LECG

ECONOMICS OF A QUEENSLAND ETHANOL INDUSTRY

Prepared for the

Queensland Department of State Development and Innovation

John M. Urbanchuk, M.A.
George Barker, D. Phil. (Oxon)
William Wells, Ph.D

EXECUTIVE SUMMARY

This report provides an independent assessment of the economic potential of producing ethanol in Queensland.

Future Demand for Ethanol

The demand for Queensland ethanol may change significantly over the next 5-10 years varying primarily in its use in motor fuel. The potential market is substantial and Government policy will be a key factor. A summary of potential scenarios developed in the report for fuel grade ethanol is shown in table E1.

Table E1
Queensland Potential Fuel Grade Ethanol Demand in 2010

Underlying Assumptions	Potential Market Mil Litres/Year	Current supply (fixed)	Shortfall
Petrol (E10)			
30% penetration in 2010	130.6	4.5	126.1
National E10 mandate (Qld market)	435.0	4.5	430.5
E-Diesel (15% ethanol)			
30% market penetration	189.0	NA	189.0
50% market penetration	315.0	NA	315.0
Combined			
30% market penetration both E10 and E-Diesel	319.6	4.5	315.1
E10 Mandate & 50% E-Diesel market penetration	750.0	4.5	745.5

The first column of the table shows potential market demand consists of:

- Demand for E10 (10 percent blend of ethanol with petrol), ranging from
  - 130 million litres if E10 (10 percent ethanol blends) achieves a 30 percent market penetration as in the U.S., to
  - a maximum of 435 million litres if E10 were mandated for all petrol in Queensland; and
- Demand for ethanol in Queensland for use in E-diesel, ranging from
  - 189 million litres at 30 percent market penetration to
  - 315 million litres depending on a 50 percent market penetration
- The combined scenarios mapped out at the bottom of the first column of the Table aggregate the different assumptions for potential demand for E10 and E-diesel

The second column of the table identifies that currently about 4.5 million litres of fuel grade ethanol is produced in Queensland. As the third column shows Queensland may thus need between 126 and 430 million litres of new capacity to meet just the Petrol E10 demand scenarios. The supply shortfall could be as high as 745 million litres if E10 were mandated for petrol and E-diesel achieved 50 percent market penetration.

Expanding Plant Capacity

Current planned new investment in plant capacity is identified in Table E2 below. This planned additional capacity of 324 to 413 million litres would be sufficient to meet the need for between 126 and 430 million litres of new capacity under the Petrol E10 demand scenarios outlined above.

However this capacity will be insufficient the meet the shortfall of 745 million litres if E10 were mandated for petrol, and E-diesel achieved 50 percent market penetration. On the other hand, if a national E10 mandate is not enacted, or other efforts put in place to build ethanol demand, this expansion would result in a potential oversupply of ethanol in Queensland.

Table E2
Proposed Ethanol Projects in Queensland

Project Name	Location	Capacity (Mil litres/yr)	Feedstock(s)
QUEENSLAND			
Austcane	Burdekin, Qld	60-100	Cane juice
Australian Ethanol Ltd	Mossman, Qld	25	"C" molasses
Bundaberg Sugar	Mareeba, Qld	6-15	"C" molasses
CSR Ethanol	Burdekin, Qld	60-100	"C" molasses (on hold)
Subtotal Sugar		151-240	
Dalby Bio-Refinery Ltd	Dalby, Qld	82	Sorghum and feed wheat
Lemon Tree Ethanol Pty Ltd	Millmerran, Qld	76	Sorghum
Rocky Point Distillery	Brisbane, Qld	15	Hard grain / sugar
Subtotal Grain		173	
Total Queensland		**324-413**	

It should be noted that this list indicates ethanol projects that are under consideration or have been proposed. It is difficult to accurately assess at what stage any of these projects is, how likely they are to be completed, and on what timeline. It is likely that several of these projects may be only at the initial feasibility study phase.

Feedstock Supply

In order to expand production to meet potential demand, there not only need to be plants capable of producing ethanol, there also needs to be feedstock available at reasonable prices for the plants to draw on. Table E3 below presents data on the potential supply of feedstocks and the amount of ethanol that could be produced.

By diverting all of the molasses and sorghum currently being exported, and only 5 percent of sugar exports to ethanol production, Queensland could produce nearly 400 million litres of ethanol.

1255 Drummers Lane, Suite 320, Wayne, PA 19087
main 610.254.4700 fax 610.254.1188 www.lecg.com

Table E3
Potential supply for fuel grade ethanol

.	2004 Production (Thou mt)	2004 Exports (Thou mt)	Used for Ethanol (Thou mt)	Ethanol Yield (Litres/mt)	Potential Production (Mil litres)
Molasses	1,200	400	400	270	108.0
Sorghum	1,400	364	364	450	163.8
Sugar	5,500	4,019	201	600	120.6
Total	8,100	4,783	965	407	392.4

Assumptions:
Sorghum exports estimated at 26% of production (average of last 20 years)
All exportable supplies of molasses and sorghum used for ethanol
5% of sugar exports diverted to ethanol production

Ethanol profitability

The profitability of ethanol production is primarily dependent on the world oil price, the exchange rate, and ethanol prices. At current world oil prices ethanol production in Queensland is profitable. The net cost of producing ethanol from molasses at current commodity prices (including by-product credit for dunder) is estimated at A$0.295 per litre, while the net cost of producing ethanol from sorghum is A$0.337 per litre. This compares to an "ex-terminal" petrol price of A$0.871 per litre (including the .A$ 0.381 per litre excise tax on petrol). Using molasses as a basis for comparison, adding transportation and storage costs of 8 cents per litre to the plant-gate price of A$0.295 per litre provides a terminal price of A$0.375 per litre. When ethanol is blended with petrol the weighted average price of E10 is 5.9 percent below the price of unblended petrol. This does not take into consideration any credit for octane improvement or the price effect of increasing petrol supplies by 10 percent.

The economic viability of the ethanol product is largely sensitive to the world oil price (in $A). It is estimated the world oil price would have to fall below A$20 per barrel for ethanol-based fuel not to have a cost advantage. It is expected that only a slight retail price differential for ethanol would be sufficient for demand of ethanol-based fuel to rise significantly.

Impediments to Ethanol Development

The main potential impediments to ethanol industry growth include:

- Changes to the world price of oil (and/or exchange rate);
- Adverse consumer sentiment towards ethanol-based fuel;
- Increase in prices for alternative use of raw materials, both sugar and grain; and
- Changes to fuel excise arrangements that reduce the relative advantage of ethanol.

