Western Australian Rock Lobster Biofuel Study

A study completed by the Kondinin Group for the Western Rock Lobster Council and the Fisheries Research and Development Corporation

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KONDININ GROUP

Australian Government
Fisheries Research and Development Corporation

Courtesy of Australian Renewable Fuels (ARF)

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For their kind contribution of photographs, images and diagrams, Western Rock Lobster Council, Michael Poole, West Australian Fishing Industry Council and FRDC are also acknowledged.

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Disclaimer

To members of the Rock Lobster industry

In 2007, in response to increasing fuel prices the industry representatives requested that the Western Rock Lobster Council investigate the use of biodiesel in the rock lobster industry.

The WRLC commissioned the national independent farming group the Kondinin Group to investigate the feasibility of using biodiesel in the lobster industry. Kondinin Group was selected as it undertakes similar research on behalf of its members on a wide range of topics.

With financial support from FRDC, this project has now been completed. This report provides a thorough and comprehensive review of all aspects of the use of biodiesel in our industry, presented in a very clear and simple format.

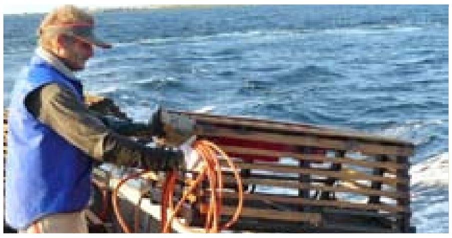
I commend this report to you for your consideration

Yours sincerely

Dexter Davies

Dexter Davies
Executive Chairman
WRLC



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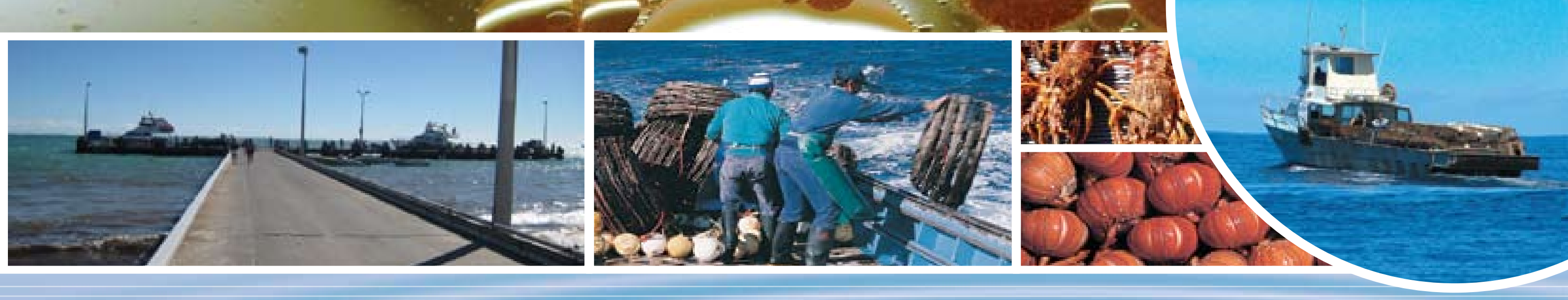

Acronyms and abbreviations

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
AGO	Australian Greenhouse Office
AOF	Australian Oilseeds Federation
ARF	Australian Renewable Fuels
Biodiesel	Diesel of recent animal or vegetable origin
B5	Blend of five per cent diesel in petroleum diesel
B10	Blend of 10% diesel in petroleum diesel
B20	Blend of 20% diesel in petroleum diesel
B100	100% biodiesel
CBH	Cooperative Bulk Handling Ltd
CO	Carbon monoxide
CO_2	Carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFWA	Department of Agriculture and Food Western Australia
Diesel	Diesel of fossil/mineral/petroleum origin
E10	Blend of 10% ethanol with petrol
EPA	Enviromental Protection Authority
FRDC	Fisheries Research and Development Corporation
Gasoil 50	Diesel of Singapore origin, used as diesel benchmark for Australia
GHG	Greenhouse Gas
GMO	Genetically Modified Organism
GST	Goods and Services Tax
Ha	Hectare
HC	Hydrocarbon
ISO	International Standards Organisation
K	Potassium
L	Litre
LCA	Life Cycle Analysis
LSD	Low sulphur diesel
ML	Megalitre
MSDS	Material Safety Data Sheet
Na	Sodium
NOx	Oxides of nitrogen
NREL	National Renewable Energy Laboratory (USA)
PM	Particulate matter
TPG	Terminal Gate Price
t	Tonne
UCO	Used cooking oil
ULSD	Ultra low sulphur diesel
WA	Western Australia
WRLC	Western Rock Lobster Council

List of units

Barrel of oil ..... 159 litres or 42 US gallons

L 1000ml

KL .... One thousand litres

ML .... One million litres

Tonne .... One thousand kilograms

US Gallon .... 3.785 litres

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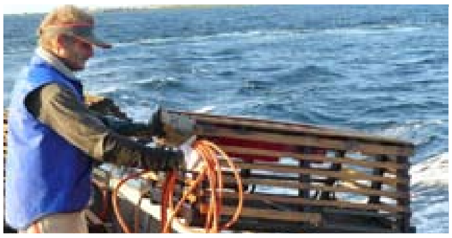


Executive Summary – Synthesis and Key Messages

- The Western Australian rock lobster fleet (490 boats) uses about 30 million litres (ML) of diesel fuel annually. Use pattern is uneven, given that the industry operates from November 15 to June 30, and there are peak demand months, usually December and March. An average boat uses about 60,000 litres (L) of fuel per year, constituting about 30 per cent of production costs. Fuel costs have been rising rapidly, causing great concern in the fleet.

- The fuel demand is spread across 22 anchorages. The fleet divides into A, B and C zones, with roughly half the boats in the northern A and B zones and half in the southern C zone. Fuel for the A (Abrolhos) zone is supplied from Geraldton by tanker boats.

- Biodiesel is used in various ratios with mineral diesel fuel. For example, B20 is 20% biodiesel: 80% diesel. At present, most biodiesel is sold as B5, B10 and B20. These levels are widely accepted around the world in road transport. Although B100 is being used, there has been some resistance to moving to that level until more experience is gained with its use. To fuel the Western Australian (WA) lobster fleet at the different ratios would require the following amounts of biodiesel: B5=1.5 ML, B10=3 ML, B20=6 ML and B100=30 ML (as outlined in the first point, above).

- Biodiesel is made by mixing a plant or animal oil source (such as canola oil or tallow) with methanol and a small amount of sodium or potassium hydroxide as a catalyst. Biodiesel and glycerol are formed in the process and separated into two streams. Glycerol is sold to offset production costs.

- Producing biodiesel from canola grown in the agricultural hinterland for the WA rock lobster fishery is technically feasible and relatively straightforward. Its success will be driven by economic rather than technical factors.

- The economics of biodiesel production depend upon three main drivers: the cost of mineral diesel; the cost at which biodiesel could be manufactured and delivered to the jetty; and the cost of feedstock used to produce it.

- The profitability of a biodiesel manufacturing operation shifts constantly as the relativities between the major drivers change. This report uses sensitivity analyses to assess the impact of the main drivers at various price levels on the viability of the operation.

- The price of diesel at rock lobster anchorages in WA is driven by the price of Singapore Gasoil 50 (diesel), which provides the basis for diesel costing in Australia on an import parity basis. The price of Gasoil 50 closely follows the Tapis crude oil price, which generates Terminal Gate Prices in Australia and changes daily. Wholesaler and retailer margins, transport costs and sometimes wharfage charges are added to the TPG, to give a jetty-side price for lobster boat owners.

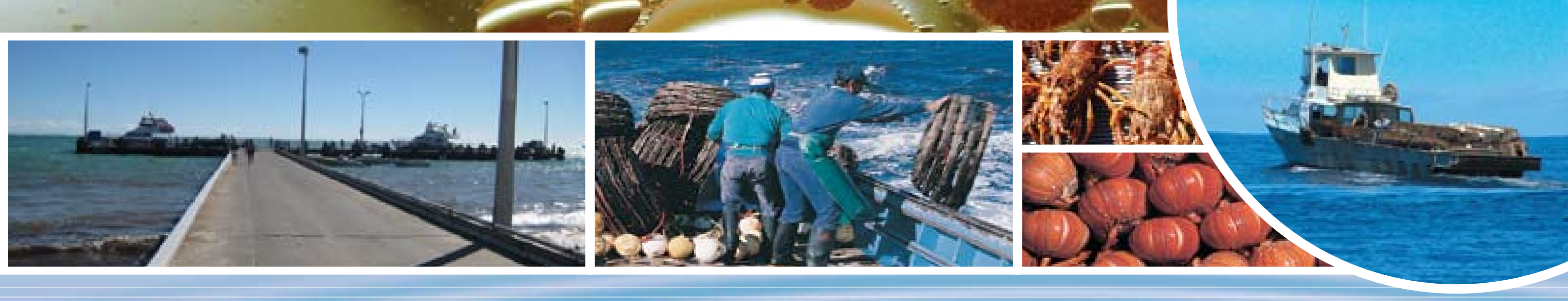
- Biodiesel can be manufactured from a range of animal and vegetable oil feedstocks. Immediately available sources, in quantity in WA, include locally-produced canola oil, tallow and imported palm oil.

- A range of other feedstocks are on the horizon. Oil-bearing tree crops are under development in WA. While showing some early promise, these are at least a decade away from being available in commercial quantities. These crops include Moringa oleifera and Pongamia pinnata. Both are of tropical/subtropical origin. Biodiesel from algae is also a possibility and WA may have comparative advantages for its production but, again, many technical and economic issues need to be addressed; and it is at least a decade away from making large commercial quantities available.

- Given the relatively small supplies of available tallow, the seed of canola crops is the main option to provide the raw material oil to go into a biofuel plant. The seed is about 42% oil and extraction is usually about 35%. Canola is well adapted and widely grown in WA. A closely-related crop, Juncea canola, is being developed that could make a contribution in the future. The animal fat tallow could make a contribution, if it is available at a competitive price, although supplies in WA are limited and mostly tied up. Palm oil imports from Asia could provide an option in some circumstances, but there are environmental concerns about its production.

- To fuel the WA rock lobster fleet with oil from canola would require (at 35% oil extraction, equivalent to 380L of oil/tonne of canola seed) about 80,000t of canola. This could be grown on 80,000 hectares (ha) at a yield of 1t/ha. The region inland from the rock lobster fishery already grows in excess of that amount.

- The price a biodiesel producer would pay for canola seed (sourced for biofuel production) from a canola farmer would depend upon the price that farmer could get at the farm gate from competitors, such as the export market (in shiploads) and local canola seed crushers (which is a relatively small industry). The price of canola moves with world demand.



- The biodiesel producer would have two purchase options: buying the canola seed and going through a two-stage process of crushing the seed to extract the oil, then converting the oil in a biodiesel production plant; or buying canola oil from a separate crushing plant, as oil ready to go into the biodiesel plant.

- Where a biodiesel producer buys seed for crushing, they would produce about 380L of oil/t of seed crushed. In addition, they would produce about 650kg of meal. The meal is a valuable source of protein for livestock and established markets already exist. The price of meal moves with time, and the price achievable to offset costs will have a significant effect on the viability of the operation.

- Production of biodiesel is a fairly straightforward process that can be carried out at scales, from 'backyard' producers meeting their own needs to a large industrial plant capable of producing sufficient fuel to meet the (30ML) needs of the entire WA rock lobster fleet. This report examines three scales of production: a single boat owner meeting the 60KL needs of one boat; a consortium of 10 boat owners coming together to supply their 600KL needs; and a large industrial plant producing 30ML fuel for the entire fleet.

- While the capital investment required for these three scales of production ranges from about $50,000 for the single operator to about $20 million for the industrial production plant, the capital cost per litre is similar, at 11 cents/L for the single operator and the 10-boat consortium, and eight c/L for the industrial plant.

- At canola seed and meal prices of $650/t and $400/t respectively, the expected cost of production for biodiesel is 138c/L for the single operator, 135c/L for the 10-boat consortium and 132c/L for the industrial plant.

- The cost of biodiesel production is sensitive to the price of canola, rising by 13c/L for each $50/t increase in the price of canola. The increase drops to about six c/L when the price of canola meal is tied to the price of canola.

- At current spot prices (first week of July, 2008) of $730/t and $500/t for canola and canola meal respectively, the estimated cost of biodiesel is 131c/L. The retail price for mineral diesel is 185c/L and, therefore, the price of diesel for fishermen (185 cents, less GST, less 38.1 cents) is 130c/L. At these prices, the production of biodiesel from canola is a competitive option for fishers.

- Biodiesel has significant environmental advantages over fossil-based diesel. It produces less net green house gases and less particulates in emissions; it is also more biodegradable and less harmful in spillage situations.

- Engine manufacturers differ in their attitudes to biodiesel. Most of the larger manufacturers endorse biodiesel at varying levels, up to B20. Acceptance of higher levels in blends, and across manufacturers, is growing as governments in some countries mandate use of biofuel in the fuel mix and the world community grows more aware of carbon-related issues.

- Biodiesel for sale must meet the Australian biodiesel standard set by government, as this is a requirement to claim excise rebates.

- The excise and tax regimes relating to biodiesel are complex and dynamic. However, lobster boat owners receive full rebate of excise as off-road primary producers and GST tax allowance as an input tax. This simplifies the comparisons between the two fuel sources in this report.

- Anyone contemplating biodiesel production will need to comply with a range of local, state and Australian government approvals and operating requirements, as biofuel production is viewed as an industrial process.

- Biodiesel production requires several input and output materials that are considered hazardous and require Material Safety Data Sheets. Although these are not unduly hazardous if handled with normal care, occupational health requirements must be met.

Conclusion

From a technical standpoint, biodiesel production to fuel the WA rock lobster fishing fleet is a viable proposition. The economic viability of such an initiative will depend upon the relative prices of several components, dominated by the prevailing mineral diesel price, the price at which the oil used to make the biodiesel enters the production system and, if the production plant is crushing canola or a similar oilseed to obtain vegetable oil, the price that can be obtained for the canola meal produced as a co-product.

Other factors of lesser impact – but which are still important given the fine margins involved – are the returns from glycerol sales, the capital cost of the plant, the cost of methanol and the cost of labour.

The production of biodiesel could operate at scales from a single boat owner through a consortia of boat owners and large industrial plants that fuel the whole industry and perhaps also other local diesel users.

Chapter 1. Introduction

Rapidly rising fuel costs are of significant concern to the WA rock lobster industry. Fuel costs have risen about 40% during the past three years (see Table 1) and now represent about 30% of operating costs for boat owners. Fuel is the next largest cost after labour. Fuel prices are expected to continue to rise and there are no nearby technologies available to replace diesel — or biodiesel — in marine engines. At the same time as the escalation in fuel costs, lobster populations have been down and fishers have had go further to meet their catch targets. Beach prices for lobsters have also declined as the US dollar has strengthened. Other costs have risen sharply, putting significant cost and return pressures on the industry.

Table 1. Retail diesel prices in WA 2000/01–2007/08

Year	cents/L
2000/01	95
2001/02	97
2002/03	90
2003/04	100
2004/05	117
2005/06	135
2006/07	142
2007/08	185

The Western Rock Lobster Council (WRLC) sought to examine various avenues to keep the industry profitable. Recognising the developments in biofuels during recent years and, given the existence of agricultural industries nearby to the lobster boat anchorages, the WRLC decided to seek an analysis of the potential of biofuels for the WA rock lobster industry.

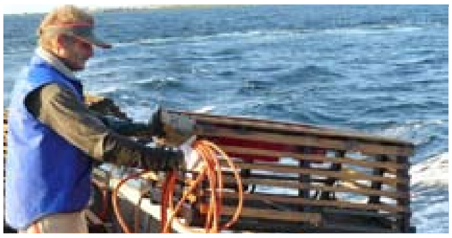
The WRLC sought the assistance of Kondinin Group, due to its status as a leader in the communication of technology changes to industry and its broad experience in analysis of rural and regionally-based industries. Subsequently, the WRLC supported an approach by Kondinin Group to seek funding from the Fisheries Research and Development Corporation (FRDC) to undertake a study of the potential for biofuels for WA's rock lobster industry.

FRDC allocated funds for a six-month project initiated in November 2007. This report is the outcome of that study. Kondinin Group became fully conversant with the industry and its fuel needs by firstly interviewing industry participants and carrying out a literature review. It then used its extensive knowledge of agriculture production systems and the rapidly-growing biofuels industry to put the potential to supply biofuels against fishery fuel demand and analyse whether a business proposition would stand up. Fuel prices, agricultural systems and farm economics are ever-changing, so sensitivity scenarios were built around the analyses to assist assessment of the viability and robustness of a biofuels industry.

Kondinin Group and the WRLC recognised that several business models needed to be investigated, ranging from single boat owners making their own biodiesel, to a consortia of several boat-owners meeting the fuel demands of the group and large regional manufacturing facilities meeting industry-wide fuel requirements. The project also examined within- and between-season supply and demand issues for fuel and raw material supplies, as they affected the viability of a biofuels business.

The principal investigators for the project were Dr William Ryan, Chief Executive Officer of Kondinin Group and Professor Michael Poole, Agriculture and Environment consultant to Kondinin Group, formerly of the Department of Food and Agriculture WA and CSIRO.



Chapter 2. Western rock lobster industry fuel needs

To gain an appreciation of the fuel demand for a biofuel industry servicing the WA rock lobster industry, it is useful to build a profile in terms of volume, seasonal demand and location. The profile information below has been drawn together from literature, industry consultation and boat owner interviews.

Litres used per boat (extracted from Bird Cameron report and other sources)

Assume:

- 140 pots per boat
- Fuel use/season is $500/pot less, $100/pot diesel rebate = $400/pot (2006 values)
- Therefore, cost of fuel per boat is $56,000
- Take fuel cost of $1.28/L, less 38c/L rebate = 90c/L
- Therefore, fuel used per boat is 62,200L/season
- Boats work 200 days each season = 311L/boat/day

Total litres used by industry

- 62,200L x 485 boats = 30.16ML
- This is used during season of Nov 15 to June 30 = 7.5 months = 235 days
- Say 200 days, after allowing for the weather, moon, holidays and downtime
- Therefore, fuel use by industry per day = 150,800L/day
- Across 485 boats = 311L/day
- Spread across 22 anchorages in three zones

Biodiesel industry to produce 31.1ML

- Each tonne of canola produces 380L of biodiesel
- Each hectare produces one tonne of canola
- Therefore, 84,000t of canola is needed for B100, 25,000 tonnes for B30 and 8400t for B10
- About 450,000t of canola is produced in WA annually
- About 100,000t is produced in the Northern Agricultural Region

Number of boats and distribution by zone

The total number of boats in the fishery during 2007 was 491, down from 536 during 2005. In 2008, it is estimated at 485 boats. While boat numbers have been falling for many years, boats have been getting larger. They are carrying more pots as they are transferred from boats leaving the fishery. This trend is expected to continue.

The western rock lobster fishery is divided into three zones.

- Zone A — 128 boats duirng 2007, 136 during 2005.
  Zone A is the Abrolhos fishery, boats returning to Geraldton and other ports in the off season.
- Zone B — 111 boats during 2007, 130 during 2005.
  Zone B is north of 30 degrees S (north of Green Head).
- Zone C — 252 boats during 2007, 270 during 2005.
  Zone C is south of 30 degrees S (south of Green Head).

From a fuel supply viewpoint, the fishery divides roughly in two, with the boats in zones A and B forming a northern group of 239 boats and a southern group of 252 boats from Zone C.

Typical modern boat

- 16–18 metres
- Engine 600–1000 HP marine diesel, single or twin
- Fuel tank 2500–5000L
- Fuel use — 30–50L/hour at cruising speed of 20–24 knots
- Range is about 2000km
- 150 pots
- Refuel about twice per week, varies widely with boat and location

Lobster boat home ports

- Kalbarri
- Geraldton
- Dongara
- Leeman
- Green Head
- Jurien
- Cervantes
- Lancelin
- Ledge Point
- Seabird
- Yanchep/Two Rocks
- Fremantle
- Mandurah
- Bunbury
- Busselton
- Augusta
- Abrolhos Islands, during the season

Fuel outlets and distribution

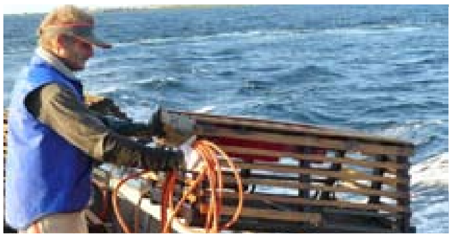
Bailey's Marine Fuels (Scott Bailey) is a major modern marine fuel distributor with facilities around Australia. Baileys is estimated to service 75–80% of the western rock lobster fishing fleet. Baileys has eight outlets at:

- Leeman — 1 x 55,000L underground tank, 1 dispenser
- Denham — 1 x 90,000L aboveground tank, 2 dispensers
- Kalbarri — 1 x 110,000L aboveground tank, 2 dispensers
- Geraldton — 3 x 55,000L aboveground tanks, 4 dispensers
- Lancelin — 1 x 55,000L aboveground tanks, 2 dispensers
- Fremantle — 3 x 55,000L aboveground tanks, 7 dispensers
- Mandurah — 1 x 90,000L aboveground tank, 3 dispensers
- Bunbury — 1 x 55,000L aboveground tank, 1 dispenser

The balance of fuel is supplied by other significant operators, such as the Two Rocks Marina and Comen Ltd/Jurien Boatlifters facilities at Jurien and Cervantes. Several smaller suppliers meet fuel needs at the minor anchorages.

The Abrolhos fishery is fuelled mainly by service boats owned by consortia of Abrolhos fishers, which ferry fuel from Geraldton. Some larger boats travel back to Geraldton to refuel.



