

Table S.1 Remaining commercial reserves at 1 January 2004 and estimates of reserves that have not yet been declared commercially viable (i.e. non-commercial) reserves

Commercial reserves			
Crude oil	Condensate	Liquid petroleum gas	Sales gas
(GL)	(GL)	(GL)	(BCM)
127.3	101.2	120.9	782.8
(million bbl)	(million bbl)	(million bbl)	(Tcf)
800	637	760	28
Non-commercial reserves			
Crude oil	Condensate	Liquid petroleum gas	Sales gas
(GL)	(GL)	(GL)	(BCM)
123.5	258.3	167.8	3138.0
(million bbl)	(million bbl)	(million bbl)	(Tcf)
777	1625	1056	111

The Yolla Field commenced construction in April 2003 and will be the first gas production from the Bass Basin, located in exploration permit T/RL1, 120 km offshore from Tasmania and 220 km south-east of Melbourne in a water depth of 80 m.

ROC Oil is progressing towards the development of the Cliff Head oil field, which was discovered at the end of 2001 in the offshore Perth Basin, permit WA-286-P. The field is situated approximately 11 km off the Western Australian coastline in 16 m of water.

In the Carnarvon Basin, Woodside is planning to drill additional subsea development wells into the Perseus field. The wells will be drilled in the southern and western parts of the Perseus field to drain reservoir layers not directly drained by the Perseus wells drilled from the North Rankin A platform. The first phase of this development will involve the drilling of three wells tied back to the Goodwyn A platform via a 16-inch pipeline.

In March 2003, Woodside Energy Ltd submitted the preliminary field development plan to the Government as a precursor to an application for a Production Licence over the Enfield oil field, and the development was approved by the Woodside Board in March 2004.

The Enfield oil field is located approximately 16 km north of the northermost part of Ningaloo Reef in exploration permit WA-271-P in the offshore Carnarvon Basin. The development comprises subsea wells tied back with flowlines to a floating production, storage and offloading facility (FPSO) of double-hulled construction, disconnectable mooring, its own propulsion system to allow it to evade tropical cyclones, and a storage capacity of approximately 143 000 m³ (900 000 bbl). The FPSO will be positioned west of Enfield in a water depth of 550 m. Due to the proximity of the development to the Ningaloo Reef, both produced water and surplus gas will be reinjected back into the reservoir unit.

On 9 June 2003 Woodside submitted a Preliminary Development Concept to the Government as a precursor to an application for production licenses over the Geographe and Thylacine gas fields. The Geographe and Thylacine gas fields are in exploration permits

In 1999, the Commonwealth published the *Australian Offshore Petroleum Strategy* document which provided guidance on the sizes of release areas, and exploration permits. This new guide provided a framework for a more focussed approach to offshore petroleum exploration, and it was applied to both the 2000 and subsequent Acreage Release Programs.

In mature, relatively well explored sedimentary basins, release areas are generally restricted to a maximum of eight graticular blocks (approximately 640 km²) in size. In the less well explored, frontier basins, release areas generally have a maximum size of 80 graticular blocks (approximately 6400 km²). The maximum preferred sizes of release areas in immature and sub-mature sedimentary basins are 40 and 20 graticular blocks, respectively.

In 1999, the Government implemented an Acreage Re-release Program to allow exploration companies to retain 'good standing' in the event of a default in work-program conditions in a permit. These arrangements require a defaulting company to spend the agreed value of any outstanding work commitments on new field-work in the minimum guaranteed period of new permits awarded from the Re-release Program. Although the re-release of any area is at the discretion of the Joint Authority, it is generally intended that any area that does not attract a successful bid in the annual Acreage Release Program will be included in the Re-release Program. The re-released areas are open to all interested bidders under the work-program bidding system, with closing dates for bids coinciding with the next closing date under the normal acreage release process.

In early 2004, as part of the 2004–2005 Budget, the Australian Government announced the introduction of a taxation incentive designed to encourage petroleum exploration in Australia's remote offshore areas. The Government will increase the value of deductible pre-appraisal exploration expenditures incurred in designated offshore frontier areas by 50% for the determination of petroleum resource rent tax (PRRT). This 150% uplift applies to the initial term of the exploration permit awarded over a Designated Frontier Area.

