# Submission on Ethanol to the Senate Inquiry on Australia's Future Oil Supply and Alternative Transport Fuels.

# The Senate Committee on Rural and Regional Affairs and Transport

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## *Summary*

The potential grain based ethanol industry in Australia has significant differences to the successful maize based ethanol industry in the USA. The differences between the industries leads to three basic paradoxes that make the risks for the grain based ethanol industry in Australia much higher than they might otherwise be:

1. For grain based ethanol plants to be successful in Australia they need low priced grain but if they are successful then the price of grain will rise making them uneconomic.

2. In order to produce grain based ethanol at an internationally competitive price you need to build a large scale commercial plant but the market size in Australia is too small to justify the investment in a large scale commercial plant

3. The government is supplying excise relief as a support for an emerging industry. If the industry becomes too successful then that support will be withdrawn, reducing economic viability.

These paradoxes results in an industry in Australia that is much higher cost than its competitors internationally and with much larger risks.

There is a significant risk that current government policy will result in either an investment bubble with significant financial losses to investors and grain farm suppliers, or a situation where grain based ethanol plants make excessive profits largely fuelled by government subsidies. Whether these scenarios come true is largely dependent on where the long run oil price settles to.

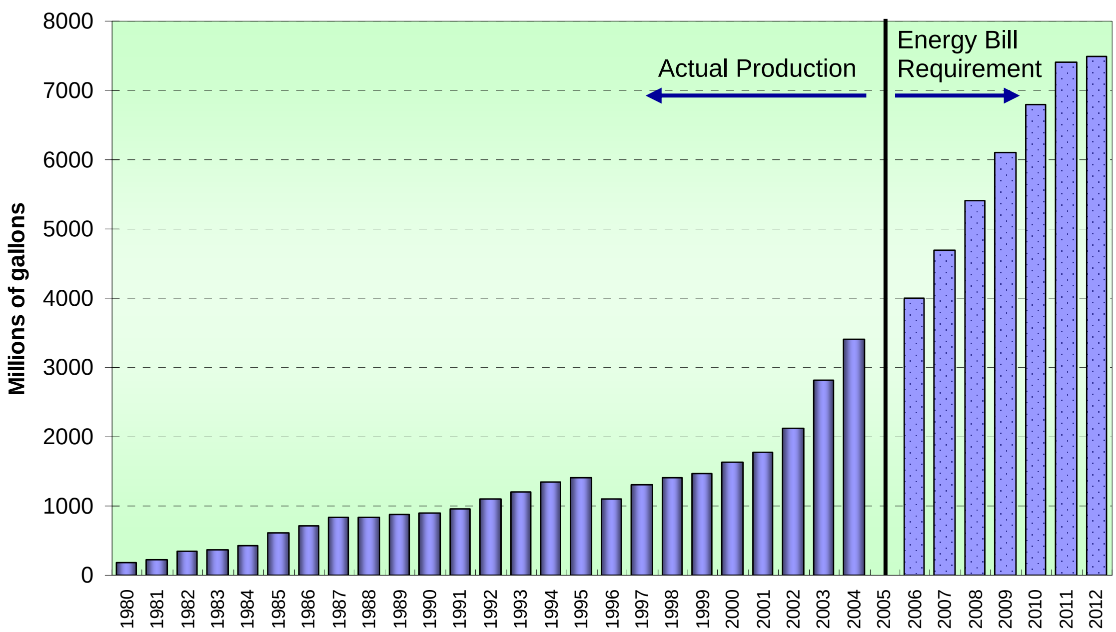
I recommend that the government changes the current excise regime so that less industry support is available if oil prices rise.

I further recommend that a biomass ethanol strategy be developed for Australia as announced for the USA by George W Bush during his 2006 State of the Union address.

## *Comparison to the US industry*

Proponents of a grain based ethanol industry in Australia often point towards the ethanol industry in the USA as a success story. Grain based ethanol in the USA has certainly grown significantly over the last few years but for reasons that are different from what might occur in Australia. Figure 1 shows the actual production volumes and projected volumes for ethanol in the USA from the Renewable Fuels Association in 2005[1]. The predicted volumes in 2006 have already been exceeded in 2005 with 4.2 billion gallons produced (15.9 billion litres)[2]. From discussions with various people on a trip to the United States in January 2006, it is expected that more than 5 billion gallons (18.9 billion litres) will be produced in 2006, far exceeding expectations for that year from early 2005. This of course needs to be put in the context that 655 billion litres of diesel and petrol were used in the United States in 2005 so total ethanol production only equals 2.4% of total transport fuel consumption

**Figure 1 : US ethanol Production Figures**




*Source – Renewable Fuels Association*

These massive increases in production of being driven by the following key factors:

[1] These figures are US gallons which equal 3.785 litres
[2] Michael Wang, Argonne National Laboratory

## 1. Government subsidy and mandating programs.

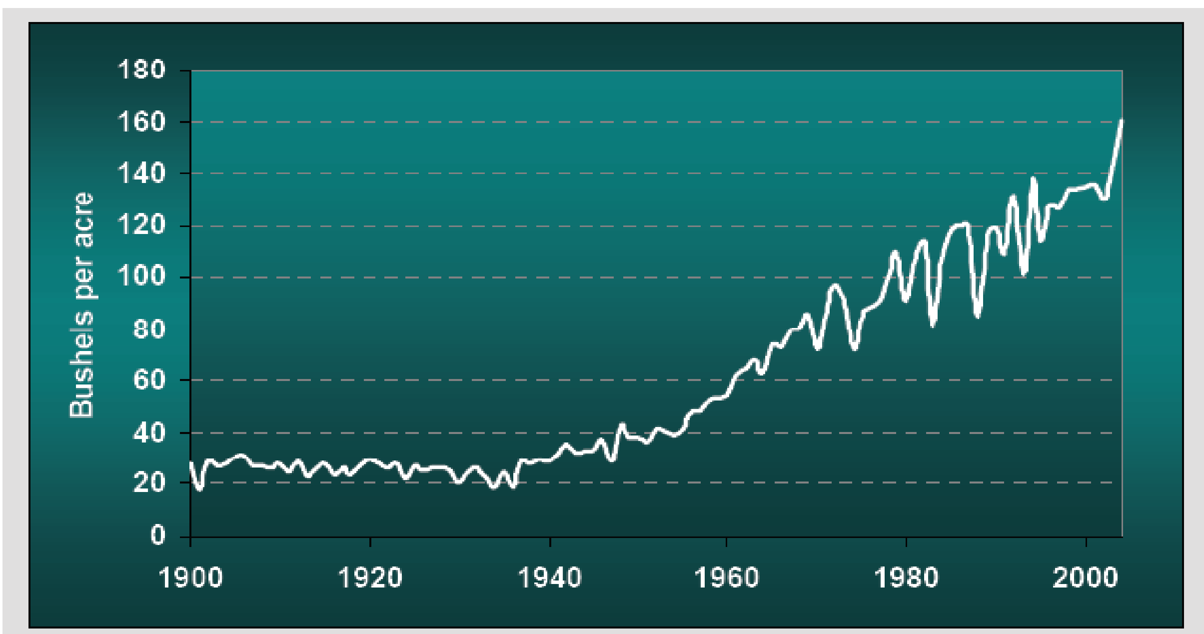
There are a variety of assistance programs for the industry in the USA including

