Benchmarking the Price of Fuel Ethanol in Australia

Report to
Australian Competition and Consumer Commission

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1 Key Findings

The import parity price (IPP) for fuel grade ethanol is determined in the same manner as that for the IPP for petrol.

However, unlike the large volume of petrol imported from Singapore to Australia, there have been no imports of fuel ethanol into Australia in recent years. The volume of chemicals sourced from Brazil, the key alternative source of ethanol for Australia, is very small. Therefore, Australia does not have any regular ethanol trade that it can reference for the determination of an IPP.

A contributing reason for there being no imports has been the application of 38.143 cents per litre (cpl) (excise equivalent) customs duty on fuel ethanol imported into Australia. Currently, fuel ethanol imports are subject to customs duty in addition to a 5 per cent import duty. Domestically produced ethanol, on the other hand, is effectively excise free. It is probable therefore, that imports of ethanol into Australia will be limited until the treatment of excise/customs duty for both domestic and imported ethanol becomes more aligned (as is proposed from 2015) and imports are priced more competitively with domestically produced ethanol.

A key finding of this report therefore, is that it is not possible at this stage to determine an IPP for fuel ethanol with the same level of confidence or reliability as that for determining the Australian IPP for petrol or diesel.

The reasons for arriving at this finding include:

- **Export availability.** Brazil is currently the dominant world exporter of fuel ethanol. There is no assurance that Brazil will always have regular volumes of exports available for the Australian market, like Singapore has refined petroleum available for the Australian market. Brazil’s export volume is variable, and subject to domestic consumption and internal mandates.

- **Thin freight market.** Freight is a key IPP component and is difficult to benchmark without regular trade between Australia and the source market – in this case Brazil. Chemicals (including industrial ethanol) are transported in small seagoing ships called chemical carriers, often as part cargoes, and freight is negotiated on a case by case basis. The number of voyages of chemical carriers between Brazil and Australia is estimated to be very few. It is questionable therefore, whether freight costs can be as reliably sourced as they can for petrol imports into Australia for benchmarking purposes.

- **No published freight assessment.** There is no published or visible freight index for chemical carriers for the Australia/Brazil route unlike the Platts freight assessments for petrol or diesel imported into Australia.

- **Limited coastal infrastructure.** Importing fuel ethanol requires specially equipped storage facilities located at coastal chemical terminals. There are only a few ports located around the Australian coast that can accept fuel ethanol for intermediate storage, before blending with petrol.
2 Summary

About fuel ethanol

- Anhydrous ethanol is an alcohol that does not contain water. It is the only grade of ethanol suitable for blending with petrol in Australia, and:
  - Has around 68 per cent of the volumetric energy value to that of typical petrol, thus impacting on fuel economy;
  - is an oxygenate (its molecule contains oxygen) which helps the fuel to burn better and cleaner; and,
  - has a higher octane rating of 129 research octane number (RON) than regular unleaded petrol (RULP) of 91 RON.

- Most ethanol blended fuel in Australia is made up of 10 per cent ethanol and 90 per cent petrol and is referred to as E10. The demand for ethanol blended fuel in Australia has increased significantly from 2006 to 2009. Consumption of ethanol blended petrol in 2009 amounted to 1,972 megalitres (ML) or 10 per cent of Australia's petrol consumption. States with the largest blended ethanol sales are NSW, Queensland, and Victoria.

- Ethanol production from existing operations in Australia is expected to expand to about 490 ML by the end of 2010. Currently, Australia has sufficient ethanol production capacity to meet current demand for fuel ethanol.

- World ethanol production is concentrated in the USA (50 per cent) and Brazil (38 per cent). Brazil is the world's largest exporter of ethanol and the USA is a net importer. Other Asian ethanol producing countries - China and Thailand are balanced in ethanol consumption and production.

- Brazil would be the most likely source of imports of fuel ethanol for Australia.

Factors influencing ethanol pricing in Australia

- Australian consumers of petrol are price sensitive. The ACCC in 2007 noted that petrol prices are highly visible and that ‘...consumers of unleaded petrol are highly price sensitive and are willing to switch locations from which they buy petrol for a very small price difference’.

- Consumers of ethanol blended fuel may be influenced by a number of factors including value for money, a performance benefit over RULP, and a fuel that will potentially reduce carbon emissions. Producers focus on the cost of producing ethanol and wholesalers focus on the supply chain costs between the producer and the wholesaler/retailer.

Current pricing of ethanol as a blend with petrol (E10)

- The pricing of fuel ethanol in Australia is, currently, linked to the price of petrol with adjustments for energy and excise. The rationale for adopting petrol linked ethanol pricing is that ethanol is used as an extender or a replacement for petrol.

- However, the current overriding pricing factor is that blended fuel needs to be priced competitively (that is, cheaper) with petrol to encourage consumer acceptance at the pump.

1 In this report from this point on and, unless otherwise qualified, ‘ethanol’ refers to fuel grade ethanol. Fuel grade ethanol is primarily pure ethanol containing an allowable (i.e. hydrocarbons in the petrol boiling range or corrosion inhibitors) denaturant that meets the Australian Standard for fuel ethanol (see Appendix 1)

2 ACCC, Petrol Prices and Australian Consumers, December 2007, p30
**Generic method of current price determination**

- The negotiated price for ethanol blended with petrol to form E10 is based on the following formula:

  \[ \text{Ethanol Price} = \text{petrol Terminal Gate Price (TGP)} \text{ adjusted for energy content and excise advantage.} \]

- In the recent market (late May 2010) in Sydney, when the TGP for RULP was about 119 cents per litre (cpl), the TGP for E10 was about 115 cpl. The ethanol producer would receive about 67 cpl of ethanol sold at the terminal gate (Table 2).

**Ethanol import parity pricing (IPP)**

- In markets where domestic refinery output is insufficient to meet demand, the IPP method of pricing represents the cost of the best alternative source of supply of that commodity, as is the case with Australian petrol pricing.
- In a highly liquid, open, and internationally competitive market like that of the petroleum industry, price negotiations predominantly centre on the limits set by the IPP and the export parity price (EPP).
- IPP for fuel ethanol can be expressed as:

  \[ \text{Fuel Ethanol IPP} = \text{benchmark price} + \text{freight} + \text{insurance and loss} + \text{wharfage}. \]

- The ethanol IPP formula does not take into account energy adjustments or other quality premiums/discounts (e.g. octane credit) that would be components of the TGP for the ethanol blended fuel.

**Ethanol benchmark price for Australian IPP**

- As with the petrol benchmark price, there are a number of agencies or industry sources that provide an assessment of the price of ethanol FOB Brazil and for other markets (Table 6).
- So long as Brazil is the dominant source of fuel ethanol for the export market, it can be argued that a benchmark ethanol price should be based on Brazil price quotations, FOB price at a major export terminal in Brazil. Santos, located near São Paulo, is the major seaboard terminal in Brazil for the export of ethanol.
- However, unlike the large volume of petrol imported from Singapore to Australia, the volume of chemicals sourced from Brazil is very small. Furthermore, there have been no imports of fuel ethanol into Australia in recent years. Therefore, Australia does not have any regular ethanol trade that it can reference for the determination of an IPP and any determination would be theoretical at this stage.

**The Brazilian ESALQ ethanol price index**

- From EnergyQuests’ experience, the ESALQ (Escola Superior de Agricultura Luiz Queiroz) index (published by CEPEA - a research centre of the University of São Paulo) in Brazil is the local measure of ethanol pricing and the most referenced price in ethanol contracts worldwide. Ethanol traders operating in Asia also use ESALQ as the key price source (Section 6.5.2).
- ESALQ quotes for anhydrous and hydrous ethanol are given on a mill gate basis excluding taxes. The Australian market requires anhydrous ethanol (99 per cent purity) for use in fuel blending.

**Other pricing sources**

- Given the dominance of Brazil in the world trade of ethanol, no other benchmarks at this stage justify any lengthy consideration.
- In the case of the USA, ethanol is manufactured predominantly from corn. Both corn and ethanol are traded locally on the Chicago Board of Trade (CBOT) and this is the mechanism for pricing. Because of
the distortions of government subsidies and import tariff protections however, this pricing mechanism is limited to the US.

- **China** has the largest production in the Asian market but most of the ethanol produced is consumed as a beverage or used as a solvent in their domestic industrial markets. **India** and **Thailand** - two countries that have large sugarcane industries - have local programmes to encourage ethanol based fuels and as such are more likely to be destination markets for fuel ethanol rather than being significant exporters.

**Other components of the IPP**

- The other components that make up the IPP are freight, insurance and loss, and wharfage.

**Freight assessment is more complex**

- Australia does not have any regular ethanol trade that it can reference for the determination of an average freight rate for fuel ethanol.

- Ethanol is shipped in smaller ocean going vessels called **chemical carriers**. Typical capacity of a chemical tanker is between 10,000 and 15,000 tonnes. This compares with the carrying capacity of a Medium Range (MR) product carrier of between 30,000 and 40,000 tonnes. As a result, freight cost for carrying chemicals is significantly higher than that for bulk petroleum products.

- Freight assessments for the **chemical carrier market** are not as visible as they are for the MR freight market. Freight rates for chemical carriers are negotiated on a case by case, voyage by voyage basis. To assess chemical carrier freight rates, especially for the Brazil/Australia leg, it is necessary to have access to the negotiated rates – information which is generally confidential.

- In the absence of any other visible mechanism (like that for petrol imports), one approach is to obtain a monthly consensus assessment of rates (in US$/tonne) for specific routes (e.g. Brazil/Australia; Asia/Australia) from ship owners (such as Dorval/Stolt/Botany Bay Shipping) and two or three brokers who are familiar with the Australian trade (see section 7.2.4).