Chapter 3. Fuel price components

To work back to a biofuel processing plant price, it is useful to set out the components that make up the price of mineral diesel at the lobster anchorage jetty. This will provide an insight into where the main cost components lie and where there is room to move. The following points outline the rationale behind different cost components and their dimensions.

- Australian fuel prices are set at import parity pricing with Singapore fuels.
- A barrel of crude oil passes through the refinery to produce the products laid out in Table 2.

Table 2. Products derived from one barrel of crude oil

Component	%
Gasoline	46.7
Diesel	28.6
Jet fuel	9.1
Petrochemicals	3.8
Coke	3.8
Asphalt	3.1
Liquefied gases	2.9
Lubricants	1.3
Kerosene	0.9
Waxes	0.1
Total	**100.00**

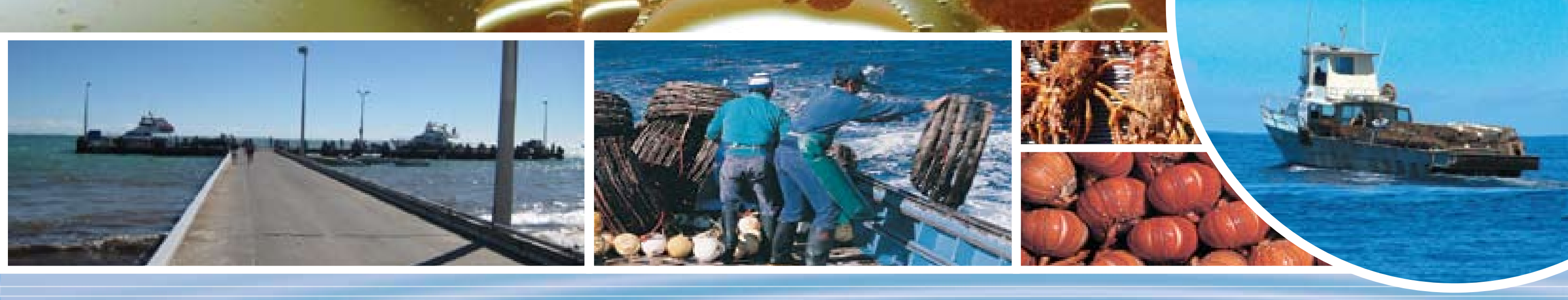
- Mineral diesel benchmarks against Singapore 'Gasoil 50 ppm Sulphur diesel'
- Australian fuels benchmark against this refined fuel, rather than the often quoted crude oil price, because: there is a time lag between crude oil purchase and refining; crude oil is fractionated into many products; and, while petrol and diesel are the main components, other products are an important part of the refinery's business. In broad terms about 50% of a barrel of crude oil goes to petrol and about 30% goes to diesel. Nonetheless, the price of crude oil and diesel usually track closely together. The relationship and a full description of how prices are struck for diesel in Australia are shown in the web link in Appendix 4.
- One barrel of oil is 159L or 42 US gallons. On that basis, crude oil at $100/barrel is worth 62.9c/L and at $150/barrel is worth 94.3c.
- The prices of crude oil and diesel in Singapore are usually about $5 apart, varying slightly with market conditions. Global perturbations such as hurricane Katrina, in 2005, can cause the two prices to separate sharply at times when nearby diesel becomes temporarily scarce. Many products of different value are refined from a barrel of oil to make up the refinery's total business.
- The components that make up the fuel price at a lobster anchorage in WA are as follows: Gasoil 50 ppm Singapore; $US to $AUD exchange rate; shipping Singapore to port terminal in WA; wholesale price ex terminal (known as the Terminal Gate Price or TGP — a key figure in fuel price determination quoted daily by major oil companies on their websites); freight to country depot; wholesale and retail margins for fuel distributors, depending on arrangements; jettyside costs, in some circumstances; and excise and GST (see Table 3). Excise is rebated in full for professional fishers and GST is claimed back as an input tax.

Table 3. Typical components of price for diesel costing 172c/L jettyside

	Costs (AUD) c/L
Gasoil 50ppm ex Singapore	104.0
Additional costs	
Shipping	2.5
Oil company margin	3.0
Freight - terminal to country depot	3.0
Wholesale / retail margin	6.0
Excise	38.1
GST	15.7
Total cost	**172.3**
Cost to lobster fishermen	
Refund of excise	38.1
Refund of the GST	15.7
Final price to lobster fishermen	**118.5**

(Note: jetty/wharfage costs of a few cents apply at some refueling sites, as do tanker boat costs for the Abrolhos boats)

- The next step, covered in the following chapters, is to work back through the production costs of biodiesel offset, by the revenue from byproducts to assess if the biodiesel production enterprise is viable. That is, it can produce biodiesel as economically, or more economically, than mineral diesel.



Chapter 4. Biodiesel industry — world, Australia and WA

What is biofuel?

Biofuel is a generic term generally used to define biodiesel and bioethanol.

Biodiesel is used either as a full replacement (B100) for mineral oil-derived diesel or in mixes (B10, B20 etc.) with mineral diesel.

Bioethanol is a replacement for petrol (E100) or a mix (E10, E20, etc.). WA rock lobster boats are universally powered by diesel engines and bioethanol will not be further covered in this report.

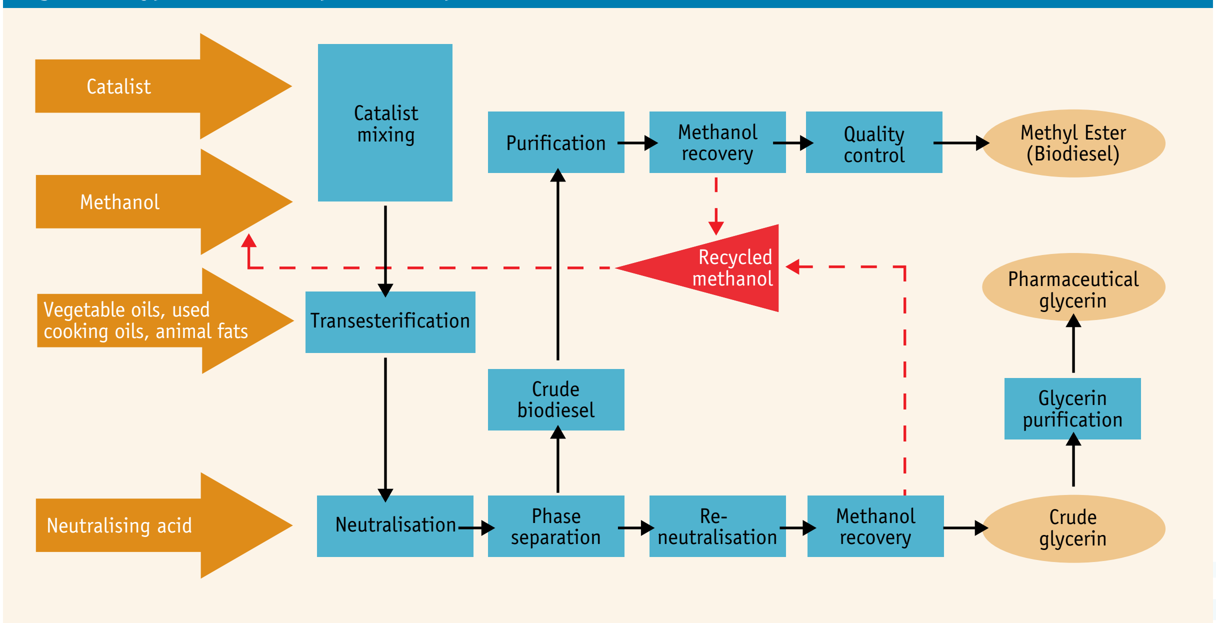
What is biodiesel?

Biodiesel, as defined in the Australian Biodiesel Fuel Standard is "a diesel fuel obtained by esterification of oil derived from plants or animals". Biodiesel refers to a non-petroleum-based diesel fuel consisting of short chain alkyl (methyl or ethyl) esters, typically made by transesterification of vegetable oils or animal fats, which can be used (alone or blended with conventional petrodiesel) in unmodified diesel-engine vehicles (source: Wikepedia). Essentially, triglyceride oils or fats consisting of a glycerol backbone and three long chain fatty acids are chemically reacted with methanol and a catalyst such as sodium hydroxide to form methyl esters (biodiesel) and glycerol.

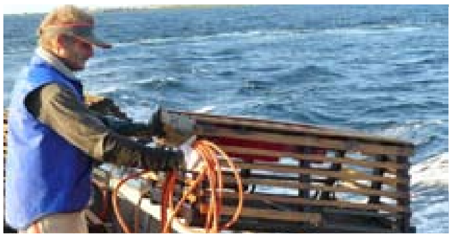
Typically, 1000L of canola oil or tallow mixed with 110L of methanol and five kilgrams of NaOH or KOH produces 1000L of biofuel and 110L of glycerol.

Biodiesel can be produced at all scales from backyard operations to large industrial plants. It is relatively simple to make but, beyond the backyard level, care must be taken during manufacture to ensure it meets government and engine manufacturer standards, to ensure government concessions on excise are triggered and that engine warranties are honoured. Figure 1 is a flow diagram from the US National Biodiesel Board website of a typical biodiesel production process.

Figure 1. Typical biodiesel production process





World

The worldwide biodiesel industry has been expanding rapidly, especially in Europe where government support schemes and mandated levels of biofuels in the fuel mix are forcing the industry into being. Table 4 shows the growth in biodiesel production capacity and actual production during recent years. It is not yet possible to gauge whether the present worldwide fuel versus food debate will slow expansion of the industry.

Table 4. World biodiesel production 2002–2008 (million tonnes)

Year	Capacity	Production
2002	2	1.5
2003	2.5	2
2004	3	2
2005	6.5	3.5
2006	12	7
2007	23	9
2008	32	11

Australia

In Australia, the industry has expanded quickly during the past five years (see Table 5, next page), although at present, due to high raw material input costs (tallow and canola oil), some owners have put plants put into care and maintenance. Most of the less expensive and readily-available raw materials, such as tallow and used cooking oil, have been taken up by existing capacity and new developments will either have to compete for these resources or utilise materials such as canola, mustard or imported palm oil. See Chapter 5 for a description of these different materials and their strengths and weaknesses.

This report primarily investigates the option of canola or mustard oils as raw material inputs, derived from crops grown in agricultural areas inland from the lobster industry and thus capitalise on freight advantages and complementarities with other industries, such as livestock production.

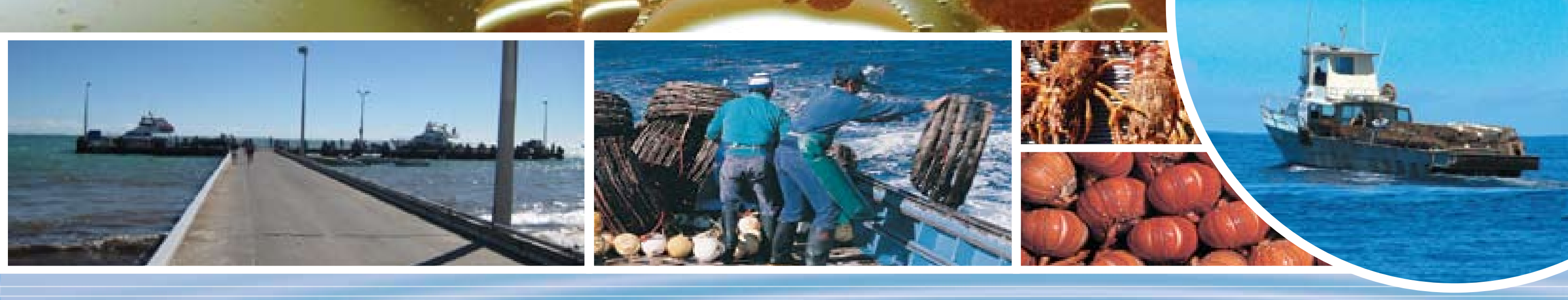
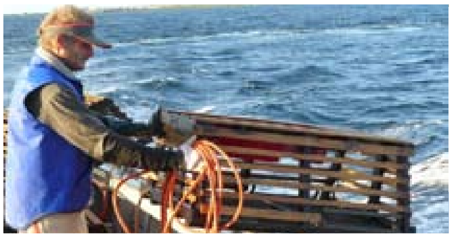


Table 5. Biodiesel production capacity in Australia

Company	Location	Feedstock(s)	Capacity	
			2007 (ML)	Planned (ML)
Queensland				
Australian Biodiesel Group	Narangba	Various	160	160
Eco Tech Biodiesel	Narangba	Tallow	30	75
Evergreen Fuels	Mossman	Used cooking oil	1	1
New South Wales				
Australian Biodiesel Group	Berkeley V.	Various	40	45
Biodiesel Industries Australia	Rutherford	UCO and other oils	12	20
Future Fuels	Moama		30	30
A J Bush	Sydney			60
Riverina Biofuels	Deniliquin			45
Biosel	Sydney			24
Natural Fuels	Port Botany			150
Victoria				
Vilo Assets	Laverton	UCO, tallow	50	50
Axiom Energy	Geelong			150
Biodiesel Producers	Barnawartha			60
Western Australia				
Australian Renewable fuels	Picton	Canola and tallow		45
South Australia				
Australian Renewable fuels	Largs Bay	Tallow		45
S.A. Farmers Federation	Gepps Cross			15
Northern Territory				
Natural Fuels Australia	Darwin	Palm oil		147
BIODIESEL TOTAL			**323**	**1122**

Note: There are a range of other second generation fuels for which new feedstocks and processes are being developed and commercialised. These are largely based on lignocllulosic feedstocks. Many of these new technologies are in demonstration phase, and not yet cost competitive although there is some indication that within 3–5 years some of these might become competitive with oil (within the oil price ranges experienced in 2005–2007).

Source: O'Connell et al 2007



Western Australia

There is currently one large, recently commissioned, biodiesel production plant at Picton, near Bunbury, WA. It is operated by Australian Renewable Fuels, an ASX listed company found at **http://www.asx.com.au/** and home page **http://www.arfuels.com.au/**. This plant, and a similar ARF plant in South Australia, were each set up to produce 44ML of biodiesel and were initially designed to use tallow as a raw material source, although they can also accept canola and palm oil. During late 2007 to early 2008, the price of tallow increased to such an extent compared with fuel prices (which were also rising rapidly, but not as fast as the raw materials used to make biofuel) that the company put the facilities into care and maintenance. At the time of writing (May 2008) the company was exploring the opportunity to restart the plant. The plant nonetheless provides a local opportunity to see the scale of operation needed to supply the lobster industry fuel needs of 30ML per year, from a single facility.

There are two other companies providing biodiesel technology and advice in WA. The first is Bioworks **(http://www.bioworks.com.au/index.shtml)**. This company specialises in small-scale production and has arrangements with overseas suppliers to source seed crushing and processing plants of suitable scale, and supply some of the inputs such as methanol and NaOH in small quantities. The other company is Bluediesel, which can be found at **http://www.bluediesel.com.au/**. An extraction from the company website (below) shows its interest in developing a new processing method for biodiesel.

Extract from Bluediesel

BlueDiesel Pty Ltd is a WA company created to meet the need to improve the production of biodiesel. Our unique technology was developed in our own biodiesel plant. The revolutionary BlueDiesel process is a high intensity reactor. This reactor produces biodiesel several times faster than conventional biodiesel production equipment.

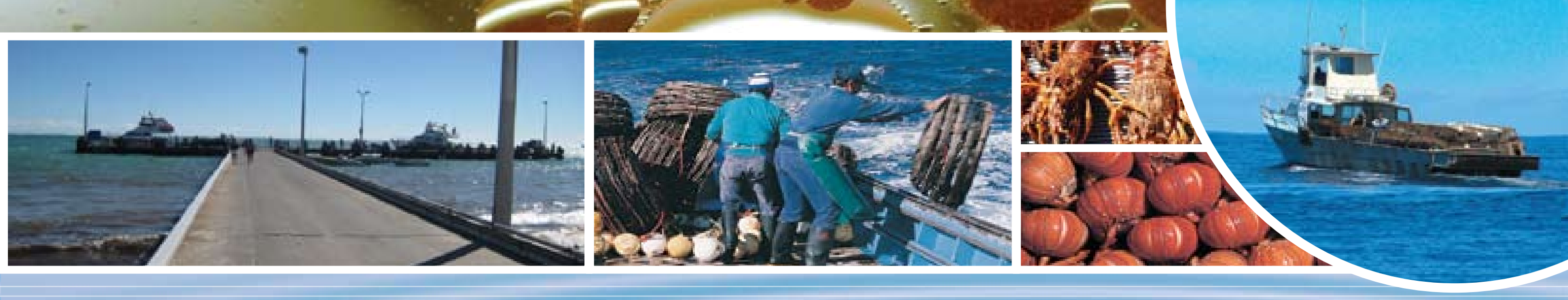
In February 2007, BlueDiesel began commercial operations in Hazelmere, WA, using tallow as the primary feedstock. The main purpose of this operation is to further prove the effectiveness of BlueDiesel technology in a commercial environment. At BlueDiesel, we have also established a marketing platform for distributors of biodiesel, potential buyers, and licensees of the company's plants and technology.

Bluediesel has a pilot plant operating successfully in Hazelmere, WA, and has been able to convert a range of vegetable oils to biodiesel.

Several other parties have shown interest in biodiesel production in WA, but appear to have slowed their efforts in response to high raw material input costs.

In addition the Department of Agriculture and Food WA (**http://www.agric.wa.gov.au/)** has been carrying out research and development work for the past three years on farm production of biodiesel from canola and mustard. It has developed a mobile demonstration biodiesel production plant, which can operate in the field. The main contact is Mr Graham Mussel.

TAFE and The University of Western Australia (UWA) both conduct 'brew your own biodiesel' short courses.



Chapter 5. Biofuel raw material — sources

A processing plant could convert a number of oil source materials to biodiesel. The configuration and settings of the plant would depend upon the source material, byproducts and waste streams produced. The sources expected to underpin an Australian biodiesel industry are as follows:

Canola

Canola, *Brassica napus*, is an annual crop of the cruciferous family which includes well-known plants such as cabbage, cauliflower and mustard. The seed of canola is harvested at maturity and contains about 42% canola oil. Technology for production of the crop on farms in Australia is well established. While it is not as easy to grow as wheat and barley, it has advantages in crop rotations as a cleaning crop for cereals and as a cash crop in its own right. Canola is expected to hold its place in Australian farming systems.

It is grown throughout WA's agricultural areas, although it performs better in medium and higher rainfall regions. Canola is adapted to the agricultural regions inland from the lobster boat anchorages between Geraldton and Perth, although at present it is best adapted in the Great Southern region. Nonetheless, the northern agricultural region can comfortably produce 100,000t of Canola seed annually in average rainfall years. This could be converted to 38ML of biodiesel, sufficient to power the entire lobster fishing fleet with 100% biodiesel.

The annual production of canola in WA fluctuates with the season and the economics of supply and demand. But, on a year in year out basis, WA produces around 450,000t of canola. Tables 6 and 7 show canola production for Australia and WA.

Most canola produced in WA is exported as grain at present, although about 55,000t is processed for vegetable oil production at the Riverland plant at Pinjarra and a small plant at Kojonup. A biodiesel processing plant could capture much of the export tonnage, if it was price competitive with export parity.

Infrastructure for harvest, transport and storage is well established and, under suitable conditions, stocks can be held in storage for more than a year.

There would be freight and handling advantages for canola growers in delivering direct into dedicated biodiesel production facilities between Perth and Geraldton. Given that the production technology for biodiesel from canola is well established across the entire chain, and is widely used around the world with off the shelf production plants available, canola is the first and most obvious choice as a substrate for biodiesel production in the midwest region.

Table 6. Canola production in Australia 2000/01–2007/08

Year	Hectares (,000)	Tonnes (,000)
2000/01	1459	1775
2001/02	1332	1756
2002/03	1298	871
2003/04	1211	1703
2004/05	1377	1542
2005/06	979	1436
2006/07	944	513
2007/08	1061	1116

Source: ABARE, ABS, AOF

Table 7. Canola production in WA 2000/01–2007/08

Year	Hectares (,000)	Tonnes (,000)
2000/01	517	353
2001/02	394	419
2002/03	349	299
2003/04	358	527
2004/05	428	488
2005/06	485	650
2006/07	400	365
2007/08	360	475

Source: ABARE, ABS, AOF

Mustard

Mustard (*Brassica juncea*) is very closely related to canola. It has been widely grown in Asia for thousands of years as a source of cooking oil and also as a heating and lamp oil. In recent years, it has received attention in Australian plant breeding programmes as an alternative vegetable oil to canola and (most recently) as a possible source of oil for manufacture of biodiesel. The first commercial variety of mustard showing canola oil-like characteristics has just been released in Australia by the Victorian Department of Primary Industries. It has been given the name Juncea canola, to distinguish it from other mustards.

Mustard has the advantages over canola of: not shedding its seed at maturity which allows easier direct harvesting; possibly being better suited to dry conditions than canola; and being more disease resistant. The WA Department of Agriculture and Food has been experimenting with mustard as a biofuel source for three years. It has yielded about the same quantity as canola in most trials but, given its other advantages, may be cheaper to grow. DAFWA has also used mustard seed in a farm-scale biodiesel pilot plant. Several DAFWA vehicles have been running quite satisfactorily on mustard-based biodiesel for a year or so.

Mustard shows considerable promise as a source of oil for biodiesel manufacture in WA, although it will be some years before commercial quantities become available. The oil is very similar to canola oil and the two should substitute for each other in a crushing plant and biorefinery without significant changeover problems.

The region inland from the Perth- Geraldton coast should be well suited to mustard production and a 'watching brief' needs to be kept on the crop as it develops. A biodiesel manufacturing plant in the region could provide a significant stimulus to the development of a mustard industry. At present, the meal from mustard is not quite as attractive as canola meal for livestock production due to the presence of small amounts of glucosinolates (the substances which impart the hot flavour to mustard). Plant breeding programmes are working to reduce glucosinolates in mustard to the very low levels found in canola.