- Ongoing Farm Bill subsidies for corn production maintain volume and price of corn production
- Federal government pays US 51 cents per US gallon to ethanol producers (18 cents per litre)
- Various State government incentives such as US 15 cents per US gallon (5.3 cents per litre in Minnesota
- Mandating of E10 ethanol in Minnesota

## 2. Increased corn productivity and low pricing

Figure 2 shows the massive increase in productivity that has occurred in maize farming in the last 45 years. This productivity increase has kept costs of production down and the price of maize into the market down.

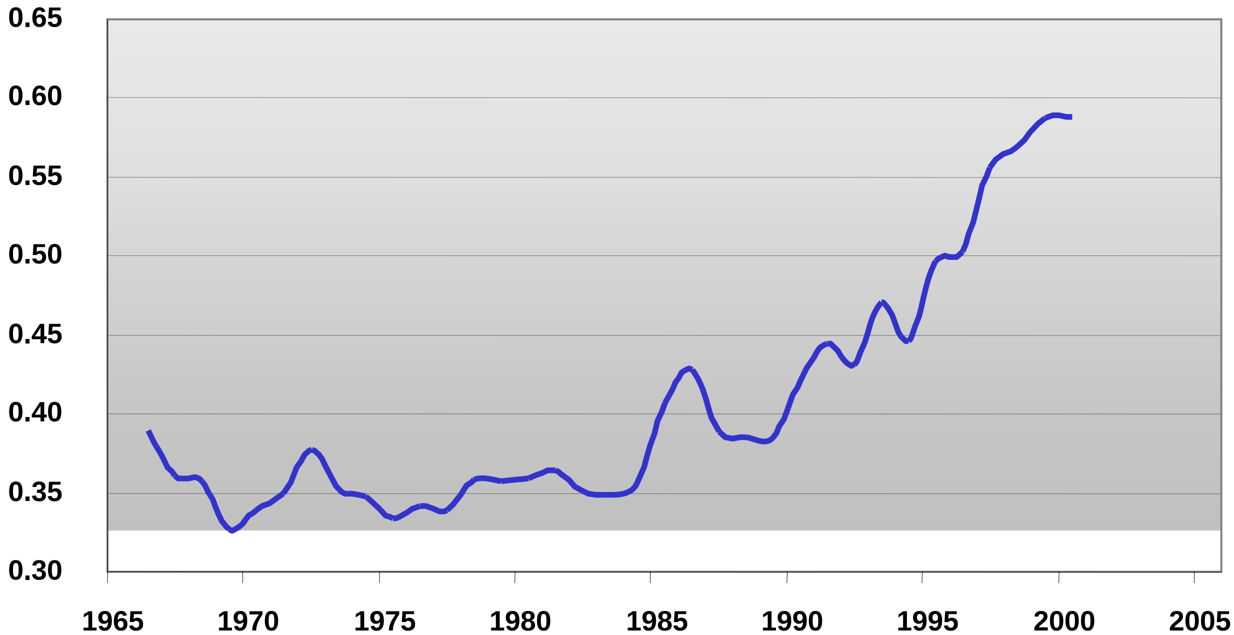
**Figure 2: USA Corn productivity**




**Source: Oak Ridge National Laboratory (2005)**

Productivity per unit of nitrogen fertiliser has also grown dramatically. Figure 3 shows a massive increase in yields per pound of fertiliser in the last 20 years. This increase has become even more important in the last decade as natural gas prices have dramatically increased the USA as shown in Figure 4. Prices have subsequently risen to US$10.97 per thousand cubic feet in October 2005.