The legislative amendments to provide for the 150% uplift have yet to be implemented (February 2005).

This new incentive to promote exploration of Australia's frontier offshore areas applies to the annual offshore acreage releases for 2004 through to 2008. Up to 20% of the areas offered each year under the annual offshore Acreage Release Program can be designated as frontier acreage, eligible for this new taxation incentive, although Designated Frontier Areas must be at least 100 km from an existing commercialised oil discovery and will not be adjacent to an area designated in the previous year's Acreage Release Program. In the 2004 Acreage Release Program, six frontier, offshore areas are eligible for the new 150% uplift on PRRT.

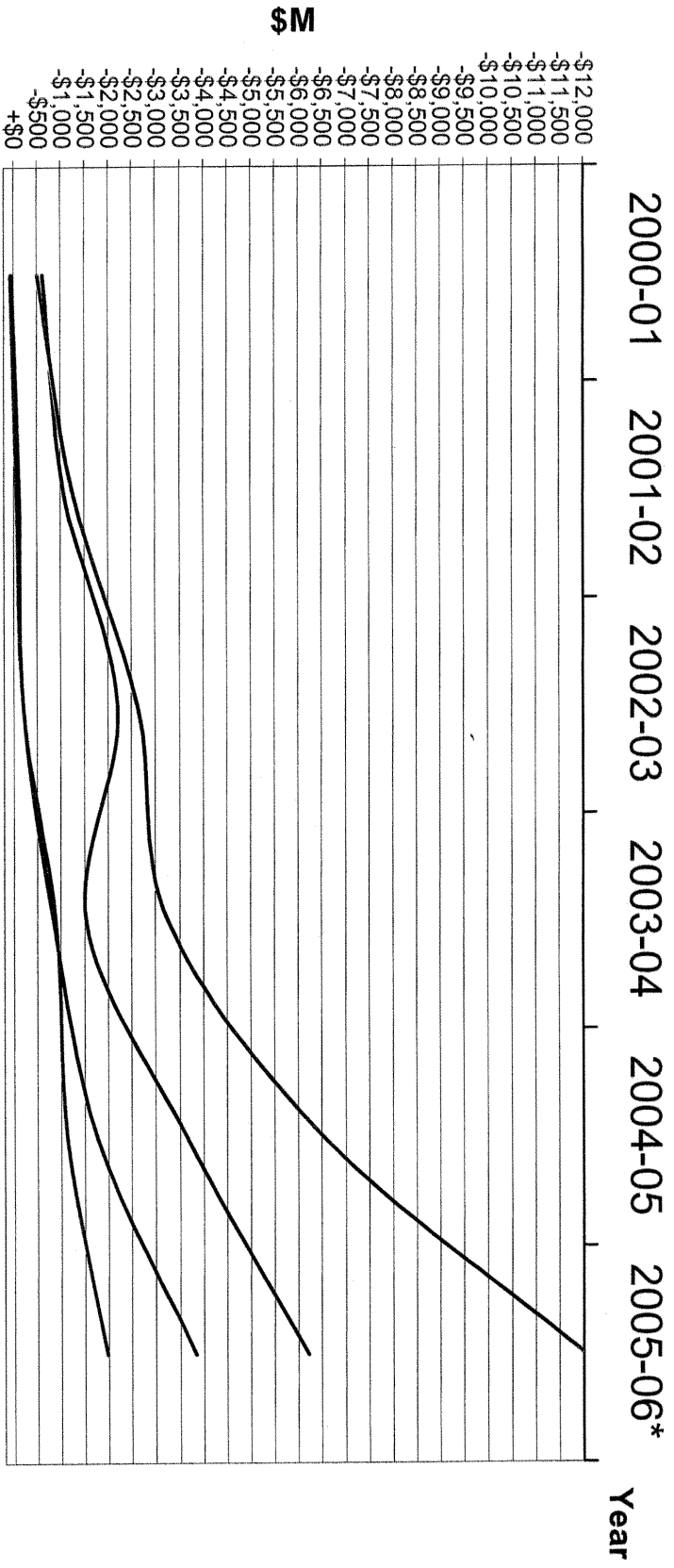
Final results of the 2002 offshore Acreage Release Program

In 2002, 41 offshore exploration areas were offered to petroleum explorers in two tranches. Closing dates for bids were 24 October 2002 (seven areas) and 10 April 2003 (34 areas).

