Integration of First Generation Biodiesel into the Australian Diesel Fuel Market

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Declaration

This is my own account of my research, any external references are appropriately acknowledged.

I disclose that I was employed by BP Australia for part of the time that I was completing this dissertation. None of the content provides, or is based on information that is confidential to BP Australia.

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Abstract

In a carbon constrained world, transitioning some or all of the fuel for transport away from fossil fuels to renewable sources of energy will become increasingly important. This dissertation examines the current penetration of first generation biodiesel in the Australian diesel market and identifies the factors that will most influence current and future penetration.

The research identifies three critical factors in shaping penetration: price relativity to mineral (regular) diesel, government policy, and the environmental benefits of biodiesel. This dissertation concludes that these factors will be definitive in determining the penetration of biodiesel in the Australian diesel market.

Analysis of price relativity shows that mineral diesel is currently cheaper to supply than biodiesel, despite significant subsidisation. Importantly, the research also shows that biodiesel is likely to remain more expensive than mineral diesel under a carbon price or carbon tax regime.

The biodiesel policies and programs at the federal and state government levels are examined and critically assessed. The option of mandated targets is discussed and analysed. The research finds that despite several programs and policies currently in place, there is a lack of overall policy direction on biodiesel in the short term. The

analysis also highlights the significant potential for government policy to shape pricing relativity – either in favour of, or against biodiesel.

The environmental and sustainability benefits of first generation biodiesel are assessed. The emerging role of the various sustainability roundtables in providing sustainability assurance is outlined and discussed. The research concludes that biodiesel does offer both environmental and sustainability benefits over mineral diesel – providing that sustainability criteria are adhered to. The research also concludes that there is not a clear consensus on those credentials among the various stakeholders and that more needs to be done to increase awareness of those benefits to foster uptake.

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Acknowledgments

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1.0 Introduction

The International Energy Agency (IEA, 2008), in its *Energy Technology Perspectives 2008*, outlined a global 'blue map' scenario for the future evolution of biofuels in a world addressing the problem of climate change. The scenario was based on overall global carbon emission reductions of 50% by 2050 from a 2005 baseline level. This scenario envisaged the potential for biofuels to contribute a substantial portion of total carbon emission reductions in the longer term (2.2 of the 48 Gt CO_2/year) and 17% of the total reductions in the transport sector (67, 94). The IEA (2008) forecast that by 2050 second generation biofuels technologies (non-crop based biofuels, see section 2 for a full description of different generations of biodiesel technologies) would have fully matured, production costs would have greatly declined and global production increased exponentially as a result. While this paints an impressive picture for the future global potential for biofuels over the longer term, the immediate future for biofuels, and in particular biodiesel, is less clear. The immediate future is likely to be one where cost of technical change remains high, first generation feedstocks (plant crop and animal based feedstocks) are the only economically viable basis for production, and penetration of biofuels into the road transport market remains relatively low (Sims & Taylor 2008, 98).

Given the available technologies and feedstocks, as well as the dynamics of the existing fuels market, what are the determinant factors in shaping the market penetration of biodiesel in Australia? The objective of this paper is to outline the most significant determinant factors and to examine the current status of biodiesel in the Australian market from the perspective of these aspects. This paper looks at the short to medium

term timeframe, focusing specifically on one market – the Australian diesel fuel market, and one product – first generation biodiesel.

As will be discussed in this paper, currently available biodiesel has direct product substitution potential with mineral diesel ('regular', fossil fuel based diesel) and is available to the Australian market in sufficient quantity - including the potential to import further supplies. However the current penetration of biodiesel at less than 1% of the total Australian diesel market is glaringly low.[1] The reasons for this are complex. The literature, including government commissioned reports, show that sustainability and carbon emissions are a significant factor in shaping the relevant government policies (O'Connell et al. 2009; CSIRO 2008; Batten & O'Connell 2008).

Some policy advocates and organisations such as the International Energy Agency, who are attempting to develop technology roadmaps for biofuels and other renewable energy technologies, highlight that supply chain and infrastructure requirements are significant (Childs & Bradley 2007, 13; International Energy Agency 2008). The attributes of the product itself need consideration, particularly in relationship to existing product standards (O'Connell et al. 2009, 57).

Analysis by Robert Cooper (1994) of several hundred new product introductions over twenty years into existing markets shows that the most important driving factor in

[1] based on an estimated 0.4% penetration in 2006-7 by CSIRO (O'Connell et al. 2009, 20) and relatively little change in production capacity since that time (ABARE 2009)

achieving success is product superiority: a product that offers unmatched benefits in critical areas is far more likely to be successful than a product that does not.

This paper attempts to analyse the core product attributes and benefits of first generation biodiesel, assess whether product superiority exists and identify potential 'drivers' (elements that can create large scale change) for market penetration, including identifying potential institutional or regulatory changes that could lead to increased penetration. Close attention is paid to the current characteristics of the Australian diesel fuel market, with the view that it is the dynamics of the existing market that are important in shaping penetration in the short to medium term.

Part 1 of this paper provides an introduction to biodiesel in Australia, examining the characteristics of the product, the current production and consumption of the fuel in Australia, and looks closely at the functioning of the mineral diesel market in Australia.

Part 2 of this paper will analyse some key attributes of first generation biodiesel that have the potential to be driving factors for penetration:

1. Price relativity to mineral diesel – an analysis of the relevant costs in manufacturing and supplying mineral diesel and biodiesel to determine the potential for a price advantage either now or in the future.

2. Government policy – examining the current policy frameworks at the state and federal levels of government to determine whether there are policies in place that

will drive biodiesel penetration. The potential for future policy development to foster increased penetration is also examined.

3. Environmental and sustainability benefits over mineral diesel. The environmental and sustainability attributes of biodiesel are assessed, as well as the current perceptions of these attributes.

2.0 PART 1 – INTRODUCTION TO BIODIESEL IN AUSTRALIA

2.1 First Generation Biodiesel

Current generation (first generation) biodiesel is manufactured through the esterification process from plant or animal feedstock. By combining the feedstock with an alcohol and introducing a catalyst, water is condensed and removed, leaving the fatty acids behind. These fatty acids can then be combusted in current technology diesel engines in place of a petroleum based diesel fuel. Typical feedstocks used in biodiesel include tallow (animal fats), oilseeds and vegetable oil such as canola, soy or palm; and recycled products such as used cooking oils. An excellent description of the production process used by one of the major Malaysian producers of biodiesel, Carotech, is available at www.carodiesel.com.

Biodiesel can be used in a pure form (referred to as B100) or mixed with petroleum based diesel (mineral diesel) – common blends are 20% biodiesel to 80% mineral diesel (B20), 5% biodiesel to 95% mineral diesel (B5) and 2% biodiesel to 98% mineral diesel (B2). This product can then be used in place of mineral diesel, without any engine modification or other adaptation required (O'Connell et al. 2009, 21). As a fuel product biodiesel has some differences to mineral diesel, including higher viscosity, and a lower cloud point

(propensity to solidify at cold temperatures). Some of these provide benefits to end users, such as better lubrication properties (O'Connell et al. 2009, 66). However, these are not likely to position biodiesel as a superior product to mineral diesel from the perspective of engine performance. Indeed there are also product attributes of biodiesel that detract from any benefits, such as lower cloud point (minimum storage temperature) and some product quality issues (O'Connell et al. 2009, 59). Biodiesel greenhouse gas emissions are different from mineral diesel – usually lower, however they can potentially be higher under certain production regimes when examined from a life cycle emissions perspective (Beer et al. 2007, 91). Biodiesel emissions relative to mineral diesel emissions are examined in part 2.

2.2 Second and Third Generation Biodiesel

Second generation biodiesel is produced from non-food crops, usually from lignocellulosic feedstock such as crop, forest or wood process residues. They can also be produced from purpose grown perennial grasses or trees, such as Jatropha (Sims & Taylor 2008, 33). The feedstocks are usually processed through either a biochemical or thermochemical process. Second generation biodiesel technology is currently available, with several plants in the demonstration stage (Sims & Taylor 2008). However costs of production remain high and second generation biodiesel cannot yet compete with either mineral diesel or first generation biodiesel in Australia (O'Connell et al. 2009, 15).

Third generation, or advanced biodiesel, is sometimes considered a sub-group of second generation biodiesel. Usually produced from algal feedstock but including other liquid

fuel conversion technology this group of biodiesel is either in concept phase or in demonstration phase (Sims & Taylor 2008).

2.3 The Current Status of Biodiesel in Australia

In 2009 the Australian Bureau of Agricultural and Resource Economics (2009) established the current production rate of biodiesel in Australia at around 100 million litres per annum (65). This represents a total share of diesel produced in Australia of less than 1%. When the quantity of mineral diesel imported in Australia to meet consumption demand is considered, the total share of biodiesel in meeting Australian consumer diesel demand is less than 0.4% (19).The available capacity of biodiesel production facilities in Australia is significantly higher, at around 135 million litres per annum (64),[2] however a variety of factors, including high feedstock prices have resulted in production at below capacity in recent years (65-66).

Australia currently supports a relatively modest biodiesel industry – at early 2011 there were six biodiesel production facilities across Australia (Biofuels Association of Australia, 2010). In addition, some companies are importing biodiesel to sell into the Australian market. Biodiesel production in Australia is predominantly based on the use of tallow (animal fat) as a feedstock, with cooking oil also used as a base feedstock. Other feedstocks used include vegetable oil, poppy seed oil, canola oil and juncea (mustard

[2] The Biofuels Association of Australia (2010) has total capacity, including planned and mothballed capacity, at 430 million litres, of which 187 millon litres per annum of capacity is currently operating (2)

seed) (Biofuels Association of Australia, 2010; Australian Bureau of Agricultural and Resource Economics, 2009).