**Figure 3 – Bushels Produced per lb of fertiliser**[3]

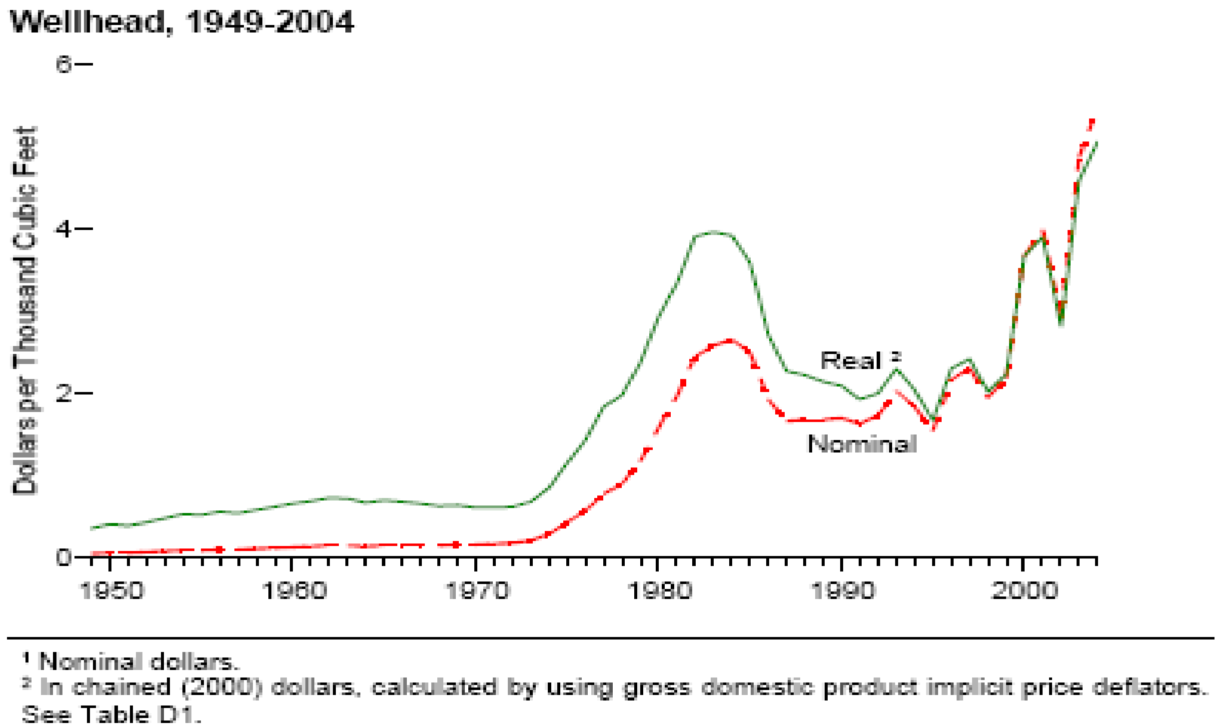



***Source: Michael Wang Argonne National Laboratory (Based on USDA data)***

Most nitrogen fertiliser is made from natural gas so the improvements in productivity per unit of fertiliser have kept the costs of maize production down, and at the same time reduced the total amount of fossil energy required from farm to petrol tank per unit of ethanol produced. This has become important in the debate over energy flows in renewable transport fuel production.

[3] One tonne equals 39.4 bushels of corn

**Figure 4 ; Natural gas wellhead prices in the USA 1949-2004**



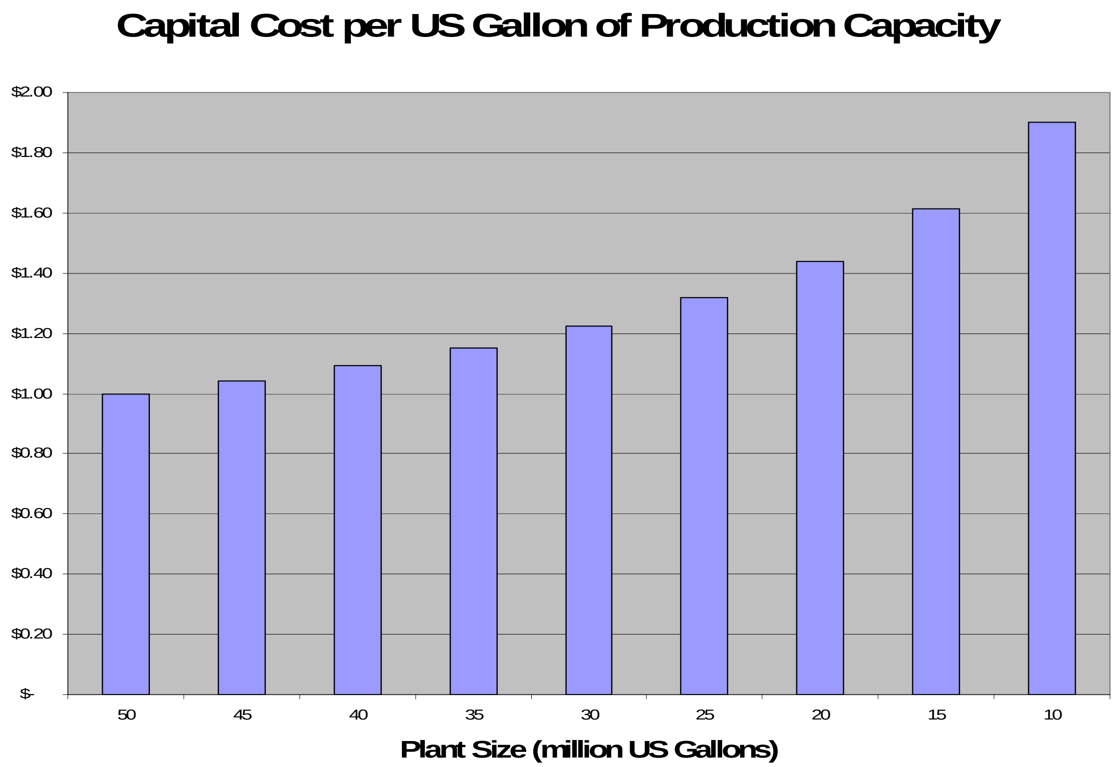

***Source: EIA***

## 3. Increased scale of plants reducing costs

The standard commercial grain ethanol plant those being built in the USA now is 200 million litres, and people are now talking about building plants with 400 million litre capacity. The standard plant size has increased from about 40 million litres in the nineties primarily due to economies of scale. Figure 5 shows a simple cost model that I have calculated based on the ratios of cost to scale supplied to me by the National Renewable Energy Laboratory in Denver, Colorado[4]. These figures clearly sows that there are significant cost advantages in building larger plants with the capital costs of building a plant almost halving on a cost per unit of annual production basis as you move from a 10 million US gallon plant to a 50 US million gallon plant. These increases in plant size reduce cash operating costs, reduce capital operating costs and improve returns on capital at the same time.

[4] Kelly Ibsen – Biomass Research program

**Figure 5 – Capital Cost Modeling for Grain Based Ethanol plants**




## 4. Reduced energy use as energy costs increased

As well as the reduced input costs in maize production there have been significant reductions in the use of energy in ethanol plants due to high natural gas prices. A lot of energy is used in ethanol plants in the initial jet cooking and fermentation processes, and then to distill the ethanol to the required concentrations for transport fuel. Increases in the concentrations of sugar in the fermentation liquids and improvements in the tolerance of the yeasts involved in the fermentation process have resulted in greater ethanol concentrations in the final liquid. This has reduced the amount of energy required to distill the ethanol to the required concentrations. Efforts are continuing to reduce the use of fossil energy in plants. New innovations include the use of granulated starch enzymes to reduce the initial jet cooking phase, and the gasification of corn stover to replace natural gas with Syngas (see later in the report for information on gasification).

## 5. More recently higher oil prices

Higher oil prices in the USA in the last two years have meant that ethanol has become more competitive against petrol and therefore the price of ethanol has risen.