Economic Benefits of Ethanol Development

The economic benefits that Queensland will realize as a result of ethanol development will depend on the amount of new capacity added and the annual amount of ethanol produced. Ethanol will provide important rural economic benefits. Since ethanol plants and ethanol production are likely to be located near the sources of raw material supply, rural economies in Queensland would benefit significantly from development of an ethanol industry. This includes the primary impact resulting from capital spending for construction, direct new jobs and income, and a large share of the indirect spending effects.

In either of the two scenarios discussed above, the development of ethanol is expected to provide positive economic benefits for Queensland.

- The combination of spending for annual operations and capital spending for new plants is expected to add between A$441 million (130.6 megalitre industy) and A$1,490 million (435 megalitre industry) to the Queensland economy by 2010.

- New jobs would also be created as a consequence of increased economic activity caused by ethanol production. The increase in gross output (final demand) resulting from ongoing production and construction of new capacity is expected to support the creation of as many as 2,038 to 6,886 new jobs in all sectors of the Queensland economy by 2010.

ECONOMICS OF A QUEENSLAND ETHANOL INDUSTRY

Prepared for the

Queensland Department of State Development and Innovation

John M. Urbanchuk
George Barker, DPhil (Oxon)
William J. Wells, Ph.D

OJECTIVE

This objective of this study is to provide an independent assessment of the economic potential of producing ethanol in Queensland. The analysis focuses on the economics of manufacturing ethanol from sugar, molasses and grain (notably sorghum) produced in Queensland, and assesses the benefits to the Queensland economy. Specific areas of concentration include an analysis of the market potential for ethanol in Queensland; distribution issues; and the impact of ethanol use on retail fuel prices.

BACKGROUND

1) <u>Characteristics of ethanol</u>

Ethanol is a renewable alcohol produced primarily by fermentation of sugars found in raw and processed sugar, grains and other biomass. Ethanol is a clear, colourless, flammable oxygenated hydrocarbon, with the chemical formula C_2H_5OH. Ethanol can be produced via fermentation from a diversity of feedstocks, including grains such as corn, wheat, barley, and sorghum or other biomass such as sugar cane and molasses, and vegetable waste. Converting cellulose into its constituent sugars, which then are fermented and distilled into alcohol, also can produce ethanol.

Synthetic ethanol, which is derived from crude oil or gas and coal, and fermentation ethanol are chemically identical. Less than 5 percent of total global ethanol production is accounted for by synthetic feedstocks.[1]

[1] According to F.O. Licht, synthetic alcohol production is concentrated in the hands of a relative few multi-national companies such as Sasol with operations in South Africa and Germany, SADAF of Saudi Arabia (a joint venture between Shell of the UK and Netherlands and the Saudi Arabian Basic Industries Corporation, and BP of the UK as well as Equistar in the US).

2) Ethanol applications

Ethanol has three major uses: as a renewable fuel, as a beverage, and for industrial purposes. Fuel use or "fuel grade ethanol" is the largest component, accounting for more than 85 percent of total global production. This component of demand is the focus of this report. The use of ethanol in the production of alcohol beverages is the oldest form of ethanol use and accounts for about 10 percent of total demand. The last component of ethanol demand is use in industrial applications primarily as solvents. Solvents are utilized in the production of paints and coatings, pharmaceuticals, adhesives inks and other products. Ethanol represents one of the most important oxygenated solvents in this category. Production and consumption is concentrated in the industrialized countries in Northern America, Europe and Asia.

An important distinction to keep in mind is the difference between anhydrous and hydrous ethanol. Anhydrous ethanol is free of water, is at least 99 percent pure, and can be blended with petrol. Hydrous ethanol contains some water and usually has a purity of 96 percent; it can be used as a "neat" (e.g. pure) fuel in dedicated engines but cannot be blended. Brazil, which produces ethanol primarily from sugar, is the only country that uses 100 percent ("neat") ethanol in cars with dedicated engines. According to the U.S. Renewable Fuels Association, about 40 percent of the cars in Brazil operate on "neat" ethanol. The remaining cars run on a blend of 22 percent ethanol (78 percent petrol). The U.S., by comparison, uses ethanol in about 30 percent of its motor fuel, mostly at a blend of 10 percent ethanol and 90 percent petrol).

Brazil and the U.S. are the world's largest producers and users of ethanol. Brazil is expected to produce more than 16 billion litres of ethanol in 2005 and the U.S. will produce more than 13 billion litres.

3) Benefits of ethanol

Ethanol provides several significant benefits as a fuel. First, ethanol is used as a high quality octane enhancer to improve automobile performance. Second, ethanol is blended with petrol to produce an oxygenated motor fuel that reduces air pollution. The most common blend of ethanol is E10, 10 percent by volume of ethanol and 90 percent petrol. In spark ignition engines, ethanol emits significantly less carbon monoxide and toxic air pollution than petrol therefore reducing the amount of harmful emissions released into the atmosphere. Also, blending ethanol with motor petrol effectively expands the amount of fuel available to consumers. Ethanol easily blends with petrol but not with diesel. If E-diesel blends contain more that three percent ethanol special emulsifiers (additives) are needed. Finally, ethanol production adds value to agricultural commodities, benefits farmers and the agricultural sector, and provides an important economic stimulus to the national and local economy.

1255 Drummers Lane, Suite 320, Wayne, PA 19087
main 610.254.4700 fax 610.254.1188 www.lecg.com

Australian Ethanol Policy

The sugar industry in Australia first identified the fuel ethanol industry as a potential option to broaden the financial base and improve the sector's financial returns in 2000. Proponents argued that a fuel ethanol industry could be established without building a new infrastructure, as distilleries could be annexed to existing sugar mills. A return to low world sugar prices in 2002 further increased interest in using Australian sugar for ethanol production.

In 2000 the Federal Government provided an exemption for ethanol from excise taxes on petrol and set an objective that fuel grade ethanol and biodiesel produced in Australia from renewable sources will contribute at least 350 million litres (or one percent) of the total fuel supply by 2010. It also supported two ethanol projects (via capital subsidies) in the context of its policy response to curbing greenhouse gas emissions (Greenhouse Gas Abatement Program).

a) One project is based at a sugar mill in North Queensland, which uses molasses and sweet sorghum as feedstocks.

b) The other project was an ethanol blending facility in Brisbane at BP's Bulwer Island refinery, which produced a 10 percent ethanol/petrol blend beginning in May 2002. BP stopped producing the E10 blend in February 2003 because of consumer fears over the possible danger to car engines. Another oil major, Caltex Australia, started a 6-month ethanol blend trial (E10) in May 2003 in the city of Cairns, using ethanol from sugar cane, to test the extent to which consumers would move to the blend.

In September 2002, the government shifted support for the nation's ethanol industry. The fuel excise exemption (amounting to around A$0.38/litre) was ended and an ethanol production subsidy at the same rate for ethanol used in petrol was implemented for one year. The change in support policy raises the cost of importing ethanol, thereby strengthening the level of assistance to the local industry.