Small quantities of mustard based biodiesel could now be sourced for trial in marine engines.

Tallow

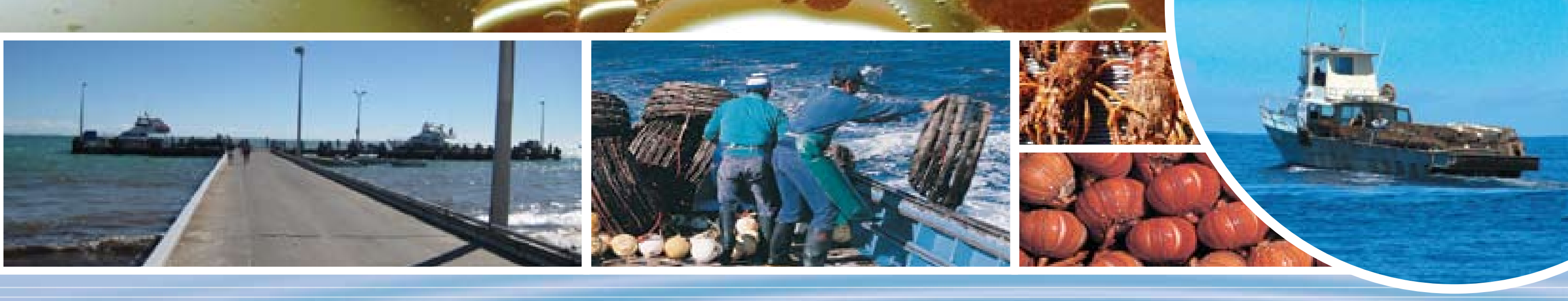
Tallow is the fat produced as a byproduct of the animal abattoir industries and is widely recognised worldwide as a source of raw material for biofuel production plants. Already in Australia, there are processing plants going into operation to produce fuel from tallow. At Picton, near Bunbury, WA, Australian Renewable Fuels has established a biorefinery using tallow as the raw material resource. It is expected that this plant will capture most of the tallow produced in WA that is not used for edible purposes and tallow renderers have been contracted to supply the plant, with additional draw from producers in the Eastern States.

The annual production of tallow in WA is about 40,000t and this is expected to grow only slowly, in line with population growth. Australian production is 600,000t. Tallow converts to biodiesel at 894L/t of tallow. The potential production of biodiesel from Western Australian tallow is then around 36ML annually, which (if it all could be secured) would be sufficient to fuel WA's rock lobster fleet.

Tallow-based biodiesel has some drawbacks as a fuel. Being derived from a saturated fat, it can 'cloud 'and solidify at low temperatures causing plugging of filters and fuel lines. Although there are technical solutions to this problem in the refinery, care needs to be taken when used in cold conditions. Another approach is to keep the amount added to fossil diesel to below five per cent. Tallow is generally seen as better suited to subtropical and tropical areas. Assessment of its value in marine applications requires careful analysis, given the cool conditions sometimes experienced in winter months in WA, and that fuel tanks in boats equate to sea water temperatures.

Used cooking oil (UCO)

The food industry produces significant quantities of used deep frying cooking oils, which are discarded after they become tainted or altered through use. Supplies of UCO are limited and will only grow slowly, in line with food industry growth. It is difficult to get reliable figures for UCO, given the dispersed and somewhat cottage industry nature of its production and collection. But Australian production is generally thought to be about 90,000t per annum. Western Australian production is likely to be around 10,000t. However, single boat owners may be able to source enough UCO to meet their own biodiesel manufacturing needs.



Palm oil

Australia does not produce palm oil at present. It is grown in substantial quantities in nearby countries such as Malaysia and Papua New Guinea and there is potential for production in the Kimberley, where analysis suggests it could grow satisfactorily. At present, its economic potential in the Kimberley is unknown and significant production would be at least fifteen years away.

Palm oil is a saturated fat and suffers from some of the problems found with tallow in that it solidifies at higher temperatures than unsaturated oils, such as canola and mustard. It is recognised as a potential substrate source for an Australian biodiesel industry. A biodiesel production facility being established in Darwin will source palm oil as its main input and it should not be discounted as a raw material source, given the proximity of supplies to WA. But it could face technical hurdles if it is to be incorporated in marine applications. It could also face opposition from environmental groups, given the negative publicity palm oil plantations have received when they replace rain forests. This report recognises these difficulties, but includes palm oil in the feasibility study because of availability, price, and WA's close proximity to Asia. It may be an option in times of shortages of local sources, such as canola or tallow.

Other sources

Many plants that produce oil in their seeds are potentially suitable for biodiesel production. Apart from canola, mustard and palm oil (mentioned above) some consideration needs to be given to soya oil, cotton seed oil, sunflower seed oil, linseed oil, safflower oil, olive oil and camelina and crambe oils. However, these are generally considered to be too expensive, or are produced in insufficient quantities to be serious contenders in WA. Eastern States biodiesel production demand, price and freight disadvantages seem to rule out soya, cotton seed, sunflower and safflower oils. Camelina and crambe would need extensive genetic and agronomic development to become serious contenders and a significant industry is not in sight.

Linseed is the only oilseed crop, apart from canola and mustard, for which suitable germplasm and agronomic systems have been developed for southern Western Australian broadacre farming systems. It was produced in significant quantities many years ago, but has fallen from favour due to the comparative success of canola, which is easier to grow and more profitable for farmers. Olive oil is too expensive and demand from the food industry is unlikely to see significant quantities become available for biodiesel production, but a mid-west-based biodiesel production industry should keep a watching brief on olive oil, given that it is produced in the region in growing quantities and, being similar to canola oil in fatty acid composition, could be used without major processing plant modification. It is possible that off grade olive oil could find a small place in a WA biodiesel refinery. However, the present price of olive oil rules it out in the short to medium term.

Three other species deserve comment as they are being put forward as potential biodiesel substrates. The first is jatropha curcas. This plant is a perennial tree widely promoted in countries such as India, where extensive plantations are being established. It is toxic to stock and an aggressive and invasive weed. At present, jatropha is a declared weed in WA and it is most unlikely that it would be approved for cultivation here. In any event, it would be at least a decade before supplies could come on stream.

The two other species of interest that are under test by the Western Australian Department of Agriculture are pongamia pinnata and moringa oliefera. These also are perennial trees of tropical and subtropical origin. Although moringa, in particular, is showing some promise in experimental plots in a research programme led by Dr Henry Brockman of DAFWA, it is unproven at commercial scale and, again, it is likely to be at least a decade before the genetics and agronomy of this source could be sorted out in a Western Australian context and could come on stream commercially.

A watch should be kept on developments with these species, but they are unlikely to provide raw materials for a WA-based biofuels industry for some years to come.

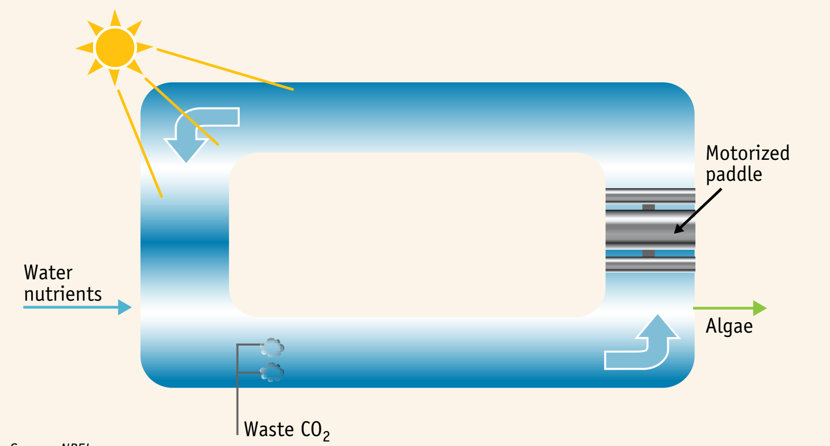
Chapter 6. Algae as a biodiesel source

The production of biodiesel from micro-algae has been studied since the mid 1970s. Micro-algae are single celled organisms which, like plants, use photosynthesis to convert solar energy to chemical energy. They are more efficient at this than terrestrial plants because they grow in suspension where they have greater access to light, water, CO_2 and nutrients. They can grow in open field ponds or in closed bioreactor vessels. Some strains can be manipulated in the production process to produce high oil contents. They show great potential as a source of transportation fuels, but many biological, engineering and economic hurdles are yet to be overcome. A major attraction is that, theoretically, they can produce many times the fuel output of terrestrial biological systems per unit of land area, a figure of 30 times for an equivalent area is quoted by the US Dept of Energy's National Renewable Energy Laboratory (NREL). In addition, they offer an opportunity to use waste CO_2 from sources such as electricity generation, possibly offering credit or offset advantages. To date, there is no large-scale commercial production of micro-algal-based biodiesel anywhere in the world, although there are many pilot scale facilities coming into production.

The most comprehensive research programme has been carried out by NREL under its Aquatic Species Programme, over the period 1978-1996. The research concentrated on finding suitable algal strains; understanding the biology and chemistry of biomass and oil production in micro-algae; and testing bio-oil production at pilot scale in bio-reactor systems and open ponds.

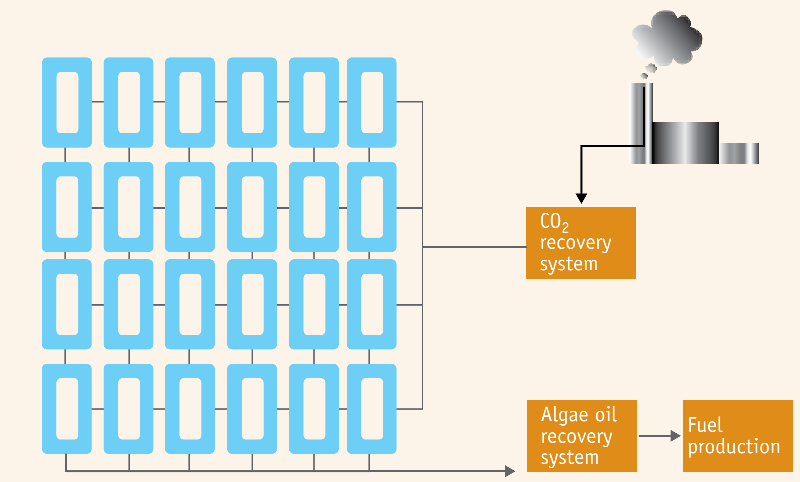
The closed circuit bioreactor vessel technologies have the advantage of being able to maintain algal strain purity, and control over other system drivers, such as nutrients and temperature. Their main disadvantage is size and cost, which at present appear to put them beyond the economic production of biodiesel from algae, despite the recent rises in oil price. Open pond systems rely on large shallow ponds, possibly using wastewater and CO_2 emissions from power generation plants. The configuration tested under pilot conditions involves shallow 'raceway' ponds, where water and nutrients are fed in at one end and algae are continually pulled off at the other. Banks of raceway ponds can be connected to cover large areas. (See Figures 2 and 3.)

Figure 2. Schematic diagram of an open raceway pond

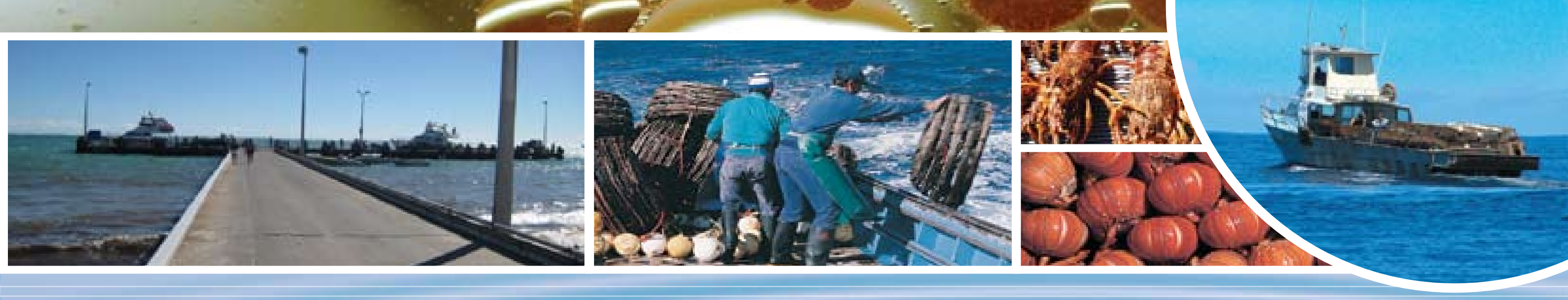


Source: NREL

Figure 3. Schematic diagram of a bank of ponds using power station CO_2



Source: NREL



In its extensive summary document, in 1996, NREL reached the conclusion that the conditions prevailing at that time (biological and economic obstacles) were such that there was no immediate future for algal based biodiesel production. The image (right) shows a prototype algal bioreactor processing CO_2 from a power station.

The recent rise in oil prices has rekindled interest and, in October 2007, a powerful NREL and Chevron Corporation alliance announced a collaborative research and development agreement to study and advance technology to produce liquid transportation fuels using algae. Earlier, in late 2006, the South Australian Research and Development Institute (SARDI) commenced research on algal biodiesel under the auspices of a grant from the Commonwealth Government Renewable Energy Development Initiative (REDI) to Australian Renewable Fuels (ARF). The research is based at the SARDI research facility at West Beach, Adelaide.

Several other groups are showing interest in algae production for biodiesel in Australia. Professor Michael Borowitzka, based at Murdoch University in WA, has a long-term interest in algae production for commercial purposes and his team has an operational small-scale plant, with plans for a larger facility.

The Fisheries Department of WA (Steve Nel) and the Aquaculture Facility at Challenger TAFE, Fremantle (Greg Jenkins) are examining the prospects for microalgae production and its potential for WA.

For many years, commercial culture of algae for high-value products has proceeded under the auspices of Betatene Pty Ltd at Port Gregory in WA. Recently, a new company, APBE Pty Ltd was established by Stephen Clark and Jason Heydock to build a pilot scale closed bioreactor system for algae production.

At an international level, several major companies in the energy sector are looking at microalgae as a possible future fuel source. The US company, Greenfuel Technology Corporation, has developed pilot and demonstration plants in the US and has recently formed a link with the Australian Victor Smorgon Group for demonstration in Australia. Royal Dutch Shell PLC and HR Biopetroleum, via a new joint venture company Cellana, have announced the construction of a pilot facility in Hawaii to grow marine algae for biofuel production.

A number of companies dedicated to producing biodiesel from algae are promoting the technology and commencing pilot plant production in the US. Petrosun Biofuels is building a plant in Arizona. Solazyme, a US company specialising in algal strain development for industrial applications, is partnering with the US oil industry to bring algal biodiesel on line, although commercial quantities are still some time away.

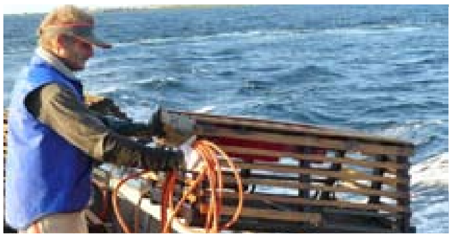
At an international level, several major companies in the energy sector are looking at microalgae as a possible future fuel.

There is considerable interest in the environmental benefits or otherwise of biodiesel from algae. There is little published on Life Cycle Analysis of production systems, to help determine whether they will have a positive or negative energy balance. The balance is likely to vary greatly from situation to situation. There are concerns about escape of undesirable algal strains to the environment and, for that reason, some operators are using only locally abundant strains. Issues of wastewater disposal and nutrient loads to the environment may also cause concern in some situations.

The value of CO_2 offsets for major coal fired power generators as a contributor to profits for an algal biodiesel plant remains to be quantified and proven at commercial scale.

WA has several natural features that could provide a comparative advantage for an algal biodiesel industry — abundant sunshine, cheap flat land, saline or brackish water resources and experience in pond technology. However, its main power generation sites are not close to areas with these natural advantages and therefore do not, at this time, seem to offer an integrated system opportunity. It is possible that further examination will reveal possibilities in other parts of the state, especially the north.

At this stage, the commercial production of micro-algae-based biofuel at a commercial scale, which could service the WA rock lobster industry, seems more than a decade away. The industry should keep a 'watching brief' on the developments outlined above, but investment in micro-algal biodiesel production is not recommended at this time.



Chapter 7. Biodiesel production processes and scale of operation

Making biodiesel is a simple chemical process that can be carried out at scales from a single operator making fuel to meet the needs of a lobster boat, to a local cooperative that meets the needs of several boat owners, to a large regional production plant providing fuel for the whole industry and possibly allied industries. The physical requirements of the different scales of operation are described below, while Chapter 12 provides an economic and business case analysis of the three options.

As outlined earlier, the essential ingredients to make biodiesel are an animal or vegetable oil, an alcohol (usually methanol) and a base catalyst such as sodium hydroxide (NaOH) or potassium hydroxide (KOH). These are mixed together to produce methyl esters (biodiesel) and glycerol, as a byproduct.

It is important to note that care is required in the washing and filtering stages (to meet biodiesel specifications that will trigger Government excise rebates and to meet engine warranty standards). A schematic diagram of the process was provided in Chapter 4.

Case 1. Single boat owner

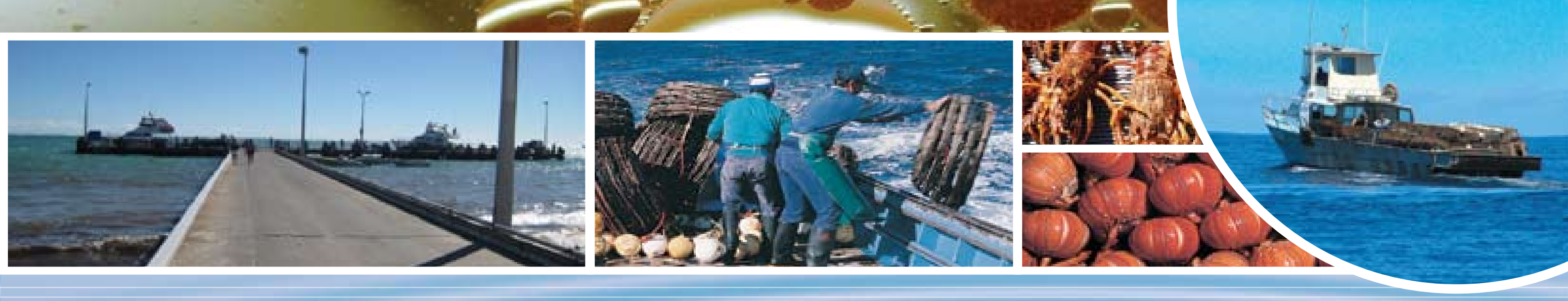
Assume a boat owner uses 60,000L of fuel per annum, which is about the average for a modern 18 metre boat fishing 150 pots (figures taken from the Bird Cameron report and advice from boat owners interviewed as part of this project). That is about the same fuel use as a 4000ha wheat farm. Around Australia, a few farmers are successfully producing their own biodiesel needs and they provide real world examples of how to go about it. To make 60KL of biodiesel will require:

60,000L of vegetable oil or tallow + 6,600L of methanol + 300kg NaOH or KOH = 60,000L of biodiesel + 6600kg of glycerol.

If canola seed is used as the oil source, at an extraction rate of 380L of oil per tonne, then 158t of canola is required. This can be grown on about 160ha. Such a quantity of seed could be readily sourced from a single farm. It will produce 103t of canola meal as a byproduct, which would find a market in the local stockfeed industry or could be used as fertiliser back on the farm.

Small crushing plant

A small off-the-shelf crushing plant can crush five tonnes per day, two crushers operating in tandem will require 16 days of annual operation to meet fuel demand.



Case 2. 10 boat owner co-operative

The WA lobster industry has a culture of cooperative arrangements, demonstrated by a long history of cooperative processing and shared Abrolhos supply boat arrangements. A 10 boat cooperative or consortium could pool resources to meet their fuel needs. Essentially, the calculations for the single boat owner are multiplied by 10. There are some modest economies of scale through opportunities to pool labour at busy times, employ casual labour, negotiate better prices for input supplies and byproducts, and employ the particular talents of individual members of the consortium.

Fuel demand is 600,000L, methanol demand 66,000L and NaOH 3000kg. Again, biofuel produced is 600,000L, glycerol 66,000L.

If canola seed is used as the oil source, 1,580t will be needed, requiring about 1600ha of production. This is the typical canola production from three or four farms.

This model could operate with five, 5t/day canola presses crushing 25t/day for 66 days in three separate 22 day periods over the year. Biodiesel production would be in batches.

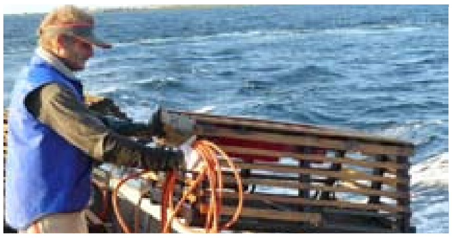
Farmers could join boat owners in the cooperative with the production plant built on-farm, to take advantage of freight savings and avoiding double handling with the fuel manufactured going to the boat owners and the farmers.

A typical off-the-shelf medium sized biodiesel plant

This kind of arrangement could be expanded by inviting more boat owners/farmers into the syndicate, by running the plant for more months of the year, or by adding modules to the plant.

Two Perth based companies, Blue Diesel and Bioworks, have developed technologies and containerised modules that could suit this configuration.