All of these factors have combined to make current returns on grain based ethanol plants in the USA are astoundingly high as shown in the following figures:

- Ethanol production costs are roughly US95 -100 cents per US Gallon (33-35 A$ cents per litre)
- They are receiving about $1.50 in the market
- Federal subsidy = US51 cents per US Gallon
- Therefore margins are US$1.00/Gallon
- Capital costs are US$1 per gallon of annual capacity
- Therefore they are making all their capital back in the first full year of operation.

This is driving huge investment in the industry with a lot of venture capital being invested to build new plants. This is also driven by the race to the Federal Government subsidy which is capped at 7.5 billion gallons. It appears that if you build your plant before the cap is reached you will receive the full subsidy on a continuing basis for your plant. How this will work in practice is a little unclear but it is driving people to construct plants before the cap is reached.

All of this information is being used by proponents of the ethanol industry to promote a grain based ethanol industry in Australia.

There are however, some significant differences between the industry in the United States and the potential industry based on grain in Australia. The key differences are:

1. ***In the USA maize production far exceeds domestic demand which means that large volumes are exported. This means that the price of corn is likely to stay low into the future.***

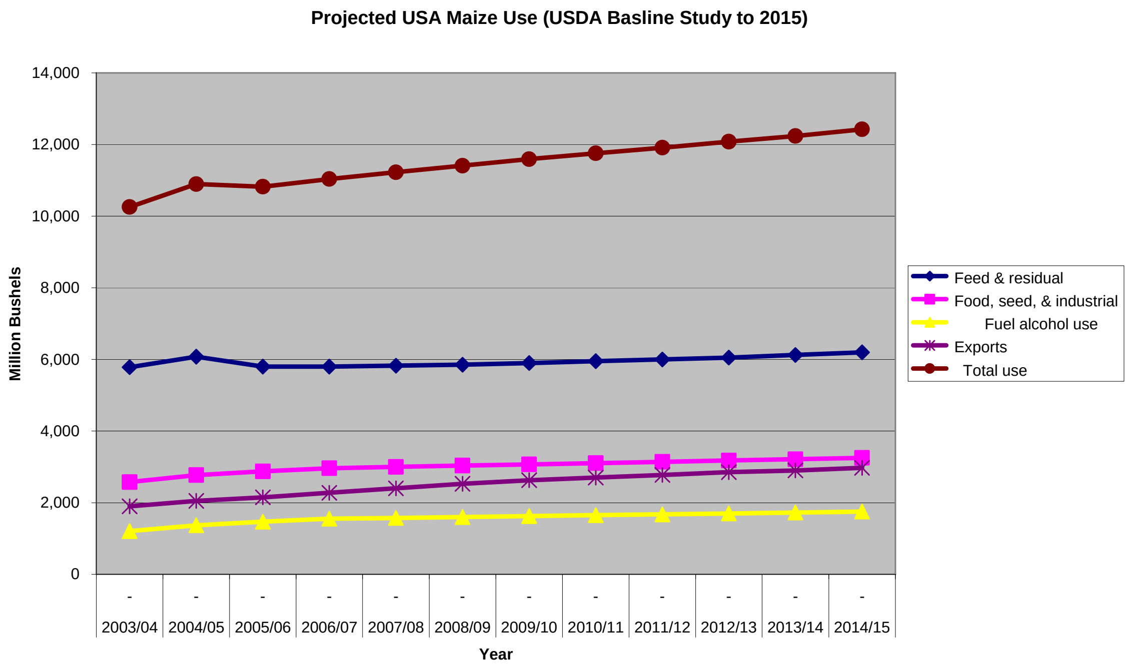
   Figure 6 shows that despite the fact that use of maize by ethanol plants is forecast to rise to 1.75 million bushels by 2014/2015 the USDA is predicting that exports of corn will grow during the intervening period. This means that the rapid increase in ethanol production is unlikely to have much effect on maize pricing in the USA. More detailed figures are contained in the table in Appendix A showing that the USDA is expecting that acres harvested, and yields are both predicted to increase during this period leading to significantly higher production volumes. The USDA is also predicting that the price will rise approximately 22% during this period. Even if this occurs then the price of maize will still only rise to A$128 a tonne at current exchange rates.

   Maize is currently going into ethanol plants in the USA at around A$103 a tonne. In contrast ABARE used A$152 a tonne in its analysis for the Primer Minister's Biofuels Task Force[5] (a level which I believe is far too low). This makes ethanol far

[5] Prime Minister's Biofuels Task Force Report August 2005 – Appendix 3 – ABARE Analysis

more expensive to produce in Australia even if prices do not rise in response to ethanol plant demand.

**Figure 6 – Projected USA Maize Use**




In contrast to the USA we have a much tighter supply demand situation in Australia. While the numbers on feed grain supply are more difficult to estimate in Australia due to the lack of a large dedicated feed grain industry it is clear that supply is close to demand, especially when climate variability is brought into the equation. The MLA commissioned a report in 2003[6] where it was forecast that demand from the current livestock feed grain users would result in feed grains having to be imported into the East coast of Australia in the next ten years. If grain demand from ethanol plants is then injected into the analysis grain prices must rise in response to demand. While this sounds good in theory to grain growers driving up the price of grain will also drive up the price of ethanol production, making them less competitive against petrol and driving them out of business, depending on the price of oil. At the recent Maize Conference at Griffith (Feb 23 2005) a representative for Australian Ethanol Limited[7] answered in response to questions from the floor that they would be looking at contracting maize at A$175 a tonne delivered to the refinery. This is 75% above the current price that ethanol plants in the USA are paying but farmers came up to me after the presentation and said “if they want to contract at those prices they won’t be getting any maize around here”.

[6] MLA Report – Review options to reduce feedstuff supply variability in Australia. FLOT.123 November 2003.