In March 2004, the government acted to extend the subsidy for ethanol producers to June 30, 2011. From July 2011 to July 2015 excise rates for ethanol and biodiesel will rise progressively to $A0.125/l and $A0.191/l respectively. At the same time it set a 10 percent limit on the blending of ethanol with petrol in conjunction with mandatory labelling of ethanol blends.

The Market for Ethanol in Queensland

The potential market for ethanol in Queensland is significant. Since ethanol is blended with petrol or diesel fuel, demand is tied directly to the number of vehicles and petrol use, and is affected by ethanol prices. The market for ethanol in Queensland has two main segments: E10 (petrol blended with 10 percent ethanol), and E-diesel (diesel fuel blended with ethanol).

1) E10

The market for ethanol to be blended with petrol is the largest potential market segment in Queensland. As can be seen in Table 1, the Australian Bureau of Statistics (ABS) reported that nearly 27.6 billion litres of fuel were used in 2003 and that petrol accounted for nearly 65 percent of consumption. Queensland accounted for 19.3 percent of the motor vehicles registered in Australia in 2003. Assuming that fuel use per vehicle in Queensland mirrors national patterns, an estimated 5.3 billion litres of motor fuel were used in 2003, of which petrol accounted for an estimated 3.4 billion litres and diesel fuel totalled 1.5 billion litres. Other fuels make up the remaining 0.4 million litres.

Table 1
Australia and Queensland
Motor Vehicles and Fuel Use, 2003

	Total AU Vehicles (Mil)	Total AU Fuel Use (Mil l)	**QLD Vehicles (Mil)**	**Estimated QLD Fuel Use (Mil l)**
Passenger vehicles	10.415	17,282	**1.911**	**3,171**
Motor cycles	0.378	83	**0.082**	**18**
Light coml trucks	1.893	4,275	**0.447**	**1,010**
Rigid trucks	0.347	2,185	**0.073**	**460**
Articulated trucks	0.063	3,164	**0.013**	**670**
Non-freight trucks	0.018	52	**0.003**	**9**
Buses	0.060	523	**0.014**	**122**
Total	13.174	27,564	**2.544**	**5,322**
Petrol		17,751		**3,427**
Diesel		7,966		**1,538**

Source: "Survey of Motor Vehicle Use, 12 Months Ended 31 Oct 2003."
Australian Bureau of Statistics. 9208.0 21-10-04

Petrol demand in Australia increased at an annual rate of 3.5 percent between 1999 and 2003. Assuming this same rate of growth, petrol demand in Queensland will top 4.35 billion litres by 2010. If E10 (10 percent ethanol blends) achieved a 30 percent market penetration (the current penetration in U.S. petrol), ethanol demand in Queensland would reach 130.6 million litres, or about 37 percent of the 350 million-litre target for all of Australia. A national mandate that all petrol include 10 percent ethanol would result in a market of 435 million litres in Queensland. Considering that currently only 4.5 million litres of fuel-grade ethanol is produced in Queensland, this suggests that between 126 million and 430 million litres of new annual capacity may be required in Queensland by 2010

2) E-diesel

E-diesel is a blend of conventional diesel fuel and up to 15 percent ethanol. E-diesel is made by splash blending fuel-grade ethanol with conventional diesel. If E-diesel blends contain more than three percent ethanol, special emulsifiers (additives) are needed. E-diesel provides several benefits. Notably, field tests in the U.S. have shown that E-diesel blends may reduce certain components of exhaust emissions compared to regular No. 2 diesel, especially particulate matter.

The market for E-diesel in Queensland also may be substantial. There appears to be some disagreement about the precise size of the diesel fuel market. As shown in Table 2, the Australian Bureau of Statistics (ABS) reported that nearly 8 billion litres of diesel fuel were used nationwide in 2003. Following the procedures used to estimate Queensland petrol use and assuming that fuel use per vehicle in Queensland mirrors national patterns, this suggests that an estimated 1.5 billion litres of diesel fuel were used in Queensland in 2003. However, private discussions with fuel distributors and marketers indicate that the Queensland market for diesel fuel is much bigger than suggested by ABS and may be as large as 4.2 billion litres. Also, sources indicate that as much as 95 percent of Queensland diesel is not sold through over-the-road retail outlets, rather it is sold in bulk quantities to mines, farms, and some independent truckers that self-fuel at central locations; and for electricity generation in remote areas.

The difference between the ABS and industry estimates of diesel fuel use may stem from the size and importance of the mining and agricultural industries in Queensland, and the fact that the ABS statistics primarily reflect on-road vehicles such as trucks and buses. If we use the industry estimate of 4.2 billion litres of diesel, assume a 15 percent ethanol content and market penetration of 50 percent, the market for ethanol in E-diesel could reach 315 million litres.

3) Conclusion

Table 2 summarizes the potential demand for ethanol both in petrol and E-diesel under the various alternative scenarios discussed above. The first data column of the table shows potential demand scenarios in Queensland first for E-10 (10 percent blend of ethanol with petrol), and second for ethanol use in E-diesel. The bottom rows of the Table combine these different assumptions for potential demand for E10 and E-diesel.

The second data column of the table identifies the potential shortfall, and new capacity required given that Queensland's current ethanol capacity available for fuel use is about 4.5 million litres. As the second column shows Queensland may need between 126 and 430 million litres of new capacity to meet just the Petrol E10 demand scenarios. The supply shortfall could be as high as 745 million litres if E10 were mandated for petrol and E-diesel achieved 50 percent market penetration.

Table 2
Queensland Potential Ethanol Demand

Underlying Assumptions	Potential Market (Mil Litres/Year)	New Capacity Required (Mil Litres/Year)
Petrol (E10)		
30% penetration	130.6	126.1
E10 mandate	435.0	430.5
E-Diesel (15% ethanol)		
30% market penetration	189.0	189.0
50% market penetration	315.0	315.0
Combined Market		
30% market penetration	319.6	315.1
E10 mandate + 50% E-diesel	750.0	745.5

Ethanol Production in Queensland

Ethanol production levels will vary depending on the demand for ethanol, production capacity available, and profitability – largely determined by the price of feedstocks (raw materials) used to produce ethanol. This section discusses existing ethanol production capacity in Queensland and identifies new capacity currently under consideration or actual planning.

1) Existing capacity

Currently an estimated 135 million litres of ethanol are produced annually in Australia on industry capacity of about 198 million litres. Table 3 lists existing Australian ethanol producers by location, estimated capacity, and feedstock. Two firms in Queensland (CSR Ethanol and Rocky Point Distillery) have an estimated 65 million litres of ethanol capacity using "C" molasses as a feedstock. According to industry sources, fuel-grade ethanol production in Queensland currently totals about 4.5 million litres.