Approximately half of the exploration areas released in 2002 were located on the North West Shelf. Acreage was made available in frontier to mature areas, in a variety of geological settings and in a range of water depths.

Australian Petroleum Industry Trade Deficit

Gasoline, Diesel, Crude Oil & Other Refinery Inputs



\$ Million * Based on June 06 data

Year	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06*
Gasoline Deficit	+\$68	-\$59	-\$202	-\$888	-\$1,124	-\$1,969
Diesel Deficit	+\$60	-\$106	-\$195	-\$841	-\$1,767	-\$3,835
Crude Deficit	-\$616	-\$1,068	-\$2,208	-\$1,539	-\$3,665	-\$6,218
Total Fuel Deficit	-\$488	-\$1,233	-\$2,605	-\$3,268	-\$6,556	-\$12,022
Total Aust Trade Deficit	+\$413	-\$1,614	-\$18,875	-\$23,422	-\$25,434	-\$16,708
% Petroleum Deficit/ Total	-118%	76%	14%	14%	26%	72%

Statistics From: <http://www.abareonlineshop.com/>

1996-97 to 2004-05 Statistics Source Table 311 Australian Commodity Statistics: Deficit History Stats As at July 05 By ANZ Bank

* 2005-06 Stats Basis: Imports 12 Months, Exports 12 months, Balance of Trade Deficit 12 Months (all extrapolated to 12 months)

30 May 2005

Hon John Howard MP
Prime Minister
Parliament House
CANBERRA ACT 2600

COPY

Dear Prime Minister

AWB is a supporter for the development of the renewable fuels industry in Australia. We are also advocates for your Government's commitment to develop a commercially viable bio-fuels industry and bolster consumer confidence in ethanol-blended fuels.

AWB supports this young and potentially vital industry as it will increase demand for Australian grain and provide an alternative energy source to underpin the future growth of our economy. AWB believes there are long-term benefits to the development of a new grain demand sector in the local economy, particularly in regional areas where the industry is most likely to be based.

The Government's commitment to alternative and renewable fuels, most recently through your election commitments, is welcomed. The Government's support sends a critical message of confidence to potential investors.

Despite this recent commitment, AWB has been informed that the renewable fuels industry is currently placed at a cross-road. While there are strong indications of further private investment in the industry, this will not necessarily be free flowing without some positive indication from the Government in relation to the viability and importance of the renewable fuels industry.

As the Government is aware, a thriving renewable fuels industry in Australia would have positive public benefit impacts in a number of sectors, including the environment and health. While AWB is supportive of such benefits, we are particularly focused on those which benefit the grains industry and regional areas, including:

- Increase in the domestic demand for grain that will provide important market alternatives for Australia's grain growers. While the market could be subject to pricing pressures in the short term, it can be expected that regional grain markets will stimulate price signals to increase grain production to meet this demand.
- Growth in bio-fuels also promises to increase the availability of sources of high protein vegetable matter that could displace large amounts of soy-meal that are imported annually into Australia. In addition (to lower production costs for users of protein meal), the availability of locally produced high protein dry distillers grain as a substitute for imported sources of protein meal, could in fact prove to be positive for local livestock producers.

The recent introduction of the Australian Stock Exchange (ASX) sorghum and feed wheat contracts, provides grain processors every opportunity to reduce their exposure to movements in domestic grain prices. The use of these risk management options will provide greater certainty of price for processors, thereby reducing concerns of the potential for adverse price movements as a result of increased domestic demand.

AWB notes that international governments such as the United States Congress have mandated the use of bio-fuels such as oxygenated fuels (or ethanol). Some reports imply that such measures are necessary to ensure the viability of the renewable fuel industry.

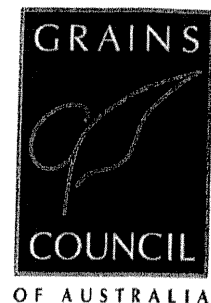
AWB would encourage and welcome messages from the Federal Government, which indicate its support of this important industry and foster confidence in further private sector investment in this sector.

For these reasons, AWB believe it would be a good outcome for grain growers and AWB for a larger renewable fuel industry to continue to be developed in our country.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Brendan Stewart', with a stylized flourish at the end.