[7] Stuart Rendell, Swan Hill Chemicals

It is difficult to estimate what the price of grain may do in response to increased ethanol demand due to climatic variability, and production numbers varying considerably. However one can safely predict that if 370,000 tonnes of Sorghum demand is injected into the Darling Downs[8] alone it must cause upward pressure on long run prices in that region. If the combined volumes predicted by Australian Ethanol Limited (540mL), Lemon Tree Ethanol (60mL), Dalby Refinery (80mL) and Four Arrows (200mL) all come to fruition they will require 2.2 million tonnes of grain. Proponents of the plants claim that new supply will come on line to meet this demand. While this is probably true it is likely that it will only do so at higher grain prices. This leads to the first of the three major paradoxes of the business plans of ethanol plants in Australia:

***For grain based ethanol plants to be successful in Australia they need low priced grain but if they are successful then the price of grain will rise making them uneconomic***

2. ***In the USA the total transport fuel market is 655 billion litres while in Australia it is only 33 billion litres.***

   The size of the market, mandating programs in some states and the fact that there are 4.5 million flex fuel vehicles[9] in the United States means there is much more scope for large scale commercial plants in the USA than in Australia. As we have seen earlier in this submission a large scale plant is much cheaper to construct and has much lower operating costs. This leads to the second paradox in grain based ethanol in Australia:

   ***In order to produce grain based ethanol at an internationally competitive price you need to build a large scale commercial plant but the market size in Australia is too small to justify the investment in a large scale commercial plant***

   If we assume that ethanol will only go into petrol in any significant volumes then this means that a grain based ethanol plant of 200 million litres would have to capture 10% of the total market for petrol in Australia if E10 was used. This to use 200

[8] Combined predicted volumes of the Dalby Refinery (80mL) and Lemon Tree Ethanol (60mL) plants.
[9] Flex fuel vehicles are those that will run on anywhere from zero to 85% ethanol combined with petrol. There are a large number of these vehicles in the USA as tax incentives to vehicle manufacturers resulted in the flex fuel vehicles being cheaper than standard vehicles. Therefore a lot of them were constructed. However most of them are only using petrol because their owners do not even know they will run on ethanol. This means that if ethanol becomes significantly cheaper than petrol there is a huge market of ready made vehicles available to use lost of ethanol. For instance if each of those vehicles uses 50 litres per week and they used on average 50% ethanol the market is 5.85 billion litres of ethanol.

million litres of ethanol you need to sell 2 billion litres of E10 fuel, and because we use just under 20 billion litres of petrol last year[10] this is more than 10% of the market.

These facts have led to the proposed construction of plants of a small scale in Australia. To take the example of the proposed plant at Dalby in Queensland they have announced that the first stage of the plant will by $54 million for a 40mL plant. This means construction costs will be $1.35 million per mL versus $352,000 per mL for a 200 mL facility in the USA[11]. This means that if such a plant is built it will be well below world best practice in costs of construction and operation.

### *3. Difference in government support levels*

In the USA the Federal government is supporting ethanol production at the level of US$0.51 per US gall or A$0.18 per litre. This is lower than current Australia excise relief support but higher than the long term excise relief support in Australia. It is also difficult to see that support being unwound given the political realities in the USA around ethanol investment and maize farming. Current Australian government policy is for an excise holiday for ethanol until 2011, and then phasing in excise levels to half the level for petrol on an energy equivalent basis by 2015 as shown in Table 1.

**Table 1 – Government Excise Levels**

5 Excise transition path for fuels entering the excise net

| Fuel type | | | July 2003 to July 2010 | July 2011 | July 2012 | July 2013 | July 2014 | July 2015 |
|---|---|---|---|---|---|---|---|---|
| **High-energy content** | nominal | c/L | 0 | 3.8 | 7.6 | 11.4 | 15.3 | 19.1 |
| Biodiesel | real **a** | c/L | 0 | 3.1 | 6.2 | 9.1 | 11.9 | 14.5 |
| **Mid-energy content** | nominal | c/L | 0 | 2.5 | 5.0 | 7.5 | 10.0 | 12.5 |
| LPG, LNG, ethanol | real **a** | c/L | 0 | 2.1 | 4.1 | 6.0 | 7.8 | 9.5 |

**a** In 2004-05 terms.
*Source*: Energy Grants (Cleaner Fuels) Scheme Bill 2003; Energy Grants (Cleaner Fuels) Scheme (Consequential Amendments) Bill 2003.

***Source- ABARE analysis for Prime Minister's Biofuel Task Force***

The excise holiday acts as both a subsidy against competing fuels and a tariff barrier against imported ethanol due to the fact that all suppliers of ethanol pay the excise on their fuel and then the excise is rebated back to Australian producers. Proponents of grain based ethanol in Australia claim it is not a subsidy but if the same support is not available to Brazilian or North American exporters of ethanol it cannot be called anything else.

[10] ABS Vehicle statistics
[11] US$1 million per US gallon at an exchange rate of 0.75

Based on a yield of 380 litres of ethanol per tonne of grain used the full excise holiday equals a subsidy of $95 a tonne for every tonne of grain used at zero excise applied, and $47.50 a tonne once the half excise is applied.

I have done some calculations based on probable and reasonably possible scenarios for ethanol production in Australia showing the total excise support that the government would give in each situation. As can be seen in Table 2 in the high scenario this will lead to the government subsidising the ethanol industry with more than $1 billion over the next 10 years. It should be noted that the high scenario I describe is only approximately 69% of the proposed ethanol plants, while the medium scenario is only 40%.

**Table 2 - Excise totals for two ethanol production scenarios**

| | Ethanol Production(mL) | | Subsidy Levels ($m)[12] | | | | Excise Rate (c/L |
|---|---|---|---|---|---|---|---|
| | High | Medium | | High | | Low | |
| 06/07 | 80 | 40 | $ | 20.00 | $ | 10.00 | 0 |
| 07/08 | 270 | 120 | $ | 67.50 | $ | 30.00 | 0 |
| 08/09 | 450 | 240 | $ | 112.50 | $ | 60.00 | 0 |
| 09/10 | 540 | 280 | $ | 135.00 | $ | 70.00 | 0 |
| 10/11 | 630 | 370 | $ | 157.50 | $ | 92.50 | 0 |
| 11/12 | 630 | 370 | $ | 141.75 | $ | 83.25 | 2.5 |
| 12/13 | 630 | 370 | $ | 126.00 | $ | 74.00 | 5 |
| 13/14 | 630 | 370 | $ | 110.25 | $ | 64.75 | 7.5 |
| 14/15 | 630 | 370 | $ | 94.50 | $ | 55.50 | 10 |
| 15/16 | 630 | 370 | $ | 78.75 | $ | 46.25 | 12.5 |
| **Totals** | | | **$** | **1,043.75** | **$** | **586.25** | |

This leads to the third paradox of the ethanol industry in Australia:

***The government is supplying excise relief as a support for an emerging industry. If the industry becomes too successful then that support will be withdrawn, reducing economic viability.***

It is hard to see the government continuing to pay out $70-80 million dollars a year to support an industry which would be larger than a lot of existing industries. In addition if the excise support is put on the table during international negotiations on agricultural

[12] Note that these dollar figures have not been adjusted for inflation. Therefore the totals would be lower in 2006 dollars than represented here.

trade and there are significant concessions available to all of agriculture then it is clearly possible to see situations where Australia would negotiate the excise relief away.