Case 3. Large regional plant

This option explores the raw material needs of a plant to meet the 30ML fuel requirement of the lobster industry. In WA a new 44ML biodiesel plant built by Australian Renewable Fuels was completed at Picton, near Bunbury, in 2007. It provides a ready model of the dimensions and configuration of such a plant. The Picton plant was developed around the concept of buying in tallow and therefore does not carry its own oilseed crushing facility. It has an arrangement to source its tallow needs from around Australia through Gardner Smith, and has the option to source canola oil from the Gardner Smith oilseed crushing plant at Pinjarra **(http://www.gardnersmith.com/).** The Picton plant is a sophisticated industrial operation. It has a nominal capacity of 44ML/annum. If a similar plant were built at, say Geraldton or Jurien, to run on canola or mustard oil, it would have the following needs:

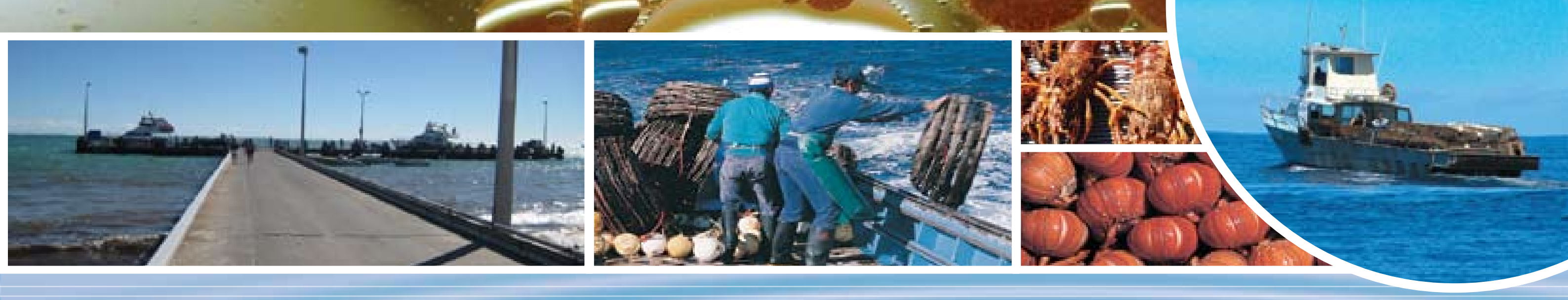
- A site of about 1ha for: crushing facility, biofuel manufacturing plant, oil, methanol, biofuel and glycerol tanks and associated pipe work, seed silos, machinery sheds/workshop, staff facilities, office block, meal drying and processing, meal storage shed, catalyst and chemical storage
- Good road access, suitable for large articulated grain and fuel trucks, up to double trailer 50t loads
- Supply of heavy-load electricity
- Good-quality water supply
- Waste disposal/sewerage
- Environmental buffer zone
- Suitable water supplies and drainage/sewerage

The canola required to meet the 30ML demand at 380L/tonne of seed would be 79,000t. This could be sourced from the northern agricultural region in most years. The methanol demand would be 330,000L per annum and catalyst 165t.

Canola meal production would amount to about 51,500t/annum. Glycerol production would total 330,000L. The sale and/or disposal of the meal and glycerol would be a significant feature of the operation, and may provide some marketing challenges.

Images of the Picton plant — courtesy of ARF Website

On a basis of 11 months plant operation each year six days per week, the daily throughput on a 275 day year would be 300t/day. The delivery and storage facilities would need to be designed for such a throughput.



Chapter 8. Byproducts of biodiesel production

The byproducts of the biodiesel production process form an important component of the economic viability of the enterprise. The main byproducts are:

Canola Meal

- Harvested canola grain commonly contains about 42% oil, varying from 35% to 45%, depending on variety and growing conditions. Debits and bonuses usually apply around the 42% figure. Moisture content and admixture can also vary by the truckload, and are allowed for in price setting. See CBH delivery standards for a detailed description.
- Two main oil extraction methods are used. Solvent extraction strips out nearly all the oil, leaving 0-2%. Mechanical presses leave about 5-10% oil behind, depending upon the expellers used and operating temperatures. This has significant impact on the quality of the meal from an animal diet perspective, as oil is an energy source for animals. Higher oil meals are favoured by the animal industry.
- In WA at present there are two main producers of canola meal, Riverland Oils at Pinjarra **(http://www.riverland.com.au/)** and Kojonup Oils at Jingalup near Kojonup. Annually, Riverland Oils crushes around 50,000t of canola and Kojonup Oils about 6000t. Between them both, the plants produce about 30,000t of canola meal per year. Both processing plants are mechanical heat presses and typically leave about seven per cent oil in the meal. A biofuel operation would need to trade off oil extraction and meal quality to determine the most economical mix from a plant sophistication and cost viewpoint and from an end product value perspective. Links to Riverland Oil meal and oil specifications are shown in Appendix 9.
- Canola meal is used locally for poultry, pig, and dairy feeds (see Table 8). Coffey (2005) showed the following breakup of the market for local canola meal by buyer and animal industries (see Tables 8 and 9).

Table 8. Canola meal use by livestock type

Livestock	Usage (%)
Poultry	60
Pig	25
Dairy	10
Beef	4
Other	1

Source: Coffey 2005

Table 9. Breakup of canola meal market by buyer

Consumer	Usage (tonnes/annum)
Inghams Poultry	8,000
Wesfeeds	4,000
Poultry Growers Co-op	3,000
Milne Feeds	1,500
Ketteridge Stock Feeds	1,000
Dairy TMR Users	1,000
Macco Feeds	1,000
Thompson & Redwood	1,000
Beef Feedlotters	500
Others	500

Source: Coffey 2005

- Canola meal enters the livestock feed market against several competing products, especially imported soyameal and locally grown lupins. Soyameal dominates world meal markets and is widely traded, so it provides a useful benchmark against which to judge competing feeds. Inghams, for example, import around 10,000t of soyameal into Western Australia each year in two part cargoes (Coffey 2005). Feeds vary widely in their composition and usefulness in animal diets, both from a nutritional point of view and in the amount that can be added. Feed compounders continually scan the market for components to make up least cost rations that meet the needs of different livestock classes. Canola meal is widely known and accepted as an animal feed component and finds a ready market, at a price.
- In recent years, in the WA feed industry, canola meal has fetched about 75% of the prevailing imported soyameal price. Canola meal appears to hold price against soyameal rather than lupins. The price of domestic canola meal in recent years is shown on Table 10, on the next page.
- Australian Pork Ltd, through its weekly newsletter *Eyes and Ears,* quotes prices for a range of feed components. In November 2007, Canola meal was quoted at $440/t at several Eastern States locations, while soyameal was quoted at $550/t. In this example, canola price is 80% of soyameal price, due to the high demand generated by the Eastern States drought. In the longer-term, a figure of 75% of soyameal price could be used.



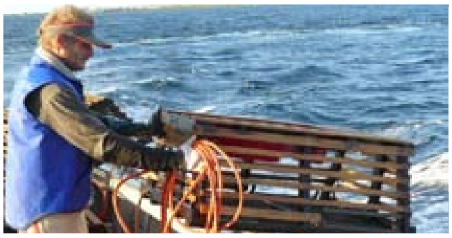



Table 10. The price of canola meal 2000/01–2007/08

Year	$AU/tonne
2000/01	320
2001/02	400
2002/03	440
2003/04	380
2004/05	310
2005/06	300
2006/07	415
2007/08	500

Source: Eyes and Ears, *Australian Pork Ltd*

- The other important price components to use when building up a framework to compare the relative profitability of biodiesel production (in comparison to mineral diesel price) are canola seed price and canola oil price. The tables opposite (11 and 12) show these prices for the period 2001 to 2008.

- A value for meal (as an offset for oil going into the biodiesel process) can be derived as follows. At the time of writing, early 2008, canola is fetching around $500/t and meal around $440/t. Assume canola contains 42% oil and 34.7% is extracted by a mechanical press. A tonne of canola will give 347kg of oil and 653kg of meal. Oil has a specific gravity of 0.914kg/L, therefore there will be 380L of oil. Meal (653kg) at $440/t is worth $287. Subtract the meal return from the cost of seed ($500-$287) = $213 as the net price of the 380L, of oil extracted as it goes into the biofuel process. That works out at 56c/L. This is explored in depth in the later chapter on economics of biofuel production.

- Using the same methodology, a table can be built up to show the price of oil at different seed costs and meal returns (Table 13, next page). Note that the extraction cost of the oil must be added to give a full oil input cost to the biofuel process. Commonly quoted toll crushing prices for canola are in the $90–120/t range.

Table 11. Canola seed WA pool price ($AU)

Year	$AU/tonne
2000/01	320
2001/02	400
2002/03	500
2003/04	420
2004/05	345
2005/06	380
2006/07	395
2007/08	630

Source: ABARE, AOF

Table 12. Canola oil price import parity WA ($AU)

Year	$AU/tonne
2000/01	500
2001/02	670
2002/03	1000
2003/04	835
2004/05	700
2005/06	720
2006/07	957
2007/08	1350

Source: ABARE, AOF

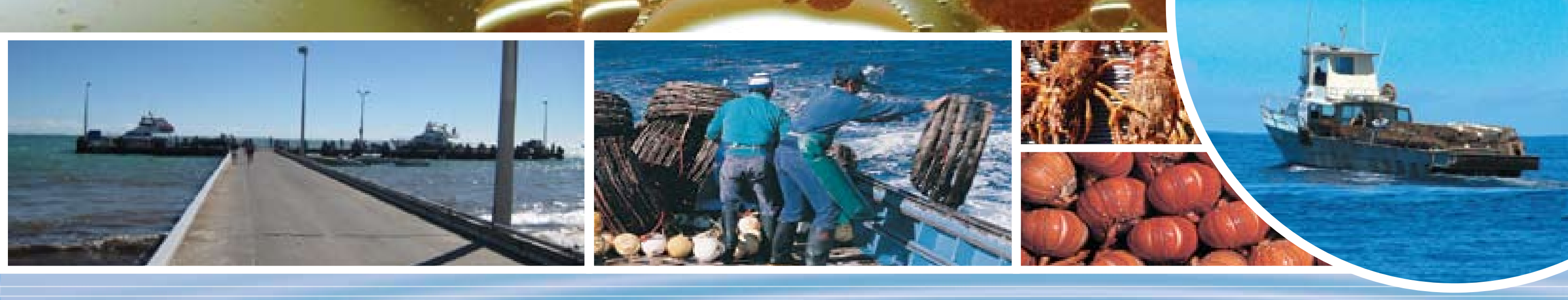


Table 13. The net cost of canola oil (c/L) related to the purchase price of canola and the sale price of the canola meal, post oil extraction

Price of canola meal ($/t)	Price of canola seed ($/t)							
	400	450	500	550	600	650	700	750
100	88	101	115	128	141	154	167	180
150	80	93	106	119	132	145	159	172
200	71	84	97	110	124	137	150	163
250	62	76	89	102	115	128	141	155
300	54	67	80	93	106	120	133	146
350	45	58	72	85	98	111	124	137
400	37	50	63	76	89	102	116	129
450	28	41	54	67	81	94	107	120
500	19	33	46	59	72	85	98	112

Glycerin, glycerol

- Glycerin is a byproduct of biodiesel production. The crude vegetable or animal oils used as raw materials for biodiesel production are triglycerides, with fatty acids attached to a glycerin backbone. When treated with methanol and a base catalyst, such as sodium or potassium hydroxide, the fatty acids combine with the methanol to form methyl esters (biodiesel) and crude glycerol is produced as a byproduct.
- Crude glycerol is about 80% pure. It can be further treated to produce refined glycerol, which is 95–99% pure and is the product widely used in pharmaceuticals and available from pharmacies. Refined glycerol meets strict international health standards.
- For every tonne of biodiesel produced, approx 128kg of crude glycerol is produced, which refines to 93kg of pharmaceutical and 5kg of technical grade glycerol.
- Canola oil has a specific gravity of 0.912, meaning each 1000L of canola oil weighs 912kg.
- Glycerin has a specific gravity of 1.21. This means each litre of glycerin will weigh 1.21kg.
- Glycerol prices have shown great variation in recent times, largely as a response to quantities coming onto the market as a byproduct of biodiesel production (see Table 13). Up until 2005, crude glycerin sold for around US 8-10c/lb but, by late 2006, the price had plunged to about 2c/lb in the face of growing supplies. At this price, many northern hemisphere biodiesel processors saw it as a waste product and getting rid of it sometimes was a debt against the production process. During 2007, prices slowly rose again to around 5c/lb.
- Refined glycerol commonly sold for around US 60 c/lb until 2005, but market pressure saw it selling for around 30-40c/lb through 2007 to date.
- The 'c/lb' figures quoted above are US units. To convert this to an Australian base, use 2.2lbs/kg and an exchange rate of US 95 cents to the AU$. This converts to $0.90/kg for glycerol at US 40c/lb.

Chapter 9. Biodiesel from canola — farm aspects

Reliable supplies of canola for biodiesel production will depend upon farmers getting a reasonable return for their canola crop. Canola is one of several crop and animal enterprises that can be carried out in a mixed farming enterprise. Within the farm, then, canola must compete to hold its place. Major determinants of its value to farmers are yield, cost of production, price received and rotational benefits, such as disease and weed control. The points below give a brief background to farm issues, as they relate to a nearby biofuel enterprise.

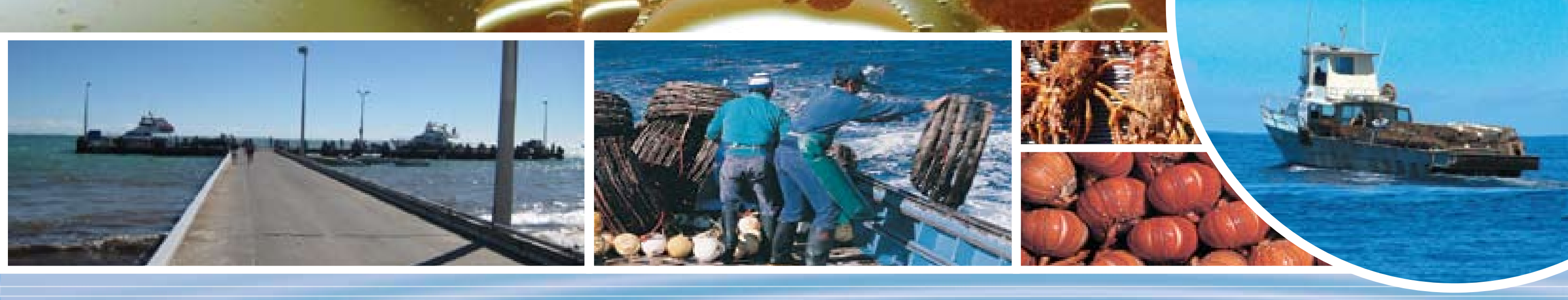
- As a first approximation, the costs of production of canola up to the farm gate are the same for canola grown for export and canola grown for a local biofuel processing plant. In time, biofuel canola (or mustard) may differentiate from food canola, with the introduction of varieties bred for oil yield/ha and possibly also the use of GMOs and special agronomic techniques. With present technology, differences in farm returns will arise from differences in freight and handling costs between the two systems, post farm gate.
- Most grain is delivered from farm to silo by single tray (25t) or double tray (50t) articulated trucks. CBH uses doubles under contract for long haul transport to port. The figure commonly used for farm to local silo delivery is $7–$15/t. Anderton and Kingwell (2007) quote 5.8c/t/km. The transport industry is highly competitive and cartage rates vary widely with season and locality. Fuel price rises are impacting on freight rates also.
- Looking at the CBH system, total marketing costs from farm gate to port are about $60/t for canola. This covers freight from farm to silo and silo to port, handling, storage charges, financing charges, research, other levies and other minor items. The details are show in Table 14. To bring an export price at port back to farm gate return, take the FOB price and deduct $60.

Table 14. Storage, handling and transport costs included in the canola price at the port

Charges	Amount ($)
CHB store, handle receive	11.05
Grain assessment	1.05
Fobbing and up country costs	13.21
Research levy	4.99
Skeleton weed levy	0.31
National residue levy	0.05
State rail freight to port	19.25
Road freight farm to silo	9.15
Total fees and charges	**59.06**

Source: Farm Budget Guide 2008

- For a biofuel plant located on the coast at, say Jurien, there are two main options available for accumulation of canola for processing. The first is to use the CBH system as a warehousing arrangement whereby they receive and store canola grain for the biofuel company and it is delivered to the processing plant as needed. The costs for this may be something like $25–30/t, if it is assumed that the costs cover receival, storage and handling. Then the company would need to cart the grain to the processing plant at, say $7–10/t. So, there might be a saving of around $15–20 for locally delivered grain against export grain. The second option is for the company to operate entirely independently of the CBH system, in which case it would need to construct its own long-term receival and storage facilities or arrange for farmers to store grain on farm for delivery through time. Given that all the canola is harvested in November/December and the crushing and oil plant would operate through most of the year, storage requirements would be large. The storage options need to be costed out carefully when considering the detailed business plan for a particular biofuel plant.
- Whether the lower cost to get grain to the fuel processing plant will be a benefit to the farmer or the biofuel processor is a moot point. It is likely that the processor will pay the farmer just enough to pull grain away from the export market or local crushers. Farmer part ownership of the processing plant and take-off of some of the biodiesel produced for their own use may be an attractive option.



Chapter 10. Economic analysis of biodiesel production

This chapter takes information presented earlier in this report and places it in an economic context. It outlines the assumptions used, comments on the uncertainties and builds model cost and benefit flows for the three scales of operation outlined earlier. The analyses estimate the component costs of producing a litre of biodiesel and the sensitivity of each of the costs on the final price of the biodiesel.

Prices and returns for all components of this analysis have undergone large changes over the six months this report has been in preparation, perhaps larger and more rapid changes than have been seen over a similar period in recent decades. Lobster boat owners, and the fishing industry generally, are acutely aware of these changes. Amongst others, they have seen large changes in diesel prices, labour costs, exchange rates, interest rates, input material costs to biodiesel plants and prices received for outputs.

Below, an attempt has been made to provide background to the main costs involved in biofuel production. In some cases, ranges have been used, based on historical data and future possibilities, then sensitivity analyses have been conducted to illustrate the major price factors that impact a biodiesel operation. In combination, the interacting prices of inputs and returns from outputs dictate the viability, or otherwise, of biodiesel production.

Mineral diesel (at various shadow prices) is used as a benchmark against which biodiesel must compete to be accepted as a viable alternative. Diesel fuel prices have risen rapidly in recent times, and the prices chosen reflect prices over the past few years and the recent rapid rise, as shown in the introduction to this report, and the possible prices in the medium future - if the price forecasts of some commentators play out.

When preparing these scenarios, the authors have drawn information from many reports and websites. The work of Duff (2006), O'Connell et al (2007), O'Connell and Batten (2007), Kingwell (2006) and the WA Biofuels Taskforce (2007), has been very helpful. Their contribution is acknowledged.

As outlined earlier, at this time, the main contenders as substrates for biodiesel production in WA are canola oil, tallow and palm oil. They are all internationally traded commodities and international prices set levels, at which a WA industry could source material locally or internationally on an import parity basis. At the time of preparation of this part of the report, in late July 2008, prices quoted from available sources were:

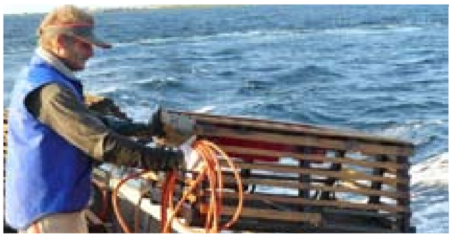
Canola oil – AU$1400/t, ex Canadian ports (Canola Council of Canada)

Tallow – AU$900/t, ex works Australian processors (Meat and Livestock Australia)

Palm oil – AU$1000/t, ex Malaysian ports (PalmOil.com)

These prices are at historically high levels. The three commodities have been up to 30% cheaper at various times during the 2000 to 2008 period.

In a biodiesel manufacturing plant context, these oils enter the plant as very close to equivalent products, in an energy supply (calorific value) and conversion sense, and the processes to convert them to biodiesel are similar. For simplicity and, given the large supplies of canola available in WA, the following analyses have been built around canola, but tallow and palm oil could be readily analysed in a similar way, using current prices. It also allows the three sources to be compared, should their respective prices/t depart significantly, which, given their partial substitutability in both food and biofuel uses, is unlikely. Canola usually carries a modest premium, as above, because of the value placed on unsaturated oils in the food market.



Canola seed prices

Canola (and mustard) seed has been chosen as the most likely nearby material available in sufficient quantity to provide the fuel needs of the WA lobster fleet. Prices have risen rapidly in the past two years, as can be seen from the following table. (for ease of reference, Table 11 has been repeated from page 28)

Table 11. Canola seed WA pool price ($AU)

Year	Canola seed WA pool price ($AU)
2000/01	320
2001/02	400
2002/03	500
2003/04	420
2004/05	345
2005/06	380
2006/07	395
2007/08	630

Source: ABS, ABARE, AOF

As canola seed and the oil extracted from it are major cost inputs to a potential biodiesel operation, a range of prices between $350 and $800/t have been used in the analyses, to show the impact on the financial viability of the enterprise. This is a biodiesel factory gate price. Transport and storage costs need to be subtracted to bring canola back to a farm gate price for farmers. A figure of $30/t has been allowed, $15 for freight and $15 for storage on-farm, for delivery to the factory over time.

To compare factory gate or farm gate price to export parity, refer to Table 14, on page 30.