A production facility, based in Darwin, utilising palm oil as a feedstock exists but is not currently operating, and a facility that will use soya is currently being developed in NSW (ABARE 2009). Each biodiesel facility can utilise a range of feedstocks without needing to change equipment. The choice of feedstock is usually based on cost factors, including the ability to process and market a by-product of production (or biodiesel may itself be the by-product of a different process, such as manufacture of stock feed from soya) and proximity to raw feedstock supply, such as an abattoir.

Table 1 outlines the Australian located biodiesel production facilities in 2010, with the capacity of each facility and the feedstock used.

Table 1

Biodiesel Plants in Australia, 2010

BIODIESEL PLANT	LOCATION	OWNER (* BAA MEMBER)	TOTAL INSTALLED CAPACITY (ML) (AT 01.07.10)	FEEDSTOCK	STATUS (AT 01.07.10)
ARF Largs Bay	Adelaide, SA	Australian Renewable Fuels*	45	Tallow, Used cooking oil	In production
ARF Picton Plant	Picton, WA	Australian Renewable Fuels*	45	Tallow, Used cooking oil	In production
BIA Biodiesel Plant	Maitland, NSW	Biodiesel Industries Australia*	20	Used cooking oil, Vegetable oil	In production
BioWorks	O'Connor, WA	BioWorks Australia Pty Ltd*	2	Used cooking oil and low-grade Tallow	In production
BPL Biodiesel Plant	Wodonga, VIC	Biodiesel Producers Limited*	60	Tallow, Used cooking oil	In production
Eco Tech Biodiesel Plant	Narangba, QLD	Gull Group*	30	Tallow, Used cooking oil	Not in production
National Biofuels Plant	Port Kembla, NSW	National Biofuels Group*	300	Soya	Not yet constructed
Smorgon Fuels – BioMax Plant	Melbourne, VIC	Smorgon Fuels Pty Ltd*	15-100	Tallow, Canola Oil and Juncea Oil	In production, possible expansion
N/A	Darwin, NT	Vopak*	130	Palm Oil	Not in production
TOTAL CAPACITY (ML)			**430**		

Source: Biofuels Association of Australia 2010. Used with permission.

In addition to Australian domestic production of biodiesel there has also been some importation of biodiesel, predominantly from the United States. There have been recent reports that 20 million litres of soy-based biodiesel was imported to be sold into the Australian market (Murphy 2010). However, this seems to be at most an infrequent occurrence to this point in time.

Several companies are marketing biodiesel directly to consumers, usually a B100 product. Several of the large oil companies are supplying low ratio blends (B5 or B2) directy to consumers through their retail networks, while supplying higher ratio blends (usually B20) directly to their commercial customers - such as mining and transport companies (Caltex 2011; Bacovsky et al. 2009, 3).

Presently, biodiesel is subject to the diesel excise rate, of 38.143 cents per litre (ATO, 2010). This is payable by fuel retailers and charged to end users by the retailers. This also applies to imports of biodiesel. However, a clean fuel grant is paid to retailers of biodiesel, fully offsetting the excise charge - this makes biodiesel effectively excise free. This grant is also available to importers of biodiesel. The effect of this as a policy measure is discussed in detail in part 2. Retailers need to be able to show that a sufficient product quality has been achieved in order to claim the excise – this test is conducted by the supplier on each batch of biodiesel produced. The testing process imposes a cost per batch to the producer, which has eliminated many of the potential small-scale providers from producing and marketing biodiesel (Peacock 2004).

2.4 The Australian Diesel Fuel Market

The Australian diesel market is a mature market, having expanded to meet the growing needs of the demanding road transport market and, more recently, the booming mining market (McLennan Magasanik Associates 2009). The on-road market is primarily light commercial vehicles and heavy trucking. Other major segments of the Australian diesel market include the stationary fuel market (primarily electricity generation), agriculture and shipping (BP 2010; Shell 2010). (These latter three segments have complex demand, supply and taxation factors, and as such are not examined closely in this paper.)

A large portion of diesel is purchased under contract with fuel suppliers, either through a retail service station or supplied directly into bulk fuel tanks stored at transport company depots – the Department of Resources, Energy and Tourism (2010, 5) states that as much as 75% of all diesel sold in Australia is sold in bulk to commercial and industrial customers under long term contracts.

Fuel sold to mining companies is supplied directly into tanks at mining sites, under agreed contracted prices (Department of Resources, Energy and Tourism 2010). The penetration of diesel passenger vehicles into the Australian market is currently very small (Martin 2010) and as such makes up only a very small portion of total diesel fuel supplied.

A total of 19,044 million litres of diesel was consumed in Australia for the twelve months to June 2010 (Department of Resources, Energy and Tourism 2010, 1). Australia has several refineries, most of which are located on the eastern seaboard. A large proportion of diesel consumed in Australia is imported– for the twelve months to June 2010 a total of 8,772 million litres of diesel was imported, 46% of total consumption (Department of Resources, Energy and Tourism 2010, 1). Diesel fuel prices in Australia are closely aligned to Import Parity Prices (IPP) - the cost to Australian diesel sellers to obtain fuel of the relevant standard from the global diesel fuel market and ship it to Australian ports (McLennan Magasanik Associates 2009). The import parity price concept also applies to diesel fuel produced in Australia and is a reference to the substitutability of that locally produced product (and all imported product) to the globally traded product. The import parity price is determined by several factors, all of which have a dynamic demand/supply balance. These are listed and described below.

1. Crude prices: the price of raw crude oil on the global market.

2. Refined product prices: the price of refined diesel fuel on the global market, based on the crude price, with an additional price for the refining process. This additional price varies in line with refining availability, for different product specification and across regions. The applicable refined product price for the Australian market is the Singapore price, for a 10 parts per million sulphur content diesel. (McLennan Magasanik Associates 2009; Australian Institute of Petroleum 2010)

3. Shipping costs: The price for shipping also varies with shipping availability and demand for shipping in different regions. (McLennan Magasanik Associates 2009; Australian Institute of Petroleum 2010)

4. Exchange rate: global prices are set in US dollars and need to be converted to Australian dollars. (McLennan Magasanik Associates 2009; Australian Institute of Petroleum 2010). This reflects the nature of oil as a globally traded commodity and the US dollar is the standard currency used in valuing and trading oil globally.

IPP can be considered to be the cost of goods sold for fuel sellers. Fuel sellers need to also recover their costs - including storage terminals, freight, working capital, retail networks and corporate overheads. Fuel sellers offer a Terminal Gate Price (TGP) for the wholesale of diesel fuel in the Australian market, and pump prices for the sale of diesel fuel through retail outlets (Department of Resources, Energy and Tourism 2010; Australian Institute of Petroleum 2010).

The IPP price can be considered to be the price at which fuel retailers are willing to source diesel fuel to then sell into the market.

3.0 PART 2 – BIODIESEL PENETRATION FACTORS

This paper will argue that there are relatively few factors that will influence the uptake of first generation biodiesel in the Australian market. The starting point for this analysis is the assumption that the current diesel market in Australia is a mature market, in demand and supply equilibrium, and with significant barriers to new entry and change. To overcome those barriers to entry, a new product like biodiesel needs to either be cheaper to produce and therefore offer a price advantage, or have benefits that cannot be matched by mineral diesel. There are likely to be benefits of biodiesel that would provide some advantages but they may be not significant enough to overcome the barriers to entry that exist. For example, a noticeable feature of biodiesel production is that it often leads to investment and employment in regional areas (O'Connell and Batten et al. 2009). This benefit would be an appealing feature of large biodiesel industry, however this does not significantly impact demand or supply and may play only a supporting role in helping shape government policy.

Resource availability, production capacity and product quality can also be considered beneficial features that will not in themselves have the effect of overcoming the major barriers to entry – each factor listed is required for biodiesel to achieve and sustain high penetration, however achieving high levels on each of these factors will not lead to high penetration. As will be discussed further below, government policy has the potential to magnify or diminish the features and benefits of biodiesel and dramatically adjust the

barriers to entry into the diesel market – either knocking down those barriers or putting them up further.

It is important to note that over the longer term some factors, such as production capacity and improved technology will also have significant flow-on effect on the cost of production and the market price of biodiesel. As such, these factors can be seen as essential in indirectly shaping the future of biodiesel by providing scale and cost efficiency and therefore allowing it to compete with mineral diesel in the market.

Three potentially differentiating factors have been identified for analysis, as listed below.

1. The different cost basis for biodiesel compared to mineral diesel could present a price advantage for biodiesel – this is further analysed to assess whether a price advantage does or could exist.

2. Government policy settings already shape much of the landscape for biodiesel – through the excise and grant regime, acceptance of imports and a mandated target in NSW. The potential for further government policies and support to 'tilt the balance' in favour of biodiesel is analysed.

3. The environmental benefits and sustainability credentials of biodiesel are assessed to determine whether this provides the 'superior benefit' described in the introduction and

the potential for these benefits to be enough for various stakeholders to favour biodiesel over mineral diesel is analysed.

3.1 Factor 1: Price Relativity to Mineral Diesel

In simple terms, in the absence of government subsidies or other incentives, biodiesel will be financially appealing to retailers or wholesalers of fuel if their purchase price for biodiesel is less than the IPP for mineral diesel supply, as described in Part 1. This financial benefit can be retained or used to achieve competitive advantage by lowering prices. This applies equally to current sellers of diesel switching to biodiesel as well as new entrants supplying biodiesel to compete against sellers of mineral diesel. This assumes that customers either prefer to use biodiesel or are equally willing to use it as a replacement for mineral diesel, and that there is no incentive other than price for customers to adopt biodiesel or for retailers to sell biodiesel. Both these assumption will be examined further later in this paper.