## *Possible Future Scenarios*

The future of grain based ethanol plants is going to be determined by how competitive grain based ethanol is against petrol because if ethanol is significantly cheaper than petrol people will buy lots of ethanol, and if it is much more expensive than petrol people will not buy much ethanol. Therefore to look to the possible futures of grain based ethanol in Australia we need to understand what the cost of producing ethanol will be in Australia and what might be the likely price of petrol.

If we look at the possible costs of grain based ethanol in Australia then ABARE calculated that the cost of producing ethanol from sorghum in Australia would be 36 cents per litre based on the following assumptions[13]:

- That the long run price for sorghum utilised in the plant would be $152/tonne. This includes all transport, storage, and handling costs for all year round supply and utilisation.
- That the yield of ethanol from a tonne of sorghum would be 380 L.
- That the price received for DDGS would be $220 per tonne at the refinery gate.
- A cost of $1million dollars per 1 mL of annual ethanol production capacity.

I believe that the yield assumptions are reasonable. However, I believe that the other three assumptions have serious flaws in them:

- DDGS has been sold in the last few months in Australia at prices equivalent to A$120-$130 at the refinery gate. This price matches almost exactly the price in the US for DDGS through 2004[14] 2 with prices now falling further. These prices will vary with grain and protein prices but $220 a tonne seems wildly optimistic given the current market signals. At these levels the offset from the sale of this “waste” product is considerably lower than in the ABARE calculations. The price of producing ethanol is 1c a litre higher for every $11 per tonne of reduced price for DDGS. If DDGS is sold at $130 a tonne then the calculated price of ethanol production rises 8 cents a litre under the ABARE calculation method. There are advantages in plants like the proposed Lemon Tree Ethanol development where a cattle feed lot will be attached to the plant. This means that the energy costs of drying the distillers grains, and the transport costs from refinery gate to customer will be significantly reduced. This means that value to refinery will be higher.

[13] Report of the Biofuels Taskforce to the Pime Minster August 05 – Appendix 3 ABARE Analysis
[14] Pat Paustian (November 2004 ) National Distiller Grains Marketing Survey, Iowa Ag Innovation Centre.

- The capital costs of a plant in the USA are approximately US$1 million per million litres (mL) of annual capacity which equals A$352,000 per mL of annual capacity. The Dalby refinery has announced that it will build a 40 mL plant for A$54 million. While they plan to expand to 80 mL in the future the cost of the plant they are actually announced will be $1.35 million per mL or almost four times the cost of plants in the US and 35% higher than the estimates in the ABARE report. These differences add operating costs in servicing the cost of capital and also reduce capital returns. The differences between the Australian and the American situation appear to be about 50% economies of scale, and about 50% on construction costs. Information from the national renewable energy laboratory (NREL) in the USA indicates that a 40 mL plant costs almost double the cost of the 200 mL plant on a per litre basis. The other advantage that the American industry has is that there is so much construction going on, overall construction costs have fallen.

So if we take all of these figures we can make a comparison with the ABARE figures on what the real cost of ethanol production in Australia might be. I believe that a reasonable case would have the costs of production as shown in Table 3:

**Table 3 – Reasonable case ethanol production costs in Australia**

| **Calculation base** | **Ethanol Cost c/L** |
|---|---|
| ABARE Calculations | **36** |
| Feed Grain at $182 per tonne ($30 higher per tonne equals an extra 7.89c/L at 380 litres per tonne) | **44** |
| DDGS sold at the refinery gate at $150 a tonne ($25 a tonne above current market levels) adds 6.36 cents a litre due to reduced by-product credit. | **50** |
| Extra capital operating costs due to higher capital costs than ABARE report ($1.35 million mL versus $1 million/mL) adds 3 cents a litre | **53** |
| Equivalent price for petrol | **80** |

This means that without excise relief the oil price would have to stay at or above current levels for ethanol to be the same price as petrol on an energy equivalent basis.

Of course it is extremely difficult to know what the oil price will be over the next ten years and current government regulations on excise mean that ethanol will still have excise relief at half the rate of petrol in 2015. Factoring in this excise protection means and calculating oil prices at current exchange rates means that oil has to stay above US$46 a barrel for ethanol to be equivalent in price to petrol from 2015 onwards. As I have previously stated it is unlikely that significant volumes of ethanol will be sold at the same price as petrol, therefore my estimate is that the oil price will have to be above US$50 a barrel for grain based ethanol to be a serious player in Australian transport fuel market.

This leads to the possibility of three basic scenarios assuming that the exchange rate stays at a similar level to the current exchange rate :

**Oil falls to below US45 a barrel**

In this scenario what actually happens depends on the timing and size of the fall in the oil price. If the fall takes place after grain based ethanol plants have been built and the oil price ends up in the US$30-US$40 a barrel range for a significant period of time and then there will be significant financial problems for the plants that have been built. If a fall takes place in the near future then most of the planned ethanol plants will not be built.

**Oil sits between US$45 and US$70 a barrel**

It oil sits in this range for a significant period of time then grain based ethanol plants in Australia will make significant profits, largely based on government assistance. Volumes of ethanol that are produced will depend on how much capital is invested in plants, and the effect that creating extra grain demand has on local grain price.

**Oil moves above US$70 a barrel and stays there**

If the oil price moves consistently above current levels of pricing then grain based ethanol plants will make very high profits. Volumes of ethanol that are produced will depend on how much capital is invested in plants, and the effect that creating extra grain demand has on local grain price. We have calculated that for example if oil moved to US $105 a barrel then grain based ethanol plants would be able to pay up to $340 a tonne for grain and still make a profit. This would cause significant damage to current grain value adding businesses as grain demand rose in response to ethanol demand.