Brendan Stewart
Chairman



The Hon John Howard
Prime Minister
House of Representatives
Parliament House
Canberra ACT 2600

Production of Bio-fuels

Dear Prime Minister

I am writing to you on behalf of the Grains Council members to bring to your attention the policy GCA is developing toward the use of cereal and oilseed crops in the production of bio-fuels.

In the grain industries Single Vision strategy, demand for crops for industrial uses, including the production of ethanol and bio-diesel, is forecast to grow strongly over the next decade.

This growth will drive an expansion in markets for Australian grain and oilseeds that will realistically double over the next two decades.

The development of a viable renewable fuel industry in Australia will provide producers with a fourth major demand stream to compliment the existing export, feed grains and domestic milling markets.

While the demand for cereals and summer crops for fuel production will require some adjustments in production and supply patterns, we believe the new demand will be largely compatible with existing demand streams.

The Grains Council is working with the Livestock Feed Grain Users Group and Minister Truss to put into place long term strategies that will help guide the adjustment of the grain industry to producer greater quantities of grain and oilseeds for use in livestock feeding and industrial processes, such as fuel production.

The development of ethanol refineries in regional Australia should provide new job and skill development opportunities. We believe the Australian ethanol industry should develop best practice operations, with the aim of exporting technology, skills and knowledge.

While supportive of ethanol production, we are also keen to promote the development of a viable bio-diesel industry. As the main fuel in agricultural production is diesel, production of bio-diesel will allow agricultural industries to produce a percentage of their own energy needs and positively contribute to reducing Australia's greenhouse gas emissions.

The grains industry wishes to thank you and your governments' commitment to the bio-fuel industry and we hope, in the face of higher world oil prices, that the government will continue to work with industry to develop the bio-fuel sector.

Yours sincerely

A handwritten signature in black ink, appearing to read "Keith Perrett". The signature is stylized and includes a long horizontal stroke extending to the right.

Keith Perrett
President – Grains Council of Australia
Monday, 14 February 2005

NOTE: Senator Dianne Feinstein of California has lobbied constantly for the oil companies for many years.

<http://www.latimes.com/news/nationworld/nation/la-na-energy16jun16,0,3873912.story?page=2&coll=la-home-headlines>

THE NATION

Senate Gives Ethanol an Added Boost

Farm-state lawmakers push through a measure to double the amount in the gas supply by 2012. The potential effect on prices is unclear.

By Richard Simon and Warren Vieth
Times Staff Writers

June 16, 2005

WASHINGTON — For years, Congress has showered tax breaks on ethanol, portraying the fuel that is derived mostly from corn as a homegrown alternative to oil imports.

But even the Corn Belt could not have imagined its good fortune Wednesday as the Senate voted to double the amount of ethanol, to 8 billion gallons, that must be added to the nation's gasoline supply by 2012.

"The Senate is poised to make ethanol a cornerstone of America's energy policy," said Sen. John Thune, a Republican from ethanol-producing South Dakota.

The provision was added on a 70-26 vote to a far-ranging energy bill moving through the Senate. It is widely regarded as critical to getting Congress to adopt a new national energy policy, a priority of President Bush's.

But opponents of the provision, including a number of East and West Coast senators and the oil industry's trade association, the American Petroleum Institute, contend that it could increase gas prices because of the cost of transporting ethanol from the Midwest.

Sen. Charles E. Schumer (D-N.Y.) called the mandate "nothing less than an ethanol gas tax" that would be levied on every motorist in the country.

"There is no sound public policy reason for mandating the use of ethanol — other than the political might of the ethanol lobby," he said.

The 8-billion-gallon requirement is higher than any amount that has previously come before Congress, and would give the industry its biggest boost since a tax break for the fuel was first approved in 1978.

Ethanol, a high-octane fuel made from corn or other renewable products, is typically blended with gasoline at a rate of 10% ethanol to 90% gasoline for use in standard combustion engines. The use of such reformulated gasoline — which proponents say burns more efficiently — is required as a clean-air measure in areas with high levels of ozone or carbon monoxide.

About 30% of gasoline consumed in the United States last year was an ethanol blend, according to the American Coalition for Ethanol, a trade association that supports increased ethanol use.