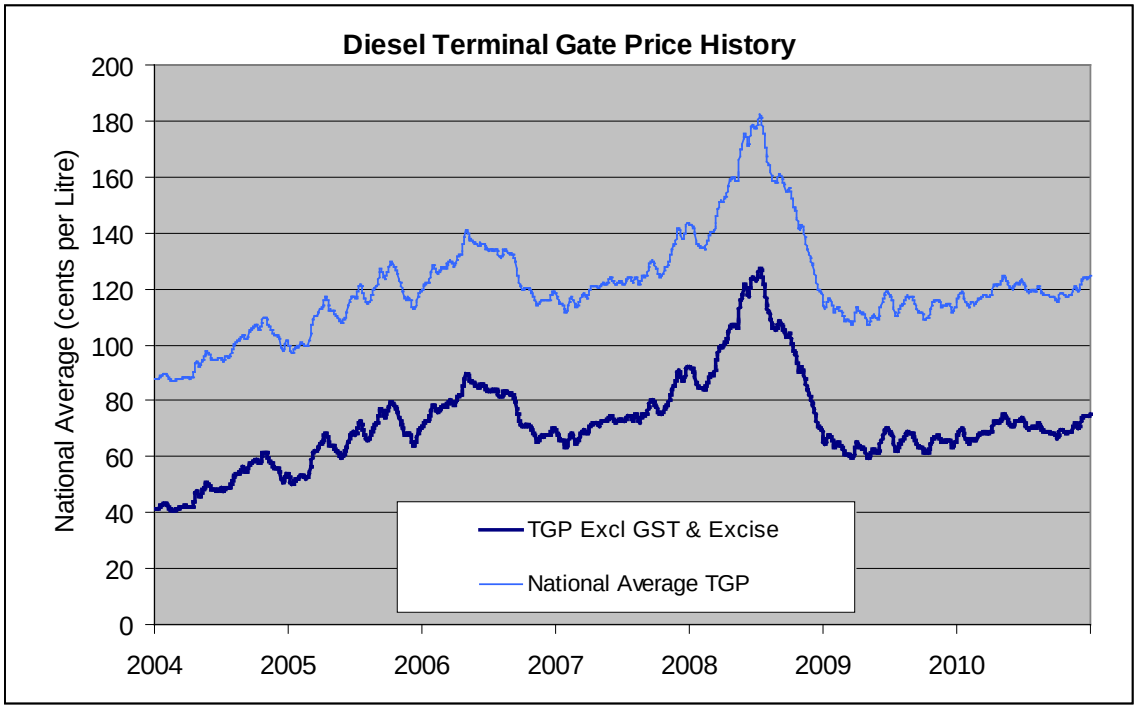
Once fuel suppliers have a financial incentive to supply biodiesel in place of mineral diesel, the obstacles to adoption must be overcome before actual product supply commences. This ‘cost of change’ effectively sets a hurdle cost – the price incentive must not only be advantageous, but it must be advantageous enough to overcome the cost of change within a realistic timeframe. Likewise, for new entrants the financial incentive must be enough to recover the cost of any outlaid capital within a realistic timeframe. It is worth noting that the required return for investment in biodiesel is likely to be higher than for mineral diesel – due to the increased risk attached to new technologies and emerging industries. This would translate into a higher cost of capital and decreased net present value of investments.

Therefore, the question to be answered is: can first generation biodiesel be supplied at a significant discount to the prevailing IPP for mineral diesel and sustain that price position over time.

3.1.1 Mineral Diesel Supply Prices (IPP)

Oil companies do not disclose their cost of supply for diesel fuel (their IPP price). A proxy can be used in the terminal gate price (TGP) – by removing the excise and GST components as this roughly equals an IPP price with the difference being a gross wholesale margin (McLennan Magasanik Associates 2009). A history of national average diesel TGP for diesel is shown in chart 1, and a second curve is shown with excise and GST removed.

Chart 1



Source: Australian Institute of Petroleum, 2011

Deducting an allowance of about 10 cents per litre for wholesale margins and costs,[3] this data suggests that the IPP for diesel may have hovered around 50 to 60 cents per litre in 2009 and 2010, and reached highs of around 110 to 120 cents per litre in 2008.

3.1.2 Cost of biodiesel

Biodiesel and mineral diesel fulfil much the same utility, however, the physical makeup and hence the price components for both products are very different. Diesel prices are based on crude oil, refining and shipping costs – as determined by the global market – as well as domestic factors such as fuels quality standards. Biodiesel prices are made up of the feedstock price, for example tallow, the biodiesel manufacturing cost and any shipping or freight cost to supply the product into the major markets. Feedstock prices are usually linked to internationally traded agricultural commodity prices. Taxes and charges are large components of both product prices, and will be discussed further in section 3.1.4.

Beer et al. (2007) analysed the unit costs of biodiesel feedstocks. The results of this analysis are shown in table 2. These are expected costs of procuring a litre of feedstock, which then needs to be processed, distributed and sold – incurring further costs.

[3] The AIP (2009,) published a review of the downstream petroleum market and included a component in the retail petrol price breakdown called 'Wholesale/retail margin and freight' and allocated an amount of 10 cents per litre to this component.

Table 2: Feedstock costs

Feedstock	Yield (L/T)	Price ($/T)	Cost (c/L)
Waste oil	870	170	20
Tallow	894	450	50

Source: Beer et al. 2007

The price of tallow increased very significantly after 2007, this is shown in table 3.

Table 3: Updated Tallow Cost, December 2009

	Yield (L/T)	Price ($/T)	Cost (c/L)
Tallow - December 2009	894	802	90

Source: Morgan 2010

Despite the limited available data, this analysis suggests that biodiesel produced from tallow is unlikely to be cost competitive with mineral diesel, given that the feedstock price of tallow was close to or higher than the estimated IPP for mineral diesel at both the points in time measured. The IPP for mineral diesel would have been around 50 cents per litre in December 2009, while the cost of tallow based biodiesel was far higher at around 90 cents per litre. In 2007 the IPP would have been around 60 cents per litre, while tallow feedstock was around 50 cents per litre. However, while the raw tallow feedstock would need to be processed into a biodiesel before distribution and selling – adding further cost, the mineral diesel would be ready for sale.

The data shown above for used cooking oil hints that this feedstock may have the potential to be cost competitive, as it held a significant price advantage to tallow in the Beer et al. (2007) analysis. However further data including more current pricing and cost

of production would be required to ascertain this. Further, the lack of significant production volumes of used cooking oil based biodiesel in the Australian market (Biofuels Association of Australia, 2010; Australian Bureau of Agricultural and Resource Economics, 2009) suggests that it is not an economically viable alternative.

The increase in the tallow price shown above is significant. Table 4 shows Australian tallow prices from 2008 to 2010. Some commodity commentators, for example Thomas Morgan of the Meat and Livestock Association (2010), have linked this increase to tallow's increased use as a feedstock. Morgan believes that that tallow price is driven by demand for tallow, which is strongly influenced by the palm oil price (the dominant biodiesel feedstock) which in turn is positively correlated to the crude oil price (as a potential substitute). This also partly explains some of the similarity in the shapes of the crude oil, palm oil and soy bean price history charts – as discussed in the next section.

Table 4: Tallow Prices in Australia

	2008 (Dec)	2009 (Nov)	2009 (Dec)	2010 (Oct)
Tallow (1% FFA) $/tonne ex works	481	685	802	826

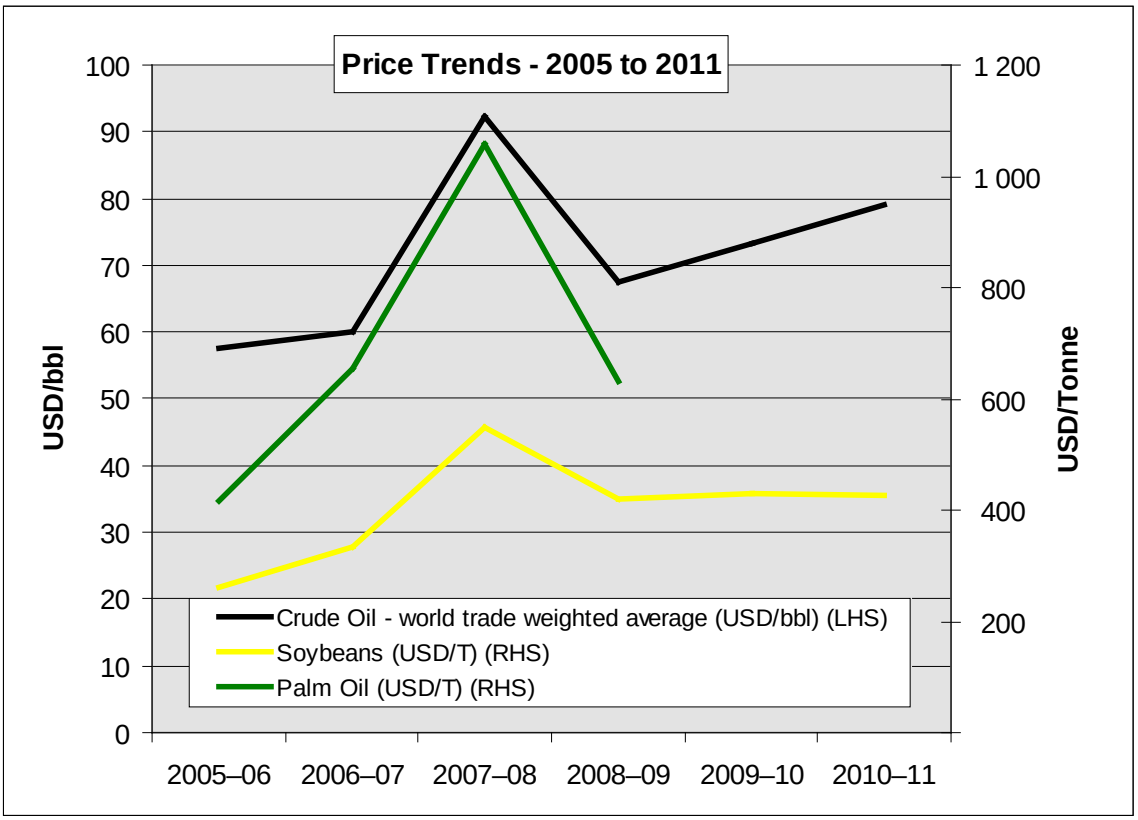
Source: Meat and Livestock Australia 2011

3.1.3 Feedstock cost variability to diesel prices over time

The variability in the traded commodity prices that make up the basis for mineral diesel and biodiesel prices add further complexity to the price comparison. While mineral diesel prices in particular are exposed to movement in several components including exchange rates, shipping rates and refinery prices, the majority of variability of the price

differential over time between mineral diesel and biodiesel can be attributed to the variability between feedstock prices and crude oil prices. Chart 2 shows the relationship over time between two biodiesel feedstocks: soy beans and palm oil; and the crude oil price.