- Any assessment would need to be ‘normalised’ to reflect the rate for a ‘typical’ size cargo taking into account the current market for chemical carriers, rates of other routes of similar voyage length, part cargo penalty, and other factors that play on the current market.

**Insurance, loss and wharfage**

- Insurance on chemical cargoes is typically 0.4 per cent of the landed cargo value and loss of product during a voyage is generally claimable beyond 0.5 per cent by volume.

- Average wharfage of the respective port authorities in Brisbane, Botany and Melbourne (Coode Island) amounts to 0.245 cpl.

**Current IPP estimate**

- As at end May 2010, we estimate the IPP (before excise equivalent customs duty and GST) for ethanol from Brazil would be approximately A$71 cpl landed east coast Australia. On an energy equivalent basis to petrol, this would be A$104 cpl (Table 8).

- The ‘ex Terminal’ price for ethanol (before blending) with the new excise regimes operating in July 2011 and in July 2015 will, in today’s dollar terms, reduce from A$128 cpl in June 2010 to A$100 cpl in July 2015 (Table 9).

- A key finding of this report is that it is not possible at this stage to determine an IPP for fuel ethanol with the same level of confidence or reliability as that for determining the Australian IPP for petrol or diesel.
3 Scope

The agreed scope of this study is as follows:

1. International benchmark prices for ethanol:
   a) Outline the current method of pricing for fuel ethanol in Australia (this is required to put any international price mechanism in context).
   b) Identify the benchmark/reference prices that are used to determine the price of ethanol (and ethanol-blended gasoline if appropriate) in the relevant global markets (e.g. ESALQ, CBOT, emerging assessments, other).
   c) Discuss how these prices are derived/assessed.
   d) Comment on their transparency in the open market.
   e) Determine how ‘representative’ are these reference prices for trading.
   f) Comment on which benchmark price(s) would be most appropriate for the Australian fuel ethanol market, especially as a basis for IPP determination.

2. Other components of IPP for fuel ethanol:
   a) Apart from the international price for ethanol, describe the other elements that would be associated with an IPP for ethanol in Australia (e.g. freight, losses).
   b) Comment on the determination of the (ocean) freight component of the IPP and factors that would impact on freight costs.
   c) Determine how would these components can be measured or indexed.
   d) Discuss the costs, structures, economies, and other factors that might impact on the transportation of ethanol to Australia from representative market sources.
   e) Analyse and recommend freight benchmarks that can be used for typical import cargo load sizes to Australia.
4 Introduction

4.1 Ethanol

- Ethanol in its pure state is otherwise known as ethyl alcohol, alcohol, or grain-spirit. It is a clear, colourless, flammable, oxygenated hydrocarbon with a boiling point of 78.5 degrees celsius in the anhydrous state.
- Commonly referred to as ‘alcohol’, ethanol (and its derivatives) has a long history of different uses. For example, in industry (as a solvent), food (alcoholic beverages) and medicine (sterilising agent), transport (fuel) and agriculture.
- Ethanol is hygroscopic – that is, it easily absorbs water from its surroundings.
- Most ethanol is produced by a fermentation process using sugars (sugar cane, sugar beet and molasses), starch (corn, wheat, grains) or cellulose (forest products) as raw materials. Ethanol can be produced synthetically from ethylene, but it is not a major source in world ethanol production.
- Ethanol produced and refined up to 99.9 per cent purity is potable (drinkable). When sold as alcohol contained in beverages such as spirits, beers, wine etc in Australia, ethanol attracts an excise of around A$60 per litre of alcohol contained in that beverage. To distinguish potable from non-potable ethanol, a ‘denaturant’ is added to pure ethanol. Denatured (non-potable) ethanol is generally not subject to excise, depending on its application.

4.2 Ethanol as a fuel

- Fuel grade ethanol is blended with petrol and consumed specifically as a transport fuel.
- The relevant chemical characteristics of fuel ethanol (compared with petrol) include:
  - Ethanol in its anhydrous form is directly **miscible** (mixes without layering or separating) **with petrol** and can be easily blended making it a viable petroleum additive.
  - **Density.** Compared with petrol, anhydrous ethanol has a heavier density of 0.789 kg/l or 1266 litres per tonne (petrol density is about 0.74 kg/litre or 1360 litres per tonne).
  - **Energy value.** Ethanol has a lower energy rating of 23.4 MJ/litre or 29.6 GJ/tonne (petrol is 34.2 MJ/litre or 46.4 GJ/tonne). This means that ethanol has around 68 per cent of the volumetric energy value to that of typical petrol, thus impacting on fuel economy.
  - Ethanol is an **oxygenate** – that is, unlike petrol/hydrocarbons, its molecule contains oxygen which helps the fuel to burn better and cleaner.
  - Ethanol in its anhydrous form has an **octane rating** of 129 RON.
  - When ethanol is blended with RULP which has an octane rating 91 RON, the octane rating of the blend increases. Thus, when 10 per cent ethanol is blended with RULP to make E10, the blend has an octane rating of about 94 RON.
  - Ethanol is **hygroscopic** – an absorber of moisture/water. If an ethanol/petrol blend is exposed to moisture, it will cause the ethanol contained in the blend fuel to ‘layer’ i.e. the ethanol and water will separate out from the petrol.
  - Although ethanol itself has a Reid Vapour Pressure (RVP) less than that of petrol, its addition to petrol markedly increases the volatility of the blend, which can lead to increased evaporative
emissions. It is generally accepted that the peak RVP of ethanol blends occurs at around 5 to 10 per cent ethanol concentration\(^3\).

- The quality of ethanol for blending in Australia is determined by the Department of the Environment, Water, Heritage and the Arts (DEWHA). The Australian Ethanol Standard (Appendix 1) states that ethanol must contain between 1 per cent and 1.5 per cent denaturant and at least 95.6 per cent (pure) ethanol by volume.

- The Australian Petrol Standard allows up to 10 per cent ethanol to be blended with gasoline. This is the most common ratio for ethanol blend in Australia and is commonly referred to as E10. Other blends of up to 85 per cent ethanol (E85) are available at only a few retail outlets in Australia.

- Petrol containing ethanol must be so labelled at the retail point.\(^4\)

- As with petrol and diesel fuel, ethanol is subject to a fuel excise of 38.14 cpl. However, to promote ethanol as an alternative fuel, Australian producers of fuel grade ethanol currently receive a government Production Grant of 38.14 cpl which fully offsets the excise payable. (See Section 5.8 for more details on excise and the production grant).

### 4.3 Increasing demand for E10

- As shown in Figure 1, the demand for petrol in Australia is currently in slight decline. However, the demand for ethanol blended fuel has increased significantly from 2006 to 2009. According to the Australian Petroleum Statistics (APS), consumption of ethanol blended petrol in 2009 amounted to 1,972 ML or 10 per cent of Australia’s petrol consumption.

- States with the largest blended ethanol sales are NSW, Queensland, and Victoria.

- This growth has been supported by:
  a) Federal Government policy where a domestic producer receives a grant to the value of excise (38.14 cpl) to offset the impact of the excise on the ethanol price. The grant does not apply to imported fuel ethanol.
  b) Promotion of regional development (especially agricultural and rural economy) through the production of ethanol either as a by-product of existing operations (CSR and Manildra) or from new green field production (Dalby Bio-Refinery).
  c) The emergence and implementation of State government mandates. NSW was first to introduce an ethanol mandate in October 2007. Initially it required ethanol (in petrol-ethanol blend) to make up a minimum of 2 per cent of the total volume of petrol sales. The same mandate requires that all RULP sold in NSW contain 10 per cent ethanol from mid 2011. Queensland plans to introduce a 5 per cent mandate for RULP from January 2011.
  d) Market forces wanting to deliver a lower carbon fuel platform in response to the developing consciousness on climate change.

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\(^4\) Fuel Quality Information Standard (Ethanol) Amendment Determination 2005 (No. 1)
4.4 Ethanol production in Australia

- Australia has three producers of fuel ethanol – Manildra (located at Bomaderry, NSW), CSR Ethanol (Sarina, Qld) and Dalby Bio Refinery (Dalby, Qld). The total production capacity of these plants is currently estimated to be 360 ML pa. Production from existing operations is expected to expand to about 490 ML by the end of 2010.

- Currently, Australia has sufficient ethanol production capacity to meet current demand for fuel ethanol. However, according to APAC Biofuel Consultants, it is uncertain if there will be sufficient domestic production from 2011 when the proposed Queensland mandate comes into effect and the NSW mandate requires all RULP to contain ethanol.

4.5 World fuel ethanol production

- According to the United States Energy Information Administration (US EIA), world ethanol production in 2008 was concentrated in the USA (50 per cent) and Brazil (38 per cent). World ethanol production in 2008 amounted to 70,800 ML (1.22 million barrels per day).

- According to the US EIA, ethanol production in the USA will continue to grow to meet the volume requirements of the Renewable Fuel Standard. The US EIA projects ethanol production (in the USA), which averaged 700,000 bbl/d (40.6 BL pa) in 2009, to increase to an average of 800,000 bbl/d (46.4 BL pa) in 2010 and 850,000 bbl/d (49.3 BL pa) in 2011.

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5 APAC Biofuel Consultants, Australian Biofuels 2009, Client Study, September, 2009, p34
8 More information on the Renewable Fuel Standard is in section 6.6.1.
5 Ethanol pricing in Australia

In determining the price for ethanol currently sold into the Australian petrol market, a number of considerations need to be taken into account.