The provision adopted by the Senate on Wednesday was eagerly sought by Democratic and Republican farm-state lawmakers, underscoring that energy policy was often shaped by regional politics rather than party affiliation. The ethanol coalition, based in Sioux Falls, S.D., cheered the vote as the "strongest display of support for ethanol to date in the U.S. Senate."

Bush applauded efforts to boost the ethanol requirement, saying it was a key element of a broader strategy to reduce the nation's dependence on foreign oil. "We're pretty good about growing corn here in America, and we've got a lot of good corn growers," he told industry officials at an energy efficiency conference in Washington.

Bush said he looked forward to the day when a future president would say, "Show me the crop report," instead of asking, "How many barrels of crude oil are we importing?"

Although he did not endorse a specific amount, Bush said it was important for Congress to approve a renewable fuel standard requiring a minimum amount of ethanol and biodiesel, which can come from soybeans as well as recycled waste products such as cooking grease.

The president prodded the Senate to set aside partisan politics and pass an energy bill quickly, saying the public's patience, not to mention his own, was wearing thin.

"My advice is, they ought to keep this in mind: Summer is here, temperatures are rising, and tempers will really rise if Congress doesn't pass an energy bill," Bush said.

Bush's call for action reflected a more confrontational approach than his past public comments on presidential priorities that stalled in Congress.

Sen. Tom Harkin (D-Iowa) called the ethanol mandate something "we've been waiting for for a long time," and warned that if the provision was stripped out during House-Senate negotiations on a final bill, "there won't be an energy bill, period."

The energy bill passed by the House in April would require that 5 billion gallons of renewable fuel be added to gasoline by 2012, virtually assuring that an ethanol mandate of some amount would be in the final version of the legislation.

The Senate vote came after the National Corn Growers Assn. urged its members to send gas receipts to senators with messages written on the back asserting that increased ethanol use would help to prevent spikes in gas prices.

But what effect increased ethanol use would have on gas prices is disputed.

Some have suggested that increased ethanol use would lower gas prices, mainly because ethanol is so plentiful now that the price is cheaper than gas.

However, said Edward Murphy of the American Petroleum Institute, "if there was an opportunity for people to increase their market share right now by adding ethanol to gasoline and undercutting your competition by a fraction of a cent a gallon, people would be banging at the door to do it."

He added that when the government required industry "to use a production process they wouldn't otherwise use, you're going to get higher cost." He also contended that the ethanol mandate would have a negligible effect on imports.

So eager are farm-state lawmakers for increased ethanol use that Sen. Ben Nelson (D-Neb.), who helped settle a Senate fight over using filibusters to block judicial nominees, has begun trying to find a solution to the major sticking point that doomed energy legislation in 2003. That dispute is over whether the government should give legal protections to producers of methyl tertiary butyl ether, or MTBE, a fuel additive blamed for fouling groundwater sources from California to New Hampshire.

Under the Senate measure, the amount of ethanol that would have to be added to gasoline would gradually increase to 8 billion gallons by 2012. Thereafter, ethanol use would grow in proportion to the percentage of ethanol in the gas supply in 2012. The United States is projected to use about 4 billion gallons of ethanol this year.

Oil companies could choose the regions where they would add ethanol to gas by buying credits from refiners that exceeded their ethanol requirement.

The bill includes a provision, sought by Sen. Dianne Feinstein of California, that would exempt California from having to use ethanol during the hot summer months when, state officials say, its use could increase emissions. But Feinstein and her California Democratic colleague, Sen. Barbara Boxer, voted against the ethanol mandate.

California has repeatedly sought a waiver from the mandated use of ethanol or similar substances, saying the state's stringent gasoline standards reduce emissions without requiring such additives. But the requests for waivers have repeatedly been denied, and the state, under existing federal law, expects to use

nearly 1 billion gallons of ethanol this year.

Jerry Martin, spokesman for the California Air Resources Board, said the state could live with a nationwide mandate of 6 billion gallons — or 650 million gallons in California. Feinstein spokesman Howard Gantman said that if the state was forced to use 880 million gallons, oil companies in California would probably be forced to buy credits from companies that use more than their required amount, a cost they would most likely pass onto consumers.

Sen. John McCain (R-Ariz.) also complained about additional government support for the ethanol industry. "How much is enough?" he asked after voting against the measure.