Table 3
Existing Australian ethanol capacity (rum, beer, wine excluded)

Company	**Location**	**Capacity**, Ml/yr	**Comments**
Manildra	Nowra, NSW	75-125	Waste starch after gluten processing and some whole grain, wheat midds. Capacity is industry estimate, details closely held. Believed to be able to produce most or all of capacity as anhydrous fuel grade, blending E10 in affiliate-owned petrol stations.
CSR Ethanol	Sarina, Qld	60	"C" molasses, maybe a third of total could be dried to anhydrous at Yarraville, VIC processing plant, molecular sieve to be added in Sarina *ca.* 2006 for fuel grade capability. Selling to majors blending in Qld at various sites, also for State vehicle fleet.
Rocky Point Distillery	Woongoolba, Qld	5	"C" molasses. Have anhydrous, fuel grade capability. Awarded federal biofuels grant to upgrade facility.
Tarac	South Australia	8	Excess grapes, hydrous only.

2) <u>Ethanol Projects Under Consideration</u>

The significant global interest in ethanol development is also taking place in Australia. Information provided by industry sources indicates that at the present time 15 new ethanol plants are under various stages of consideration for Australia. As detailed in Table 4, seven of these totalling between 324 and 413 million litres of annual capacity are targeted for Queensland. About half of this new capacity intends to use molasses or cane juice as a feedstock while the remainder intends to use grain (sorghum or wheat).

Table 4
Proposed Ethanol Projects in Australia

Project Name	Location	Capacity (Mil litres/yr)	Feedstock(s)
QUEENSLAND			
Austcane	Burdekin, Qld	60-100	Cane juice
Australian Ethanol Ltd	Mossman, Qld	25	“C” molasses
Bundaberg Sugar	Mareeba, Qld	6-15	“C” molasses
CSR Ethanol	Burdekin, Qld	60-100	“C” molasses (on hold)
Subtotal Sugar		151-240	
Dalby Bio-Refinery Ltd	Dalby, Qld	82	Sorghum and feed wheat
Lemon Tree Ethanol Pty Ltd	Millmerran, Qld	76	Sorghum
Rocky Point Distillery	Brisbane, Qld	15	Hard grain / sugar
Subtotal Grain		173	
Total Queensland		**324-413**	
OTHER STATES			
Australian Ethanol Ltd	Coleambally, NSW	100	Corn, wheat, barley, sorghum
Australian Ethanol Ltd	Forbes, NSW	100	Corn, wheat, barley, sorghum
Australian Ethanol Ltd	Swan Hill, VIC	100	Corn, wheat, barley, sorghum
Australian Ethanol Ltd	Lake Grace, WA	100	Corn, wheat, barley, sorghum
Primary Energy	Gunnedah, NSW	120	Sorghum and wheat
SymGrain Plant	Western VIC	100	Proprietary wheat
SymGrain Quirindi Plant	Quirindi, NSW	100	Proprietary wheat
Unnamed	South Australia	40	Multiple feedstocks
Total Other States		**760**	

It should be noted that this list indicates ethanol projects that are under consideration or have been proposed. It is difficult to accurately assess at what stage any of these projects is, how likely they are to be completed, and on what timeline. It is likely that several of these projects may be only at the initial feasibility study phase.

Potential Queensland Supply and Demand Balance

As indicated earlier, Australia currently produces about 135 million litres of ethanol, of which about 4.5 million litres are used for fuel. Some expansion of industrial uses for ethanol is expected as the economy continues to grow. However, the most significant potential increase in demand will be as fuel. If all of the plants currently under consideration for Queensland were built, total ethanol production would amount to between 360 and 439 million litres. This will more than accommodate the ethanol requirements provided by a national E10 mandate and up to a 30 percent market penetration of E-diesel. Without a national E10 mandate or E-diesel, the sum of planned investments would create a potential oversupply of ethanol for Queensland. However, any oversupply situation would need to take into account other measures (such as a concentrated marketing effort) to stimulate consumer demand for E10.

Feedstocks for Ethanol Production

Profitability in the ethanol industry is largely determined by the price and availability of raw materials, or feedstocks, used to produce ethanol. Discussions with Australian ethanol industry participants indicate that agricultural feedstocks typically account for about 70 percent of the cash, or operating, cost of producing ethanol. The remaining costs include utilities and water, direct labour, maintenance, overhead, insurance and taxes, adjusted for by-product credits.[2]

Virtually all of the ethanol produced in Australia today is made from wheat starch or “C” molasses, two of the most widely available feedstocks. All current ethanol capacity in Queensland uses sugar/molasses as the primary feedstock. As shown in Table 5, using 2004 production and exports of molasses, sorghum, and sugar as a base, Queensland has the potential for producing nearly 400 million litres of ethanol annually. In essence, Queensland alone could meet Commonwealth ‘Biofuels’ target of 350 million litres by 2010.

The attributes of each potential feedstock are discussed in the following section.

[2] This estimate is consistent with the experience of state-of-the art mid-sized (e.g. 40 million gallons per year, or 150 mega litres) dry mill ethanol plants in the U.S. The cost of production does not include capital costs. In regard to capital recovery costs, as a general rule of thumb, based on experience in the USA, the fixed capital cost for a new dry mill ethanol plant is in the $1.25 to $1.50 per US gallon ($US0.33 to $US.39 per litre). A recent example includes a new dry mill plant in Indiana which had a rated capacity of 40 MGY (million gallons per year or 151.4 megalitres p.a.) ethanol using corn as the feedstock. The plant was quoted fixed asset expenditures of $US 53.655 million. This provides a capital cost of $US1.34 per gallon (US$0.35 per litre). This is in line with other new dry mill plants in the USA known by LECG. (conversion 3.785 litres = 1US gal)

Table 5
Queensland Potential Ethanol Production

	2004 Production (Thou mt)	2004 Exports (Thou mt)	Used for Ethanol (Thou mt)	Ethanol Yield (Litres/mt)	Potential Production (Mil litres)
Molasses	1,200	400	400	270	108.0
Sorghum	1,400	364	364	450	163.8
Sugar	5,500	4,019	201	600	120.6
Total	8,100	4,783	965	407	392.4

Assumptions:
Sorghum exports estimated at 26% of production (average of last 20 years)
All exportable supplies of molasses and sorghum used for ethanol
5% of sugar exports diverted to ethanol production

1) Sugar

Sugar is Queensland's largest crop with an annual crop value of about A$2 billion, and is Australia's second largest export crop. Queensland produces more than 94 percent of Australia's raw sugar followed by 5.1 percent in New South Wales and 0.7 percent in Western Australia. There are 26 raw sugar mills in Queensland (including one mill that processes sugar cane to syrup stage only).