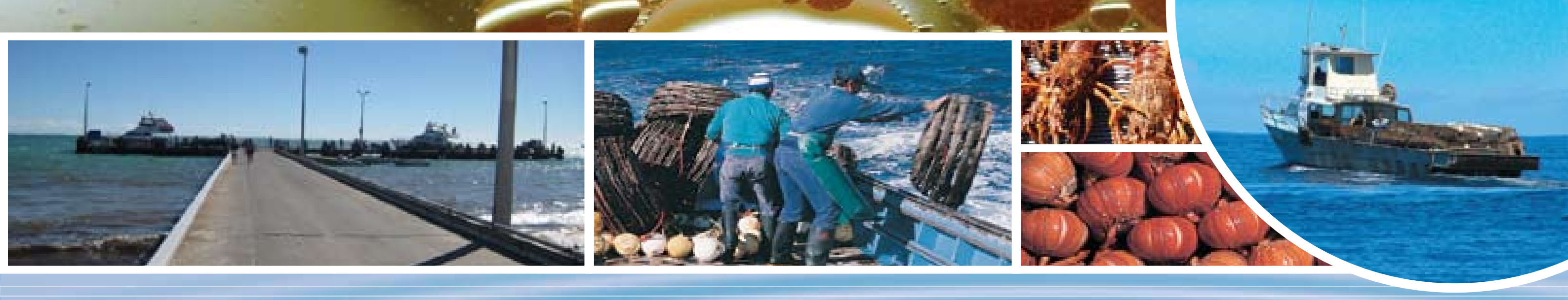
Based on the assumptions outlined in the two paragraphs above the price at the gate of the biodiesel factory is estimated to be about $30/t less than the price quoted for delivery to the ship.

Methanol prices

Methanol is an important input to the biodiesel manufacturing process, as outlined earlier, with 110L of methanol required to produce every 1,000L of biodiesel. Single operators are likely to buy methanol in 200L drums from fuel suppliers, at a current price of around $1/L. The 10 boat consortium and large industrial processors will buy in bulk, in 35,000L tankers, from dedicated methanol producers and at a significant discount to that price. Guided by current world prices and, recognising that methanol is a widely manufactured and traded bulk chemical used in many industrial processes, a price of 70c/L has been used here for larger operations. This equates to 11c/L of biodiesel produced for the small operation and 8.25c/L of biodiesel for the larger producers.

Sodium/potassium hydroxide

The NaOH or KOH catalysts used are readily available industrial chemicals. WA is a large manufacturer and user of these chemicals for the mining industries. At a use of 5kg per 1,000L of biodiesel produced, this is not a significant cost. World market quotes are approx $500–$700/t (May 2008). A cost of 1c/L of biodiesel produced has been factored in for single operators, and half that for larger producers.



Canola meal

The net price of oil going into a biodiesel production facility, where the factory crushes seed for oil extraction, will significantly depend on the offset obtained for canola meal sales, given that about 650kg of meal will be produced for every tonne of seed crushed. Canola meal is one of many protein meals entering the animal livestock feed market, and prices received vary with a mix of international and local factors. Canola meal benchmarks against the world dominant soya meal and, in WA, it usually fetches between 70–80% of the price of imported soya meal. Recently, prices have gone as high as $500/t, in response to the Australian drought and after sitting at around 350–450/t for a long period, as Table 10 shows (for ease of reference, Table 10 has been repeated from page 28).

Table 10. The price of canola meal 2000/01–2007/08

Year	Canola meal WA price ($AU)
2000/01	320
2001/02	400
2002/03	440
2003/04	380
2004/05	310
2005/06	300
2006/07	415
2007/08	500

Source: Eyes and Ears, *Australian Pork Ltd*

In this analysis a range of prices has been used to indicate the sensitivity of biodiesel returns as canola meal prices change.

Glycerol price

Glycerol is a major co-product of biodiesel manufacture. About 110kg of glycerol is produced per 1000L of biodiesel. Quoted returns from glycerol vary widely, depending on many local and international forces. At worst, the glycerol is a waste product and dumped at cost to the enterprise. At best, it is refined to pharmaceutical grade glycerol and fetches up to $1000/t. Crude glycerol has been selling in some markets for $120/t. In this analysis, a conservative figure of $100/t has been used. This equates to an income for the sale of glycerol of 1c/L of biodiesel produced.

Biodiesel price

Clearly, for biodiesel to be a viable option for lobster boat owners, it must come in under mineral diesel prices. The degree to which it needs to beat diesel prices will depend on individual attitudes towards its use, taking into account convenience, acceptance as a diesel equivalent and concerns about fuel performance in engines in an immediate and lifetime sense.

In this analysis a 1:1 comparison with diesel is assumed. Again, sensitivity analyses have been constructed to compare different scenarios for the production of biofuel and the prices of mineral diesel.

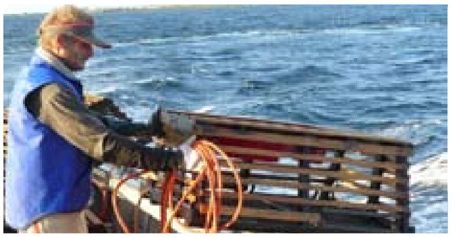
Excise and taxes

Commercial lobster boats come under the category of off-road primary industry users and, as such, the fuel excise of 38.14c/L (which applies to private users) is rebated. GST, as an input tax, is also rebated. While biofuel producers receive a grant of the full 38.14c/L, this is due to ratchet down to half that between 2011 to 2015, and the fuel buyer cannot then claim the rebate again. The net sum of this complicated arrangement is that no fuel taxes apply to biodiesel or mineral diesel lobster boat owners. In essence, the diesel benchmark price against which biodiesel must compete is the retail price of diesel, less 38.14c, less GST. The net price to boat owners, after these allowances have been used, is the price biodiesel must beat to be a viable proposition. Table 16 shows the relationship between the retail price and final price paid by lobster fishermen.

Table 15. The relationship between retail diesel price and the price paid by lobster fishermen

	Retail price of diesel ($AU)				
	120	140	160	180	200
Price to fisherman (after excise rebate and GST input credit)	71.0	89.1	107.4	125.5	143.7



Capital equipment

Capital equipment is a significant item in canola crushing and biodiesel manufacturing operations. It varies considerably with the technology used (e.g. press versus solvent extraction of oil, batch versus continuous flow for biodiesel manufacture). These equipment needs will vary with the scale of operation.

Single operators, taking farmers who are producing their own biodiesel as an example, often use existing silos, augers, second hand tanks, farm fabricated pipework, etc., or alternatively buy small scale crushers and biofuel plants. To produce 60,000L of biodiesel, it is estimated that the capital cost of equipment will be in the range of $30,000-$70,000. Small scale plants are available for purchase off-the-shelf. Bioworks, in O'Connor, WA, market the Biomaster 150 plant for between $4,000 and $5,000. This plant is a batch process that can produce 150L every 24 hours. Two such plants would be sufficient to produce 60,000L per year. Small scale crushers can also be purchased for $4,000 to $5,000.

The capital investment for the 10 boat owner consortium is estimated to be in the range of $400,000-$600,000, with little gains from economies of scale over the single operator. The Swedish company, Agaretec, markets fully-automated plants with capacities starting at 2,000L (P2 plant) per batch and going up to 8,000L per batch (P8 plant). These plants can run 24 hours a day, seven days a week, producing two batches per day. The P2 plant, if run for 180 days, at two batches per day, would produce 576,000L of biodiesel. Under the same scenario, the P3 plant (at 3,000L per batch) would produce 864,000L. The P2 and P3 plants are priced at $250,000 and $339,000, respectively.

Another WA company, Bluediesel, has developed a high pressure continuous production system for biodiesel and has indicated that its 1ML and 2ML plants would cost about $600,000.

A large industrial processing facility producing 30–40ML annually, would meet all the fuel needs of WA's lobster industry and, taking recently completed biodiesel plants in Australia as a guide, this is likely to cost in the range of $16 to $24 million.

Cost of capital

The cost of capital must be included as a component of cost/L of biodiesel produced. The cost per litre will vary with the life assigned to the plant (depreciation), at the interest rate on capital as in any industrial operation. Accounting practices for tax purposes commonly use 15% depreciation on plant and equipment, which would discount the asset to zero in seven years, and much smaller levels, as low as 4%, on fixed assets, such as buildings.

The likely useful life for a well maintained plant is 20 years and that figure has been used in this analysis, i.e. a depreciation rate of 5%. The interest rate figure used here on funds employed (income from money forgone) is 8.5%. As capital cost, interest rate and true plant life will vary greatly with circumstances and, through time, sensitivity has been checked by assigning varying rates and plant lives, then bringing back to a current c/L cost.

Based on the indicative capital cost for the three production scenarios, the depreciation rate of five per cent and interest rate of 8.5%, Table 16 shows the estimated range of capital costs in cents per litre of biodiesel produced.

Production costs, maintenance and overheads

All other costs not caught in the above will, again, vary with the scale and sophistication of the operation. In line with the foregoing calculations, a c/L of production has been assigned. Costs include: maintenance and repairs, energy and water, rates and charges, rent, management overheads, packaging materials, licenses, analyses, etc. These will be highly case specific. The literature, other case studies and company prospectuses were searched and a figure of 10c/L, across all scales, chosen.

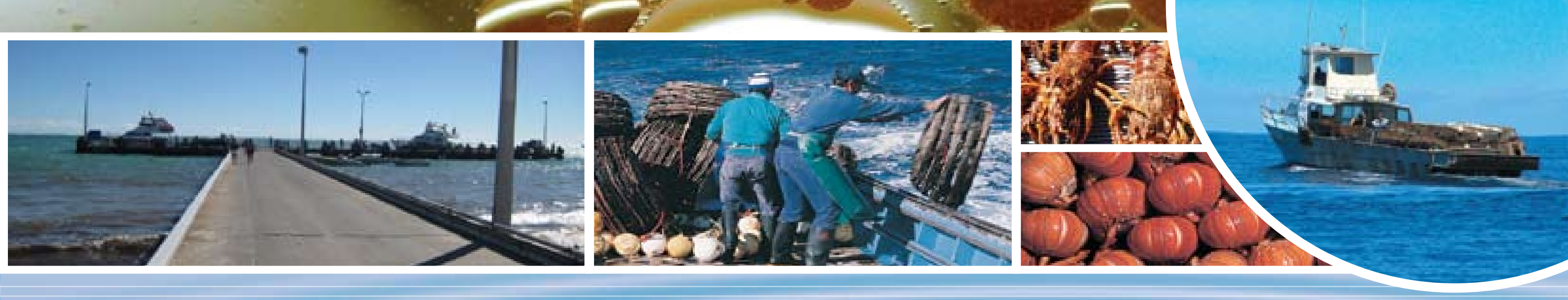
Labour

The number of labour units required for the production of biodiesel will vary with the scale of the operation and the degree of automation in the larger plants. From the information available, a value of four cents/L has been used for all production levels.

The next step is to use the prices and returns derived above to examine sufficient scenarios to test the viability of biodiesel as a potential fuel for the Western Australian Rock Lobster Industry.

Table 16. Estimated capital investment required for the production biodiesel at a range of scales of production

Scale of operation	Capital investment ($)	Capital cost (c/L)	Range in capital invested ($)	Capital cost (c/L)
Single operator	50,000	11	30,000–70,000	7–15.8
10 boat owner consortium	500,000	11	400,000–600,000	9–13.5
Industrial processing facility	20 million	8	16–24 million	6–9



The base case

Because there are many variables that can determine the cost of production of biodiesel and its competitiveness with mineral diesel, a simple base case has been set up that outlines the cost of production of biodiesel for the three scales of operation i.e. single operator, 10 boat consortium and large scale industrial production. The base case incorporates reductions in the costs of capital and other inputs achieved through increases in scale. It is not tied specifically to lobster boat owners, or particular geographic areas. (See Table 17.)

The base case is based on the following assumptions (note that costs quoted at c/L equate to the cost of each component for each litre of biodiesel produced):

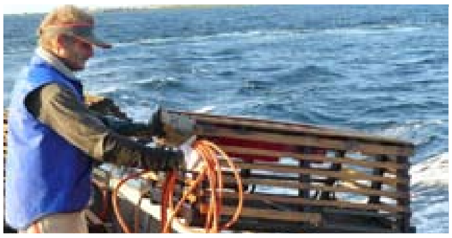
- The cost of capital is 11c/L for the single operator and the 10 boat consortium, and 8c/L for industrial production.
- Canola is delivered to the factory at $650/t.
- The cost of methanol is 11c/L per litre of biodiesel produced for the single operator and 8.25c/L for the 10 boat consortium and industrial plant.
- The cost of catalyst is 1c/L for the single operator and 0.5c/L for the 10 boat consortium and industrial plant.
- Maintenance, operating and overheads is equivalent to 10c/L of biodiesel produced.
- Labour costs for all scales of production is equivalent to 4c/L.
- Canola meal is sold for $400/t and glycerol for $100/t.
- No excise or is GST payable, no rebates give a neutral position.

The reduction in the cost of capital and input costs achieved with an increase in the scale of operation, result in an estimated reduction in the net cost of biodiesel of about 6c/L from the single operator, through to the industrial scale processing plant.

Table 17. The estimated costs of production of biodiesel for a single operator, 10 boat consortium and an industrial plant

	Single operator	10 boat consortium	Industrial scale
Capital cost	11	11	8
Operating cost			
Canola – $650 – 380L oil	171	171	171
Methanol			11
Catalyst			1
Production costs, maintenance	10	10	10
Labour			4
Total operating costs	**208.1**	**204.8**	**201.8**
Income			
Meal – $400/t – 650kg/t	68	68	68
Glycerol	1	1	1
Net cost for biodiesel	**138.6**	**135.4**	**132.4**



Sensitivity analysis

While the base case indicates the range of variables that will impact the cost of production of biodiesel, the key variable determining the viability, or otherwise, of the process is most likely to be the cost of the feedstock used.

To understand the relationship between changes in the cost of feedstock (in this case, canola seed) and the final cost of the biodiesel produced, sensitivity analyses were completed to determine the impact of changes in the price of canola seed and canola meal and interaction of the two.

For simplicity, the sensitivity analyses have been carried out using the base case of the 10 boat consortium. This is based on the assumption that the impact of canola seed price, canola meal price and the interaction between the two will be independent of the scale of the operation and, therefore, the impact will be similar in each case.

Canola seed

As indicated earlier in the report, the price of canola seed has varied greatly in recent years and the following sensitivity analysis (in Table 18) includes a range in canola prices from $350–$800/t. All other parameters, including the price received for canola meal ($400/t) remain constant in this comparison.

This sensitivity analysis indicates that for each $50/t increase in the price of canola, the cost of producing biofuels increases by 13.2c/L. The range in the cost of biodiesel is more than 118c/L, from 56.4c/L to 174.9c/L.

It is very unlikely, however, that the price of canola seed would vary independently of the price received for the canola meal, following the extraction of the oil. Over the past eight years, while the price of canola and canola meal have not moved in unison, they have remained in a ratio that has ranged from 1:1 to 0.8:1. To reflect this closer relationship, the sensitivity analysis in Table 19 shows the impact of changes in the price of canola, when the price of canola meal is pegged at 80% of the price of canola.

The closer relationship between the price of canola and canola meal reduces the spread in the net cost of biodiesel, ranging from 77c/L to 133.8c/L with the resulting increment in biodiesel cost being reduced to 6.3c/L for each $50 increase in the price of canola. It also insulates the cost of production of biodiesel from the impact of high canola prices with the cost being 133.8c/L at a canola price of $800/t, some 41.1c/L lower than the highest cost estimate in the sensitivity analysis in Table 18.

Table 18. The impact on the net cost of production of biodiesel (c/L) of canola seed prices ranging from $350–$800/t. The base case is highlighted in yellow

	Price of canola ($/t)									
	350	400	450	500	550	600	650	700	750	800
Net cost of biodiesel (c/L)	56.4	69.6	82.8	95.9	109.1	122.2	135.4	148.5	161.7	174.9
Change in price (c/L)		13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2

Table 19. The impact on the net cost of production of biodiesel (c/L)of a change in the price of canola from $350–$800, when the price of canola meal is maintained at 80% of the price of canola

	Price of canola ($/t)									
	350	400	450	500	550	600	650	700	750	800
Price of canola meal ($)	280	320	360	400	440	480	520	560	600	640
Net cost of biodiesel (c/L)	77.0	83.3	89.6	95.9	102.2	108.5	114.9	121.2	127.5	133.8
Change in price (c/L)		6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3

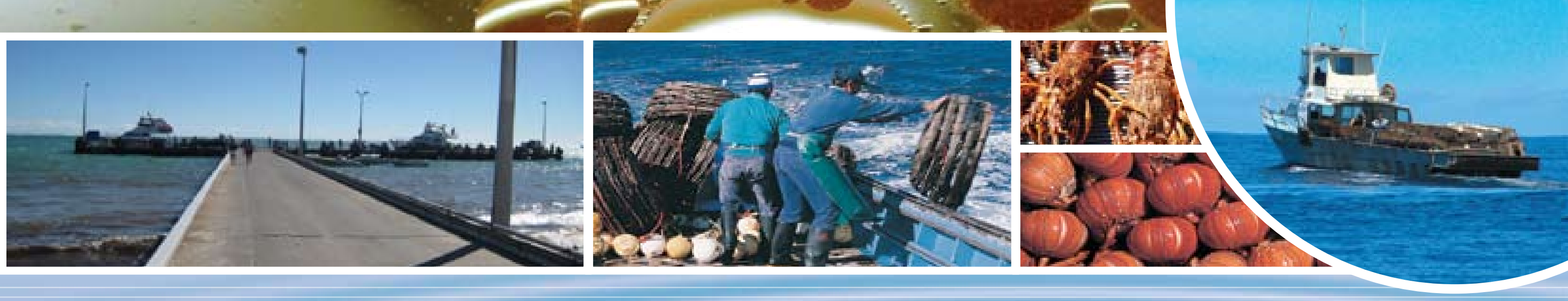


Table 20. The impact on the net cost of production of biodiesel (c/L) of a canola seed prices ranging from $350–$800/t and canola meal prices ranging from $250–$700/t

Price of canola meal ($)	Price of canola ($/tonne)									
	350	400	450	500	550	600	650	700	750	800
250	82.1	95.3	108.4	121.6	134.7	147.9	161.0	174.2	187.4	200.5
300	73.5	86.7	99.9	113.0	126.2	139.3	152.5	165.6	178.8	192.0
350	65.0	78.1	91.3	104.5	117.6	130.8	143.9	157.1	170.3	183.4
400	56.4	69.6	82.8	95.9	109.1	122.2	135.4	148.5	161.7	174.9
450	47.9	61.0	74.2	87.4	100.5	113.7	126.8	140.0	153.1	166.3
500	39.3	52.5	65.6	78.8	92.0	105.1	118.3	131.4	144.6	157.8
550	30.8	43.9	57.1	70.3	83.4	96.6	109.7	122.9	136.0	149.2
600	22.2	35.4	48.5	61.7	74.9	88.0	101.2	114.3	127.5	140.6
650	13.7	26.8	40.0	53.1	66.3	79.5	92.6	105.8	118.9	132.1
700	5.1	18.3	31.4	44.6	57.8	70.9	84.1	97.2	110.4	123.5

In reality, while the price of canola meal is likely to vary with the price of canola seed, it is very unlikely to do so in a fixed proportion as used in the sensitivity analysis in Table 19. The sensitivity analysis (shown in Table 20 above) shows the cost of production of biodiesel for a range of both canola seed and canola meal prices. For ease of reference, the base case is highlighted in yellow.

This analysis provides an indication of the wide range in the cost of producing biodiesel, attributable to changes in the price of canola and canola meal and in the interaction of the two.

Comparison with the price of mineral diesel

One of the continuing questions concerning biodiesel production is its comparison with the price of mineral diesel. How does it compare today, and how is it likely to compare in the future? The changes in the price of mineral diesel, canola and canola meal have been significant in the last 12 months and, as a result, a number of commercial biodiesel plants closed towards the end of 2007, when the increase in the price of feedstock made production uneconomical. In the first half of 2008, oil prices have reached record levels and this has resulted in significant increases in the price of mineral diesel, which may enable some of these plants to open again.

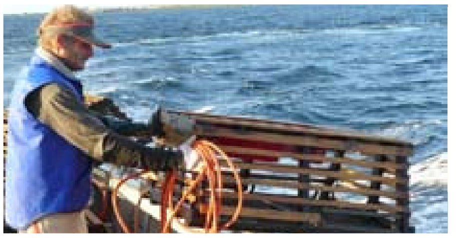
The following provides a comparison of the situation as at the first week of July 2008.

Mineral diesel

Retail price of diesel in WA	= $1.85/L
Effective price to lobster fisherman	= $1.30/L
Biodiesel production	
Canola delivered to port	= $730/t
Estimated price delivered to the biodiesel plant	= $700/t
Canola meal	= $500/t
Estimated cost of biodiesel produced (from Table 20 above)	= $1.31/L

These estimates indicate that the production of biodiesel is currently a break-even proposition with mineral diesel. A significant harvest of canola in the second half of 2008 in WA will see an increase in available supplies, and this may result in a easing of the price. Any easing of price will make the production of biodiesel more cost effective.



Ongoing comparison

Any comparison between biodiesel and mineral diesel will be immediately dated by a change in any of the main variables. Table 21 provides a simple template to monitor the ongoing relationship between the key variables involved, by taking the two-way sensitivity table for canola and canola meal and highlighting the ranges of retail diesel prices that relate to it (according to the colour coding seen in the below legend). While not precise, is does provide a very quick reference as to the relativity of the three prices (ie canola, canola meal and the retail price of mineral diesel).