## *Policy Recommendations*

Overall I believe that the supporting of the biofuels industry in competition with other value adding industries for feed grain and other plant products is poor policy. This is particularly emphasised when one examines the scenarios that I have described above which clearly show that the excise holiday is only really supporting the biofuels industry in a narrow range of possible oil prices. Below those oil prices the industry will not survive and above those oil prices the industry will do very well without any assistance. The government risks a situation where the capital grants program and the excise assistance provide enough incentive for people to invest in grain based ethanol plants that are not sustainable in the long term, thus creating an investment bubble where people lose all their money.

If the government is still prepared to take these risks then at the very least the they should be doing the following:

1) Reducing assistance to the biofuels industry as the oil price rises. This would avoid the situation that is occurring in the United States where investors are making extremely high profits and a large percentage of those profits are coming from government subsidies. Such a situation would clearly be unacceptable in Australia and the government should change current arrangements so that investors have a clear picture of the framework within which that taking investment risks. This would mean creating an excise framework where biofuels would progressively charged more excise up to the energy equivalent levels charged on petrol, as the oil price rises.

2) The government should create a strategy for the long-term for the production of biofuels from biomass[15]. I do not believe that much research investment to be done in the actual plant technology because most of those risks are currently being taken overseas. However, I do believe the strategy should containing the following elements:

    i) Mapping the possible available biomass in Australia in a similar manner to the mapping that is being carried out in the United States.

    ii) Practical studies to examine reducing the supply chain costs of supplying agricultural waste such as straw into a biomass biofuels plant.

    iii) The provision in the medium term of assistance and risk capital in the early adoption phrase of biomass biofuels in Australia.

[15] I have included some information on biomass ethanol in appendix B. It is likely that biomass ethanol will become a significant player in the biofuels industry in the medium term.

iv) The provision of ongoing assistance for biomass ethanol, as opposed to other ethanol feedstocks on the basis of the better greenhouse gas results, and the creation of a value adding industry that does not destroy other value adding industries.

## *Appendix A - USDA 2015 Baseline Study for Maize*

| Item | 03/04 | 04/05 | 05/06 | 06/07 | 07/08 | 08/09 | 09/10 | 10/11 | 11/12 | 12/13 | 13/14 | 14/15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Area (million acres):** | | | | | | | | | | | | |
| **Planted acres** | 78.7 | 81.0 | 81.0 | 81.0 | 81.5 | 82.0 | 82.5 | 83.0 | 83.5 | 84.0 | 84.0 | 84.0 |
| **Harvested acres** | 71.1 | 73.3 | 73.6 | 73.6 | 74.1 | 74.6 | 75.1 | 75.6 | 76.1 | 76.6 | 76.6 | 76.6 |
| **Yields (bushels per acre):** | | | | | | | | | | | | |
| **Yield/harvested acre** | 142.2 | 160.2 | 145.6 | 147.4 | 149.2 | 151.0 | 152.8 | 154.6 | 156.4 | 158.2 | 160.0 | 161.8 |
| **Supply and use (million bushels):** | | | | | | | | | | | | |
| **Beginning stocks** | 1,087 | 958 | 1,819 | 1,724 | 1,549 | 1,394 | 1,264 | 1,159 | 1,109 | 1,109 | 1,164 | 1,194 |
| **Production** | 10,114 | 11,741 | 10,715 | 10,850 | 11,055 | 11,265 | 11,475 | 11,690 | 11,900 | 12,120 | 12,255 | 12,395 |
| **Imports** | 14 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| **Supply** | 11,215 | 12,714 | 12,549 | 12,589 | 12,619 | 12,674 | 12,754 | 12,864 | 13,024 | 13,244 | 13,434 | 13,604 |
| **Feed & residual** | 5,783 | 6,075 | 5,800 | 5,800 | 5,825 | 5,850 | 5,900 | 5,950 | 6,000 | 6,050 | 6,125 | 6,200 |
| **Food, seed, & industrial** | 2,577 | 2,770 | 2,875 | 2,965 | 3,000 | 3,035 | 3,070 | 3,105 | 3,140 | 3,180 | 3,215 | 3,250 |
| **Fuel alcohol use** | 1,204 | 1,370 | 1,470 | 1,550 | 1,575 | 1,600 | 1,625 | 1,650 | 1,675 | 1,700 | 1,725 | 1,750 |
| **Domestic** | 8,360 | 8,845 | 8,675 | 8,765 | 8,825 | 8,885 | 8,970 | 9,055 | 9,140 | 9,230 | 9,340 | 9,450 |
| **Exports** | 1,897 | 2,050 | 2,150 | 2,275 | 2,400 | 2,525 | 2,625 | 2,700 | 2,775 | 2,850 | 2,900 | 2,975 |
| **Total use** | 10,257 | 10,895 | 10,825 | 11,040 | 11,225 | 11,410 | 11,595 | 11,755 | 11,915 | 12,080 | 12,240 | 12,425 |
| **Ending stocks** | 958 | 1,819 | 1,724 | 1,549 | 1,394 | 1,264 | 1,159 | 1,109 | 1,109 | 1,164 | 1,194 | 1,179 |
| **Stocks/use ratio, percent** | 9.3 | 16.7 | 15.9 | 14.0 | 12.4 | 11.1 | 10.0 | 9.4 | 9.3 | 9.6 | 9.8 | 9.5 |
| **Farm price (US$/bushel)** | 2.42 | 1.90 | 2.00 | 2.15 | 2.25 | 2.35 | 2.40 | 2.45 | 2.45 | 2.45 | 2.45 | 2.45 |

## *Appendix B – Biomass Ethanol Information*

The production of biomass ethanol essentially means the production of ethanol from plant material other than sugar or grain. George W Bush announced in his recent State of the Union address that the USA would be continuing a large effort to produce ethanol from these sources There are two ways of achieving the production of ethanol from biomass:

### 1. Fermentation

This method relies on the fact that most plant material is made up of cellulose and hemicellulose, with varying amounts of lignin and minerals making up the rest. Cellulose and hemicellulose and complex carbohydrate structures of sugar molecules. Therefore if they can be broken down into their component sugar molecules, that sugar can then be fermented to produce ethanol. We have had the technology to achieve this for a long time including the Americans making ethanol from forestry waste for transport fuel during World War 2. The problem has been that while it has been technically possible to achieve ethanol from biomass it has been more expensive to do so than from other sources. The two key barriers to reducing cost have been:

- Breaking down the cellulose and hemicellulose into sugar. If this was easy to do then most plant material in the world would easily dissolve so clearly plants have developed strong defense mechanisms for their structural integrity and it has proven to be expensive to breach those defense mechanisms. This is generally achieved through a combination of acid hydrolysis and enzymes.