5.1 Fuel consumer’s viewpoint

Australian consumers of petrol are price sensitive. The ACCC in 2007 noted that petrol prices are highly visible and that ‘...consumers of unleaded petrol are highly price sensitive and are willing to switch locations from which they buy petrol for a very small price difference’9.

The following are factors that consumers may consider when choosing to buy ethanol blended fuel:

- that they receive value for money using an ethanol blended fuel compared with the alternative of RULP. Ethanol blended fuel is seen as a discount product rather than a premium product and currently the majority of E10 is discounted by around 2 to 3 cpl relative to RULP,
- the potential performance benefit over RULP because of the higher octane rating of the ethanol blended fuel,
- the potential ‘green’ benefit of reduced carbon emissions using an ethanol blended fuel,
- that the vehicle is technically capable of operating on ethanol blended fuel. There are a number of vehicles which cannot use E10. The Federal Chamber of Automotive Industries (FCAI) lists on its website (www.fcai.com.au) vehicles capable of running on E10. The list includes most vehicles manufactured after 1986,
- with the introduction of state government mandates, some service stations (particularly in NSW and Queensland) may offer only E10 in lieu of RULP,
- the degree of consumer confidence that ethanol blended fuel is a safe alternative to RULP.

5.2 Ethanol producer’s viewpoint

From an ethanol producer’s viewpoint, there are some additional considerations that surface when considering the price of ethanol to be sold into the fuel market. The key question for a producer is the cost of production of ethanol.

The cost of production of ethanol is dominated by the main substrate, or base feedstock, from which the fuel is derived. Currently in Australia, the main substrates are wheat, molasses (sugar), and sorghum. Typically, feedstock price alone can make up between 70 per cent and 85 per cent of the cost of production. These commodity inputs have separate pricing cycles that are not ‘hard wired’ to the petroleum price or the price of oil. As a result, there are times when the costs of ethanol feedstocks may be uncompetitive with the oil and RULP price (see Section 5.7.3). This presents the greatest cost risk to producers selling product into the same highly competitive market. It is also a risk that can make or break a sustainable fuel ethanol production base.

5.3 Fuel wholesaler’s viewpoint

From a wholesaler’s perspective, the question is how the risk will be shared between the producer and the wholesaler/retailer with respect to changing costs of production and the realities of what the market is prepared to pay. There are significant costs in configuring and investing in the supply chain to cater for

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9 ACCC, Petrol Prices and Australian Consumers, December 2007, p30
different fuel types. Switching between products is costly, uneconomic and not desirable at the wholesale/retail points.

For a wholesaler, producer, or retailer who has invested in blending infrastructure and market development of a new fuel, the cessation of ethanol availability from an otherwise reliable supplier due to profitability issues is economically damaging, unless the wholesaler has alternative economic sources of ethanol. To supply ethanol blended fuel into the market, it is essential that the blender/wholesaler has access to a reliable and continual source of fuel ethanol.

5.4 Role of the petrol IPP and ethanol pricing in Australia

Australia is a net importer of petrol. In 2009, Australia imported 24 per cent of its petrol requirements. The IPP is central in setting petrol prices in Australia. Recent reviews by the ACCC on the pricing of petrol confirm that the Singapore market and the IPP remain the appropriate basis for benchmarking the price of petrol in Australia. The IPP, in turn, forms the basis for the TGP (wholesale price) in Australia which forms the basis for the retail price for petrol. The benchmark price for the petrol IPP is the price of petrol (Mogas 95 RON) sold FOB Singapore. The Mogas price used is that quoted daily by the pricing agency, Platts (referred to as MOPS). As demonstrated in the ACCC’s report, the largest component of the IPP for petrol is the Singapore price (converted to Australian dollars), which accounted for around 91 per cent of the IPP in 2008-09.

Pricing of fuel ethanol is unlike the pricing of petrol or diesel in Australia. However, the pricing of fuel ethanol in Australia is, currently, linked to the price of petrol with adjustments for energy and excise.

The rationale for adopting petrol linked ethanol pricing is that ethanol is used as an extender or a replacement for petrol.

However, the current overriding pricing factor is that blended fuel needs to be priced competitively (that is, cheaper) with petrol to encourage consumer acceptance at the pump.

5.5 Generic ethanol price structure

The petrol linked ethanol formula in generic form can be expressed as:

Ethanol Price = Petrol TGP adjusted for energy content and excise advantage.

The use of a direct IPP method for ethanol pricing has (as discussed later in this report) not yet been adopted in the Australian market. Besides, imported fuel ethanol is subject to 38.14 cpl excise equivalent customs duty and a 5 per cent import duty. Fuel ethanol produced in Australia is currently effectively excise free. Thus, there are only pockets of opportunity to import ethanol when the world ethanol price is low or the price of oil is very high in relative terms.

When considering price structures, it is assumed that the price is based on a formula to apply over a period of deliveries (often referred to as a ‘term’ price, as opposed to a ‘spot’ price). The price therefore generally applies to deliveries over (say) a six month, twelve month, or longer period.

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10 RET, Australian Petroleum Statistics, December 2009
11 ACCC, Monitoring of the Australian petroleum industry, December, 2009, p83
12 Mean of Platts Singapore (MOPS) is the mean of the high and low components of a Platts assessment for oil cargoes loading from Singapore. Platts publish a daily assessment of Singapore Mogas 95 RON FOB is based on a Market on Close (MOC) principle in the Spot Market. The assessments reflect the closing level within the Platts trading window and uses a combination of the bids, offers and transactions concluded by traders for both physical products and related paper swaps during the daily assessment process.
13 ACCC, op cit, p85
This generic form of pricing may not apply to all contracts for fuel ethanol. Other factors that can influence price are discussed in Section 5.7 below.

5.6 Generic pricing model – worked example

There are a number of pricing models in use for pricing fuel ethanol in Australia, but all embrace the principles of recognising the lower energy content of ethanol in the establishment of a pricing formula. For the purposes of this report the following sets out a generic pricing model for illustrative purposes. The model determines the price of ethanol and the price of E10 at the retail point based on price negotiations for the sale of ethanol into the fuel market. This model, in its generic form, is based on Energy Quest’s understanding of Australian industry practice.

There are three steps in this particular model:

a) determine the TGP for RULP (Table 1) (an already established method in Australia),

b) determine the equivalent IPP for ethanol by back calculating from the TGP for RULP (Table 2), then

c) determine the equivalent E10 TGP and retail price (Table 3).

This example assumes the 2010 excise rates and ethanol production grants are applicable to Australian producers. It is also based on assumed values for MOPS, Singapore/Australia freight, exchange rate, terminal charges and, margins as at late May 2010.

5.6.1 Step 1 - Determine the TGP for RULP

Table 1 Determination of the TGP for RULP

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>May 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singapore MOPS 95 Petrol (mogas) Price</td>
<td>USD/bbl</td>
<td>$83.000</td>
</tr>
<tr>
<td>plus Freight: Singapore to Australia</td>
<td>USD/bbl</td>
<td>$3.000</td>
</tr>
<tr>
<td>Wholesale Petrol</td>
<td>USD/bbl</td>
<td>$86.000</td>
</tr>
<tr>
<td>AUD Exchange rate</td>
<td>AUD/USD</td>
<td>0.850</td>
</tr>
<tr>
<td>IPP MOPS 95 Petrol*</td>
<td>A$/litre</td>
<td>$0.636</td>
</tr>
<tr>
<td>plus Terminal Costs + Margin</td>
<td>A$/litre</td>
<td>$0.059</td>
</tr>
<tr>
<td>plus Petrol Excise</td>
<td>A$/litre</td>
<td>$0.381</td>
</tr>
<tr>
<td>plus GST</td>
<td>A$/litre</td>
<td>$0.108</td>
</tr>
<tr>
<td>TGP MOPS 95 Petrol</td>
<td>A$/litre</td>
<td>$1.185</td>
</tr>
</tbody>
</table>

*excluding quality premium
5.6.2 Step 2 – Determine IPP ethanol equivalent based on MOPS

<table>
<thead>
<tr>
<th>Petroleum Energy Content</th>
<th>GJ/KL</th>
<th>34.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol Energy content</td>
<td>GJ/KL</td>
<td>23.4</td>
</tr>
<tr>
<td>Ethanol Energy Equivalence to Petrol</td>
<td>%</td>
<td>68%</td>
</tr>
<tr>
<td>Energy Equiv. Ethanol TGP (incl. GST)</td>
<td>$/litre</td>
<td>$0.810</td>
</tr>
<tr>
<td>less GST</td>
<td>$/litre</td>
<td>$0.074</td>
</tr>
<tr>
<td>Equivalent Ethanol TGP (excl. GST)</td>
<td>$/litre</td>
<td>$0.737</td>
</tr>
<tr>
<td>less Terminal Costs + Margin (assumed for ethanol)</td>
<td>$/litre</td>
<td>$0.070</td>
</tr>
<tr>
<td>less Excise payable</td>
<td>$/litre</td>
<td>$ -</td>
</tr>
<tr>
<td>IPP Ethanol Equivalent MOPS 95</td>
<td>$/litre</td>
<td>$0.667</td>
</tr>
</tbody>
</table>