Conclusions

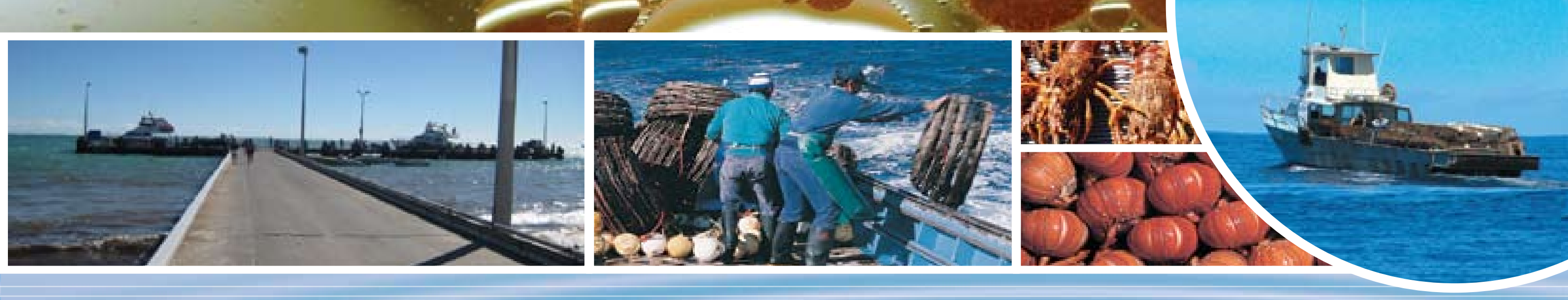
The price paid for canola seed and the price obtained for the meal produced are the two key factors that will determine the viability of biodiesel production from canola. The impact of relatively small changes in these prices ($50/t) is much greater than changes in the other costs involved in the production of biodiesel, such as the cost of capital, labour and other inputs. At the current price of diesel ($1.85/L), canola is very close to providing biodiesel at an equivalent cost.

Table 21. The comparison of canola and canola meal prices and the estimated cost of biodiesel produced (c/L) at those prices with the retail price of mineral diesel

Price of canola meal ($)	Price of canola ($/t)									
	350	400	450	500	550	600	650	700	750	800
250	82.1	95.3	108.4	121.6	134.7	147.9	161.0	174.2	187.4	200.5
300	73.5	86.7	99.9	113.0	126.2	139.3	152.5	165.6	178.8	192.0
350	65.0	78.1	91.3	104.5	117.6	130.8	143.9	157.1	170.3	183.4
400	56.4	69.6	82.8	95.9	109.1	122.2	135.4	148.5	161.7	174.9
450	47.9	61.0	74.2	87.4	100.5	113.7	126.8	140.0	153.1	166.3
500	39.3	52.5	65.6	78.8	92.0	105.1	118.3	131.4	144.6	157.8
550	30.8	43.9	57.1	70.3	83.4	96.6	109.7	122.9	136.0	149.2
600	22.2	35.4	48.5	61.7	74.9	88.0	101.2	114.3	127.5	140.6
650	13.7	26.8	40.0	53.1	66.3	79.5	92.6	105.8	118.9	132.1
700	5.1	18.3	31.4	44.6	57.8	70.9	84.1	97.2	110.4	123.5

Legend: The mineral diesel prices imposed above

Range in retail price (c/L)	Equivalent price to fishermen (c/L)
140 – 160	89.1 – 107.3
160 - 180	107.3 – 125.5
180 – 200	125.5 – 143.7



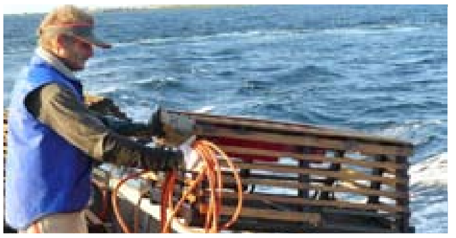
Chapter 11. Biodiesel fuel standards and draft regulations

Biodiesel must meet Australian fuel standards to attract Government excise allowances and to satisfy engine manufacturer warranties (see Chapter 12). The current standards for Australian biodiesel are set out in Table 22.

Table 22. Australian standards for biodiesel

Parameter	Standard	Test Method	Date of effect
Sulfur	50mg/kg (max) 10mg/kg (max)	ASTM D5453	18 Sep 2003 1 Feb 2006
Density	860–890kg/m^3	ASTM D1298 or EN ISO 3675	18 Sep 2003
Distillation T90	360°C (max)	ASTM D1160	18 Sep 2003
Sulfated ash	0.020% mass (max)	ASTM D874	18 Sep 2003
Viscosity	3.5–5.0mm ^{2}/s @ 40°C	ASTM D445	18 Sep 2003
Flashpoint	120.0°C (min)	ASTM D93	18 Sep 2003
Carbon residue (10% distillation residue) (100% distillation sample)	0.30% mass (max) OR 0.050% mass (max)	EN ISO 10370 ASTM D4530	18 Sep 2003
Water and sediment	0.050% vol (max)	ASTM D2709	18 Sep 2003
Ester content	96.5% (m/m) (min)	prEN 14103	18 Sep 2003
Phosphorus	10mg/kg (max)	ASTM D4951	18 Sep 2003
Acid value	0.80mg KOH/g (max)	ASTM D664	18 Sep 2003
Total contamination	24mg/kg (max)	EN 12662 ASTM D5452	18 Sep 2004
Free glycerol	0.020% mass (max)	ASTM D6584	18 Sep 2004
Total glycerol	0.250% mass (max)	ASTM D6584	18 Sep 2004
Oxidation stability	6 hours @ 110°C (min)	prEN 14112 or ASTM D2274 (as relevant for biodiesel)	18 Sep 2004
Metals	≤ 5mg/kg Group I (Na, K) ≤ 5mg/kg Group II (Ca, Mg)	prEN 14108, prEN 14109 (Group I) prEN 14538 (Group II)	18 Sep 2004
Methanol content	≤ 0.20%(m/m)	prEN 14110	18 Dec 2004
Copper strip corrosion (3hrs @ 50°C)	if the biodiesel contains no more than 10mg/kg of sulfur – Class 1 (max) if the biodiesel contains more than 10mg/kg of sulfur – No. 3 (max)	EN ISO 2160 ASTM D130 ASTM D130	18 Dec 2004
Cetane number	51.0 (min)	EN ISO 5165 ASTM D613 ASTM D6890 IP 498/03	18 Sep 2005



At present, the amount of biodiesel permitted in fuel blends is not limited by regulation, in contrast to bioethanol which has a 10% limit. At the time of report preparation, the Australian Government was going through a public consultation process seeking to amend that situation. The Executive summary of the discussion paper outining the Government's preferred position is presented below. Note that if the amendment goes through, industries such as the lobster industry could apply for permission to use higher percentage mixes.

Executive summary of Government's discussion paper

The Australian Government is considering management options for standardising diesel/biodiesel blended fuels to help provide certainly to market. A discussion paper *Setting National Fuel Quality Standards – Standardising Diesel/Biodiesel Blends* was released in November 2006, to obtain stakeholder views on the development of an appropriate position on the issue of diesel/biodiesel blends.

The Government has now developed a preferred management approach to diesel/biodiesel blends, which takes into account the wide range of stakeholder views received. The preferred approach is set out in this position paper, which was open for public comment until March 14, 2008.

The Government's preferred position on standardising diesel/biodiesel blends is to:

- Amend the Australian diesel standard (the *Fuel Standard (Automotive Diesel)* Determination 2001) to allow the addition of up to five per cent by volume of biodiesel[1], with the biodiesel component required to meet the biodiesel fuel quality standard (the *Fuel Standard (Biodiesel) Determination 2003*). The resulting blend will be required to be fully compliant with the fuel quality standard for diesel (the *Fuel Standard (Automotive Diesel) Determination 2001,* as amended): and
- In the short term, accommodate the supply of higher diesel/biodiesel blends (e.g. B20) through the *Fuel Quality Standards Act 2000,* Section 13 approvals process.

This approach takes into consideration three key factors:

1. The use of B5 diesel/biodiesel blends is *generally* accepted by Original Equipment Manufacturers (OEMs) as not requiring modifications of standard diesel engines[2].
2. Allowing up to five per cent biodiesel in the diesel fuel standard is consistent with current international practice.
3. The need for certainty and confidence for both retail and commercial consumers.

It is recognised that there are circumstances where supply of diesel/biodiesel blends greater than 5% biodiesel is appropriate. In the short term, supply above 5% can be accommodated through existing procedures within the *Fuel Quality Standards Act 2000*. It is proposed that this approval process will only be available where fuel is supplied for use in vehicles where individual OEM's have sanctioned use at higher concentrations e.g. in captive and/or commercial fleets.

The Government acknowledges that, in the longer term, with further developments in biofuel production and application, there may be a need to consider changes to the process for authorising the supply of blends above 5%. Any review of the Section 13 approvals process, and its longer applicability to biofuels, would be undertaken in consultation with the biofuels industry.

Further, recognising the consideration of 10% biodiesel/90% diesel blends (B10) by the European Commission, the Australian Government will establish a working group under the Fuel Standards Consultative Committee (FSCC) to monitor developments and consider issues relating to the use of higher blend levels in the current fleet, under Australian conditions.

The Australian Government is not proposing to require labelling of B5 diesel/biodiesel blends.

The full paper is available at **www.environment.govt.au/atmosphere/fuelquality/publications/pubs/diesel–position–paper.pdf.**

The key issues for WA's rock lobster industry are that, if it wishes to use blends higher than 5%, then boat owners would need to be satisfied that the biodiesel incorporated in mixes meets the Australian Biodiesel Fuel Standard and ensure manufacturers support the higher fuel mixes so engine warranties are not voided. (See Chapter 12 for engine manufacturer attitudes to biodiesel.)

[1] *This specification would be listed in the* Fuel Standard (Automotive Diesel) Determination 2001 *as Fatty Acid Methyl Ester (FAME) content – 5% (vol/.vol) max.*

[2] *The Federal Chamber of Automotive Industries recommend that the resultant blend meet the* Fuel Standard (Automotive Diesel) Determination 2001.

Chapter 12. Engine performance, manufacturer attitudes and warranties

a) Performance and emissions characteristics

The information below is an extract on diesel performance from the US Department of Energy. The full document is available at **www.eia.doe.gov/oiaf/analysispaper/biodiesel/**.It is a fair coverage of the issues. Canola based biodiesel can be expected to behave much like soya oil based biodiesel, in that its cold weather characteristics are better than biodiesel derived from animal fats or palm oil. WA does not get the severe winters experienced in much of the continental US, and it is unlikely that canola biodiesel would cause cloud point or cold start problems here.

A point not picked up in the summary is that high percentage blends and pure biodiesel have caused some problems with plastic and rubber components in older engines. Those planning to use biodiesel should check the compatibility of those components with engine manufacturers. Many newer engines have materials that are more resistant to this problem.

Extract from the US Department of Energy

"One of the most important characteristics of diesel fuel is its ability to autoignite, a characteristic that is quantified by a fuel's cetane number or cetane index, where a higher cetane number or index means that the fuel ignites more quickly. US petroleum diesel typically has a cetane index in the low 40s, and European diesel typically has a cetane index in the low 50s.

Graboski and McCormick have summarised several experimental studies of biodiesel characteristics. They report that the cetane number for biodiesel ranges from 45.8 to 56.9 for soybean oil methyl esters, with an average of 50.9. In comparison the cetane index for petroleum diesel ranges from 40 to 52. They imply that careful production control could result in biodiesel products with cetane numbers in the high end of the range, whereas petroleum diesel tends toward the low end of the range. US refiners use the catalytic cracking and coking processes to increase gasoline output from oil refineries, yielding high-octane gasoline material but low-cetane diesel material.

Lubricity, another important characteristic of diesel fuel, is a measure of lubricating properties. Fuel injectors and some types of fuel pumps rely on fuel for lubrication. One study, published in 1998 and cited by the National Biodiesel Board, found that one-half of samples of petroleum diesel sold in the United States did not meet the recommended minimum standard for lubricity. Biodiesel has better lubricity than current low-sulfur petroleum diesel, which contains 500 parts per million (ppm) sulfur by weight. The petroleum diesel lubricity problem is expected to get worse when ultra-low-sulfur petroleum diesel (15 ppm sulfur by weight) is introduced in 2006. A 1- or 2% volumetric blend of biodiesel in low-sulfur petroleum diesel improves lubricity substantially It should be noted, however, that the use of other lubricity additives may achieve the same effect at lower cost.

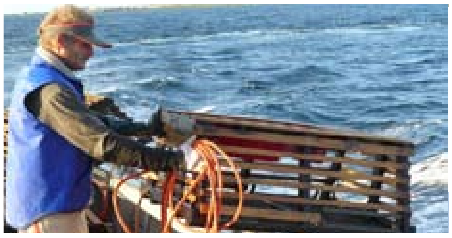
Biodiesel also has some performance disadvantages. The performance of biodiesel in cold conditions is markedly worse than that of petroleum diesel, and biodiesel made from yellow grease is worse than soybean biodiesel in this regard. At low temperatures, diesel fuel forms wax crystals, which can clog fuel lines and filters in a vehicle's fuel system. The 'cloud point' is the temperature at which a sample of the fuel starts to appear cloudy, indicating that wax crystals have begun to form. At even lower temperatures, diesel fuel becomes a gel that cannot be pumped. The 'pour point' is the temperature below which the fuel will not flow. The cloud and pour points for biodiesel are higher than those for petroleum diesel.

Vehicles running on biodiesel blends may therefore exhibit more drivability problems at less severe winter temperatures than do vehicles running on petroleum diesel. This is a potential concern during the winter in much of the US. The solvent property of biodiesel can cause other fuel-system problems. Biodiesel may be incompatible with the seals used in the fuel systems of older vehicles and machinery, necessitating the replacement of those parts if biodiesel blends are used. The initial use of B20 or B100 in any vehicle or machine requires care. Petroleum diesel forms deposits in vehicular fuel systems, and because biodiesel can loosen those deposits, they can migrate and clog fuel lines and filters.

Another disadvantage of biodiesel is that it tends to reduce fuel economy. Energy efficiency is the percentage of the fuel's thermal energy that is delivered as engine output, and biodiesel has shown no significant effect on the energy efficiency of any test engine. Volumetric efficiency, a measure that is more familiar to most vehicle users, usually is expressed as miles traveled per gallon of fuel (or km/L of fuel). The energy content per gallon of biodiesel is approximately 11% lower than that of petroleum diesel. Vehicles running on B20 are therefore expected to achieve 2.2% (20% x 11%) fewer miles per gallon of fuel.

About 11% of the weight of B100 is oxygen. The presence of oxygen in biodiesel improves combustion and therefore reduces hydrocarbon, carbon monoxide, and particulate emissions; but oxygenated fuels also tend to increase nitrogen oxide emissions. Engine tests have confirmed the expected increases and decreases of each exhaust component from engines without emissions controls. Biodiesel users also note that the exhaust smells better than the exhaust from engines burning conventional diesel.



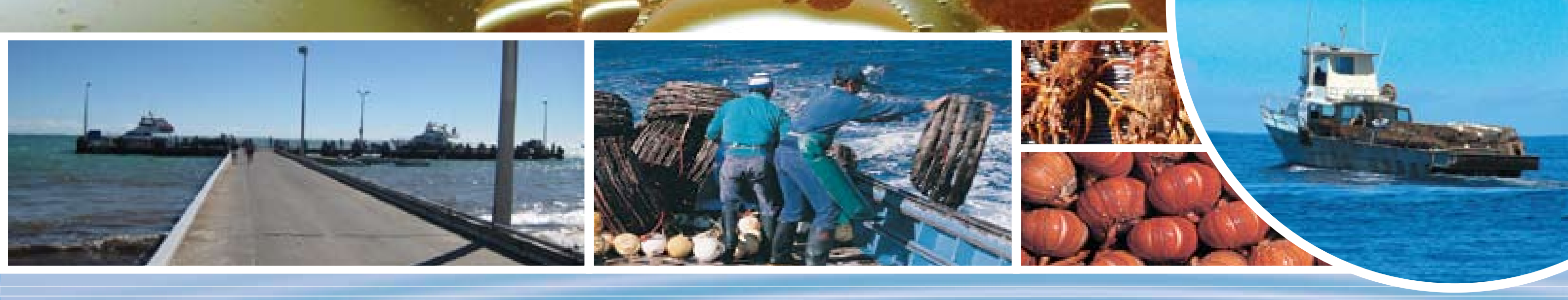
The increase in nitrogen oxide emissions from biodiesel is of enough concern that the National Renewable Energy Laboratory (NREL) has sponsored research to find biodiesel formulations that do not increase nitrogen oxide emissions. Adding cetane enhancers — di-tert-butyl peroxide at 1% or 2-ethylhexyl nitrate at 0.5% —can reduce nitrogen oxide emissions from biodiesel, and reducing the aromatic content of petroleum diesel from 31.9% to 25.8% is estimated to have the same effect. In the case of petroleum diesel, the reduction in aromatic content can be accomplished by blending fuel that meets US Environmental Protection Agency (EPA) specifications with fuel that meets California Air Resource Board (CARB) specifications. EPA diesel contains about 30% aromatics, and CARB diesel is limited to 10% aromatics.

Nitrogen oxide emissions from biodiesel blends could possibly be reduced by blending with kerosene or Fischer-Tropsch diesel. Kerosene blended with 40% biodiesel has estimated emissions of nitrogen oxide no higher than those of petroleum diesel, as does Fischer-Tropsch diesel blended with as much as 54% biodiesel. These results imply that Fischer-Tropsch diesel or kerosene could be used to reduce nitrogen oxide emissions from blends containing 20% biodiesel, although the researchers did not investigate those possibilities. Blending di-tert-butyl peroxide into B20 at 1% is estimated to cost 17 cents per gallon (2002 cents), and blending 2-ethylhexyl nitrate at 0.5% is estimated to cost 5 cents per gallon.

Oxides of nitrogen and hydrocarbons are ozone precursors. Carbon monoxide is also an ozone precursor, but to a lesser extent than unburned hydrocarbons or nitrogen oxides. Air quality modeling is needed to determine whether the use of biodiesel without additives to prevent increases in nitrogen oxide emissions will increase or decrease ground-level ozone on balance.

Most biodiesel emission studies have been carried out on existing heavy-duty highway engines. The effects of biodiesel on emissions from heavy diesel engines meeting EPA's stringent Tier II emissions standards (slated for introduction in model year 2007) have not been determined, and the EPA has concluded that the results of biodiesel tests in heavy-duty vehicles cannot be generalised to light-duty diesel vehicles or off-highway diesel engines.

Biodiesel from virgin vegetable oil reduces carbon dioxide emissions and petroleum consumption when used in place of petroleum diesel. This conclusion is based on a life cycle analysis of biodiesel and petroleum diesel, accounting for resource consumption and emissions for all steps in the production and use of the fuel. NREL estimates that the use of soybean B100 in urban transit buses reduces net carbon dioxide emissions by 78.45%. The comparison of carbon dioxide emissions and energy use begins with soybean cultivation and petroleum extraction, proceeds with all applicable processing and transportation, and ends with combustion in the bus engine. The growth of the soybean plant is assumed to absorb as much carbon dioxide as is emitted by decomposition of crop residue after the harvest and by combustion of biodiesel in the engine. Petroleum-based chemicals and fuels are used to produce the soybeans, but soybean oil biodiesel contains energy from other sources, including solar energy. NREL estimates that B100 reduces life cycle petroleum consumption by 95% relative to petroleum diesel, assuming that the quantity of biodiesel is small enough not to affect production levels of soybeans or other crops. If crop production patterns changed significantly, then NREL's analysis might not be valid."



b) Engine manufacturer attitudes and warranties

Boat owners not only require fuel to be suitable for their engines, they also do not wish to jeopardise manufacturer warranties and guarantees, although as a general rule manufacturers do not guarantee engines against fuel related problems arising from any fuel source. In addition, many marine engines are only guaranteed for a year. Nevertheless, manufacturers do vary in their attitudes and the advice they give with respect to the use of biodiesel in their engines.

Engine manufacturer views about biodiesel are changing as the following shapes their positions.

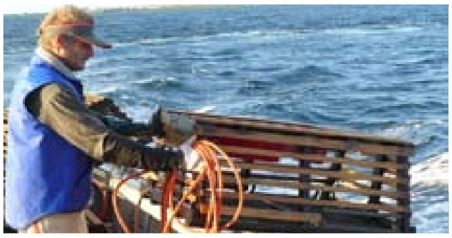
- They become more familiar with biodiesel as a fuel.
- Gain experience of running their engines for long periods under real working conditions.
- Respond to government policies on biofuels in the countries where they sell their engines; some countries are mandating levels of use of biofuels, often in the range E5 to E20.
- Attempt to attain 'green' credentials for their equipment in the market.

Not only do countries vary greatly in their attitudes to biofuels and the support mechanisms they put in place to encourage the industry, but manufacturers also have different attitudes across country borders as they attempt to respond to local market conditions.

In Appendix 6, details of websites for extracts from two major sources of information about engine manufacturer attitudes are shown. The websites are regularly updated and anyone planning to use biodiesel in engines should visit these sites for the latest information. In addition, most engine manufacturers provide comment on biodiesel on their own websites.

Information in this report should not be taken as definitive. When considering putting biodiesel into an engine, boat owners should check with the Australian representative of the engine manufacturing company, to ensure the information they receive applies to their engine model and condition of use.



Chapter 13. Government regulations and assistance

Australian excise, tax and support arrangements for biodiesel production are quite complex. Changes are scheduled to come in over the next few years and are a subject of continuing debate. The extract below from Batten and O'Connell (2007) summarises the position. The full paper is at **http://www.rirdc.gov.au/reports/BBE/07-177.pdf**. Anyone contemplating biodiesel production needs to be fully conversant with excise, taxation and support mechanisms. The Australian Taxation Office is an important information source for current arrangements. **http://www.ato.gov.au/.**

Because commercial rock lobster boat owners are classed as off-road primary producers, they receive a full rebate for excise (38.1c/L) and relief from GST as an input tax. Essentially then, much of the above does not apply to them. However, if they wished to sell biodiesel they produce to others, either private road vehicles or road transport vehicles, the above provisions become important.

Extract from Batten and O'Connell

Because most biofuels cost more to produce than petroleum products, their use has been assisted in several ways to enable ethanol and biodiesel to compete with petrol and diesel. Assistance is currently provided to all producers in the form of a production grant of 38.1c/L, which fully offsets the excise paid on biofuels. New facilities approved under the Biofuels Capital Grants Programme also receive a capital grant that provides around 1c/L in additional assistance over the lifetime of the plant.