Chart 2: Price Trends 2005 to 2011



Source: ABARES website, www.abares.gov.au

While this limited data set cannot be interpreted to show definitive linkages between the price trends, there is an apparent relationship over time and in the common 2007-08 price spike. There is also a level of variability in the price differentials over time. Variability creates uncertainty for potential sellers of biodiesel, or more accurately, price risk. Sellers could be expected to wait until a point in time where biodiesel supply prices are so far below diesel prices that there is a buffer for the expected fluctuation range.

Alternatively, sellers could be expected to act if they are confident of a future feedstock price that is advantageous to crude oil prices. However there are many variables at play. International climatic conditions, feedstock supplies and agricultural changes impact biodiesel feedstock prices. While international geopolitics, the global economy and cartel policies influence crude oil prices. It is therefore not likely that there can be good confidence in short term or medium term forecasts for feedstock differentials to crude oil.

A third option is for sellers to hedge this exposure – to effectively lock in a differential for a set amount of supply. However this option is dependent on the availability of suitable hedging instruments and future price forecasts, and in any event comes at a cost - ensuring that this is not an attractive option unless a suitably large differential can be locked in.

3.1.4 The impact of taxes

An excise or import duty is charged on all fuel supplied in Australia, including biodiesel, of 38.143 cents per litre (ATO 2010). Biodiesel produced domestically or imported is eligible for the Cleaner Fuels Grant – up until 30 June 2011 this is also 38.143 cents per litre, fully offsetting the excise/import duty. For blended products this grant is applied to the proportion of the blend made up of biodiesel – for example 5% for the B5 blend.

From June of 2011 the Cleaner Fuels Grant will be reduced annually to a rate of 19.1 cents per litre in 2015 – half of the current excise rate (ATO 2010). Table 5 shows the amount of the Cleaner Fuels Grant and the effective excise rate during this timeframe.

Table 5: Cleaner Fuels Grant Reduction

	Current	Mid-2011	Mid-2012	Mid-2012	Mid-2014	Mid-2015
Cleaner Fuels Grant	38.143	34.33	30.53	26.72	22.91	19.10
Effective Excise	0	3.8	7.6	11.4	15.30	19.10

All figures cents per litre. Source: ATO 2010

In addition, many businesses (including heavy transport and mining) are eligible for the fuel tax credit – a credit for any excise or import duty paid (ATO 2010). Presently this is paid at the full excise amount of 38.143 cents per litre on any product that meets the diesel specification. Typically, this applies to biodiesel blends of up to 5%. Therefore, for a purchase of a B5 blend eligible businesses can receive the Cleaner Fuels grant on the 5% biodiesel portion of the fuel as well as the fuel tax credit for the full portion of the fuel. This creates a significant price difference between a B5 blend and a higher biodiesel blend such as B20. As shown in table 6, there is a 1.91 cent per litre advantage to business customers eligible for the Fuel Tax Credit under the current (pre mid 2011) excise conditions.

Table 6

Current Excise Regime

	Diesel	B5	B20	B100	
Excise	38.14	38.14	38.14	38.14	
Fuel Tax Credit	-38.14	-38.14	-30.51	0	*
Cleaner Fuel Grant	0	-1.91	-7.63	-38.14	**
Total Credit	-38.14	-40.05	-38.14	-38.14	
Total Tax	0	-1.91	0	0	

*based on proportion of mineral based diesel for blends >5%
**baased on proportion of biodiesel
All numbers cents per litre

This result may skew business customers towards a B5 blend. This is particularly relevant once the Cleaner Fuel Grant reduces and the effective excise on biodiesel increases. Table 7 shows the same product range under the planned 2015 regime. For mining and transport customers (eligible for the Fuel Tax Credit) the savings are significant, with a B5 blend nearly 20 cents per litre cheaper than a B100 blend.

Table 7

Planned Excise Regime from mid-2015

	Diesel	B5	B20	B100	
Excise	38.14	38.14	38.14	38.14	
Fuel Tax Credit	-38.14	-38.14	-30.51	0	
Cleaner Fuel Grant	0	-0.96	-3.82	-19.10	
Total Credit	-38.14	-39.10	-34.33	-19.10	*
					**
Total Tax	0.00	-0.95	3.81	19.04	

*based on proportion of mineral based diesel for blends >5%
**baased on proportion of biodiesel
All numbers cents per litre

GST is applied to the final price to the consumer for both mineral diesel and biodiesel, at the standard rate of 10%. While final prices to the consumer remain similar, the GST impact will be similar. There is no separate treatment or benefit on the GST charge on biodiesel.

3.1.5 Internalising externalities and the cost of carbon emissions

While any environmental and sustainability benefits in themselves do not directly impact the price of biodiesel, if these externalities were to be captured (internalised) in the cost build up of biodiesel or of mineral diesel there would be a change in the price balance between the two products, based on the different levels of emissions. The most relevant mechanism to achieve this is through a carbon emission cost, such as that proposed under the, now deferred, Carbon Pollution Reduction Scheme. An alternative would be a tax on all carbon emissions, as recently proposed by the Federal Government.

Evaluating the life cycle emissions for biodiesel is complex, both because of the complicated impacts from farming, production and combustion processes and also due to the variability in emissions from different types of feedstocks. One further point of contention is that agriculture for first generation biofuels is often either at an opportunity cost of an alternative crop which may provide a better emissions benefit or be conducted in a way that creates additional emissions, for example land clearing by fire for planting of palm oil crops (Beer et al. 2007). The issues surrounding life cycle emissions for biodiesel are discussed further in section 3.3.1.

Table 8 shows the greenhouse gas emissions for the range of common biodiesel products and blends in the Australian market, as assessed by CSIRO in a lifecycle emission comparison conducted for Caltex in 2007. The various factors behind these lifecycle emissions and some of the variables that may significantly impact these emissions is

described later in this paper. The Extra Low Sulphur Diesel referred to in the table is the current standard mineral diesel in Australia.

Table 8: Lifecycle Greenhouse Gas Emissions for Biodiesel blends

Product	**XLSD** (Extra Low Sulphur Diesel)	**Canola**		**Palm Oil***		**Tallow**		**Used Cooking Oil**	
Blend	Na	B5	B100	B5	B100	B5	B100	B5	B100
Greenhouse Gas Emissions ($g\ CO_2$-e/km)	855	835	433	823	175	823	209	818	109
Notes	10 ppm Sulphur			existing plantation					

Source: Beer et al. 2007

This comparison demonstrates a significant range in emissions - with some biodiesel blends providing almost no greenhouse gas emissions saving, and some, such as a B100 blend based on used cooking oil providing a dramatic reduction. This relativity can be used to provide an extrapolation of the possible price impacts of a charge for greenhouse gas emissions, through either a direct charge (tarrif/tax) mechanism or through a market-based mechanism such as an emissions trading scheme. The issue of imports raises a potential problem here, in that where production occurs outside of Australia a carbon tax or carbon price will not apply unless a tariff is applied on the importation of that product.

If the cost of emissions has a cost impact on Extra Low Sulphur Diesel of 8 cents per litre, then the cost saving of the various blends and feedstocks would be as shown in table 9. This assumes that the carbon cost would be proportional to the life cycle greenhouse gas emissions of the various blends.

Table 9: Forecast Impact of Internalising Lifecycle Emissions

Product	Extra Low Sulphur Diesel (XLSD)	Canola		Palm Oil*		Tallow		Used Cooking Oil	
Blend	Na	B5	B100	B5	B100	B5	B100	B5	B100
Greenhouse Gas Emissions Indexed to XLSD	100	97.7	50.6	96.3	20.5	96.3	24.4	95.7	12.7
Carbon Price Component (cpl) Based on 8cpl for XLSD	8	7.8	4.1	7.7	1.6	7.7	2.0	7.7	1.0
Discount to XLSD (cpl)		-0.2	-3.9	-0.3	-6.4	-0.3	-6.0	-0.3	-7.0

This analysis shows that under a regime where lifecycle greenhouse gas emissions were internalised, savings of between 4 and 7 cents per litre would be likely for B100 blends, while much smaller savings of between 0.2 and 0.3 cents per litre would be available for B5 blends. The savings for B5 blends, while small, are in addition to future benefits provided to B5 blends under the future excise changes, while the more significant savings on the B100 biodiesel products make up less than half of the negative impact of the excise changes.

3.1.6 Factor 1 conclusions

A comparison of the basic costs that make up both mineral diesel and biodiesel feedstock prices shows that mineral diesel holds a price advantage over biodiesel at present. However that comparison also highlights that the relativity between the feedstock prices and mineral diesel prices will vary over time. While on one hand that inherent price risk poses a barrier for change, it also opens up the possibility that biodiesel prices will move

below mineral diesel prices over time. It would seem unlikely that this would be the result of a dramatic drop in biodiesel costs – however it could occur if mineral diesel prices were to rise significantly due to increases in crude oil prices.