5.6.3 Step 3 – Determine the equivalent E10 TGP and retail price

<table>
<thead>
<tr>
<th>IPP MOPS 95 Petrol*</th>
<th>$0.636</th>
<th>$0.573</th>
<th>$0.064</th>
<th>E10=90% of RULP</th>
</tr>
</thead>
<tbody>
<tr>
<td>plus IPP Ethanol Equivalent MOPS 95</td>
<td>$ -</td>
<td>$0.067</td>
<td>$0.07</td>
<td>10% of IPP Eth. Equiv</td>
</tr>
<tr>
<td>Terminal Costs + Margin</td>
<td>$0.059</td>
<td>$0.070</td>
<td>$0.011</td>
<td>From Step 1</td>
</tr>
<tr>
<td>plus Excise</td>
<td>$0.381</td>
<td>$0.343</td>
<td>$0.038</td>
<td>E10=90% of RULP</td>
</tr>
<tr>
<td>plus GST</td>
<td>$0.108</td>
<td>$0.105</td>
<td>$0.002</td>
<td></td>
</tr>
<tr>
<td>TGP</td>
<td>$1.185</td>
<td>$1.158</td>
<td>$0.027</td>
<td></td>
</tr>
<tr>
<td>plus Retail Margin + Frt.</td>
<td>$ -</td>
<td>$0.075</td>
<td>$0.075</td>
<td></td>
</tr>
<tr>
<td>plus GST on Retail Margin+Frt.</td>
<td>$ -</td>
<td>$0.01</td>
<td>$0.008</td>
<td></td>
</tr>
<tr>
<td>Fuel Pump price</td>
<td>$1.185</td>
<td>$1.241</td>
<td>$0.056</td>
<td></td>
</tr>
</tbody>
</table>

*excluding quality premium

5.7 Factors that can impact on the ethanol price

There are a number of variations to this generic form of pricing which are negotiated between the ethanol seller and the buyer. Variations could include:

a) adjustment for the higher octane rating of ethanol,

b) positive adjustment for carbon (depending on the price of carbon),

c) sharing risk with the application of a floor price and a ceiling price. The floor price generally relates to the cost of production.

5.7.1 Pricing Ethanol as a substitute for petroleum (octane)

As mentioned above, ethanol has the effect of raising the octane level of petroleum as it is classed as an oxygenate. Anhydrous ethanol has an octane value of 129 RON. When combined with petrol in a 10 per cent blend ethanol has the effect of lifting the octane rating by about three octane (RON) points.

An October 2009 study by MMA on the method and basis of the setting of the IPP for unleaded petrol noted that an “implied” value of octane could be deduced from examining the historical difference in the price of...
Mogas grades. The difference in octane values between MOPS 95 (the benchmark for RULP) and MOPS 97 (the benchmark for PULP 95) varied between around $US 1 bbl to $US 2.5 bbl over the period 2004 to early 2009. Therefore, it can be argued that a higher octane in E10 of an additional three points over RULP 91 RON would have an added value to the price of E10.

5.7.2 Possible carbon pricing implications

Currently there is no price set on carbon through either an emissions trading scheme (ETS) or a carbon tax. However, it is probable that, if introduced in the future, a carbon price will influence the pricing of various types of transport fuels. The following briefly addresses the impact on emission costs when ethanol is used as a transport fuel.

Ethanol can have lower embodied carbon than petroleum, depending on the substrate from which ethanol is produced (i.e. sugar, molasses, grain etc).

<table>
<thead>
<tr>
<th>Carbon price $/t CO2-e</th>
<th>Molasses Cogeneration. cpl</th>
<th>Molasses Grain Sorghum cpl</th>
<th>Wheat Wheat Starch Waste cpl</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>–0.077</td>
<td>–0.050</td>
<td>–0.037</td>
</tr>
<tr>
<td>15</td>
<td>–0.116</td>
<td>–0.074</td>
<td>–0.055</td>
</tr>
<tr>
<td>20</td>
<td>–0.154</td>
<td>–0.099</td>
<td>–0.073</td>
</tr>
<tr>
<td>30</td>
<td>–0.231</td>
<td>–0.149</td>
<td>–0.110</td>
</tr>
<tr>
<td>50</td>
<td>–0.386</td>
<td>–0.248</td>
<td>–0.184</td>
</tr>
<tr>
<td>100</td>
<td>–0.771</td>
<td>–0.496</td>
<td>–0.367</td>
</tr>
<tr>
<td>500</td>
<td>–3.857</td>
<td>–2.480</td>
<td>–1.837</td>
</tr>
</tbody>
</table>

Source: Cuevas-Cubria, AARES/ABARE, February 2009

According to the AARES report using carbon prices from $10 to $500 a tonne of CO2-e, the net benefit from avoided greenhouse gas emissions when substituting E10 for petrol would range from 0.01 cpl to 3.86 cpl, with the highest benefit arising from ethanol produced from molasses using cogeneration and, the lowest benefit arising from ethanol produced from wheat (Table 4).

5.7.3 Implications of ethanol production costs

In Australia, ethanol is produced from wheat (waste starch), molasses and sorghum predominantly. These substrates make up between 70 per cent and 85 per cent of the cost of production of ethanol. Each of these substrates is an agricultural commodity that has its own pricing cycle and as such, their volatility is driven by supply and demand factors influenced by population growth, weather and climate change factors.

Crude oil is the substrate for RULP. The factors that influence the price of oil vary independently of those factors that affect the price of ethanol substrates.

The ‘disconnect’ between the price of these two substrates is a major risk to the industry which needs constant management.

Figure 2 shows the wide variation that can exist between the price of oil and agricultural commodities for producing ethanol in Australia from 2001-02 to 2008-09.

**Figure 2 Comparative substrate commodity price in Australia 2001-02 to 2008-09**

![Comparative Commodity Prices 2001-02 to 2008-09 (Source: ABARE)](source: ABARE Commodity Statistics)

Figure 3 shows the same wide variation that can exist between the price of gasoline (petrol) and agricultural commodities for producing ethanol in the USA\(^1\).

**Figure 3 Indexed USA ethanol feedstock prices versus gasoline prices- January 2008 to May 2009**

![Ethanol Feedstock vs Gasoline Prices](source: IEA, Medium-Term Oil Market Report, June 2009, p71)

Given these dynamics, producers and wholesalers may look to enter into a risk sharing arrangement where, during times of high commodity prices relative to oil price and high volatility, minimum price arrangements may be agreed.

As a quid pro quo, when commodity prices are low relative to oil prices, maximum price arrangements may also be agreed. Given the volatility of commodity prices this averaging could also impact on pump pricing for...
ethanol blends. One pricing method used for containing this risk is to introduce a floor price and a ceiling price in the price formula.

5.7.4 Other commercial factors that may impact on price

The final price at the pump could also depend on other variables and commercial terms which are negotiated outside the IPP or TGP, depending on the individual situation. These terms, for example, could relate to variables such as regional freight costs (from source terminal to regional areas), payment terms, intermediate handling costs (e.g. regional depot costs), contract term and so on. These have not been considered in detail, however, they could be of importance.

5.8 Excise/customs duty and production grant impacts on ethanol fuel

Currently, fuel excise is levied on petrol and diesel at the rate of 38.143 cpl.

Imported and domestically produced ethanol is currently levied at the same rate. However, until 30 June 2011, domestic producers are eligible for a production grant of 38.143 cpl. Thus domestically produced ethanol is currently effectively excise free.

The Assistant Treasurer announced changes to the ethanol excise/import duty rate on 13 May 2010\(^\text{17}\), from 1 July 2011, ethanol will be reclassified as a medium energy density fuel and the excise/customs duty imposed on both domestic and imported ethanol will be 25 cpl for 2011-2012. Excise/customs duty will then progressively phase down annually to a final rate of 12.5 cpl by July 2015 (Table 5).

Domestic producers will be eligible for an offsetting grant commencing at the rate of 22.5 cpl in July 2011 and progressively phasing down to zero by 1 July 2015. By 1 July 2015, domestically produced and imported ethanol will be subject to the full rate of excise/customs duty of 12.5 cpl (Table 5).

Currently ethanol content in petrol sold in Australia is limited to 10 per cent by volume. The excise discount for E10 relative to petrol is therefore 3.814 cpl. The final excise rates to be implemented in 2015 will be equivalent to a discount of 2.564 cpl for E10 relative to unleaded petrol.

Should E85 fuels gain more prominence, then it would be expected that when the final excise/customs duty rates take effect in 2015, the discount relative to petroleum would be 21.797 cpl.

| Table 5 Effective fuel excise and duty rates -2010 to 2015 (cpl) |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Petroleum       | 38.143          | 38.143          | 38.143          | 38.143          | 38.143          | 38.143          |
| Domestically produced ethanol |
| E10*            | 34.329          | 34.579          | 34.829          | 35.079          | 35.329          | 35.579          |
| Imported ethanol | 38.143          | 25.000          | 21.875          | 18.750          | 15.625          | 12.500          |

* Ethanol referred to in this blend is domestically produced.

Source: Department of Resources, Energy and Tourism data.

5.9 Summarising the pricing rationales

As the market for ethanol matures it is conceivable that the following elements will contribute to the pricing matrix that will be negotiated between wholesaler and producer;

- energy parity,
- octane value,
- excise differential,
- carbon value,
- production costs,
- import parity pricing.

Second generation ethanol made from cellulose substrates, in particular could transform the benchmarks for carbon and production value. The latest view however from industry and the US IEA is that commercial production of ethanol from second generation feedstocks is still some time off and unlikely to make a major impact before 2020.
6 International benchmark prices for ethanol

6.1 Relevance of the IPP for competitive pricing

In markets where refinery output is insufficient to meet demand, the IPP method of pricing represents the cost of the best alternative source of supply of that commodity, as is the case with Australian petrol pricing\(^{18}\).

