelligent motor controls for air conditioning units in offices;
- lighting control systems in workshops; and
- smart power controllers for lighting and air conditioning in offices.

Another two opportunities – nitrogen-filled tyres and LPG-assisted diesel fuel – are currently being trialled and will also be implemented if the trials are successful. A summary is provided in **Table 1**, and further information on some of the projects is provided below.

Table 1: Summary of projects identified and evaluated

Total number of energy efficiency ideas which were identified	51
Ideas with payback periods clearly in excess of 4 years	19
Energy efficiency opportunities (payback period of 4 years or better):	32
• Investigations completed and will be implemented	6
• Trials underway and likely to be implemented	2
• Still to be investigated	24

Opportunities identified and investigated

Servicing and replacement of road trains

The initial data analysis identified significant efficiency problems with the purchased road trains for the Adelaide to Darwin route. This data was used to design a fleet replacement program. Whilst still maintaining operation of the fleet, the challenge was to introduce a plan to systematically investigate each vehicle's performance and implement a replacement program which would start with the worst performing vehicle. Key issues when designing and implementing this replacement program were fuel efficiency, cost of maintenance, the number of break downs and environmental impact of each individual vehicle. A plan was developed to:

- revise and set all existing trucks to manufacturer recommendations including adjusting horsepower and fuel flow to improve efficiency and reduce exhaust stack particulates and emissions;

- tune and service all vehicles to company fleet specifications and requirements to improve efficiency; and
- replace the most inefficient fleet with new fleet to increase fuel efficiency to 1.25 kilometres per litre.

This is an example of a new B-Triple road train that Bunker has purchased as part of the vehicle replacement program.

Improved data collection and monitoring

It became apparent throughout the trial that Bunker had very good systems in place for tracking vehicle location, reconciling vehicle fuelling records and monitoring average fuel consumption of each prime mover. However, evaluation of these systems resulted in identification of a number of opportunities for further improvement of data systems. The company already had a telematic system which reported on truck movements, fuel economy and engine vital statistics but data was only collected on a monthly basis and did not provide information on variables that impact on fuel economy.

As a result of the assessment and the questions raised, this system was modified to provide real time data and more frequent analysis. Currently 70% of the fleet are being monitored with the remaining 30% to be monitored in 2008. This additional capability will allow engine fuel economy to be reported back to base via GPS communication through the European Standard communication wiring link - SAE J1939 lines. This system will highlight when a vehicle's fuel consumption gets below a predetermined level and will allow variables that impact on fuel consumption (drivers, tractor-trailer models and configurations, transport routes and mass) to be monitored. If a vehicle's performance dips below its performance level, an alert is sent through to the workshop and the vehicle is checked to analyse the cause of fuel consumption variation.

This improved system will allow Bunker to:

- quickly rectify the causes of fuel consumption variation through preventative maintenance;
- further understand the variables that impact on fuel economy and their significance;
- accurately identify and evaluate future energy efficiency opportunities; and
- undertake more frequent real time energy analysis of data.

LPG-assisted diesel fuel

LPG-assisted diesel fuel combustion increases the efficiency of combusting diesel fuel by changing the flame propagation characteristics. Total energy consumption is lower than an equivalent engine operating on 100% diesel fuel.

A trial of LPG-assisted diesel fuel in two trucks is underway at Bunker to test the impact on fuel economy, reliability and safety. The trial is running between Melbourne and Adelaide as this route was identified as the best option for recovering the trucks if they break down. If the trials prove successful, then eventually all of the east coast runs will be on LPG-assisted fuel. The trial required modifications to the trucks and installation of refuelling facilities at the Melbourne and Adelaide depots.

This is a photo of one of the new LPG refuelling stations that has been installed as part of the LPG-assisted diesel fuel trial.

The first truck was converted in Melbourne in early October 2007 at a cost of $18,000. The cost of implementing this change across the entire fleet has been estimated to be $2,586,000 (modification of 127 prime movers and refuelling facilities at 6 depots). The annual cost savings would be around $2.8 million per

year, giving a payback of 11 months. Another benefit from the initiative is that the oil will be a lot cleaner so fewer oil changes will be required, resulting in less oil consumption and less waste. The benefits are summarised in **Table 2**.

Table 2: Benefits of LPG-assisted fuel

Approx. annual fuel savings	Approx. annual fuel savings	Approx. annual fuel cost savings	Payback	Approx. annual CO_2 emissions savings
97,000 GJ	12%	$2.8M	11 months	9,484 tonnes

Tyre capping

Bunker undertook research with Bandag tyre management group to investigate the potential benefits and outcomes of capping trailer tyres twice, thus delaying the need to purchase new tyres. This saves both cost and the 'embodied energy' used in tyres. The current practice is to cap tyres only once. Recapped tyres achieve similar mileage to new tyres (300,000km), and sometimes achieve better mileage.

The benefits include:

- cost – a new drive tyre costs $600 and recapping costs $200, a saving of 67%;
- embodied energy – 83 litres of crude oil are required to produce a new tyre but only 26 for a recapped tyre, a saving of around 69%. There are also savings in greenhouse gas emissions from the manufacturing process as less energy is needed to develop a recapped tyre; and
- less waste – the life of a tyre is extended by recapping it a second time rather than throwing it away and replacing it with a brand new tyre. This will reduce the amount of tyres going to landfill.

Caps can only be used for drive tyres; not steer tyres. The plan is to switch three-quarters of all tyres to caps, with new tyres only used for road trains and steer tyres. **Table 3** summarises the whole of business benefits of this process.