The analysis also shows that taxes, tariffs and grants have a very large impact on the price relativity. It could be argued that in the short term, this variability is actually greater than the variability in the input costs of both products. The tax regime also creates a potential skew towards a B5 blend for business users of biodiesel. Most notably, the impact of a carbon price or carbon tax does impact the price relativity of the two products, however not as significantly as other factors and not enough to see biodiesel gain a price advantage over mineral diesel.

3.2 Factor 2: Government Policy

While without doubt the future of biodiesel is heavily influenced by price relativity to mineral diesel, it cannot be avoided that a large part of that price relativity presently comes about from taxes - and therefore government policy. The fact that these policies currently override more fundamental demand and supply effects, illustrates the power of government policy to influence the future of biodiesel. Taxes are just one policy tool that need to be considered. There are other policy tools related to price, including tariffs, subsidies and rebates, as well as options not related to price, including mandates, emissions targets and investment incentives.

Biofuels in general tend to be a political 'hot potato' and biodiesel in Australia is no exception. This is not surprising given the complex mix of factors that surround biodiesel, including environment and sustainability, security of supply, regional development, employment and agriculture (Batten & O'Connell 2008). There is a suite of relevant policies and impacting taxes, duties and rebates at all levels of government; however, there is no single clear overriding Federal Government policy on biodiesel.

3.2.1 Current Government Policies

The Federal Parliament determines the fuel excise scheme, as well as providing both the On Road Diesel Grant Scheme and the Cleaner Fuel Grant, which are then administered by the Australian Taxation Office (ATO 2010). The effective excise for biodiesel is the net effect of the excise and the Cleaner Fuel Grant.

As described in Part 1, biodiesel is charged at the full excise amount, with the Cleaner Fuel Grant offsetting the excise – fully at present, and reducing to 50% by 2015. The stated purpose of the Cleaner Fuel Grant is that it "…encourages the manufacture or importation of fuels that have a reduced impact on the environment." (ATO 2010).

The Federal Government also controls import tariffs. Currently the tariff for importation of biodiesel is aligned with excise charges for locally produced biodiesel. This has become contentious recently as imports increase and the United States continues to offer a subsidy to US biodiesel feedstock producers of the equivalent of 30 cents per litre. This combination of US and Australian policies sees some US feedstocks subsidised by both the US and Australian governments, much to the consternation of the Australian biodiesel production industry – evidenced by the complaint made by members of the industry to the Australian Customs Department alleging the result was dumping of subsidised American biodiesel into the Australian Market (Australian Customs and Border Protection Service, 2010). The complaint claimed that the impacts on Australian producers of biodiesel were lost sales volumes, loss of market share, price undercutting and reduced profits and profitability (1).

The proposed Carbon Pollution Reduction Scheme (CPRS) may have impacted biodiesel, however with that framework not agreed or implemented it does not have any relevance at present, other than presenting a future potential factor that may assist penetration.

The Federal Government has developed and implemented a renewable energy program to improve penetration of renewables into the electricity industry in Australia. The Renewable Energy Target Scheme (RETS) provides a framework for electricity producers and suppliers to incorporate renewable energy into their production capacity. Biodiesel for transport use is not covered in the RETS schemes. However, energy crops for electricity generation are covered (Department of Climate Change and Energy Efficiency 2010).

The Federal Government has implemented several incubators or direct funding initiatives to foster renewable energy growth, for example, the Solar Flagships program. Biodiesel is not covered within the Solar Flagships program and there is no similar program in place for biodiesel (Department of Resources, Energy and Tourism 2011). The Federal Government did have a 350 million litre per annum target for biofuels for 2010 (O'Connell et al. 2009) - with the objective of increasing ethanol penetration - and the target was achieved through implementation of ethanol mandates in Queensland and New South Wales.

It could be implied from the above snapshot of current Federal Government policy that the government has little interest in the penetration of first generation biodiesel. The Cleaner Fuel Grant is the predominant policy tool, which is being walked back to half of its current value over the next few years. The result of this will be that if feedstock prices drop significantly for a sustained period, then the current differential can be maintained, however if feedstock prices stay at their current level, or increase further, then a price

premium will emerge and any further penetration will be stifled. There is no clear statement of intent or policy position at a federal level that implies that the government particularly cares either way, or would intervene if penetration does not increase. The Federal Opposition have made public statements regarding the inadequacies of the current approach to biodiesel, such as that made by the leader of the National Party, Warren Truss who stated that the changes to the Cleaner Fuels Grant would "destroy the Australian ethanol, biodiesel, and LPG industries" (Loughnane 2011, 1). However the Coalition has not proposed radically different policies and only took to the 2010 election a commitment of $12 million to fund a trial of B20 blend biodiesel in heavy trucks and a second generation biofuels pilot plant (Loughnane, 2010).

State Government policies are not consistent on biodiesel. The New South Wales Government has acted on its own to implement a mandate on biodiesel. This mandate, introduced in 2009, determines that 2% of diesel sold (by volume) will be biodiesel from January 2010, and that this will increase to 5% from 2012 (NSW Government: Office of Biofuels 2011). The NSW Government has promoted biofuels, as they "…are good for the environment, create jobs in regional NSW, help farmers, and reduce our reliance on foreign fuel imports" (NSW Government: Office of Biofuels 2011). The mandate is subject to several economic provisions to ensure that no significant detrimental effects are experienced as a result. The NSW policy on biodiesel is closely linked to objectives for regional development and environmental performance (NSW Government: Office of Biofuels 2011).

No other state government is currently implementing a mandate on biodiesel consumption. Other state policies include increasing, or requiring, use of biodiesel in state government diesel vehicles and direct support for biodiesel production facility investment. Table 10 summarises the various government activities.

Table 10: Summary of Federal and State Government Activity on Biodiesel

Government	Activity	Reference
Federal Government	▪ Cleaner Fuel Grant (ATO)	ATO 2010b
New South Wales	▪ 2% volume mandate (5% from 2012)	Land and Property Management Authority, Office of Biofuels 2010
Victoria	▪ 5% biofuel targets ▪ Direct investment support for production facilities	Regional Development Victoria 2007
Queensland	▪ Direct investment support for production facilities ▪ Financial support for R&D activities	Department of Tourism, Regional Development and Industry 2009
South Australia	▪ Government truck & bus fleet running on biodiesel	Government of South Australia 2010
Western Australia	▪ 5% biofuel target	Department of Agriculture and Food (nd)
Tasmania	▪ None identified	
Northern Territory	▪ None identified	

ACT	▪ None identified	

3.2.2 Impact of mandates

It is important to briefly consider the impact of mandates as a policy mechanism for biodiesel. While providing a simple tool to ensure a level of penetration, the impact of a mandate can actually be quite complex (Batten & O'Connell 2008). As a government intervention in a relatively free market, mandates will skew demand and supply. While reducing the demand for mineral diesel, the mandated quota necessitates that biodiesel supply must be procured by sellers, which may be at prices above current market prices for mineral diesel (see part 1). This will then drive up the average price in the market. A mandate also brings a cost of compliance, monitoring and enforcement. In the case of the NSW mandate, suppliers are required to report quarterly volumes of mineral diesel and biodiesel sales to the regulator, and are faced with penalties for non-compliance.

Assuming that the mandate applies to sellers of diesel (as the NSW mandate does) there are two ways for sellers to meet the mandate. Sellers can either supply large volumes of biodiesel to a small number of customers (probably for mining and/or heavy transport) or can sell a blended product to a large number of retail customers. The latter option necessitates change across the full supply chain and across a broad retail network, while the former option is unlikely to be attractive due to the low probability of suitable, willing customers at sufficient scale – particularly if it requires purchasing a very large amount of product at a premium to the mineral diesel price.

The mandate also has the potential to drive imports of biodiesel in order to meet pre-determined volumes. Based on CSIRO analysis, there is sufficient biodiesel production currently operating or in standby in Australia and sufficient feedstock resource to meet the NSW quota. (O'Connell, et al 2009) However, it may be a more cost effective option for sellers to source feedstock from overseas markets to meet the mandate.

3.2.3 Local versus imported supply

A seemingly difficult balance for the government to manage is that of fostering an Australian industry versus opening the market to imports of biodiesel and feedstock from international markets. There are good arguments for both. The Australian industry has invested heavily in biodiesel production but feels it has not been supported in achieving acceptable returns for that investment through measures that support penetration of locally produced biodiesel into the Australian market. This sentiment is captured in a newspaper editorial by former Queensland Premier Peter Beattie (2010) outlining the impact of the recent excise regime changes and competition from subsidised feedstocks from the United States. The simplest measure available to the government to assist the industry, according to the Biofuels Association of Australia (2010), is to review the excise arrangements and to remove the eligibility of overseas biodiesel and feedstock to qualify for the Cleaner Fuels Grant, or apply a tariff to offset international subsidies. It has been argued that the fostering of a local industry will provide an incentive for investment, reduce risk for investors, drive production improvement and cost reduction in locally produced biodiesel, provide jobs and investment within Australia, and help Australian industry compete in export markets. These arguments have been put forward

by the industry through the industry's peak body in Australia, the Biofuels Association of Australia (2010). There is also an argument that environmental and sustainability standards are not being met consistently in overseas markets, that tracking product is difficult, and that by supporting local production, environment and sustainability benefits can be better assured (Batten & O'Connell 2008).

The counter argument is that opening the market to importers may increase the total volume of biodiesel sold, due to greater product availability and a more open market that ensures that the lowest cost biodiesel can be supplied. Further, proponents of this argument point to the relevant sustainability standards (described further in section 3.3.2) as mechanisms by which any concerns regarding environmental and sustainability impacts can be assuaged.

Based on prevailing policies, both governments leading biodiesel policy – the Federal and NSW governments, currently hold the latter view. The Federal Government provides the same Cleaner Fuel Grant benefits to imported biodiesel as to locally produced biodiesel, and the NSW Government allows the importation of biodiesel to meet the mandated target, providing that that biodiesel meets the Roundtable of Sustainable Biofuels (RSB's) sustainability criteria, this is explored further in section 3.3.2.