The IPP also often sets a price parameter in trading commodities. For an Australian producer of a tradable commodity (such as ethanol or petroleum) selling into the Australian market, the IPP would generally represent the upper price limit the buyer would accept. Other things being equal in an open and competitive market, economics would dictate that a price above the IPP would normally force the buyer to revert to imports. Conversely, export parity price (EPP) would set the lower price parameter for the sale of an Australian produced commodity into the Australian market. In a highly liquid, open, and internationally competitive market like that of the petroleum industry, price negotiations predominantly centre on the limits set by the IPP and the EPP.

The IPP method for benchmarking the price of ethanol therefore, needs to be consistent with the IPP method for benchmarking the price of petrol if the products are trading in the same market. Also, it is probable that imports of ethanol into Australia will be limited until the treatment of excise/customs duty for both domestic and imported ethanol becomes aligned (as is proposed from 2015). As Australia does not have any regular ethanol trade that it can reference for the determination of an IPP, any determination would be ‘theoretical’ at this stage.

6.2 Ethanol IPP structure

Modelled on the IPP for petrol, the generic formula for the IPP for fuel ethanol can be expressed as:

\[
\text{Fuel Ethanol IPP} = \text{benchmark price} + \text{freight} + \text{insurance and loss} + \text{wharfage}.
\]

The ethanol IPP formula does not take into account energy adjustment or other quality premiums/discounts (e.g. octane credit) that would be components of the TGP for the ethanol blended fuel.

6.3 Sources of ethanol benchmark price quotations

In setting an ethanol IPP formula, the benchmark price component could make up about 65 per cent to 80 per cent of the IPP. As with petrol, it is preferred to use a benchmark price that is relevant to Australian trade, which is visible, credible and representative of the intended market. This compares with the benchmark price for petrol which from July 2007 to June 2009 accounted for 85 per cent to 93 per cent of the IPP.\(^{19}\)

Again, as with the petrol benchmark price, there are a number of agencies or industry sources that provide an assessment of the price of ethanol FOB Brazil and for other markets. These are listed in Table 6. The same table shows the market for which the prices are quoted, the method of assessment and a website reference.

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\(^{18}\) ACCC, op cit, p83

\(^{19}\) ibid, p.84
### Table 6 Sources for ethanol price quotations and assessment method

<table>
<thead>
<tr>
<th>Source</th>
<th>Brazil (FOB Santos)</th>
<th>USA (CBOT and others)</th>
<th>Europe</th>
<th>Asia</th>
<th>Assessment method</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.O Lichts</td>
<td>✓ ✓ ✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Weekly price discovery assessment based on industry review.</td>
<td><a href="http://www.agra-net.com">www.agra-net.com</a></td>
</tr>
<tr>
<td>Platts</td>
<td>✓ ✓ ✓</td>
<td></td>
<td>✓</td>
<td></td>
<td>Market assessment as at 3.15 pm EST (the USA); inputs are analysed and normalised to reflect market value at time; consider arm length and transparent market activity; quotes anhydrous for Brazil – hydrous ‘normalised’ to Platts specification.</td>
<td><a href="http://www.platts.com">www.platts.com</a></td>
</tr>
<tr>
<td>Argus</td>
<td>✓ ✓</td>
<td></td>
<td></td>
<td></td>
<td>Daily assessment reflects ASTM D4806 92.1% ethanol min; Brazil FOB Santos, undenatured anhydrous ethanol cargoes 50 kbl (BML / 6.3kt)</td>
<td><a href="http://www.argusmedia.com">www.argusmedia.com</a></td>
</tr>
<tr>
<td>ESALQ</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Collect prices on a daily basis, including the volume involved in the translations, through a representative group of agents that compose the São Paulo market (mills, distilleries, distributors, intermediaries). The product considered on the Indexes follows the specifications of the National Petroleum Agency (ANP).</td>
<td><a href="http://www.cepea.esalq.usp.br/english/ethanol">www.cepea.esalq.usp.br/english/ethanol</a></td>
</tr>
<tr>
<td>ICIS</td>
<td>✓ ✓ ✓ ✓</td>
<td></td>
<td>✓</td>
<td></td>
<td>Weekly assessment. Assessment based on information supplied by market participants in week to COB London or Houston; Asia closes Wednesday 1800 hrs Singapore</td>
<td><a href="http://www.icis.com/staticpage/s/ethanol">www.icis.com/staticpage/s/ethanol</a></td>
</tr>
<tr>
<td>Kingsman</td>
<td>✓ ✓ ✓</td>
<td></td>
<td></td>
<td></td>
<td>Brazil - Relies on ESALQ adjusted for FOB Santos</td>
<td><a href="http://www.kingsman.com">www.kingsman.com</a></td>
</tr>
<tr>
<td>OPIS</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Daily price discovery assessment; Brazil undenatured anhydrous ethanol of 50 kbl export price ex Santos</td>
<td><a href="http://www.opisnet.com">www.opisnet.com</a></td>
</tr>
<tr>
<td>CZARNIKOW</td>
<td>✓ ✓</td>
<td></td>
<td></td>
<td></td>
<td>Brazil - Relies on ESALQ adjusted for FOB Santos</td>
<td><a href="http://www.czarnikow.com">www.czarnikow.com</a></td>
</tr>
</tbody>
</table>

### 6.4 Proposed Brazilian benchmark price reference for Australia

As with any benchmark pricing, the challenge is to establish which pricing source is most commonly used in trading ethanol in the open market. This is difficult to determine as publishers of prices are not necessarily aware of the volume of sales based on their quotations. With Australia’s petrol IPP, Platts is a well recognised reference, which is open with its methodology, and it is accepted that many trades are based on Platt’s quotations.

*Therefore, it needs to be highlighted at this point, that the benchmark quotation for imported Australian ethanol may not necessarily be as representative of the ethanol price as Platts is for Australian petrol. This is also likely to change over time, depending on the amount of ethanol traded.*

### 6.5 Brazilian ethanol pricing

#### 6.5.1 Why Brazil? - Dominant source of export ethanol

As already discussed, ethanol is produced from other substrates around the world such as sugarcane (Brazil), corn (US), cassava (Thailand) and from second generation substrates such as woody biomass or cellulose. Each of these processes has their own cost characteristics. However, Brazilian based ethanol made from sugarcane generally sets the benchmark for the lowest cost of production.

Brazil is the world’s largest exporter of ethanol. According to the US EIA\(^2\), in 2008 Brazil produced about 7,500 ML more fuel ethanol than was consumed in 2008. The USA was a net importer of 1,370 ML. China and Thailand were balanced in ethanol consumption and production. There are other sources of ethanol for

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\(^2\) US EIA, op cit
the export market, however, and it is understood at present that their export quantities are not significant or only become available on a sporadic basis.

Brazil would be the most likely source of imports of fuel ethanol for Australia.

So long as Brazil is the dominant source of fuel ethanol for the export market, it can be argued that a benchmark ethanol price should be based on Brazil price quotations. So as to simulate the petrol IPP, the benchmark price should be an FOB price at a major export terminal in Brazil. Santos, located near São Paulo, is the major seaboard terminal in Brazil for the export of ethanol.

6.5.2 ESALQ (Brazil) is the preferred benchmark

From EnergyQuest’s experience, the ESALQ (Escola Superior de Agricultura Luiz Queiroz) index (published by CEPEA) in Brazil is the local measure of ethanol pricing and the most referenced price in ethanol contracts worldwide. Ethanol traders operating in Asia also use ESALQ as the key price source.

CEPEA is a research centre of the University of São Paulo located at the ESALQ in Piracicaba, State of São Paulo. It is focused on agribusiness issues considering a diversity of related subjects:

- market analysis and price discovery,
- international trade,
- macroeconomics,
- management strategies,
- environmental and social aspects,
- entrepreneurship, and
- family farming.

CEPEA is a group of well-trained specialists that have been collecting and analysing data from primary sources for more than 15 years. CEPEA releases on a daily basis a set of price indexes that are widely used by farmers, agribusiness agents and by the Brazilian government (http://www.cepea.esalq.usp.br).

Known as the ESALQ, daily quotes are posted for the price of hydrous and anhydrous ethanol. This quoted price is a mill gate price, which does not include any taxes that may be payable or the cost of transportation and storage. Commonly, brokers and consultants like Kingsman (http://www.Kingsman.com) and Czarnikow (http://www.czarnikow.com) take this base data and using local intelligence create a FOB Santos price, as this is the port where most ethanol is shipped from Brazil.

6.5.3 Converting ESALQ to a FOB Santos price

ESALQ quotes for anhydrous and hydrous ethanol are given on a mill gate basis excluding taxes. Changes to tax law in Brazil in 2003 to encourage exports mean that generally no tax is incurred above the ESALQ price for exports, with taxes credited back to producers. Therefore, when calculating a FOB price the considerations are as per the following formula:

\[
\text{ESALQ} + \text{Freight to Port} + \text{Port terminal & storage costs} = \text{FOB Santos price}.
\]

Given the size of Brazil, freight costs can vary significantly depending on distance of the mill from port. Port terminal costs also vary depending on the product stewardship demanded by the customer to safeguard against product contamination.

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21 For the ESALQ price, go to: http://www.cepea.esalq.usp.br/english/ethanol/
One trading company recently advised EnergyQuest to add US$60 per tonne to the ESALQ mill price to arrive at an FOB Santos price. However, further research is required to establish the integrity of such an assessment.

6.5.4 ESALQ suitability for Australian market

The Australian market requires anhydrous ethanol (99 per cent) for use in fuel blending. Procurers of ethanol have the choice of buying an anhydrous product or buying hydrous ethanol then dehydrating the product when it arrives in Australia prior to blending.