Most Australian sugarcane is grown on coastal plains and river valleys along 2,100 km of the eastern coastline between Mossman in Far North Queensland and Grafton in the northern part of the adjoining State of New South Wales (NSW). Australia harvested 415,000 hectares (ha) of sugar cane in the 2003-04 season. Most cane is grown within 80 km of the coast, mainly in high rainfall areas and on land fed by numerous river systems.

According to the Australian Sugar Milling Council, Queensland produced nearly 5.1 million tonnes of raw sugar on about 400,000 hectares in 2004. Raw sugar is generally an intermediate product, which requires refining to remove impurities before it can be used in final consumption or in food and beverage processing. About three-quarters of Australia's sugar is exported. Queensland's refineries process raw sugar into refined (white) sugar and liquid sugar products.[3]

[3] *The Australian Sugar Industry*. Report No. 19. Australian Government Publishing Service. Canberra. 16 March 1992.

Molasses is a major by-product of the sugar refining process. Molasses is produced during the processes of clarifying, concentrating and/or extracting sucrose from sugarcane juice in a raw sugar factory and from refining raw sugar in a sugar refinery. Molasses can be further processed into value added products such as rum and ethanol, or used as a feed supplement for cattle. Currently most of the molasses used in Queensland is in cattle feeding. Over the past several years Queensland has produced an average of 1.2 million tonnes of "C" molasses, of which about 400,000 tones per year are exported.[4]

Information gleaned from the literature and personal conversations with industry participants indicates that 250 to 290 litres of ethanol can be produced from a ton of Queensland “C” molasses. Using a mid-point estimate of 270 litres per tonne, Queensland could produce 108 million litres of ethanol if all molasses currently exported was directed to domestic ethanol production. Diversion of additional molasses to ethanol production would face opposition from the cattle industry that currently uses this as a feed ingredient.

Sugar diverted from the export markets could provide an additional potential source of raw material for ethanol production. This sugar might either be kept in Queensland in the form of “A” or “B” molasses, or the crushed juice might not be processed at all into crystal sugar. As happens in so-called autonomous distilleries in Brazil, some of the sugar might be left in a form usable for ethanol production.[5] As indicated in Table 5, Australia produced 5.5 million tonnes of sugar in 2004 and exported 4 million tonnes (Queensland accounts for about 94 percent of Australian sugar). If just five percent of sugar exports (201,000 tonnes) were diverted to ethanol production, the fermentation of cane juice would yield 600 litres per tonne of sucrose, providing 120 million litres of ethanol. The more effective question is how much sugar could reasonably be diverted to “B” molasses (where yields would be lower than for pure sucrose) without disturbing existing domestic requirements for “C” molasses (e.g. cattle feeding). A tonne of sugar

[4] There are three grades of molasses: A, B, and C (or final) molasses. "A" molasses is an intermediate product produced by centrifuging sugar juice in a raw sugar factory. Approximately 77 percent of the raw sugar is extracted during this first centrifugation process. "B" molasses, known as "second" molasses, also is an intermediate product, obtained from boiling together "seed-sugar" and "A" molasses to obtain a mixture which is then centrifuged to extract an additional 12 percent of raw sugar. At this point, approximately 89 percent of the total recoverable raw sugar in the processed cane has been extracted. The last molasses, known as "C", "final" or "blackstrap" molasses, is the end product obtained upon combining "virgin" sugar crystals obtained from syrup crystallization and "B" molasses to form a mixture, which after boiling and centrifuging produces "C" sugar and "C" molasses. Even though “C” molasses is considered the final product in a raw sugar factory, it still contains considerable amounts of sucrose (approximately 32 to 42 percent). “C” molasses typically is used for ethanol production.

[5] An autonomous distillery is a stand alone facility instead of one annexed to a sugar refinery.

yields 271 kg of molasses. Using the 270 litres per tonne ethanol yield discussed earlier, it will take 1.375 million tonnes of sugar to produce enough molasses (371,000 tonnes) to make 100 million litres of ethanol. However since molasses is about 50 percent sugar, the net amount of sugar diverted to make ethanol is only 1.18 million tonnes. It is this quantity that would not be available for export.

a) The economics of sugar-based ethanol

Using molasses to produce ethanol is an economically more attractive alternative than using raw sugar. With molasses prices at about A$60 per tonne, the raw material cost of ethanol production is A$0.222 per litre. Since typical raw material cost (RMC) is 70 percent of operating costs, the gross cost of producing ethanol from molasses (before adjusting for any by-product credit) would be A$0.317 per litre.[6]

Queensland can take advantage of the fact that it has an abundance of mills to crush cane and extract sugar. Otherwise, the cost to build a new "greenfield" ethanol plant would be very high. Since labour and steel prices have escalated considerably recently (steel probably due to energy increases as much as anything), current capital costs likely exceed the A$1.00 per litre that has been quoted around the industry.[7]

b) By-products of ethanol from sugar

The by-product of ethanol from sugar (molasses or cane juice) is called dunder. Dunder has limited value as an animal feed but under the right circumstances can be used as a fertilizer. One firm has perfected "thick" fermentation of sugar that provides a potassium (K) concentration high enough to qualify the dunder as a liquid fertilizer. However, the standard technology requires the use of evaporators to concentrate the dunder up to a level where it can be compounded with other ingredients into either a cattle feed or cane field fertilizer. Since these high concentration levels can lead to massive fouling with molasses they typically require

[6] At current prices of $240/tonne for sugar and a conversion of 600 litres/tonne of sugar the raw material cost for ethanol is A$0.40/litre. Using the 70 percent rule, the RMC for sugar is A$0.571 per litre. The price of molasses assumed for this analysis is A$60 per tonne. There does not appear to be a fixed relationship between sugar and molasses prices. Some analysts have indicated that as ethanol demand expands globally an increasing share of molasses will be used domestically for ethanol production and not enter export markets, resulting in an increase in both the level and volatility of molasses prices. We have assumed stable molasses prices for the period of this analysis.

[7] Naughten, Barry. *Viability of sugar cane based fuel ethanol*. ABARE report to AFFA. October 2001. In this study Naughten cites several sources that suggest capital needs of around A$50 million (in 2001 dollars) for a 50 million litre per year plant. In the United States, capital costs are significantly lower. Typical capital costs for a new dry mill ethanol pant are estimated at around US$1.25 per gallon. At today's exchange rates this is equivalent to A$1.61 per gallon, or A$0.426 per litre.

multiple evaporation runs that necessitateadditional equipment and higher labour costs due to increased maintenance.

It is not clear how to calculate a by-product credit to the price of sugar for the sale of a dunder-based fertilizer or animal feed. It is possible that revenue from the sale of dunder might reduce sugar/molasses costs by as much as 10 percent. Applying a 10 percent "by-product credit" to the dunder would reduce the RMC for molasses to A$0.20 per litre and the net production cost to A$0.295 per litre.