3.2.4 Energy Security

On a per capita basis, Australia is rich in natural gas, and has deposits of oil that are either in production or being explored. However, like most countries Australia still relies

on oil imports – often from countries with significant geopolitical risk or member countries of the Organisation of Petroleum Exporting Countries (OPEC) cartel. This creates a complex, dynamic and less than ideal energy security landscape for Australia.

Increasing penetration of biodiesel improves Australia's energy security in two ways. Firstly, by producing biodiesel in Australia and offsetting reliance on crude oil produced in overseas markets, Australia can increase the level of self reliance and remove some of the current exposure to overseas markets.

Secondly, adding a new product to the energy mix increases the diversity of supply and hence reduces energy security risk. Exposure to existing markets is reduced by a small amount, and replaced with exposure to new and different markets. While these countries and markets have their own risks, greater diversity of energy supply will reduce a country's overall energy security risk (Yergin 1991).

Increasing penetration of biodiesel does not add any significant energy security risk - it decreases risk by adding diversity of energy alternatives but could be offset with mineral diesel if supplies of biodiesel were in short supply. As it would remain a small part of the overall energy balance for Australia there is little risk that Australia would overly increase exposure to one product and its related sources. Additionally, biodiesel infrastructure, particularly when rolled-out as a low ratio blend such as B5, is backwards compatible with mineral diesel – if biodiesel became difficult to source it would simply

be a matter of reverting to mineral diesel. The importation of mineral diesel could be increased if there was a shortfall of biodiesel.

3.2.5 An argument for anticipating future supply scenarios

It has been argued that investment in first generation biofuels is wasted and that governments would be better advised to hold off for the arrival of proven second generation technologies that guarantee sustainability and environmental benefits. While there has been an absence of public debate on this topic in Australia, the potential environmental and sustainability benefits of second generation biodiesel have captured the imagination of many of the key stakeholders. This can be observed in the large body of research focussed on second and third generation technologies and the stated public positions of many environmental groups such as the World Wildlife Fund (2008). This argument portrays first generation biodiesel as a product with mixed impacts and an uncertain role, and implies that efforts should be concentrated instead on developing a second generation product as quickly as possible. There are several reasons why this can be seen to be a false argument.

Firstly, the transition from first generation to second generation technologies is likely to be a gradual one with several technologies that fall in between the simplified definitions of first and second generation feedstocks (Sims & Taylor 2008). For example, used cooking oil is a waste product currently, and conversion to biodiesel has tremendous sustainability benefits. Likewise, if tallow, which is a first generation product, can be sourced from waste product removed from abattoirs and processed at a biodiesel

production facility integrated into that facility, it also meets the definition of a second generation product.

Secondly, the amount of technical change required for the existing industry to move from first to second generation biofuels should not be underestimated. The IEA found that changes to the supply chain make up a significant part of the transition to second generation biofuels (Sims & Taylor 2008). It can be argued that a lot of that change can be made up front by increasing the penetration of first generation biodiesel, prior to the introduction of second generation biodiesels. An example of where this could be practically applied is in adapting product storage and handling technologies to suit the more viscous qualities of biodiesel compared to mineral diesel. This also applies to some of the organisational changes required. For example, crude oil trading teams need to be able to trade in biodiesel products and as such will need to develop an understanding of markets based on agriculture rather than the more familiar oil markets.

Thirdly, consumers, business customers, suppliers, regulators and other stakeholders need to increase their awareness of biodiesel products to enable widespread take-up. First generation biodiesel provides an opportunity for demand to adapt to this new product, with its different features, issues and terminology. For example, decision makers responsible for running large corporate fleets will want to understand biodiesel before committing their fleet to switch to the new product. First generation biodiesel gives these

decision makers a product to test and transition their fleet to, potentially fostering a much smoother transition to second generation biodiesel[4].

Finally, in the most simple sense, first generation biodiesel is available to the market now, and second generation biodiesel may not be available to market for some time (Sims & Taylor 2008). By investing in first generation penetration now, governments can get benefits immediately if the right mechanisms and policies are in place.

3.2.6 Factor 2 Conclusions

The analysis of government policy has shown that the Federal Government's approach to biodiesel policy is predominantly focussed on the tax regime. Whether this is part of a clear view from the Federal Government regarding first generation biodiesel cannot be determined, however there is no clear policy position on biodiesel more generally. At a federal level biodiesel seems to 'fall through the cracks' of some of the other broad renewable energy programs.

State laws vary in their treatment of biodiesel, with NSW being on its own in establishing a mandate. This has various potential impacts and will need to be monitored over time to assess its final impact on biodiesel penetration. The mandate has not been a topical

[4] Keynes view of Say's law is also relevant here, that stimulating demand for biodiesel would help to determine the supply of biodiesel. Introducing an affordable first generation biodiesel could be seen as a mechanism to stimulate biodiesel demand, creating an increase in supply.

political item and it is therefore unlikely that this mandate will be reduced in the near future, unless supply constraints become relevant.

The combined picture of the various state and federal laws, regulations and initiatives that impact biodiesel is that there are relatively few in place, but those in place have very significant impacts. This highlights that a government at either level could dramatically change the biodiesel landscape by forming a policy view and putting actions in place. Likewise, removal of the current policy tools, particularly the Cleaner Fuels Grant, which is already due to be reduced by half – would dramatically restrict biodiesel penetration. This needs to be seen as a risk to producers, and to a lesser extent, to sellers. It is a good argument for the Federal Government to form a policy position and put a mechanisms in place that provides some certainty regarding biodiesel policy in the short to medium term. There is also an argument that the Federal Government should have a position that seeks to increase penetration, in order to realise the benefits of increased energy security and to create demand to complement the future rollout of 2nd and 3rd generation biodiesel.

3.3 Factor 3: Environment and Sustainability

Proponents of biodiesel adoption usually focus on the environmental and sustainability benefits relative to mineral diesel. Second and third generation biodiesel certainly have the credentials to easily demonstrate such benefits, with greatly reduced environmental and sustainability impacts – utilising feedstock from non-food crops on marginal land, or from algae grown in ponds. However first generation biodiesel is more complex and needs closer analysis to understand its environmental and sustainability credentials. Clear and substantial advantages in these areas would certainly differentiate biodiesel from mineral diesel and as such be a driver for penetration - both as a factor that shapes government policy (and therefore potentially price relativity) and as a factor that stimulates both demand and supply. The degree to which any potential benefits can be agreed and clearly understood by the various stakeholders is an important consideration.

3.3.1 Life cycle emissions

Emissions from inputs at all stages of the production process need to be measured to assess total emissions over the full lifecycle of biodiesel.

Esterification process: the choice of alcohol used in the esterification process will impact emissions. Methanol will have a significant fossil fuel input, whereas ethanol can be sourced from renewable crops (Beer, et al. 2007)

Feedstock selection: emissions will vary greatly between the different feedstocks, particularly when secondary aspects such as land use are considered – this is discussed further in this section.

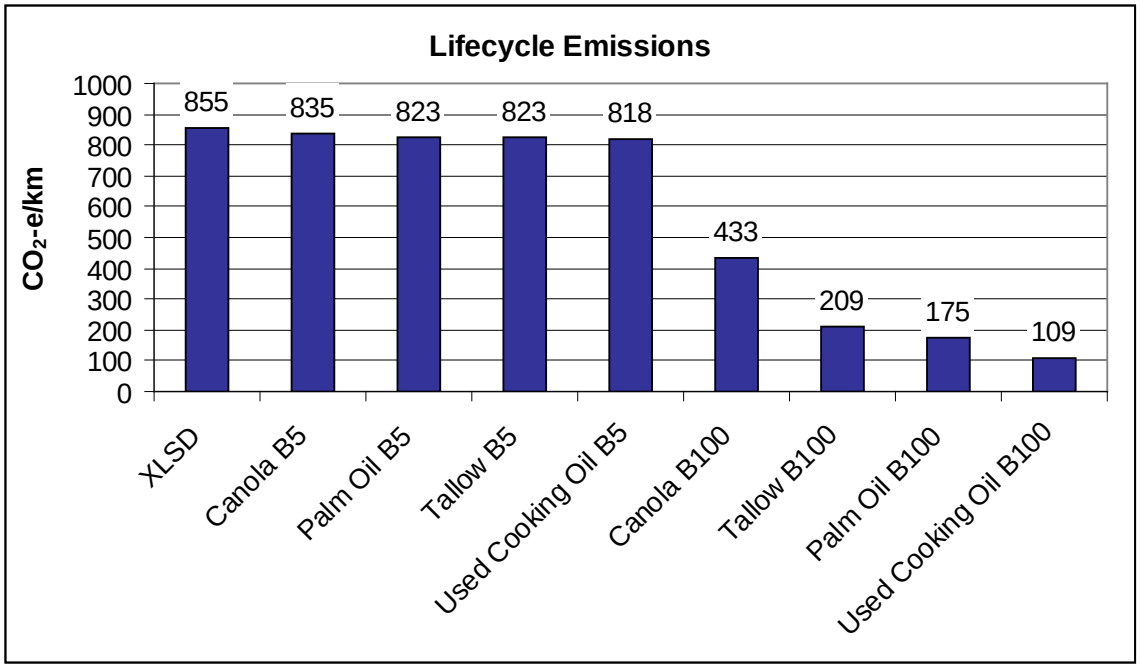
Agriculture: raw material and energy inputs into fertiliser production, farming activities, cultivation of land, transport and harvesting need to be considered and vary greatly both across feedstocks and also for the same feedstock depending on local conditions and farming practices (Beer et al. 2007).

Oil extraction: obtaining useful oil from raw produce consumes significant amounts of energy, usually in the form of electricity – which has associated emissions.