If the procurer purchases anhydrous product, terminal storage and shipping requirements become very important to maintain product quality. If anhydrous ethanol comes into contact with water it will absorb the water and become unsuitable for blending with petroleum without further processing.

*From EnergyQuest’s experience and discussions with Singapore traders, it seems that ESALQ is a key reference for benchmark price of anhydrous ethanol sourced from Brazil.*

6.5.5 About domestic ethanol pricing in Brazil

In Brazil, the domestic price of ethanol does not move concurrently with world oil prices. The price of ethanol for internal consumption is set by Petrobas, the government owned oil company, and the government. Prices generally follow world oil and products prices without the extreme highs and lows.

Brazil mandates the blend percentage of ethanol in fuel, currently at about 25 per cent. The mandate percentage varies depending on the balance of production and the opportunity cost of the price of sugar. Brazilian producers have some capability of swinging production from manufacturing sugar or ethanol and depending on export prices, are able to maximise the appropriate commodity.

Secondly, given that Brazilian ethanol is produced from sugarcane, producers are constantly monitoring four markets. These are:

- the domestic sugar market,
- the domestic fuel ethanol market,
- the export sugar market (white & raw), and
- the export ethanol markets.

Figure 4 shows how mills have been able to adjust their source of earnings from September 2005 to November 2008.

*Figure 4 Historical earnings of Brazilian sugar mills by product, including ethanol.*
Furthermore, Brazilian producers have some ability to modify the volume of ethanol versus sugar crystal that they manufacture. The relative strength of these markets determines the mix produced between these commodities (Figure 5).

**Figure 5 Portion of cane converted to ethanol in Brazil – 1975-76 to 2008-09**

![Figure 5](image)

Source: Datagro (08/09 is an estimate)

Finally, ethanol produced in Brazil comes from an agricultural base and is therefore, subject to the variability of the weather. Knowing this, the Brazilian government manipulates the mandated blend percentage of ethanol in the base petroleum to ensure continuity of supply as well as opening up opportunities for import dollars in times of high world commodity prices.

### 6.6 Other price references considered for benchmarking

Given the dominance of Brazil in the world trade of ethanol, no other benchmarks at this stage justify any lengthy discussion. However, for completeness, the following are comments about other pricing references.

#### 6.6.1 US Ethanol

The USA is not only the largest producer of ethanol in the world but the largest destination market for Brazilian ethanol (Figure 6).

**Figure 6 Americas ethanol trade**

![Figure 6](image)

Source: IEA

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22 IEA, op cit, p 73
Ethanol in the US is manufactured predominantly from corn. Both corn and ethanol are traded locally on the Chicago Board of Trade (CBOT) and this is the mechanism for pricing. Because of the distortions of government subsidies and import tariff protections however, this pricing mechanism is limited to the US. Local producers under the Renewable Fuels Scheme (RFS), receive a mandated Federal Ethanol Tax Credit of US 45 cents per gallon (US 11.9 cpl) produced (unless total production falls below 7.5 billion litres in which case it will be lifted to US 51 cents per gallon (US 13.5 cpl). Fuel blenders are required to purchase a certain number of Renewable Identification Numbers (RINS) which is equivalent to the mandated volume of bio-fuels under the RFS.

Blenders can either purchase the equivalent number of gallons of ethanol to acquit their RINS requirement or buy RINS off a separate market.

To encourage local production of ethanol and discourage imports, a US 54 cent per gallon (US 14.2 cpl) tariff is placed on imports. Most of the imported ethanol however, that finds its way into the US avoids paying this tariff. The Caribbean Basin Initiative (CBI) was established in the 1980’s and allowed some countries access to the US market without the penalty of tariffs through NAFTA (North American Free Trade Agreement). Most Brazilian ethanol is shipped to these CBI participating countries as hydrous ethanol, where it is dehydrated (value added) and then shipped into the US tariff free.

6.6.2 Asia

Many Asian countries grow sugarcane, corn and tapioca (cassava) which can be processed into ethanol. China has the largest production in the Asian market but most of the ethanol produced is consumed as a beverage or used as a solvent in their domestic industrial markets. When food prices were increasing in 2008, the Chinese government banned the export of ethanol as a fuel as they thought that it was adversely affecting their capability to feed their population. This policy has since been relaxed.

India and Thailand - two countries that have large sugarcane industries - have local programmes to encourage ethanol based fuels and as such are more likely to be destination markets for fuel ethanol rather than being significant exporters.

Most of the balance of ethanol traded across Asia is based on traditional beverage and Industrial markets.
7 Other Components of ethanol IPP

The component of the IPP so far discussed in this report relates to the benchmark price, which as already mentioned, makes up a large portion of the IPP, subject to market conditions. The other components that make up the IPP are as follows and are discussed below:

- Freight,
- insurance and loss, and
- wharfage.

Freight is the most complex element of these other components. Australia does not have any regular ethanol trade that it can reference directly for the determination of an average freight rate for fuel ethanol. This section of the report is based on EnergyQuest’s experience and on information sourced from vessel owners (e.g. Stolt Nielsen, Dorval, Botany Bay Shipping) who operate in Australia and shipping brokers who operate in Australia and Asia (i.e. Clarksons, Panasia, Braemar Quincannon, and ICIS).

7.1 Shipping ethanol in chemical carriers

Ethanol is shipped in ocean going vessels called chemical carriers. Typical capacity of a chemical tanker is about 10,000 to 15,000 tonnes. This compares with the carrying capacity of a Medium Range (MR) product carrier of about 40,000 tonnes. As a result, freight cost for carrying chemicals is significantly higher than that for bulk petroleum products.

Chemical carriers have separate on board compartments (tanks) for carrying a wide range of chemicals. These vessels can co-load ethanol with other chemical products for the same voyage. Chemical carriers have special on board cleaning facilities to ensure there is no cross contamination from previous cargoes or during the voyage. The tanks are sealed to ensure product integrity during the voyage. As discussed above, anhydrous ethanol is hygroscopic and it is essential that water (or other chemicals) is not mixed with ethanol during the voyage, thereby compromising the integrity of the cargo.

7.2 Freight

Determining the freight cost for delivering petrol or diesel to Australia is comparatively straightforward. There are well established freight rate assessment agencies (i.e. Worldscale) and market indices (e.g. Platts freight indices) for determining MR freight rates. These vessels have a carrying capacity of greater than 30,000 tonnes.

However, freight assessments for the chemical carrier market are more complex and are not as visible as they are for the MR freight market.

Freight rates for chemical carriers operating into and out of Australia are negotiated on a case by case, voyage by voyage basis. They may involve voyage or time charters. Thus, to assess chemical carrier freight rates, it is necessary to have access to the negotiated rates – information which is generally confidential.

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Information for Botany Bay shipping was sourced from the website.
7.2.1 Chemical tanker market and freight rate assessment

In the chemical shipping business, there are certain routes around the world which carry a considerable amount of traffic. As a result, the freight rates for these routes are reasonably visible and can be assessed by brokers and pricing agencies with a reasonable degree of accuracy.

However, Australia is not a destination that attracts much shipping traffic from South America, thus making it difficult to assess freight rates. On the other hand, there is considerable traffic of chemical carriers on the Asia/Australia route, thereby making freight rates for this route reasonably assessable.

In summary, there is no clear open freight market assessment for chemical carriers delivering chemicals to Australia like there is for MR carriers delivering petroleum products to Australia. As a result, vessel operators or brokers close to the chemical trade in Australia and Asia would appear to be the key source for chemical carrier freight assessments for this region.

7.2.2 Factors affecting freight rates

Freight rates for chemical carriers vary depending on a number of factors. These factors include:

- vessel availability for a specified route,
- existing time, spot charters and fixtures for specific trade routes,
- the availability or opportunity of utilising of spare capacity on a committed vessel (part cargoes),
- backhaul or ‘triangular’ (see second paragraph below) shipping opportunities.

In addition there are a number of other commercial and operating factors that impact on day to day freight costs. These factors include port congestion, demurrage, fuel cost, general freight market trends, vessel timing, voyage route and more than one port loading/discharging. These factors are difficult to quantify but are often taken into account in the general freight assessments.

One particular reason MR freight rates to Australia are higher than the more popular routes for MR’s around the world is the lack of backhaul opportunity for those vessels from Australia. MR vessels which bring petrol or diesel to Australia from Singapore mostly ‘ballast back’ (i.e. do not have product to backhaul) empty to Singapore. This adds to the overall freight rate for those voyages.

Chemical carriers, on the other hand, which carry product to Australia from distant ports such as Brazil, would not necessarily ‘ballast back’ to their original load port. Instead, once they have discharged all or part of their cargo in Australia, they will trade other chemicals through other Australian or Asian ports in the region. This is called ‘triangular’ routing. The voyage time from Brazil to east coast Australia is about 60 days. Ballasting back to Brazil is generally not an option on the grounds of economics, unless perhaps a vessel is chartered on a time basis for that route. Ship owners work hard to generate the best economics for such a long voyage configuration.

Finally, ethanol terminal storage around the Australian coast is limited. It is understood that Botany Bay (Vopak) and Port Kembla (Manildra) are the only two ports that currently can accept an ethanol parcel size of about 4,000 tonnes. Most other ports with ethanol rated storage are limited to a parcel size of less than 2,000 tonnes. The greater the number of discharge ports, the greater the freight cost.