2) Grain

Ethanol is made from grain in countries with significant available quantities. The most appropriate grain for ethanol production in Queensland is grain sorghum because it is plentiful and the least expensive to liquefy to sugar and ferment. Other grains, such as wheat, are typically more expensive per tonne. Sorghum is Queensland's leading grain, and Queensland is Australia's leading producer, accounting for about two-thirds of total output. Industry sources report that a tonne of Australian sorghum can yield 450 litres of ethanol.[8] Table 6 details the supply and utilization of sorghum for Australia and area, yield, and production of sorghum in Queensland.

Sorghum is a coarse grain used primarily for animal feed. In Australia and Queensland sorghum is fed to beef and dairy cattle. While using sorghum to produce ethanol will reduce the gross amount of grain available for cattle feed, the ethanol production process provides a medium-protein feed ingredient that is ideal for beef and dairy cattle. Alcohol production from grain involves the fermentative conversion of starch to alcohol. The fermented mash is then distilled to remove the alcohol. The remaining slurry, called whole stillage, contains the fibre and protein content of the grain and contains 5 to 10 percent dry matter.

Whole stillage is processed by various techniques to remove the large volume of water associated with the residual dry matter. The first step involves screening and pressing, or centrifuging to remove the coarser grain particles, which are then dried. The resulting product is distiller's dried grains (DDG). The liquid remaining after screening, called thin stillage, contains fine grain particles and yeast cells. Thin stillage is generally evaporated to produce syrup that may be added back to distiller's grains. The mixture is then dried to form dried distillers grains with solubles (DDGS). The protein content of distiller's grains from Australian sorghum is estimated at 38.6 percent.

[8] It is interesting to note that Australian sorghum has a higher average starch content than corn used to produce ethanol in the U.S. The typical dry mill ethanol plant in the U.S. produces 402 litres for each tonne of corn.

Table 6
Australia/Queensland Sorghum

	2000-01	2001-02	2002-03	2003-04	2004-05
Australia					
Area (thou ha)	758	823	667	570	659
Yield (mt/ha)	2.55	2.46	2.20	3.25	3.18
Production (thou mt)	1,935	2,021	1,465	1,850	2,098
Feed/Food (thou mt)	1,430	1,643	1,398	1,267	1,625
Seed (thou mt)	4	3	3	4	3
Exports (thou mt)	501	375	64	648	394
Price (A$/t)	$162.60	$187.52	$288.89	$194.70	$165.00*
Queensland					
Area (thou ha)	494	562	405	415	450
Yield (mt/ha)	2.34	2.22	2.30	3.13	3.11
Production (thou mt)	1,156	1,247	930	1,300	1,400
Qld Share					
Area	65.2%	68.3%	60.7%	72.8%	68.3%
Production	59.7%	61.7%	63.5%	70.3%	66.7%

* Jan-March 2005 domestic feed price
Source: ABARE

DDGS is particularly valued because of its bypass protein. Bypass protein is that protein which escapes digestion in the rumen. This protein is subsequently digested in the small intestine, absorbed as amino acids, and used for reproductive functions including milk production. Other valued characteristics of the product include colour, smell, palatability and texture. Up to 40 percent of a dairy cow feed ration may consist of DDGS. Dairy cows consume more feed and the feed passes through the digestive tract more quickly than in beef cattle. Dairy cows require more bypass protein than beef cattle and also more digestible fibre to maintain milk fat levels. The combination of bypass protein, digestible fibre, and fat in DDGS makes it a highly desirable feed for dairy cows.[9]

Since Australian sorghum has a higher starch content (and ethanol yield), the amount

[9] Glen Aines, Terry Klopfenstein, and Rick Stock. *Distillers Grains*. Institute of Agriculture and Natural Resources. University of Nebraska-Lincoln. 1986.

of DDGS produced per tonne would be somewhat lower than that produced from corn in the U.S. Industry sources report that each tonne of sorghum used to produce ethanol will generate 285 kg of DDGS. Consequently, for every tonne of sorghum used to produce ethanol, 285 kg of feed at the same moisture content is put back into the market, meaning only a net 0.715 tonnes are removed from the animal feed market. And the protein content of the feed ration has been significantly increased.

The amount of ethanol and DDGS that would be produced from sorghum in Queensland will depend on the amount of sorghum used for ethanol. Table 7 illustrates the potential amount of ethanol and DDGS that could be produced at different levels of sorghum utilization. If 10 percent of Queensland's sorghum crop were used for alcohol conversion, 108.6 million litres of ethanol and 69,000 tonnes of DDGS could be produced. This increases to 271.5 million litres of ethanol and 172,000 tonnes of DDGS for 50 percent utilization.

The market for ethanol has been discussed above. An ethanol industry of this size would supply a cattle industry of between 17 million and 43 million head with high protein DDGS. About half of Australia's 23.4 million beef cattle and 8 percent of the 3.1 million head dairy herd are in Queensland. New South Wales has the second largest herds.

Table 7
Potential Ethanol and DDGS Production From Sorghum

Pct of crop Used for Ethanol	Sorghum Use (Thou mt)	Ethanol Production (Thou l)	DDGS Production (Thou mt)	Cattle Fed (Mil head)
20%	241	108,594	69	17.2
30%	362	162,891	103	25.8
40%	483	217,188	138	34.4
50%	603	271,485	172	43.0

a) <u>The economics of sorghum-based ethanol</u>

As shown in Table 6 above, the average sorghum prices in Australia have increased in recent years due to the effects of drought. In the absence of a reliable forecast for sorghum prices, we will rely on the average price registered over the past 24 years as a baseline. The average price for feed sorghum at Sydney was $161.26 over this period.[10] Industry sources indicate that the cost to move sorghum from where it is grown to Sydney is about A$20 per tonne. Since ethanol plants using grain as a feedstock are likely to be located near the source of supply, this transportation fee can be subtracted from the Sydney price to result in a plant-gate sorghum price of $141.26 per tonne. Using this as a base price for sorghum, the gross raw material price for ethanol production would be A$0.314 per litre. However when the co-product credit provided by the sale of DDGS is taken into consideration, the net feedstock cost is reduced. In the absence of a market price for DDGS in Australia we have assumed that the price will hold approximately the same value to sorghum as DDG does to corn in the U.S. Note that virtually all DDG in the U.S. is produced from corn and has lower protein content than Australian DDGS will provide. Over the past 15 years U.S. DDG prices were 124.6 percent of farm-level corn prices on an equivalent unit basis. Using this relationship, an Australian sorghum price of A$141 per tonne should equate to a DDGS price of A$176 per tonne, or A$0.111 per litre. When this co-product credit is considered, the net variable cost to produce ethanol from sorghum in Queensland becomes A$0.337 per litre.