Additional consideration needs to be made for some of the secondary effects of biodiesel crops and farming practices. For example, burning forests to clear areas for plantations, as has been common in Indonesia and Malaysia for palm oil and in South America for soy – will dramatically increase emissions as carbon dioxide sequestered in the forest is released into the atmosphere (O'Connell & Batten 2009). Additionally, in Malaysia and Indonesia, it is also common for cleared areas to be located on peat soil which will release vast quantities of carbon dioxide into the area once cleared of forest (Cuevas-Cubria 2009). In both these cases life cycle emissions from the subsequently produced biodiesel will typically be higher than that of mineral diesel.

A lifecycle analysis of biodiesel emissions therefore needs to separate the various feedstocks and to provide a range of emissions for each feedstock based on some of the variables described above. One such lifecyle emissions comparison is shown in chart 3. XLSD (Extra Low Sulphur Diesel) is the standard mineral diesel in the Australian market.

Chart 3



Source: Beer, et al. 2007

With the possible exception of biodiesel produced from the previously described destructive deforestation activities, the range of life cycle emissions are below that of mineral diesel – demonstrating that moving to a first generation biodiesel would have a net benefit on greenhouse gas emissions, as long as appropriate agriculture and forestry actions are taken. Emissions are significantly lower (by around 4 times or more) for B100

biodiesel, and while the B5 blends are much closer to mineral diesel emissions, the total volume supplied would be much higher. It is worth noting that there may be significant variation in some of the lifecycle emissions actually achieved by the various forms of biodiesel when compared to the results calculated by Beer et al. The complexity of the agricultural processes and environmental context for the imported feedstocks, in particular, could be dramatic. For example, the use of a particular type of fertiliser could dramatically effect the results, as could the variation in farming techniques across regions, most notably between manual and mechanised farming. The results do however provide an indication of the broader relativity across feedstock types.

3.3.2 Sustainability

Childs and Bradley (2008, 10) stated that sustainability for biofuels means that "…maintaining today's production and consumption will not adversely impact the ability to do the same in the future." They went on to explain that this entailed more than just the emissions of the fuel, but also other socio-economic and environmental factors.

The CSIRO (2007) foresaw two possible scenarios for biofuels sustainability in Australia. Either biofuels remain marginal products with around 2% to 5% penetration- in which case sustainability issues are essentially the same as the prevailing sustainability issues for agriculture in Australia; or alternatively biofuels become a major player with significant penetration- in which case new sustainability issues arise from shifts in the balance of agricultural systems. Specifically, CSIRO points out the risk of poor policy

decisions resulting in rapid growth of high-input crops that divert or impact on significant quantities of water and food crops. (54).

The array of different biodiesel feedstocks means that there is no single set of issues that need to be considered. Some biodiesel feedstocks can be produced on marginal land, for example, jatropha. However the more common biodiesel feedstocks have a higher impact on land: palm oil is often farmed from rainforest and high conservation value areas, while soy beans usually provide far less energy yield per acre farmed than palm oil (Childs and Bradley 2008, 18).

Table 11 below summarises just some of the sustainability issues that need to be considered from various feedstocks.

To tackle this array of issues a series of sustainability standards has been developed, through a series of international 'roundtable' groups, including the Roundtable for Sustainable Biofuels (RSB), the Roundtable for Sustainable Palm Oil (RSPO) and the Round Table on Responsible Soy Association (RTRS).

Table 11: Sustainability Considerations for Biodiesel

Issue	Feedstock(s)
Resource availability	All
Forest clearing by fire	Palm Oil
Rainforest clearing	Palm Oil
Displacement of existing crops	Soy, Grainseeds
Diversion from existing use, eg human consumption or stock feed	Soy, tallow
Land degradation - farmed areas	All, excl waste products
Ecological impact – wider system	All
Poor tracking of product source and compliance with standards	Palm Oil, Soy

(Source: own audit of non-government organisation sand sustainability groups issues lists on biodiesel sustainability)

The Roundtable for Sustainable Biofuels (RSB) is a relatively new body whose stated mission is to "… ensure that biofuels deliver on their promise of climate change mitigation, economic development & energy security without causing environmental and/or social damages, such as deforestation and food insecurity." (Roundtable on Sustainable Biofuels 2010). The RSB strives to do this by providing a standards certification system, based on twelve principles and criteria. This has been adopted by many organisations and regulators, for example the NSW government will allow imports

of biodiesel towards the mandated biodiesel target if the biodiesel is sourced from an RSB accredited producer.

The RSB principles and criteria provide an insight into the type of sustainability issues that need to be considered for biodiesel, and are shown in table 12:

Table 12

Roundtable on Sustainable Biofuels: Principles & Criteria
1. Legality
2. Planning, Monitoring & Continuous Improvement
3. Greenhouse Gas Emissions
4. Human & Labour Rights
5. Rural & Social Development
6. Food Security
7. Conservation
8. Soil
9. Water
10. Air
11. Use of Technologies, Inputs & Management of Wastes
12. Land Rights
Source: RSB 2010

Similarly, the RSPO (2010) and RTRS (2010) both provide accreditation for their relevant feedstocks. The RSPO provides accreditation for Certified Sustainable Palm Oil (CSPO), largely to assure purchasers regarding forestry processes in South East Asia. This framework has been supported by several non-government organisations, such as the World Wildlife Fund (2010).

The existence of the sustainability standards simplifies a complex set of issues for biodiesel. They provide buyers, sellers and regulators with a framework for assurance that switching to that product is not detracting from sustainability objectives. Sustainability standards also provide some assurance of the potentially confusing environmental benefits by removing the risk that biodiesel is being sourced from producers participating in damaging farming and forestry activities. However, it also highlights that there are many relevant issues and some potential negative impacts from biodiesel production.

3.3.3 Food versus Fuel

In 2007 world corn prices spiked dramatically, from US$2 per bushel in 2006 to US$3.50 per bushel, and a link has been drawn to the increase in the share of the corn crop used for ethanol growing from 13% in 2006 to 17% in 2007 (Childs & Bradley 2007). This increase in corn prices led to a backlash against the use of food crops for biofuels production by the most impacted groups (for example, the Mexican ‘tortilla riots’ in 2007) and an increased awareness in the general public to the linkage between food crops and the growing use of those crops for biofuels feedstock. It is also worth noting that world oil prices rose at this time, exacerbating food price increases. Batten &

O'Connel (2008) described this growing perception and identified that, in this case, perception may be more relevant than reality.

The two significant issues in the 'food versus fuel' debate are the direct diversion of food crops for use as biofuels feedstock and the issue of switching arable cropland away from food crops to feedstock crops (O'Connell et al. 2009).

The actual impact of direct diversion of food crops to biofuels production is more notable for the price impact on that crop than for the actual shortage of available food (UN-Energy 2007). The impact on increasing food crop prices is complex. For many developing countries, where agriculture is the primary source of income for the majority of people, increases in food crop prices will often have net positive impact (UN-Energy 2007). However at a community or individual level this will often not be the case, creating a mix of winners and losers. There is not yet a consistent link between the crops used for biodiesel and the related impact on food crops (UN-Energy 2007).

The issue of land use changing away from food crops has a clearer link for biodiesel crops. Oddly, the greatest impact of biofuels crop on food crops is actually the increase in ethanol demand driving many US farmers to switch away from soy crops (a potential biodiesel feedstock) to corn crops for ethanol production (UN-Energy 2007). From an environmental perspective the creation of new crop land for biodiesel by removal of rainforest in countries such as Indonesia and Malaysia is of greater concern than the conversion of existing crop land (Beer et al. 2007, 34).

While the ‘food versus fuel’ issue may be less relevant to current biodiesel feedstock production than it currently is to ethanol production, it may still be a factor that causes confusion or detracts from the benefits of biodiesel in the minds of customers and other stakeholders.

3.3.4 Perceptions of customers and consumers

While it is possible to analyse the relative environmental and sustainability attributes of biodiesel and establish a comparison to mineral diesel, it is essential that these credentials be understood and agreed by the relevant stakeholders, particularly customers. While this may be true for many products and technologies, it is especially so for biodiesel considering some of the complex issues and potential negative impacts outlined previously.

Despite the lack of agreement on implementation of a carbon price in the Australian market, there is evidence of a desire within the Australian consumer market to use ‘greener’ and sustainable products and for Australian businesses and industry to have a progressive view on sustainability, albeit with mixed feelings towards potential price increases (CSIRO 2008). The challenge for biodiesel is therefore twofold. Firstly buyers must be aware of an environmental and sustainability benefit for biodiesel. Secondly, buyers then need to be willing to pay the necessary price to realise that benefit. It is likely that at least a portion of the community would be willing to pay a premium for biodiesel - based on an existing willingness to pay more for renewable energy in other areas. This

can be seen in the electricity industry where some customers are willing to buy 'green power' at a premium to regular electricity. The Australian Bureau of Statistics (2009) reported that by 2008 around 52% of households were aware of 'green power', 30% would consider paying extra for green power, and 5% were already paying for green power. ABS (2009) also reported that uptake had doubled to 10% of households a year later. While this effect has not been enough to fully replace fossil fuel generation with renewable generation, there is at least a proportion of the market that is willing to switch.

The current perception of biodiesel in the Australian market is not clear. The issues surrounding the food versus fuel issue that have predominantly been related to corn crops for ethanol production may still shape some potential buyers' perceptions of biodiesel, particularly that sourced from grain crops. Similarly, there is an awareness from at least some sections of the community that palm oil is a potentially damaging crop to forest environments – this was evidenced by the reaction of some consumer and environmental groups to companies associated with palm oil, such as Nestle (Greenpeace, 2010). More research is needed into the current awareness and perceptions of biodiesel within the Australian market.