7.2.3 Brazil/Australia freight assessment

As already mentioned, there is very limited chemical traffic between Brazil and Australia. This poses a problem for reliably assessing a Brazil/Australia freight rate to use in an IPP calculation.
According to Stolt, there may currently be only 10 to 12 vessels per year carrying chemicals and vegetable oils from South America to Australia. Currently a time charter with a specific importer accounts for about half of these movements.

If a vessel is chartered on a single voyage basis, then the freight could be visible to the industry. If a vessel is chartered on a time charter basis, then the freight is generally less visible to the market. Full cargoes offer the most economic freight rate.

However, the likelihood of loading and delivering full cargoes of fuel ethanol into Australia currently appears extremely remote.

Importing ethanol from Brazil in small parcel lots as part cargo with other chemicals is currently the most common configuration. However, assessing a rate for part cargoes of ethanol from Brazil to Australia needs to be treated with some caution. Such assessments will be more ‘subjective’, relying on information from brokers and ship owners who are very close to that business and will need to ‘normalise’ the rate. Also, these parties would be concerned about limiting factors such as confidentiality, competition, and possible conflict of interests in revealing rate assessments.

7.2.4 Possible sources for freight assessments

The following are possible sources for accessing freight rates for the Brazil/Australian or Asia/Australia route for ethanol.

**Stolt Nielsen ([www.stolt-nielsen.com](http://www.stolt-nielsen.com))** is a leading provider of transportation and storage of bulk liquid chemicals, edible oils, acids and other specialty chemicals. Stolt are vessel owners that operate on the South America/Australia leg and may be in a position of providing a freight assessment. Stolt has an office in Melbourne.

**Dorval Shipping ([www.dorvalusa.com](http://www.dorvalusa.com)) (USA)** operates a fleet of chemical tankers which service the Pacific area as well as occasional vessel from Brazil to Australia. As with Stolt, they may be in a position of possibly providing an assessment for the Brazil/Australia leg. Dorval also has an office in Melbourne.

**Botany Bay Shipping ([www.bbsg.com.au](http://www.bbsg.com.au))**. Botany Bay Shipping Company is a UK based shipping business which was originally established at Botany Bay, Australia. It is a global operator of modern chemical tanker vessels and provides sea transportation for liquid chemicals and other specialty liquids. Their vessels trade in the Brazil/Australian market and have transported industrial ethanol from Brazil in the past twelve months. Botany Bay Shipping may also be in a position of possibly providing an assessment for the Brazil/Australia leg.

**Clarkson’s ([www.clarksons.com](http://www.clarksons.com))** is a well established English based international shipping broker that provides integrated shipping services. They have a research unit that may be in a position of providing freight rate assessments. Clarkson’s have an office in Sydney.

**Panasia Marine ([www.panasiamarine.com](http://www.panasiamarine.com))** is a Singapore based broker that specialises in chemical carriers. Panasia may be in a position of indicating freight rate for Brazil/Asia or Australia. They are based in Singapore.

**ICIS ([www.icispricing.com](http://www.icispricing.com))** publish a weekly chemical tanker shipping report for the Americas and Asia Pacific. The report covers fixtures from Brazil to the Asia-Pacific area. This report seems relatively comprehensive for the Brazil/Australia and Asia Pacific markets. They are also based in Singapore.
Pole Shipping, Geneva (www.poleshipping.ch). Pole Shipping is a Swiss broker that covers international chemical carrier operations worldwide. Ethanol and biofuels are some of their listed products. The routes covered (according to their website) include West Coast South America to Continent, Coastal Brazil, Brazil to Continent, Brazil to USG, Transatlantic, USG to China & Far East, Continent / Black Sea to Caribs, Baltic to Med, Inter Med, Black Sea to Med, PG to Cont, PG to West/East Coast India, Intra-Northeast Asia, Southeast Asia / Northeast Asia, East Asia/West Asia. They are based in Geneva and may be a source for an ‘independent’ assessment.

There are other sources or brokers that may be in a position of making freight assessments which would require further research. However the above list would appear to be reasonably representative.

7.2.5 Possible freight rate assessment methodology

There are challenges associated with assessing freight rates for chemical carriers importing ethanol into Australia, especially for the Brazil/Australia route. Freight assessments for chemical carriers are not as visible as are freight assessments for importing petrol or diesel from Singapore.

So the question that remains is - what would be a reliable method for assessing freight rates for ethanol imported into Australia from Brazil, Asia or other sources? The following are two options that could be considered:

- One approach is to obtain a regular consensus assessment of rates (in US$/tonne) for specific routes (e.g. Brazil/Australia; Asia/Australia) from ship owners (such as Dorval/Stolt/Botany Bay) and two or three brokers who are familiar with Australian trade. These brokers would see other fixtures, movement in other freight rates - especially for the more popular trade routes, and generally be able to propose a benchmark rate for the purposes of assessing the freight component for the IPP determination.

- Alternatively, an independent broker could be contracted to make an independent assessment of the market. This would be the preferred method by EnergyQuest.

Any assessment would need to be ‘normalised’ to reflect the rate for a ‘typical’ size cargo taking into account the current market for chemical carriers, rates of other routes of similar voyage length, part cargo penalty, and other factors that play on the current market.

The potential for ‘subjectivity’ in this method of assessment is also noted. Ideally, freight assessments would have the same integrity and confidence as assessments currently used for petrol and diesel imports. Also the method of assessment needs to be acceptable to the industry. Neither option mentioned above is perfect. Furthermore, assessment methods may need to change should the characteristics of the market vary.

7.2.6 Current freight assessment

In bringing together the above freight factors and for demonstrating an IPP for ethanol for the sole purpose of this report, it is proposed to use the following rates based on a 4,000 tonne cargo. These rates were indicated recently by a chemical trader (without any warranties).

For a 4,000 tonne cargo of ethanol:

- Brazil to Australia – US$100 to US$140 pmt (use US$110 pmt),
- Mackay to Melbourne – US$55 pmt,
- Asia to Sydney - US$90 pmt.
7.3 Insurance, loss and wharfage

Insurance on chemical cargoes is typically 0.4 per cent of ((FOB value + freight) +10 per cent).

Secondly, loss of product during a voyage is generally claimable beyond 0.5 per cent by volume. On this basis, we assume there are no voyage losses.

Wharfage is that charge imposed by the port authorities at the discharge port for the vessel to use the wharf facilities. In this study we have assessed the wharfage at Brisbane, Botany and Melbourne (Coode Island) Table 7 . These are a selection of east coast ports within which there are existing chemical storage facilities.

<table>
<thead>
<tr>
<th>Port</th>
<th>Rate (incl GST)</th>
<th>cpl ethanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Botany (A$/tonne)</td>
<td>$2.31</td>
<td>0.182</td>
</tr>
<tr>
<td>Port of Brisbane (A$/kilolitre)</td>
<td>$2.959</td>
<td>0.296</td>
</tr>
<tr>
<td>Port of Melbourne (Coode Is) (A$/cubic metre)</td>
<td>$2.57</td>
<td>0.257</td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
<td><strong>0.245</strong></td>
<td></td>
</tr>
</tbody>
</table>

Sources: websites for each port – Port Charges, 3rd June, 2010.
8 Summary - IPP as a reference value for ethanol in Australia

Having discussed the derivation of the relevant components of the ethanol IPP, the following sub-sections show a worked example of the determination of the IPP for ethanol followed by a discussion on the suitability of the IPP as a reference value for imported ethanol for blending with petrol.

8.1 Worked example of ethanol IPP

8.1.1 Indicative IPP

Table 8 shows the derivation and calculation of the IPP on a straight import basis, for anhydrous ethanol sourced from Santos, Brazil. Assumptions are stated in the table. It shows that in today’s market, the IPP for ethanol from Brazil is around 71 cpl landed east coast Australia. On an energy equivalent basis to petrol, the IPP is A 104 cpl before excise.

Table 8 Indicative ethanol IPP

<table>
<thead>
<tr>
<th>Assumptions:</th>
<th>late May 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (kg/l/litres per tonne)</td>
<td>0.789</td>
</tr>
<tr>
<td>Cargo Size (tonnes/ML)</td>
<td>3,165</td>
</tr>
<tr>
<td>Freight (US$ per tonne/US$ cpl)</td>
<td>110</td>
</tr>
<tr>
<td>Freight from mill to Santos (US$ per US$ cpl)</td>
<td>60.00</td>
</tr>
<tr>
<td>Assumed load port</td>
<td>Santos</td>
</tr>
<tr>
<td>Assumed discharge port</td>
<td>east coast Australia</td>
</tr>
<tr>
<td>ESALQ Anhydrous 24 May to 28 May, 2010 (US$ cpl)</td>
<td>44.51</td>
</tr>
<tr>
<td>Exchange rate AUD/USD (late May 2010)</td>
<td>0.85</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculation:</th>
<th>cents per litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol Price (FOB Santos)</td>
<td>49.2</td>
</tr>
<tr>
<td>plus Freight</td>
<td>8.7</td>
</tr>
<tr>
<td>plus Insurance and loss</td>
<td>0.3</td>
</tr>
<tr>
<td>Price landed, east coast Australia</td>
<td>68.4</td>
</tr>
<tr>
<td>plus Import duty (5% of CFR price)</td>
<td>2.5</td>
</tr>
<tr>
<td>plus Wharfage (average east coast Australia)</td>
<td>0.2</td>
</tr>
<tr>
<td>Ethanol Import Parity Price (excl GST)</td>
<td>71.2</td>
</tr>
</tbody>
</table>

8.1.2 Impact of custom duty on ethanol 'ex terminal' price

Based on the IPP determined in Table 8, Table 9 shows the price of imported ethanol 'ex Terminal', before blending. It shows the impact of excise on the above calculated ethanol IPP under the new excise regimes operating in July 2011 and in July 2015. It also shows the corresponding petrol TGP (Sydney).
8.2 Suitability of IPP for referencing ethanol value in Australia - summary

In summary, what can be said about the suitability of the IPP as a reference value for ethanol used for blending with petrol?