Future assistance to biofuels is scheduled to fall to 12.5c/L for ethanol and 19.1c/L for biodiesel by 1 July 2015, and to continue at those levels indefinitely. Thus, new biofuels plants need to be constructed and become operational as soon as is possible – so as to capture sufficient benefits during the fuel-tax concession period and generate acceptable rates of return on capital (Biofuels Taskforce 2005).

However, most of the proposed plants still require capital and supply contracts to proceed.

The rationale for the new excise structure (see Tables 23 and 24) relates to differences in energy content, and to the level of assistance that will be given to encourage substitution of cleaner fuels for petrol and diesel. A banded excise system imposes three different rates on fuels, depending on their energy content. The excise rate for each band roughly reflects the energy content fuel relative to that of petrol and diesel. A san incentive for consumption of biofuels and other alternative fuels, excise rates for these fuels has been set at half the rate for oil-based fuels in the same energy content band. The excise transition path – or changes to the excise structure over time – is tabulated in Table 24.

Table 23. Selected fuel excise rates to apply at the end of the phase-in period

Fuel type	Energy content (MJ/L)	Excise rate (c/L)	Alternative fuels (c/L)
High-energy content fuels Petrol, diesel, biodiesel, GTL diesel	> 30	38.143	19.2 Biodiesel
Mid-energy content fuels LPG, LNG, ethanol, Di Methyl Ether	20–30	25	12.5 LPG, ethanol, LNG
Low-energy content fuels Methanol	<20	17	8.5 Methanol

Table 24. Excise transition path for fuels entering the excise net

Fuel type	Unit	July 2003–July 2010	July 2011	July 2012	July 2013	July 2014	July 2015
High-energy content fuels: Biodiesel	cent/L	0	3.8	7.6	11.4	15.3	*19.1*
Mid-energy content fuels: LPG, LNG, ethanol	cent/L	0	2.5	5.0	7.5	10.0	*12.5*
Low-energy content fuels : Methanol, *CNG*	cent/L	0 *0*	1.7 *3.8*	3.4 *7.6*	5.1 *11.4*	6.8 *15.2*	*8.5* *19.0*





This strategy broadly keeps constant the excise payable per kilometre travelled by vehicles using the fuel. For example, ethanol on a per litre basis contains 68% of the energy of petrol. The non-discounted excise rate for ethanol (25c/L) is around 65% of petrol's excise. Thus, this structure compensates for the fact that transport users of the fuel need one third more ethanol than petrol to drive a given distance.

Import competition could have an effect on domestically produced ethanol from 1 July 2011, depending on the relative competitiveness of imported ethanol compared with that which is domestically produced. While the Biofuels Taskforce did not predict this for 2011, it noted that the quote for the world ethanol price in April 2005 (about 42c/L) was below the reported Australian ethanol sale prices (in the mid-60c/L range) at that time (Biofuels Taskforce 2005).

Only domestic producers are eligible for the excise rebate from the Australian Government. Ethanol imports are subject to both a general tariff of five per cent (zero, if imports are from the US) and the full excise of mid-energy fuels of 25c/L. This differential treatment of domestic and imported sources reduces competitive pressures on domestic producers, and has been described by the Centre for International Economics (2005), as an unofficial tariff on imports.

This differential treatment of domestic and imported sources reduces competitive pressures on domestic producers and could result in the industry being less efficient than overseas competitors. This treatment does not seem to be closely related to major policy benefits of biofuel use, namely greenhouse gas emissions and urban air quality.

Chapter 14. Environment issues — biodiesel processing plants

Biofuel production is an industrial operation and, as such, it must meet all environmental clearances required by the three tiers of government — Commonwealth, State and Local. Listed below are matters that will need to be considered. These are raised for awareness only. The actual requirements will be site specific and will require extensive negotiation, once a decision is taken to proceed with a biodiesel manufacturing facility. They are thus beyond the scope of this report. Single operators producing small quantities of biodiesel on farms and/or similarly remote locations should not have onerous approval processes. Medium to large facilities will face significant approval processes, and ongoing monitoring is likely.

Environmental approvals

While biodiesel manufacture is a well established process, there are environmental and occupational health and safety issues that need to be addressed. For anything beyond a small single operator, EPA approval will be required under the provisions of the EPA Act. In some cases, depending on locality, single operators may also require approvals. The following issues are pertinent.

Air Quality

If oilseed crushing is carried out, odour emissions are likely to be an issue. Odours may also be generated if substrates such as tallow are utilised. Meal storage and packing facilities may also cause problems from time to time. Volatiles used in processing, such as methanol and the glycerol produced as a byproduct of biodiesel manufacture, may also cause undesirable odours from time to time.

Particulates

Particulates are unlikely to be a significant problem in a well run facility, but will need to be monitored.

Volatiles

Methanol is used in large quantities in biodiesel manufacture. It is highly volatile and may cause complaints from neighbouring sites.

Dust

Dust from the large volume of truck traffic could be an issue if unsealed roads exist inside or outside the manufacturing facility. Sealed surfaces inside the facility are recommended.

Traffic management

Local government will have attitudes about traffic volumes, the nature of traffic and parking, which need to be cleared with authorities at the design stage.

Noise

Truck movement, 24 hour operation and grinding and packing machinery may cause problems with neighbours and will require attention at the planning stage.

Water supplies

Water is required in significant quantities for most biodiesel production technologies, as part of the final fuel scrubbing process .

Drainage

Water runoff from large areas of sealed surfaces and water from roofs will require management, particularly as spilt oils and biodiesel may be carried with the waste water. Seepage of oils, biodiesel and methanol to groundwater is also an issue, as with any petroleum related facility. Proximity to waterways will need to be addressed.

Spills

Contingency plans and emergency response procedures are likely to be required for spill management.

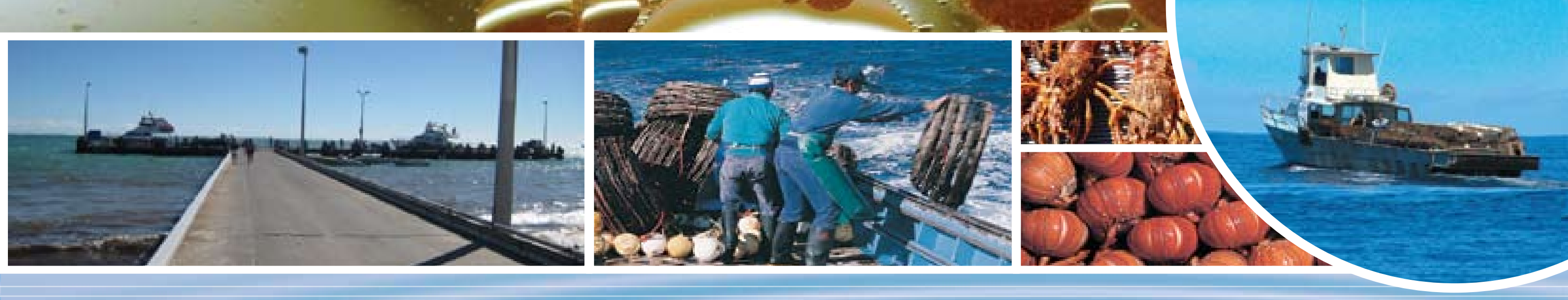
Visual amenity

As an industrial facility with large tanks, sheds and pipework, often floodlight at night, the site may be seen as undesirable by neighbours. Some beautification works may be required.

Culture and heritage

Community culture and heritage issues may require examination and attention at some sites.

The Environmental Protection Authority of WA website will assist with an understanding of the above issues **(http://www.epa.wa.gov.au/)** and the WA Government Biofuels Taskforce Report **(http://www.agric.wa.gov.au/content/sust/biofuel/BiofuelsTaskforcereportApr07.pdf)** gives detailed information on the requirement for approval of a biofuel production facility in WA (p.35).



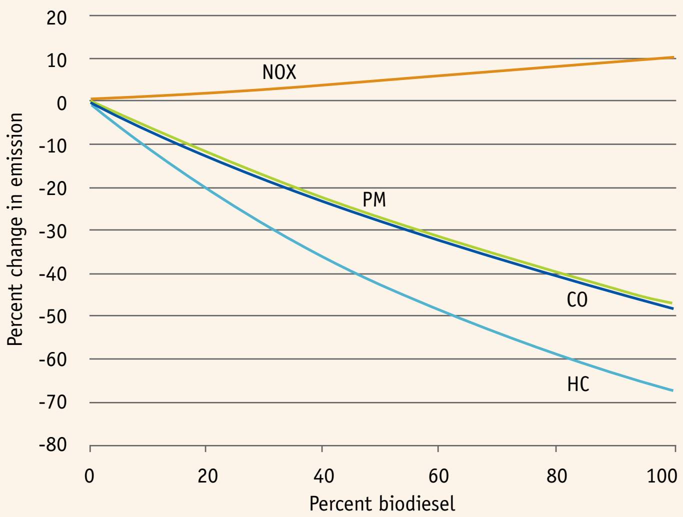
Chapter 15. Environment issues — external environments

The impact of biodiesel on the environment is considered here briefly in three parts, firstly the impact on air pollution, secondly on greenhouse gas emissions and, thirdly the degradation of biodiesel in the event of spills in marine environments. There is a large amount of literature on these issues and a full summary is beyond the scope of this report. The following information has been drawn from the Australian Government Taskforce Report (2005), the WA Government Biofuels Taskforce Report (2007), Biofuels in Australia – Issues and Prospects (2007) and marine fuel pollution websites.

Air pollution from exhaust emissions

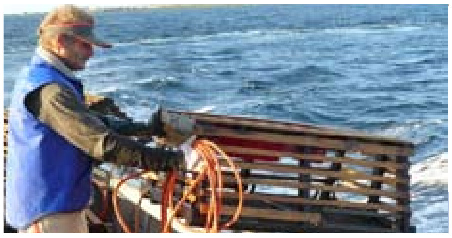
Noxious air pollutants arising from fuels in exhaust emissions are: particulates (smoke, soot), carbon monoxide, nitrogen oxides, volatile organic compounds, ozone and air toxics. The figure below (US EPA 2002) shows the emission profile for several pollutants at different levels of biodiesel in the fuel mix, ranging from pure diesel to pure biodiesel. Overall, biodiesel provides large reductions in tailpipe emissions of total hydrocarbons (HC), carbon monoxide (CO) and particulate matter (PM). There is a slight rise in the undesirable green house gas nitrous oxides (NOX). The reduction is proportional to the amount of biodiesel in the mix. B100 also has the advantage of having no sulfur or aromatics.

Figure 4. The emission profile for sevel pollutants at different levels of biodiesel in the fuel mix, ranging from pure diesel to pure biodiesel



Source: US EPA, 2002



Greenhouse gas emissions

Greenhouse gas emissions are of considerable interest, due to the imminent introduction of carbon taxes/emissions trading. The difficulty in assessing the net benefit of biodiesel, or any other new energy option compared with fossil fuels, is being able to assign values to all the 'unders and overs' in the entire production and fuel burning stream. This is called Life Cycle Analysis (LCA). For biodiesel production from canola, it usually includes: the production of canola on-farm (fuel, seed, fertiliser etc. and the energy entrained in machinery and infrastructure); the energy balances of all the inputs and outputs of the biofuel processing plants; and burning the fuel, in this case, in boats. The methodology is complex, as can be imagined, but it now mostly proceeds on defined protocols of approach. Table 26 gives an example of an LCA for B100 biodiesel being produced, and finally burned in a rigid truck (the nearest available comparison to a marine engine) in comparison with other sources and pure mineral diesel. The table is extracted from the AGBT (2005) and WA State Government Biofuels Taskforce (2007).

Table 25 indicates significant positive benefits from biodiesel. These results should translate satisfactorily to marine engines.

Degradation in marine environments

Information on the impact of biodiesel spills into a marine environment, compared with mineral-based diesel, is still being collected as use in marine applications is currently small. However, the overall picture is positive. Based on their chemical composition, biodiesel (or C16-18 methyl esters) are considered biodegradable. In tests by the University of Idaho, biodiesel in an aqueous solution was 95% degraded after 28 days, while diesel fuel was only 40% degraded. In another study by the same university, in an aquatic environment (rather than the laboratory) biodiesel was 85% degraded in 28 days (about the same rate as dextrose sugar) while diesel degradation was 26.4%.

Research continues on biodiesel degradation in environments. Conferences are scheduled on the topic and it is expected that the knowledge base will grow rapidly as biodiesel is already being used on inland waterways in Europe. Nonetheless, biodiesel is classified as a fuel by environmental authorities and the normal precautions to prevent fuel spills are required by authorities.

Table 25. A life cycle analysis of for biodiesel being produced and burned in a rigid truck

	Impact category (full life cycle) (% change to each diesel type)				
	Biodiesel (canola) B100	Biodiesel (tallow) B100	Biodiesel (waste oil) B100	ULSD diesel (from 2006)	XLSD diesel (from 2009)
To ULSD					
CO	-27.24	-36.7	-46.91	base	-1.35
NO_X	16.79	15.33	4.1	base	-10.12
VOC	-26.11	-29.2	-45.24	base	-4.9
PM	-15.14	-15.83	-23.4	base	-4.55
To XLSD					
CO	-26.25	-35.83	-46.2	1.37	base
NO_X	29.94	28.31	15.8	11.26	base
VOC	-22.32	-25.55	-42.43	5.14	base
PM	-11.1	-11.82	-19.73	4.77	base

Source: AGBT, 2005 (adapted from the 2003, 350ML Target Report)

Chapter 16. Occupational Health and Safety issues

The previous chapter on environmental issues raises several matters that, apart from impacting on the world outside the plant, could be important to the staff of a biodiesel production plant.

These include several issues relating to air quality and amenity: dust, particulates, volatiles and noise. The facility will handle large volumes of industrial liquids (methanol, biodiesel, glycerol and sodium hydroxide) and each has its own particular health and safety requirements in handling and storage.

Material Safety Data Sheets (MSDS) apply for each of these substances. Examples of MSDS are given at:

http://www.docep.wa.gov.au/worksafe/PDF/Guidance_notes/MSDS_Dec_07.pdf

http://www.coogee.com.au/MSDS/MSDS_OperationsMethanol.pdf

http://www.arfuels.com.au/

Anyone producing any of these substances for sale is required to provide an MSDS to accompany the product. A biodiesel plant would require MSDS for biodiesel and glycerol and would need to have access to MSDS for methanol and caustic soda coming into the plant.

Chapter 17. Technical material reviewed

The following provides a bibliography of the technical information reviewed as part of this project. Some of the material has been referred to in the text of the report. The remainder is provided for information.

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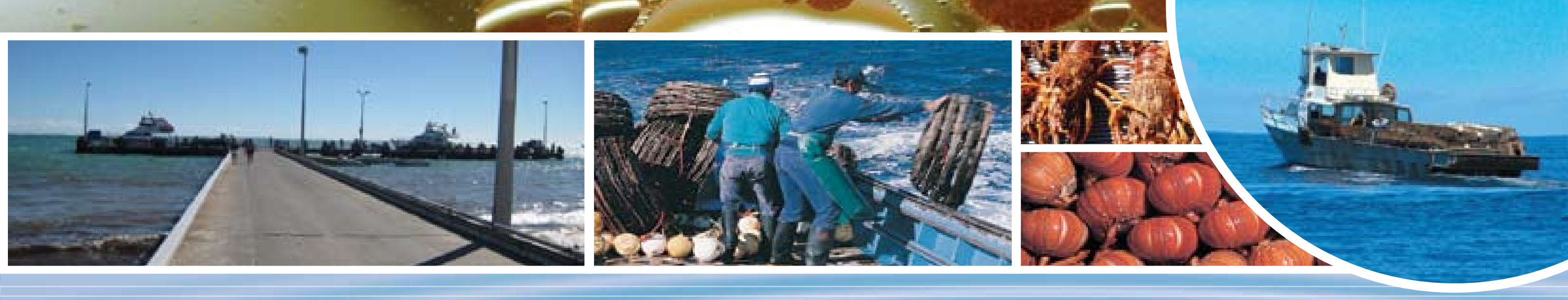

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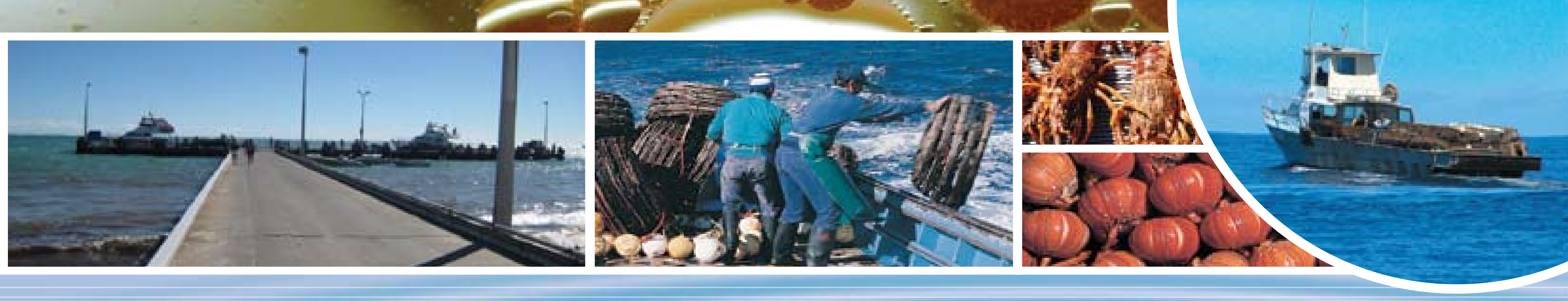
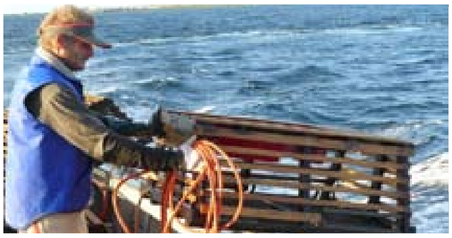


Chapter 18. Appendices

1. Summary of the Australian Biodiesel Standard — Australian Government
2. Position paper on biodiesel blends — Australian Government
3. Frequently asked questions — Biodiesel Association of Australia
4. Facts about diesel prices — Australian Institute of Petroleum
5. Diesel – frequently asked questions — Australian Government
6. Attitudes of engine manufacturers to biodiesel — US National Biodiesel Board
7. Guidance on blends above B20 — US National Biodiesel Board
8. Biodiesel excise, taxes and support — Australian Government
9. Australian canola meal guide for the feed industry — Australian Oilseeds Federation



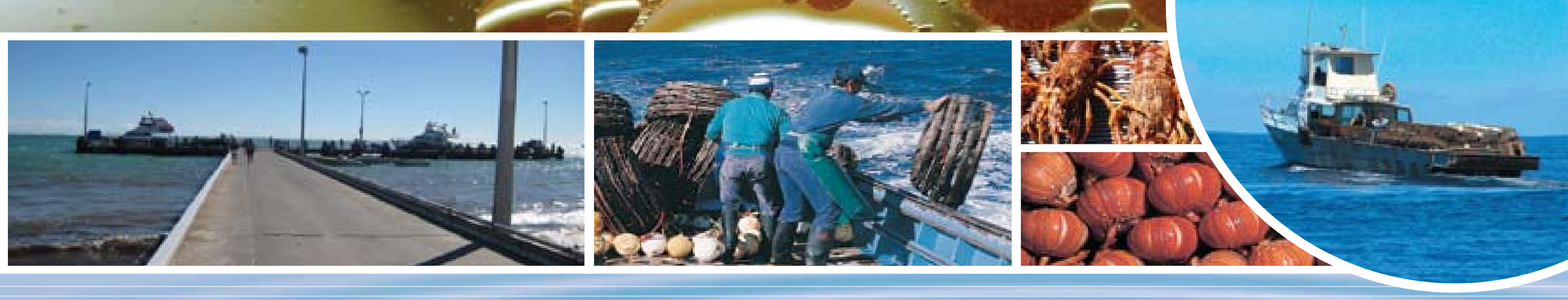
Appendix 1. Summary of the current Biodiesel Fuel Quality Standard

The biodiesel standard is summarised in the following table. The information contained in the following pages is of a general nature should only and be read in conjunction with the Fuel Quality Standards Act 2000, the Fuel Quality Standards Regulations 2001 and the Fuel Standard (Biodiesel) Determination 2003. Fuel suppliers may wish to seek legal advice about their obligations under this legislation.

See also: Fuel Standard (Biodiesel) Determination 2003.

Table 27. Australian standards for biodiesel

Parameter	Standard	Test method	Date of effect
Sulfur	50mg/kg (max) 10mg/kg (max)	ASTM D5453	18 Sep 2003 1 Feb 2006
Density	860–890kg/m^3	ASTM D1298 or EN ISO 3675	18 Sep 2003
Distillation T90	360°C (max)	ASTM D1160	18 Sep 2003
Sulfated ash	0.020% mass (max)	ASTM D874	18 Sep 2003
Viscosity	3.5–5.0mm^2/s @ 40°C	ASTM D445	18 Sep 2003
Flashpoint	120.0°C (min)	ASTM D93	18 Sep 2003
Carbon residue (10% distillation residue) (100% distillation sample)	0.30% mass (max) OR 0.050% mass (max)	EN ISO 10370 ASTM D4530	18 Sep 2003
Water and sediment	0.050% vol (max)	ASTM D2709	18 Sep 2003
Ester content	96.5% (m/m) (min)	prEN 14103	18 Sep 2003
Phosphorus	10mg/kg (max)	ASTM D4951	18 Sep 2003
Acid value	0.80mg KOH/g (max)	ASTM D664	18 Sep 2003
Total contamination	24mg/kg (max)	EN 12662 ASTM D5452	18 Sep 2004
Free glycerol	0.020% mass (max)	ASTM D6584	18 Sep 2004
Total glycerol	0.250% mass (max)	ASTM D6584	18 Sep 2004
Oxidation stability	6 hours @ 110°C (min)	prEN 14112 or ASTM D2274 (as relevant for biodiesel)	18 Sep 2004
Metals	≤ 5mg/kg Group I (Na, K) ≤ 5mg/kg Group II (Ca, Mg)	prEN 14108, prEN 14109 (Group I) prEN 14538 (Group II)	18 Sep 2004
Methanol content	≤ 0.20%(m/m)	prEN 14110	18 Dec 2004
Copper strip corrosion (3 hrs @ 50°C)	if the biodiesel contains no more than 10mg/kg of sulfur – Class 1 (max) if the biodiesel contains more than 10mg/kg of sulfur – No. 3 (max)	EN ISO 2160 ASTM D130 ASTM D130	18 Dec 2004
Cetane number	51.0 (min)	EN ISO 5165 ASTM D613 ASTM D6890 IP 498/03	18 Sep 2005



Appendix 2. Position paper on biodiesel blends — Australian Government

http://www.environment.gov.au/atmosphere/fuelquality/publications/diesel-biodiesel-position-paper.html

Appendix 3. Frequently asked questions — Biodiesel Association of Australia

This paper provides useful background on biodiesel. It must be remembered that the information is provided by a lobby group. In many cases, the material refers to the US situation, rather than to Australia specifically. The web address of the Biodiesel Association of Australia is **www.biodiesel.org.au.**

What is biodiesel?