One very important customer group to consider is the large corporate customers, such as large transport and mining companies. These companies are very significant users of diesel and in addition many have stated public environmental and sustainability goals or values. Many of these companies have initiated trials of biodiesel to capture some of the benefits available in that area - for example Rio Tinto is reported to be implementing a

biodiesel trial in its Pilbara iron ore operation (ABC Rural 2010). Many companies in this group can access the excise rebate and as such will realise an additional saving from using a B5 blend, as described in section 3.1.4. It does appear that at least some business customers are currently better informed and more supportive of biodiesel than the general Australian public.

3.3.5 The response of the major oil companies

While consumers may be able to obtain some of the environmental and sustainability benefits, there may also be benefits available to suppliers – as demonstrable evidence of corporations acting responsibly and progressively.

All the large oil companies have 'triple bottom line' reporting or similar policies that promote progressive values on environment and social responsibility (see for example, Shell Australia 2010 and BP Australia 2010). Aspects of biodiesel would appear to align with these values. Total lifecycle greenhouse gas emissions on biodiesel are lower than mineral diesel, some feedstocks can be produced from low value or waste products, such as used cooking oil, and biodiesel production investment tends to benefit regional communities. In addition, all the oil companies seem to be committed to advancing biofuels. BP Australia (2010) has tested production of a 'renewable diesel' at its Bulwer

Refinery in Brisbane, with a 5% blend based on tallow. [5] Shell (2010) and Caltex (2010) have publicised biofuels views, with Shell purchasing a biodiesel for blending with mineral diesel in NSW. BP (2010) has invested with third parties for research and development of biofuels in the United States. While major oil companies are all participating in biodiesel to some degree, none has taken a 'leadership position' within the industry by dramatically increasing production. Activity is also heavily focussed on NSW, where the mandated targets apply to the major oil company's diesel supply in that State.

There could be several reasons why oil companies have responded in this way. However, the complex environmental and sustainability issues, combined with the lack of a clear view from customers and the general public on those issues, may play a part. In particular, unsustainable feedstock is the potential brand and reputation issue that could concern larger companies – most particularly the issues surrounding palm oil obtained from unsustainable forest harvesting and soy supply out of some markets.

3.3.6 Factor 3 Conclusions

Reviewing life cycle emissions assessments of biodiesel has shown that generally biodiesel has lower emissions than mineral diesel, despite the complex chain of activities

[5] This is not a traditional biodiesel, in that the tallow is fed into the existing refining process and not processed through the esterification process. The result is a product with the chemical qualities of normal diesel that meets the diesel fuel quality standard for Australia.

that need to be considered. It is clear that from an emissions perspective, not only are the feedstocks very different, but the methods that go into cultivating the feedstock crops and managing the associated land has a huge impact on emissions. In the worst case - clearing rainforest on peat soil for palm oil - the end result could be higher emissions than those for mineral diesel. This demonstrates the importance of sustainable processes and it is clear that there is a great deal of work going into this area around the globe. The various roundtables have good participation from the relevant industry players, and their frameworks are increasingly being utilised. Entrenching the standards from the various roundtables for all product supplied in Australia would appear to be a straightforward approach to dealing with the complex sustainability issues.

The lack of clear perceptions from the general public suggests that an increased penetration of biodiesel would require education of potential buyers on the environmental and sustainability benefits of biodiesel, either through greater public debate on the relevant issues, or a deliberate education campaign. The adoption of the relevant sustainability standards, particularly on imported biodiesel, and education of the public on the sustainability assurances that these standards provide would also appear to be a necessary step in shaping the perceptions of buyers. There is only limited information available to the general public at the point of consumption regarding biodiesel's environmental and sustainability attributes in easily obtainable and understandable form.

There has been some effort made to link sustainable feedstock to the NSW mandate, by requiring feedstock to be sourced from suppliers accredited by the Roundtable on Sustainable Biofuels Standard. However there is currently no government-led activity to

more broadly raise consumer awareness of sustainable biofuels standards to help mitigate the risk to suppliers of consumer backlash.

4.0 CONCLUSION

The analysis of each of the three factors identified as potential drivers for biodiesel penetration in the Australian market provided a mixed picture. It is clear that there are some potential benefits available if biodiesel consumption increases – from an environmental perspective and possibly from an energy security perspective. It is also clear that biodiesel does have some standing on each of the factors considered – feedstock prices are near to mineral diesel prices with potential to close the gap in the longer term, it has a level of government support and it does have some good environmental credentials, while better management of sustainability issues is emerging.

However penetration remains low. If the three factors identified as potential drivers of penetration are correct, it must be seen that there is still a shortfall on each, hindering penetration. Biodiesel can currently not better mineral diesel on price. While there is some government support in the form of excise relief and a State mandate in NSW, it is not enough to overcome the price barrier. A price on carbon will be favourable to biodiesel relative to mineral diesel, but will not be enough in itself to overcome the price gap. Likewise, the environmental and sustainability aspects of biodiesel are either not agreed, understood or clear to the general public and other stakeholders to a degree great enough to overcome the price hurdle. Of course, these factors also work in combination, so potentially a small amount of progress across all three factors could drive penetration – a smaller price gap could be overcome with supportive government policies, with the general public also seeing some environmental benefits.

Shell have outlined two possible future scenarios for biofuels based on the combination of demand and supply operating within a world where greenhouse gas emissions need to be addressed – they call the two scenarios 'Scramble' and 'Blueprints' (Gerhardty 2009). In the scramble scenario there is a set of unrelated measures, with rapidly emerging issues and opportunities – it is unplanned, hectic and risky for the participants. In the blueprints scenario the pathway is a lot clearer, there is a direction and rough framework – with care and attention the participants can navigate through successfully. The scramble scenario is a good description for the current status of biodiesel in Australia.

It is worth considering, based on the factors analysed in this paper, what a 'blueprints' scenario would look like for biodiesel in Australia in the short term. There would need to be a measure in place to overcome the price gap. This could either be a government subsidy to directly address price, or a measure that negates the gap – such as a mandated biodiesel quota. This would be part of a set of clear government policies, guided by an overall position on biodiesel with a long term commitment. Barriers to entry would be specifically addressed through either direct intervention or market based mechanisms. A set of sustainability standards would be agreed and implemented. The general public would be educated on the relevant issues and enabled to make informed choices.

First generation biodiesel in Australia is languishing. The dominant factors described in this paper could influence penetration, but on each aspect biodiesel falls short. This needs to be seen as an artificial result. The benefits of biodiesel may be skewed by public perception at worst based on fallacies, and at best unbalanced and uninformed. The price

gap is not controlled by true costs, including externalities, but is made up of artificial factors such as excises, grants and subsidies. The policy environment is inconsistent, with a lack of clear overriding direction at the federal level. The integration of first generation biodiesel into the Australian diesel market must therefore be seen as unlikely to undergo rapid acceleration without a significant change in one or all of these areas.

5.0 Recommendations for Further Research

This research was limited by the breadth of this topic, combined with the limited availability of critically important but sensitive commercial and pricing information. Some areas where further analysis would provide deeper insights include:

- First generation biodiesel feedstock costs, including price forecasts and sensitivity analysis. This would assist in understanding the likely future price gap.
- Current economics of biodiesel production, including start up costs, costs of capital, energy inputs and logistics costs.
- Opportunity costs of a declining biodiesel market. This would help shape government policy.
- Detailed analysis of the various roundtable sustainability standards, the degree of compliance to those standards within Australia, and the feasibility and cost of compliance with those standards in a scenario of large-scale imports.
- Development of potential frameworks for integration of first, second and third generation biodiesel in Australia.
- A comparison of the Australian biodiesel market to international biodiesel markets, particularly where penetration has been high, or where market conditions are similar.

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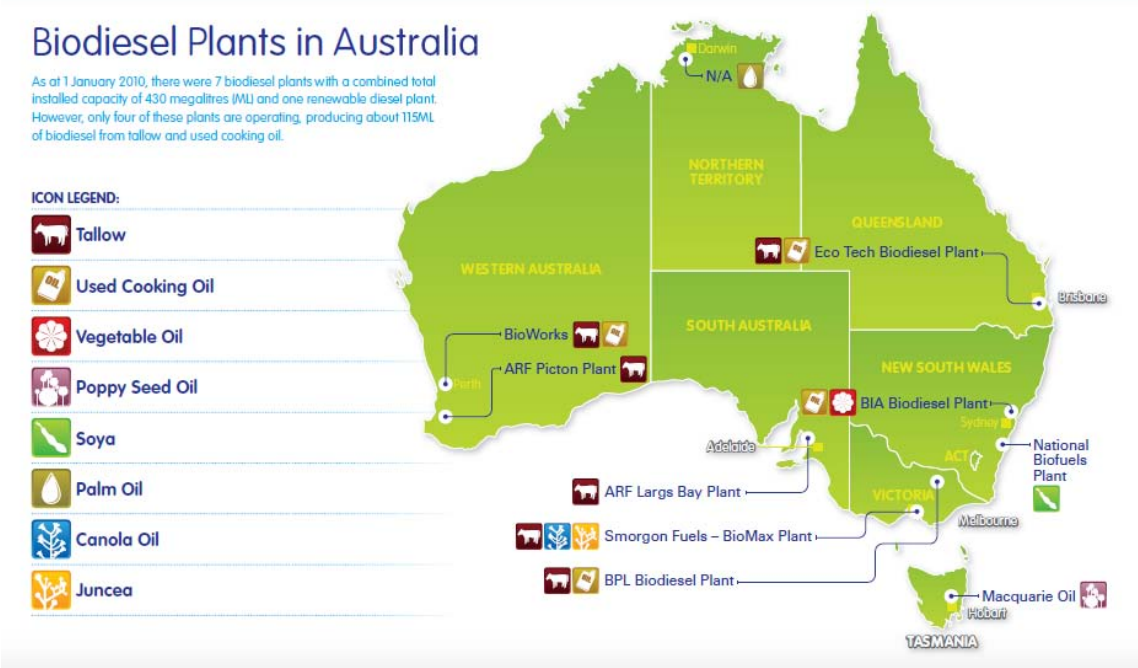
Appendices



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