A key finding of this report is that it is not possible at this stage to determine an IPP for fuel ethanol with the same level of confidence or reliability as that for determining the Australian IPP for petrol or diesel.

The primary reason for reaching this finding is that there is not sufficient ethanol trade into Australia which can be referenced for establishing, with the same degree of confidence for the petrol IPP, the components which make up the ethanol IPP for the purpose of benchmarking. Trade in chemicals between Australia and South America/Asia/USA/Europe is ongoing. The pricing components of each trade are negotiated on a case by case basis and generally apply to other chemicals.

The concerns expressed in this report about the appropriateness of an IPP for ethanol can be summarised as follows:

- Brazil is currently the dominant world exporter of fuel ethanol. Some other countries export smaller quantities of industrial grade ethanol and occasionally fuel grade ethanol. However these countries are not regular exporters like Brazil and would not be regarded as a suitable reference point for pricing. On the other hand, there is no assurance that Brazil will have sufficient volume of exports for the Australian market like Singapore has refined petroleum for the Australian market. Brazil’s export volume is variable, and is subject to domestic consumption and internal mandates.

- Freight is a key IPP component and is difficult to benchmark without regular trade between Australia and the source market – in this case Brazil. Currently freight is negotiated on a case by case basis. It is questionable if freight, for benchmarking purposes, can be reliably sourced as it can for petrol imports into Australia.

- The IPP for petrol quotes Platts data as a representative price source for petrol. In the case of ethanol, this report proposes the ESALQ index, published by CEPEA in Brazil. This is the local measure of ethanol pricing in Brazil and the most referenced price in ethanol contracts worldwide. Ethanol traders operating in Asia also use ESALQ as the key price source in contracts. It remains to be determined whether the use of the ESALQ as a benchmark for the ethanol price can be used with the same degree of confidence as Platts Mogas FOB Singapore is used for petrol.

- Finally, Australia needs to have infrastructure (namely, coastal ethanol rated terminal storage) in place if it were to regularly import ethanol (before blending). Currently, infrastructure is limited. There are a very limited number of coastal terminals that have facilities to accept cargoes greater than 4,000 tonnes.
Again, this stands in contrast to the Australian terminal infrastructure readily equipped to handle petrol and diesel imports.
Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AARES</td>
<td>Australian Agriculture and Resource Economics Society</td>
</tr>
<tr>
<td>ACCC</td>
<td>Australian Competition and Consumer Commission</td>
</tr>
<tr>
<td>anhydrous</td>
<td>Compounds that contain no water</td>
</tr>
<tr>
<td>BL</td>
<td>Billion litres</td>
</tr>
<tr>
<td>BLpa</td>
<td>Billion litres per annum</td>
</tr>
<tr>
<td>BOB</td>
<td>Blendstock for Oxygenated Blends. The increase in RVP (as a result of blending ethanol with petrol) can be overcome if ethanol is blended with a petrol blendstock which has reduced volatility (usually lower butane). This is blend is known as a Blendstock for Oxygenated Blends. It is a term used in the US market.</td>
</tr>
<tr>
<td>bpd</td>
<td>Barrels per day</td>
</tr>
<tr>
<td>denatured</td>
<td>Denatured ethanol is pure ethanol mixed with a small portion (generally between 1% and 5%) of another chemical so as to make the ethanol non-potable.</td>
</tr>
<tr>
<td>DEWHA</td>
<td>Department of the Environment, Water, Heritage and the Arts</td>
</tr>
<tr>
<td>EIA</td>
<td>Energy Information Administration, a section of the US Department of Energy (DOE)</td>
</tr>
<tr>
<td>FOB</td>
<td>Free on board</td>
</tr>
<tr>
<td>gasoline</td>
<td>petrol, mogas</td>
</tr>
<tr>
<td>GJ</td>
<td>1000 MJ (one billion joules)</td>
</tr>
<tr>
<td>GL</td>
<td>Gigalitres (1000 ML or one billion litres) (See BL definition)</td>
</tr>
<tr>
<td>hygroscopic</td>
<td>capable of easily absorbing moisture, e.g. from the air</td>
</tr>
<tr>
<td>kbd</td>
<td>Thousands of barrels per day</td>
</tr>
<tr>
<td>kbl</td>
<td>Thousands of barrels</td>
</tr>
<tr>
<td>kt</td>
<td>Thousands of tonnes (‘000 tonnes)</td>
</tr>
<tr>
<td>miscible</td>
<td>Capable of being mixed in any concentration without separation of phases</td>
</tr>
<tr>
<td>MJ</td>
<td>Megajoule (one million joules)</td>
</tr>
<tr>
<td>ML</td>
<td>Megalitres (one million litres or 6,289 barrels)</td>
</tr>
<tr>
<td>mogas</td>
<td>petrol, gasoline</td>
</tr>
<tr>
<td>MOPS</td>
<td>Mean of Platts Singapore (the mean being the average of the high and low quotation)</td>
</tr>
<tr>
<td>MR vessel</td>
<td>Medium Range vessel especially designed for carrying ‘clean’ petroleum products by sea. Typical capacity is between 30,000 and 40,000 tonnes.</td>
</tr>
<tr>
<td>Mt</td>
<td>Million tonnes</td>
</tr>
<tr>
<td>Mtpa</td>
<td>Million tonnes per annum</td>
</tr>
<tr>
<td>oxygenate</td>
<td>oxygen-containing blend stocks favoured for their octane and their clean burning quality. Oxygenates include MTBE and ethanol. a substance added to fuels, especially petrol, to make them burn more efficiently</td>
</tr>
<tr>
<td>petrol</td>
<td>A generic term referring to RULP and PULP; other names = gasoline, mogas</td>
</tr>
<tr>
<td>PULP</td>
<td>Premium unleaded petrol (95 RON min.)</td>
</tr>
<tr>
<td>RET</td>
<td>Department of Energy, Resources, and Tourism, Canberra (<a href="http://www.ret.gov.au">www.ret.gov.au</a>)</td>
</tr>
<tr>
<td>RINS</td>
<td>Renewable Identification Numbers (USA)</td>
</tr>
<tr>
<td>ROE</td>
<td>Rate of Exchange (AUD/USD)</td>
</tr>
<tr>
<td>RON</td>
<td>Research Octane Number</td>
</tr>
<tr>
<td>RULP</td>
<td>Regular unleaded petrol (91 RON min.)</td>
</tr>
<tr>
<td>RVP</td>
<td>Reid Vapour Pressure (a measure of vapour content in a liquid fuel at a specific temperature)</td>
</tr>
<tr>
<td>Second generation ethanol</td>
<td>Ethanol produced from bio-feedstocks that do not compete with food crops.</td>
</tr>
<tr>
<td>TGP</td>
<td>terminal gate price</td>
</tr>
<tr>
<td>Tonne</td>
<td>1000 kilograms</td>
</tr>
</tbody>
</table>
Appendix 1  Standard for Ethanol (up to ten per cent ethanol blended with petrol)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Date of effect</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidity (as acetic acid CH₃COOH)</td>
<td>0.007% mass by mass</td>
<td>28 June 08</td>
<td>ASTM D1613</td>
</tr>
<tr>
<td>Appearance</td>
<td>Ethanol must be clear and bright and visibly free of suspended or precipitated contaminants</td>
<td>28 June 08</td>
<td>ASTM D4806</td>
</tr>
<tr>
<td>Copper</td>
<td>0.1 mg/kg</td>
<td>28 June 08</td>
<td>ASTM D1688A (as modified in ASTM D4806)</td>
</tr>
<tr>
<td>Denaturant</td>
<td>Denaturant must be no less than 1% volume by volume and no more than 1.5% volume by volume</td>
<td>28 June 08</td>
<td>ASTM D5501</td>
</tr>
<tr>
<td>Ethanol</td>
<td>99.0 vol % min (prior to denaturing) 94.0 vol % min (after denaturing)</td>
<td>28 June 08</td>
<td>ASTM D5501</td>
</tr>
<tr>
<td>Inorganic Chloride</td>
<td>32 mg/L</td>
<td>28 June 08</td>
<td>ASTM D512C (as modified in ASTM D4806)</td>
</tr>
<tr>
<td>Methanol</td>
<td>0.5% volume by volume</td>
<td>28 June 08</td>
<td>ASTM D5501</td>
</tr>
<tr>
<td>pH</td>
<td>pH value must be no less than 6.5 and no more than 9.0</td>
<td>28 June 08</td>
<td>ASTM D6423</td>
</tr>
<tr>
<td>Solvent washed gum</td>
<td>5.0 mg/100 ml</td>
<td>28 June 08</td>
<td>ASTM D381</td>
</tr>
<tr>
<td>Sulfate</td>
<td>4 mg/kg</td>
<td>28 June 08</td>
<td>ASTM D4806 Annex 1</td>
</tr>
<tr>
<td>Sulfur</td>
<td>30 mg/kg</td>
<td>28 June 08</td>
<td>ASTM D5453</td>
</tr>
<tr>
<td>Water</td>
<td>1.0% volume by volume</td>
<td>28 June 08</td>
<td>ASTM E203</td>
</tr>
</tbody>
</table>

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