Biodiesel (alkyl esters) is a cleaner-burning diesel fuel made from natural, renewable sources such as vegetable oils.

Is it approved for use?

Biodiesel is registered as a fuel and fuel additive with the Environmental Protection Agency (EPA) in the US and the Australian standard is currently being set by the Australian Government. Biodiesel is recognised by industry, federal and state governments as a valid alternative fuel. In fact, biodiesel is listed as one of the fuels eligible for a fuel rebate.

Why biodiesel?

The use of biodiesel in a conventional diesel engine results in a substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matter. Emissions of nitrogen oxides are either slightly increased, depending on the duty cycle and testing methods. The use of biodiesel decreases the solid carbon fraction of particulate matter (since the oxygen in biodiesel enables more complete combustion to CO_2), eliminates the sulphate fraction (as there is no sulphur in the fuel), while the soluble, or hydrocarbon, fraction stays the same or is increased. Therefore, biodiesel works well with: new technologies such as catalysts (which reduce the soluble fraction of diesel particulate, but not the solid carbon fraction); particulate traps; and exhaust gas recirculation (potentially longer engine life due to less carbon).

What are the benefits?

Because it is renewable and domestically produced, biodiesel fits well to help ensure national energy security through replacing imported petroleum products with domestic alternative fuels.

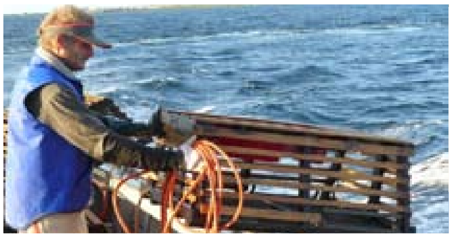
While its emissions profile is lower, biodiesel functions in the engine the same as petroleum diesel. Biodiesel delivers emissions reductions while maintaining current fleets, refuelling stations, spare parts inventories and skilled diesel mechanics. Biodiesel can be substituted for diesel with essentially no engine modifications and it maintains the payload capacity and range of diesel.

Is the use of biodiesel covered under engine warranties?

Manufacturer warranties cover defects in material and workmanship, and those warranties extend to engines burning biodiesel. These warranties do not cover engine problems related to fuel of any kind. Tests and demonstrations, however, have shown that biodiesel is no different from petroleum diesel in terms of engine performance and wear.

Is biodiesel exhaust less harmful than petroleum-based diesel exhaust?

Biodiesel is safer for people to breathe. Research conducted in the US showed biodiesel emissions have significantly decreased levels of all target polycyclic aromatic hydrocarbons (PAH) and nitrited PAH compounds, as compared to petroleum diesel exhaust. PAH and nPAH compounds have been identified as potential cancer causing compounds. Results of the subchronic inhalation testing showed no toxic results from biodiesel exhaust emissions — even at the highest concentrations physically possible to achieve. These results conclusively demonstrate biodiesel's health and environmental benefits as a non-toxic, renewable fuel.



The use of biodiesel in a conventional diesel engine also results in a substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matter, when compared to emissions from diesel fuel. In addition, the exhaust emissions of sulphur oxides and sulphates (the major components of acid rain) from biodiesel, are essentially eliminated compared to diesel.

Of the major exhaust pollutants, both unburned hydrocarbons and nitrogen oxides are ozone or smog forming precursors. The use of biodiesel results in a substantial reduction of unburned hydrocarbons. Emissions of nitrogen oxides are either slightly reduced or slightly increased, depending on the duty cycle of the engine and testing methods used. Based on engine testing, using the most stringent emissions testing protocols required by EPA for certification of fuels or fuel additives in the US, the overall ozone forming potential of the speciated hydrocarbon emissions from biodiesel was nearly 50% less than that measured for diesel fuel.

Can biodiesel help mitigate 'global warming'?

A 1998 biodiesel lifecycle study, jointly sponsored by the US Department of Energy and the US Department of Agriculture, concluded biodiesel reduces net CO^2 emissions by 78% compared to petroleum diesel. This is due to biodiesel's closed carbon cycle. The CO^2 released into the atmosphere when biodiesel is burned is recycled by growing plants, which are later processed into fuel.

Is biodiesel safer than petroleum diesel?

Scientific research confirms that biodiesel exhaust has a less harmful impact on human health than petroleum diesel fuel. Biodiesel emissions have decreased levels of polycyclic aromatic hydrocarbons (PAH) and nitrited PAH compounds, which have been identified as potential cancer causing compounds. In recent testing, PAH compounds were reduced by 75-85%, with the exception of benzo(a)anthracene, which was reduced by roughly 50%. Targeted nPAH compounds were also reduced dramatically with biodiesel fuel, with 2-nitrofluorene and 1-nitropyrene reduced by 90%. The rest of the nPAH compounds were reduced to only trace levels.

Does biodiesel cost more than other alternative fuels?

When reviewing the high costs associated with other alternative fuel systems, many fleet managers believe biodiesel is their least-cost-per-compliance mile option. The use of biodiesel does not require major engine modifications. That means operators keep their fleets, their spare parts inventories, their refuelling stations and their skilled mechanics. The only thing that changes is air quality.

Do I need special storage facilities?

In general, the standard storage and handling procedures used for petroleum diesel can be used for biodiesel. The fuel should be stored in a clean, dry, dark environment. Acceptable storage tank materials include aluminium, steel, fluorinated polyethylene, fluorinated polypropylene and Teflon. Copper, brass, lead, tin and zinc should be avoided.

Can I use biodiesel in my existing diesel engine?

Biodiesel can be operated in any diesel engine with little or no modification to the engine or the fuel system. Biodiesel has a solvent effect that may release deposits accumulated on tank walls and pipes from previous diesel fuel storage. The release of deposits may clog filters initially, and precautions should be taken. Ensure that only fuel meeting the biodiesel specification is used.

How is biodiesel marketed today?

In the US, beginning in November 1998 with the passage of the federal EPACT amendments, which allowed biodiesel greater access to the alternative fuels market, biodiesel has become one of the fastest (if not the fastest) growing alternative fuel in the country. In addition to being marketed as an alternative fuel technology to meet EPACT requirements, biodiesel has also seen widespread acceptance as a fuel lubricity additive in diesel fuel.

Where is biodiesel being used today as a fuel lubricity additive?

The largest user of biodiesel in the world is France. They add up to 5% of biodiesel to all low sulphur diesel sold in that country.

A total of seven companies in the US have released premium additive packages containing biodiesel, in which biodiesel is a major marketing aspect of the products. In the summer of 1999, Koch – the second largest privately owned company in the US behind Cargill – launched a new premium diesel fuel product, US SoyField Diesel, which is now in over 20 terminals in the midwest and expanding. Also in 1999, Country Energy (the Farmland/Cenex petroleum joint venture) launched SoyMaster, their proprietary premium diesel containing biodiesel in four terminals in the Midwest.





Will biodiesel play a role in the EPA's recent proposed regulation that limits sulphur content in diesel fuel?

In May, 2000, the EPA proposed a reduction in the sulphur content of highway diesel fuel of over 95% from its current level of 500 ppm. Biodiesel has no sulphur or aromatics and tests have documented its ability to increase fuel lubricity significantly, when blended with petroleum diesel fuel — even at very low levels. The currently proposed ultra-low sulphur diesel fuel regulations, designed to help protect human health, will require the addition of a lubricity additive. Biodiesel could be included as a low level blending component in diesel fuel as a means to improve fuel lubricity while providing environmental, economic and energy security benefits to diesel users and the public at the same time.

How much biodiesel would need to be added to provide sufficient fuel lubricity in diesel fuel?

Testing has confirmed that biodiesel can provide sufficient levels of fuel lubricity, even at blend levels below 1%, in current on-road diesel fuel. Testing is underway to determine specific blend levels that would be required in ultra-low sulphur diesel fuel (15ppm).

If biodiesel was used in all of the on-road diesel fuel in the US, would the biodiesel industry be able to produce enough fuel to meet this demand?

If 1% biodiesel was blended with the national on-road diesel fuel pool, over 300 million gallons of biodiesel would be required. There are presently 13 companies who have invested millions of private dollars into the development of the biodiesel manufacturing plants and are actively marketing biodiesel. Based on existing dedicating biodiesel processing capacity and long-term production agreements, over 200 million gallons of biodiesel capacity currently exists. In addition, many dedicated biodiesel processing facilities are capable of doubling their production capacity within 18 months.

Are there any warranty implications associated with the use of biodiesel as a low level blending component in diesel fuel?

Biodiesel enjoys the support of the Fuel Injection Equipment industry as an option to solve the lubricity problem with petrodiesel. Stanadyne Automotive Corp., the leading independent US manufacturer of diesel fuel injection equipment, supports the inclusion of low levels of biodiesel in diesel fuel for two reasons. Firstly, it would eliminate the inherent variability associated with the use of other additives and whether sufficient additive was used to make the fuel fully lubricious. Secondly, Stanadyne considers biodiesel a fuel or a fuel component – not an additive. It is possible to burn pure biodiesel in conventional diesel engines. Thus, if more biodiesel is added than required to increase lubricity, there will not be the adverse consequences that might be seen if other lubricity additives are dosed at too high a level.

Are there any adverse conditions that could arise if biodiesel were to be overdosed?

No, biodiesel can be used as a pure product or blended at any percentage with petroleum diesel. Fuel Injection Equipment manufacturers, such as Stanadyne, concur that there would be no adverse effects if more than the suggested rate was used.

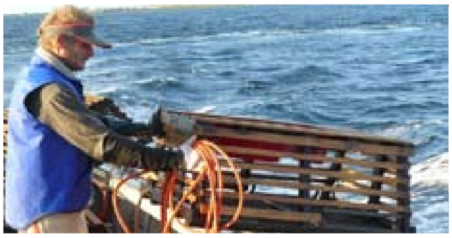
What is the industry doing to ensure biodiesel quality?

In December 1998, the American Society of Testing and Materials (ASTM) issued a provisional specification (PS 121) for biodiesel fuel. ASTM is the premier standard-setting organisation for fuels and additives in the US. The EPA has adopted the ASTM standard and state divisions of weights and measures currently are considering its adoption. This development was crucial in standardising fuel quality for biodiesel in the US market.

Can the lubricity benefits be gained through other sources?

Yes, replenishing the loss lubricity that will be apparent in future diesel fuel can be accomplished with conventional lubricity additives that are either on the market today, or are in the process of being formulated.



What is the cost of biodiesel compared to other petroleum based lubricity additives?

Economically, these products are the same or less expensive than biodiesel. Petroleum-based additives, however, do not have the same conservation, energy security, environmental, and economic benefits. All of these factors need to be weighed fully.

If 300 million gallons of biodiesel were consumed next year, would there be any environmental or economic impacts to the US?

A 1998 biodiesel lifecycle study jointly sponsored by the US Department of Energy and US Department of Agriculture, concluded that increased use of biodiesel would substantially benefit the national economy. Inclusion of biodiesel, even at very low levels, would immediately incorporate domestically produced fuels as an immediate supplement to the nation's current energy security programmes at little or no cost to the taxpayer. Increased biodiesel production would result in significant economic benefits to state economies, as well as agricultural producers. Increased use of biodiesel also results in significant environmental benefits.

The press has reported that for some alternative fuels it takes as much energy to process the fuel as the fuel contains. What is the energy balance of biodiesel?

For every one unit of energy needed to produce biodiesel, 3.24 units of energy are gained.

Is biodiesel safe?

Tests sponsored by the US Department of Agriculture confirm that biodiesel is less toxic than petroleum diesel and biodegrades as fast as dextrose (a test sugar). In addition, biodiesel has a flash point of over 125°C, which makes it safer to store and handle than petroleum diesel fuel.

Will burning biodiesel put more or less CO_2 into the atmosphere?

A US study has found that biodiesel production and use, in comparison to petroleum diesel, produces 78.5% less CO_2 emissions. Carbon dioxide is 'taken up' by the annual production of crops such as soybeans and then released when vegetable oil based biodiesel is combusted.

How much will the sale of biodiesel affect the price paid to farmers for their crops?

With agricultural commodity prices at record low levels and petroleum prices approaching record highs, it is clear more can be done to utilise domestic surpluses of renewable oils, such as soybean oil, while enhancing our energy security. A 1998 economic study conducted by the USDA Economic Research Service estimated that a sustained national market for 100 million gallons of biodiesel annually could increase the value of the US soybean crop by more than $250 million.

Has biodiesel been thoroughly tested?

Biodiesel has been extensively tested by government agencies, university researchers and private industry in the US, Canada and Europe. Many transit authorities within the US have conducted tests as well.

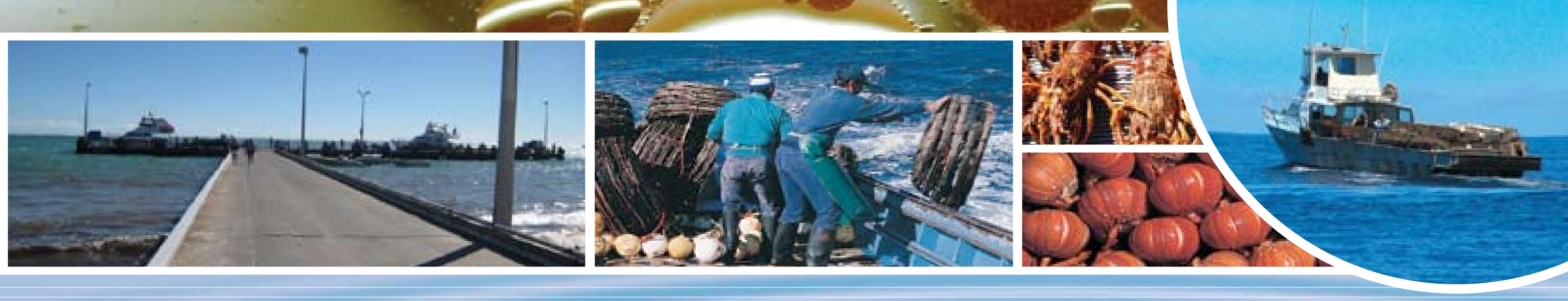
More than 100 biodiesel demonstrations, including three one-million-mile tests and more than thirty 50,000-mile tests, have logged more than 10 million road miles with biodiesel blends on US roads.

In these tests, performance, fuel mileage and drivability with biodiesel blends were similar to conventional diesel, but opacity levels were reduced and exhaust odour was less offensive. No adverse durability or engine wear problems were noted.

The biodiesel industry also has commissioned more than 40 independent studies to research benefits ranging from improved lubricity to biodegradability.

Who blends the fuel, and how is it done?

Diesel users can have their suppliers obtain biodiesel and simply blend it before delivery. Or they can have biodiesel delivered directly and mix it themselves. It blends easily, stays mixed and requires no special handling.



Which blend is best?

Depending on the application, climate and season the blend of biodiesel can be from 2% up to 100%. In Europe (especially France), where low sulphur diesel has been in-place for many years, biodiesel is added to provide the lubrication that was lost with the removal of the sulphur.

In environmentally sensitive areas (marine, alpine) and in mines where the maximum environmental benefit is required, 100% biodiesel is often used.

In the US, where biodiesel is in use in bus fleets, 20% biodiesel is mostly used — to address the best current balance of emissions, cost and availability.

How much does biodiesel cost?

That depends on the market price of diesel and vegetable oil. But, in general, 100% biodiesel will be anywhere from around the price of regular petroleum diesel up to 50% higher. However, when all the costs of meeting tougher emissions standards are considered (conversion, construction, insurance, etc.), an emissions management system based on biodiesel may be the least-cost option.

Surveys by Booz-Allen & Hamilton Inc., Sparks Companies, Inc., and the University of Georgia have found that a truck or bus fleet using a 20% biodiesel/80% petroleum diesel blend would experience lower total annual costs than other alternative fuels, when including capital requirements. Research into advanced farming practices and more efficient production would further reduce the cost of biodiesel.

Do I need special storage facilities?

Biodiesel or premixed blends can be stored wherever petroleum diesel is stored, except in concrete-lined tanks. At higher blend levels, biodiesel may result in some deterioration of rubber or polyurethane foam materials.

Who is using biodiesel?

Although biodiesel can be used in any diesel engine, among the first to switch to biodiesel include centrally fuelled fleets such as urban buses. In the US, it is now being used in transit bus fleets, heavy-duty truck fleets, airport shuttles, marine, national parks, military and mining operations, as well as other state and federal fleets.

Who else can benefit from biodiesel?

The reduction of our dependence of a 100% imported fuel and the introduction of a renewable technology benefits the entire country. The range of benefits include:

- Growth in rural economies.
- Reduced dependence on imported fuel.
- Improvement in Australia's balance of trade.
- Massive reduction in greenhouse emissions.
- Reduction of sulphur dioxide, one of the main causes of acid rain.
- Reduction of other cancer causing emissions such as benzene.
- Cheaper fuel.

Who can answer my questions about biodiesel?

The Biodiesel Association of Australia is more than happy to answer your questions or forward you to someone who can on biodiesel. Call (02) 9746 7617 for more information.

Appendix 4. Facts about diesel prices — Australian Institute of Petroleum

This paper provides a useful discussion of the factors that go to make up fuel price. It also includes graphs of prices through time. It is updated regularly and the website provides readers with latest information.

http://www.aip.com.au/pricing/facts/Facts_about_Diesel_Prices.htm

Appendix 5. Diesel — Frequently asked questions. Australian Government

http://www.ret.gov.au/Documents/200710DieselFactSheet20071120154536.pdf

Appendix 6. Attitudes of engine manufacturers to biodiesel — US National Biodiesel Board

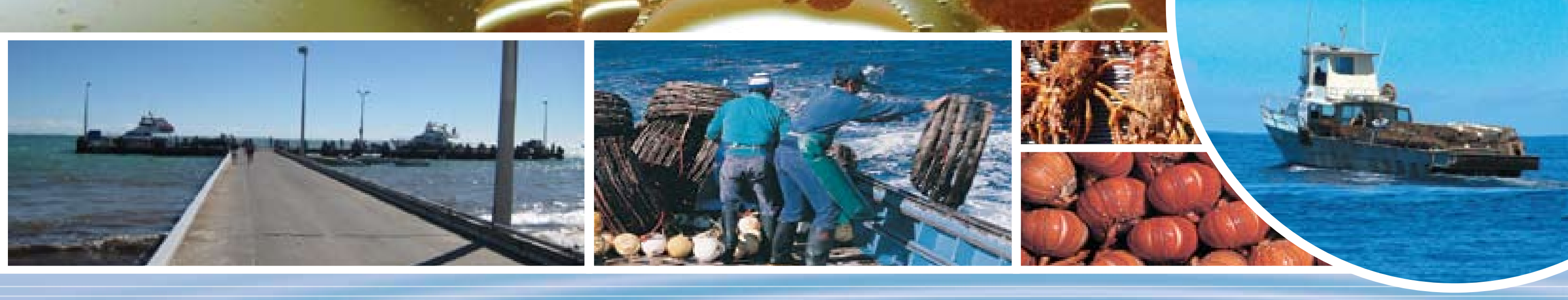
Information provided on engine manufacturer attitudes is regularly updated and readers should go to the website for latest information. Two useful sources are:

a) The US Biodiesel Board

http://www.biodiesel.org/pdf_files/OEM%20Statements/OEM_Statements_Summary.pdf

b) The EEP website

http://www.pprc.org/research/epp WarrantiesForBiodieselUse.pdf



Appendix 7. Guidance on blends above B20 — US National Biodiesel Board

This paper sets out issues relating to engines using greater than B20.

http://www.biodiesel.org/pdf_files/fuelfactsheets/Use_of_Biodiesel_Blends_above_%2020.pdf

Appendix 8. Biodiesel excise, taxes and support — Australian Government

The links below provide information on fuel excise generally and biodiesel excise in particular. The information is being constantly updated in line with policy changes by the Australian Government. The links give leads to many issues, grants and support mechanisms surrounding biofuels in Australia.

http://www.ato.gov.au

http://www.ato.gov.au/businesses/content.asp?doc=/Content/80526.htm

http://www.ato.gov.au/businesses/content.asp?doc=/Content/74398.htm

Appendix 9. Australian canola meal guide for the feed industry

The Australian Oilseeds Federation provides canola meal utilisation information at the following website.

http://www.australianoilseeds.com/__data/assets/pdf_file/0017/2591/Meal_Booklet-Net.pdf

Riverland Ltd, based in Pinjarra, WA, provides specifications for canola meal at the following website:

http://www.riverland.com.au/

A study completed by the Kondinin Group for the Western Rock Lobster Council and the Fisheries Research and Development Corporation

KONDININ GROUP

Australian Government
Fisheries Research and Development Corporation