The Senate is expected to approve the energy bill within the next couple of weeks. A conference committee would then work out differences between it and the House bill passed in April.



**THE CONTRIBUTION OF THE ETHANOL INDUSTRY
TO THE AMERICAN ECONOMY IN 2004**

John M. Urbanchuk
Director, LECG LLC

March 12, 2004

The ethanol industry is one of the most significant success stories in American manufacturing over the past quarter-century. From a cottage industry that produced 175 million gallons in 1980, the American ethanol industry has grown to include 74 manufacturing facilities with an annual capacity of more than 3.1 billion gallons per year. According to the Renewable Fuels Association 13 new plants representing an additional 500 million gallons of capacity currently are under construction and more are planned. Total ethanol production for 2004 is estimated at 3.5 billion gallons, 25 percent more than the 2003 record production of 2.8 billion gallons. An estimated 30 percent of all gasoline used in the United States will be blended with ethanol in 2004.

The ethanol industry provides a significant contribution to the American economy. The industry will spend nearly \$4.6 billion on raw materials, other inputs, goods and services to produce 3.5 billion gallons of ethanol during 2004. The largest share of this spending will be for corn and other grains used as the raw material to make ethanol. The ethanol industry will use nearly 1.3 billion bushels of corn in 2004, valued at \$3.2 billion. Ethanol production represents the third largest component of corn demand after feed use and exports and will account for 13 percent of total corn production this marketing season. In addition to providing a growing and reliable domestic market for American farmers, the ethanol industry also provides the opportunity for farmers to enjoy some of the value added to their commodity by further processing. Farmer-owned ethanol plants account for 40 percent of total industry capacity.

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; labor; and services such as maintenance, insurance, and general overhead. Spending for these goods and services represents the purchase of output of other industries. In addition, the construction of new ethanol plants results in spending for a wide range of goods and services. At an

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capacity supports the creation of more than 143,350 jobs in all sectors of the economy this year. These include almost 12,000 jobs in America's beleaguered manufacturing sector ... American jobs making ethanol from grain produced by American farmers.

- Increased economic activity and new jobs result in higher levels of income for American households. The production of ethanol will put an additional \$3.9 billion into the pockets of American consumers this year.
- The combination of increased output and GDP and higher income generates tax revenue for government at all levels. The full impact of the annual operations of the ethanol industry and spending for new construction will add \$1.25 billion of tax revenue for the Federal government and \$806 million for State and Local governments during 2004.

Table 1
Economic Contribution of the Ethanol Industry: 2004

	2004 Expenditure (Mil \$)	2004 Impact		
		Output (Mil \$)	Earnings (Mil \$)	Employment (Jobs)
Corn	\$3,175.9	\$8,759.5	\$2,054.5	89,263
Chemicals	\$279.5	\$844.1	\$201.0	4,967
Electricity	\$276.5	\$645.8	\$142.8	3,546
Natural Gas	\$311.5	\$1,034.3	\$179.9	4,607
Water	\$26.6	\$78.9	\$21.0	608
Labor	\$46.3	\$129.2	\$42.5	1,243
Maintenance	\$166.7	\$528.7	\$167.0	5,262
Insurance	\$94.1	\$270.6	\$94.3	3,046
Overhead	\$205.1	\$688.7	\$264.1	8,988
Subtotal	\$4,582.2	\$12,979.8	\$3,166.9	121,530
Construction	\$700.0	\$2,351.0	\$712.2	21,826
Total		\$15,330.7	\$3,879.1	143,356



ECONOMICS OF A QUEENSLAND ETHANOL INDUSTRY

Prepared for the

Queensland Department of State Development and Innovation

John M. Urbanchuk, M.A.
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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

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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 to 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.

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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.

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.

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

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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.

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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. Aggressive 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.

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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

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(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.

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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\$0.871. 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.

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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) The economics of sorghum-based ethanol

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

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.

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multiple evaporation runs that necessitate additional 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.

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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 plant 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.

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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 tonnes 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 tonne 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.

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.

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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)

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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.

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

Company	Location	Capacity, MI/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 <i>ca.</i> 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) Ethanol Projects Under Consideration

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

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.

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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.

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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 billion 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

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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).



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 than 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.