Table 3: Benefits of tyre capping

Approx. annual cost savings	Approx. annual reduction in crude oil (life cycle analysis)	Payback	Approx. annual reduction in CO_2 emissions (life cycle analysis)
$1,000,000	141,000L or 4960 GJ	Instant	362 tonnes

Nitrogen-filled tyres

Bunker Freight Lines in conjunction with Bridgestone is currently running a pilot using nitrogen-filled tyres. Two trailers are using the nitrogen-filled tyres on the run to Perth and these will be tested for fuel economy, longevity and shoulder-wear. Early indications from the pilot show that this opportunity has the potential to be the cheapest solution for improving both fuel economy and tyre longevity.

The aim of tyre management is to prevent the tyre from getting out of shape. This is largely achieved by keeping the tyre pressure at an optimal level. Excess tyre pressure causes tyres to rupture on varying road surfaces and can cause driver discomfort, while low tyre pressure causes tyres to deform with each wheel rotation, resulting in heat build up and an increase in the energy required to drive a truck. The pilot study is showing that nitrogen-filled tyres are likely to:

- reduce heat build up in the tyre resulting in less tyre failure; and
- lower the propensity to leak which minimises tyre pressure losses.

Bunker is also investigating and testing a new hand-held measurement device which would allow mechanics and maintenance staff to measure at a distance the air pressure as well as temperature of a tyre without the need to physically connect to the compressed air system. This will allow the company to more easily maintain tyres at the right pressure, to reduce compressed air energy use and to create efficiencies in the amount of time taken by staff to test tyre pressure.

Other opportunities

Of the 24 opportunities still to be investigated, the following are planned to be investigated in the near future:

- energy efficient tyres, based on new manufacturer technology, specifications and testing;
- use of hydrogen gas as an alternative fuel source/additive;
- increasing management awareness of the benefits of energy efficiency, making it more visible internally;
- reducing empty runs of the fleet to improve fuel efficiency and productivity;
- introducing new technologies such as high efficiency alternators; and
- enhanced driver training – initial studies are claiming a 20% energy efficiency improvement.

In the medium to long term, the opportunities worthy of future investigation include:

- the use of hybrid vehicles;
- the development of a new generation truck with trailer side skirts, more aerodynamic tractors, lighter weight tag axles and auxiliary power units; and
- the application of new technologies such as new generation engines.

Lessons learned

Potential energy savings

Despite having excellent existing data performance systems in place, the trial demonstrated that there are numerous opportunities to further improve energy efficiency. Many of these may only improve efficiency individually by around 1-2%, but collectively they can have a significant impact delivering fuel savings in excess of 12%.

New Volvo fleet arrive at the Bunker Freight Lines Head Office workshop as part of the program of introducing newer and more efficient fleet to assist Bunker meet identified energy savings targets.

Understanding energy is the key

Enhanced data collection and analysis have been crucial to the identification of energy efficiency opportunities. Bunker aims to have a fully automated live system which will report to a central monitoring facility when fuel economy or other vital engine signs fall below a specified value. Since the development of telematic systems is still in its infancy, Bunker will continue to work with its suppliers to provide live data and monitoring of fuel consumption and vital engine statistics.

Rigorous assessment frameworks

Val Gomez credits the Energy Efficiency Opportunities framework with providing the extra rigour needed to take energy management to the next level.

"…Energy Efficiency Opportunities has taught us, well forced us really, to not just look at greenhouse gas emissions but to our total energy use in a more holistic way. This has created a threefold effect where we have continued to reduce emissions and energy consumption and also saved money in the process. The Department and its consultant were vital in providing the stimulation and motivation to further challenge our thinking and push us to another level of consciousness on energy savings.

The Energy Efficiency Opportunities program is much more stringent than Greenhouse Challenge in its requirements for data collection, so we quickly realised that we needed to improve our systems to ensure that we were capable of meeting the required accuracy and reporting levels. Historically data gathering was done purely for reporting purposes and mostly for fuel usage, with little thought given to other energy uses and the connection to overall business impacts.

So the focus has switched and the introduction of new technologies and tracking systems now allows us to better measure our energy use and has created greater awareness and effort in improving efficiencies. In return it has generated benefits such as reduced greenhouse gas emissions and overall costs to the business. This was seen as an opportunity to gain some real value and create further benefits for the business in better measurement techniques to allow for additional efficiency gains.

Management has provided me with additional support as I now have a person helping me in data gathering and measurement and we are already making plans to raise the level of awareness throughout the company on energy use.

The Energy Efficiency Opportunities program has helped in making me more aware of 'energy savings' as a strategy for emissions reduction, and also empowered me to be able to obtain more assistance from management for this role, thus obtaining better data by which to make quicker adjustments and efficiency gains".

Val Gomez, National Workshop Manager, Bunker Freight Lines

Next steps

Bunker is continuing to support the implementation of the Energy Efficiency Opportunities program and further develop its ability to identify and implement efficiency opportunities that make good business sense. Further investigation continues on the remaining 24 opportunities that were identified in the Energy Efficiency Opportunities program workshops and trial process.

The Department of Resources, Energy and Tourism thanks Bunker Freight Lines for its involvement in the trial to test and develop aspects of the Energy Efficiency Opportunities program, and for sharing its results and the lessons learned. Readers should be aware that this case study is based on a trial assessment and may not represent a complete assessment as required by legislation.

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