Relationship between Petrol and Ethanol Prices

The terminal gate price for petrol in Australia is the international parity price, which is the Singapore refined fuel price plus freight, handling, margin, excise and GST. Roughly calculated, this amounts to the world oil price per barrel plus US$1.00, plus US$4 for ocean transport and US$1 for throughput in a tank in Brisbane. The spot price of West Texas Intermediate (WTI) crude oil in March 2005 averaged US$54 per barrel (bbl). This amounts to a price for petrol sitting in a tank ready for truck loading of US$60 per bbl. At current exchange rates this amounts to A$0.49 per litre. The A$0.381 per litre excise tax has to be added providing a terminal price of A$0.871 per litre.

Technically speaking, if an in-line blender was working at a terminal that only required a push of the button to make E10, a retailer would be indifferent if ethanol were purchased at the same price of A$0.87l. In reality of course, there are other issues to consider such as octane, market positioning, and discounts needed to stimulate market demand.

Assuming that ethanol is just treated like petrol and no credit is given for its high octane nor are there any demerits for handling, deduct A$0.04 per litre for storage and transportation from the retail price of A$0.871 per litre to get a "plant gate" price for petrol of A$0.831 per litre. When compared to the cost of producing ethanol from molasses of A$0.295 per litre at the plant, this provides a margin of A$0.536 per litre. When the A$0.125 excise tax is paid

[10] A recent crop report published by ABARE indicates that the Sydney feed sorghum price has declined steadily over the past two years from A$202/mt in the July-September quarter of 2003 to an estimated A$165/mt in the January-March 2005 quarter. *Australian Crop Report.* No. 133. 15 February 2005.

(the excise tax will be progressively increased between 2011 and 2015), the margin shrinks to A$0.411 per litre.

At current sugar and sorghum prices world oil prices would have to fall to A$20 per barrel (US$15.40 per bbl) before ethanol production becomes unprofitable.

Ethanol prices in the U.S. and Brazil have declined significantly since the beginning of the year. Chicago spot ethanol prices that were US$1.61 per gallon (A$0.545 per litre) during the first week of 2005 have declined to US$1.22 per gallon (A$0.413 per litre) during the first week of April.[11] Similar weakness has been reported in the Brazilian market. Reflecting this it would not be unreasonable to expect ethanol prices in Queensland to average A$0.49 to A$0.50 per litre. Even at this price, ethanol made from molasses is economically attractive.

4) Impact on consumer prices

Assuming that the transportation and storage costs for ethanol are twice that faced by petrol (8 cents per litre versus 4 cents for petrol), blending ethanol with petrol at 10 percent will reduce the pump price for consumers in Queensland by five cents per litre, or 5.7 percent, provided that this benefit is passed on to consumers. This is illustrated in Table 8.

Table 8
Impact of E10 Blends on Petrol Prices
(A$ per litre)

	Regular Unleaded Petrol (A$/litre)	Ethanol (A$/litre)	E10 (A$/litre)	E10 Diff vs Petrol (A$/litre)
Plant/refinery price	$0.450	$0.295		
Storage and transport	$0.040	$0.080		
Excise tax	$0.381	NA		
Terminal Price*	$0.871	$0.375	$0.821	-5.7%
Octane credit			$0.040	
Net Price of E10			$0.781	-10.3%

* Terminal price does not include distribution and marketing.

[11] Jim Jordan and Associates. Fuels Blendstock Report, Weekly Market Analysis. Various issues.

1255 Drummers Lane, Suite 320, Wayne, PA 19087
main 610.254.4700 fax 610.254.1188 www.lecg.com

Since ethanol is used to increase octane in petrol, adding 10 percent ethanol to petrol will result in a blend with a higher average octane. Adding 10 percent ethanol to regular unleaded petrol will add four octane points to the E10 blend. Currently, the price differential between regular unleaded petrol in Queensland (92 octane) and premium (96 octane) is about four cents. This means that each point of octane is worth about one cent. Since E10 provides a four-octane point benefit, the added value of E10 is an additional four cents per litre. Essentially this means that petrol marketers could provide consumers with a 96-octane product for the cost of a 92-octane blend. Whether this benefit is passed along to consumers or is retained by marketers to enhance margins is up to the petrol marketer. However, this represents a producer surplus that should be credited to ethanol. When the octane credit is considered, the price of E10 is 10.3 percent below regular unleaded petrol.

Transportation and Distribution Considerations

It is widely held that distribution and handling costs for ethanol and ethanol-blended fuels are higher than those for petrol. However the structure of the Queensland petrol refining and distribution industry are such that many of these costs would be mitigated. The most significant obstacle ethanol must overcome is its inability to be moved via pipeline. Since ethanol readily absorbs water, it requires dedicated storage and transport facilities to preserve the integrity of the product. Consequently, most ethanol is moved via ocean vessel or barge, rail tank car, or tank truck from production facility to distribution point where it is “splash” blended with petrol.

The vast majority of petrol in Queensland is moved by rail, truck, or vessel with little moved by pipeline. Considering this, ethanol can be moved by rail or truck to major refineries and distribution points much the same way as petrol, or can move up (or down) the coast to major metro areas for blending and distribution. The single largest additional cost may be for dedicated ethanol storage tanks at refineries or distribution points.

Potential Market Impediments

A number of factors could prove to be impediments to the successful development of an ethanol industry in Queensland. The most significant include:

- Changes to the world price of oil (and/or exchange rate)

  World oil prices have increased sharply in recent months and have stayed consistently above the US$50 per bbl (A$65 per bbl) mark. There are many reasons for the increase in prices ranging from shortfalls in production to increased demand for oil and energy in China and India. Oil prices at these levels result in high prices for petrol and diesel fuel and make ethanol a very attractive alternative fuel. However as with any commodity, oil prices may decline if supplies expand or demand growth slows. As discussed above, at current commodity price levels world oil prices would have to fall to US$15 per barrel (A$20 per bbl) before ethanol production becomes unprofitable.

- Increase in prices for primary feedstocks (sugar and grain)

  Since feedstocks represent the most significant share of ethanol production costs, sharp swings in world sugar or grain prices, and high price levels, could erode the profitability of producing ethanol. The No.1 Pool price of sugar in Australia is about 41 percent below the record A$392 per tonne recorded in 1994. The pool price for sugar has averaged A$310 over the past twenty years. Similarly, over the past twenty years the price of grain sorghum in Australia has averaged A$166 per tonne. However prices have varied from a low of A$111 per tonne in 1986 to a record $289 per tonne in 2002.

- Adverse consumer sentiment towards ethanol-based fuel

  Consumer acceptance of ethanol is a key ingredient in developing a successful market. Press reports of potential damage to auto engines resulting from high blends of ethanol with petrol created substantial consumer concern in Queensland in late 2002. Agressive response by BP and the Queensland government with factual information that refuted the allegations were able to restore consumer confidence. Having said that, the ethanol industry has vocal and well-funded opponents and consumers are vulnerable to anti-ethanol sentiment from these lobby groups.

- Changes to fuel excise arrangements that reduce the relative advantage of ethanol

  Government (both Commonwealth and State) policy in the form of excise tax exemptions and other forms of support for the ethanol industry play a major role in levelling the playing field with the petroleum refining industry. Elimination of the excise tax exemption for ethanol would increase pressures on profitability, increase risks, and discourage new investors.

Economic Implications of Ethanol for Queensland

Development of the ethanol industry can be expected to make a substantial contribution to the economy of Queensland. The spending associated with ethanol production and investment spending on new plant capacity represents the purchase of final demand from supplying industries. This spending will circulate throughout the Queensland economy several fold, thereby stimulating aggregate demand; supporting the creation of new jobs; and generating additional income.

It is important to note that since the location of ethanol plants and ethanol production are likely to be located near the sources of raw material supply, rural economies in Queensland would benefit significantly from development of an ethanol industry. This includes the primary impact resulting from capital spending for construction, direct new jobs and income, and a large share of the indirect spending effects.

Consistent with the discussion presented earlier for the E10 market, Queensland may need between 126 and 430 million litres of new ethanol capacity to meet a potential annual demand of between 130.6 million and 435 million litres by 2010. At an estimated A$1.00 per litre capital cost, the ethanol industry will spend between A$126 million and A$430 million on construction to meet this demand.

As indicated earlier, the gross annual operating cost (before by-product credit) to produce ethanol from molasses in Queensland is estimated at A$0.317 per litre. The largest share of this spending will be for molasses used as the raw material to make ethanol. The remainder of the spending by the ethanol industry is for a wide range of inputs such as industrial chemicals; electricity, natural gas, and water; direct labour; and services such as maintenance, insurance, and general overhead. Spending for these goods and services represents the purchase of output of other industries.

The impact of the ethanol industry on the Queensland economy can be estimated by applying output and employment multipliers for private domestic consumption and gross fixed capital formation to the estimates of spending described above. A recent study by Valadkhani and Robinson estimated the output multiplier for private domestic consumption in Australia at 1.5 and the multiplier for gross fixed capital formation at 1.46.[12] This suggests that a dollar increase in final demand such as represented by spending (purchase of goods and services) by the ethanol industry can stimulate total gross output (GDP) by 1.5 dollars. In the same fashion, spending one dollar on capital formation (building an ethanol plant) can create 1.46 dollars of gross output for the economy. The equivalent employment multipliers were 12.78 and 11.48. Tables 9 and 10 summarize the economic impact for Queensland resulting from a 130.6 million and 435 million litre ethanol industry using molasses as a feedstock.

[12] Valadkhani, Abbas and Tim Robinson. "An Analysis of the Output and Employment Conversion Matrices of Australia's Economy". *American Journal of Applied Sciences* 2 (2): 483-490, 2005.

Table 9
Economic Impact for Queensland of a 130.6 Million Litre Ethanol Industry Using Molasses as a Feedstock

Industry	Purchases (Mil 2004$)	Output (Mil 2004$)	Employment (Jobs)
Construction	$126.5	$184.7	1,452
Plus initial changes		$126.5	
Total		$311.2	1,452
Annual Operations			
Raw materials	$29.1		
Other costs	$10.9		
Direct labour	$1.6		
Subtotal	$41.6	$62.4	531
Plus initial changes:			
Value of ethanol production		$64.5	55
Value of co-products		$2.9	
Total Annual Operations		$129.7	586
Grand Total		**$440.9**	**2,038**

Table 10
Economic Impact for Queensland
of a 435 Million Litre Ethanol Industry
Using Molasses as a Feedstock

Industry	Purchases (Mil 2004$)	Output (Mil 2004$)	Employment (Jobs)
Construction	$430.5	$628.5	4,942
Plus initial changes		$430.5	
Total		$1,059.0	4,942
Annual Operations			
Raw materials	$96.6		
Other costs	$36.1		
Direct labour	$5.3		
Subtotal	$138.0	$206.9	1,763
Plus initial changes:			
Value of ethanol production		$214.0	181
Value of co-products		$9.7	
Total Annual Operations		$430.6	1,944
Grand Total		**$1,489.6**	**6,886**

Key assumptions underlying this analysis include:

- New ethanol plants use molasses as the feedstock and have a 60 million litre per year capacity.
- Current fuel-grade ethanol production in Queensland is 4.5 million litres per year and all new production will be designated for the fuel market.
- The capital cost for a new plant is A$1.00 per litre.
- Each plant would employ 25 workers at an average wage of A$561 per week.
- Molasses costs are A$60 per tonne and raw material costs average 70 percent of production costs as described earlier.
- By-product credits are 10 percent of molasses costs.
- Ethanol price averages A$0.492 per litre.

Key findings include:

- The combination of spending for annual operations and capital spending for new plants is expected to add between A$441 million and A$1,490 million to the Queensland economy by 2010.

- New jobs would be created as a consequence of increased economic activity caused by ethanol production. The increase in gross output (final demand) resulting from ongoing production and construction of new capacity is expected to support the creation of as many as 2,038 to 6,886 new jobs in all sectors of the Queensland economy by 2010.

- E10 blends are anticipated to reduce the price of petrol by 5.7 percent before allowing for any octane credit, and 10.3 percent in full.

CONCLUSION

The potential market for ethanol in Queensland is substantial, ranging from 130 million litres if E10 (10 percent ethanol blends) achieves a 30 percent market penetration, to a maximum of 435 million litres if a national E10 mandate was introduced.

The potential market for ethanol in Queensland for use in E-diesel could range from 189 million to 315 million litres depending on market penetration.

Considering that currently about 4.5 million litres of fuel grade ethanol is produced in Queensland, this suggests that between 126 million and 430 million litres of new capacity may be required by 2010 for E-10 alone.

Producing ethanol from molasses in Queensland is estimated to be more cost-effective than using grain sorghum. The net cost of producing ethanol from molasses from sugar at current commodity prices is estimated at A$0.295 per litre while the net cost of producing ethanol from sorghum is A$0.377 per litre. In either case, ethanol costs are below prevailing market prices for ethanol when the excise tax exemption is taken into consideration.

Queensland can reasonably produce almost 400 million litres of ethanol by diverting all of the molasses and sorghum currently being exported to ethanol production, and by diverting only 5 percent of sugar being exported.

At current world oil prices ethanol production in Queensland is profitable. World oil prices would have to fall to below A$20 per barrel (US$15.40 per barrel) for this advantage to disappear.