- If you can break down the cellulose and hemicellulose into sugar then you get a mix of sugars, not just glucose. This means that it has been impossible to use the yeasts that are used in starch based ethanol plants. Because the yeast that have been used in starch based ethanol plants have been developed over a long period they have become very efficient in producing high ethanol concentrations. Therefore organisms that are being used to convert multiple sugar solutions have a long way to catch up in efficiency, robustness and cost.

However there have been some significant improvements in the technology over the last five years. The leading company in this area is a Canadian company called Iogen[16] which has the financial backing of Shell. Iogen now believe that they have the capability of producing ethanol from wheat straw at US$1.30 per US gallon or A$0.46 cents per litre in a 200 million litre commercial plant[17]. This cost of production includes straw at US$40 a tonne. It is likely that Iogen will build a plant in

[16] www.iogen.ca
[17] Personal communication from Maurice Hladik while visiting Iogen in January 2006

the USA or Europe[18] in the next 18 months and they are currently negotiating project finance to do so. If the process can be proven to produce ethanol at this price then it is likely that commercialisation and research will drive further process improvements and cost reduction in a similar manner that has occurred in the grain based ethanol. This technology has the added advantage that the lignin component which is not broken down to sugar can be burnt to power the plant.

**2. Gasification**

Gasification is a different technology that involves turning the biomass into a gas called Syngas which can then be manipulated to turn it into other products using catalysts. The advantage of this technology is that it is technologically possible to access all of the plant material except for the minerals which end up as ash. This ash can then be used as fertiliser. The problem with the technology is that it is much more difficult to work with than fermentation technologies and is as much art as science, making technology transfer possible. The process does not produce clean gas in the first place and therefore the gas has to be cleaned up, causing increased overall costs of production. There are a number of companies working on this technology including those that are looking to use Syngas instead of natural gas to power grain based ethanol plants. They would achieve this by taking in corn stover along with the grain and gasifying the stover to produce Syngas. The technology is less advanced than the fermentation technologies but it is possible that a "wildcard" may come out of the pack of start up companies and significantly change the landscape of ethanol production.

There are a number of significant advantages of biomass based ethanol over grain based ethanol:

- The biomass ethanol process uses "waste" material as feed stock. This means that if the process technologies can be brought down in cost there is significant potential for low cost ethanol.

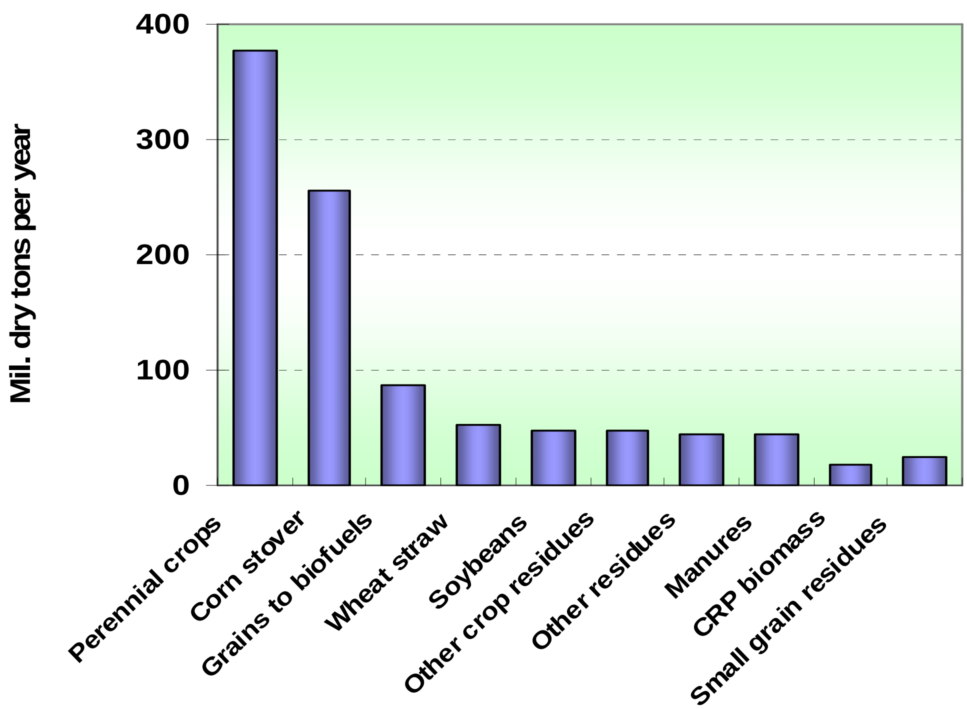
- The amount of energy produced per unit of fossil fuel energy used is much higher than for grain based ethanol due to lower nitrogen fertiliser requirements and the use of lignin or Syngas to power the plants. The most recent analysis of grain based ethanol has farm to tank process producing only 1.36 units of energy for every 1 unit of fossil fuel energy used up. In contrast biomass ethanol systems can produce up to 10 units of energy for every unit of fossil fuel energy used up[19]

[18] Iogen announced an agreement with Volkswagen I January 2006 to explore potential plant sites in Europe
[19] Argonne national Laboratory

- As a result of the previous point the net greenhouse gas benefits of biomass ethanol are much higher than grain based thanol.

- There are vast amounts of potential feedstock. The Oak Ridge National Laboratory in the USA has estimated that there is 1.3 billion tons of biomass available for biofuel production as shown in Figure 7 and Figure 8.

**Figure 7 – Potential agricultural biomass sources in the USA**




Depending on the technical possible yields this resource could produce up to 500 billion litres of transport biofuels, and amount that would take 1.3 billion tonnes of grain, significantly impacting on world grain supplies and trade.

In addition the perennial crop numbers mean crops that can be grown on erosion effected and marginal cropping land. As plants such as woody switch grass and elephant grass are deep rooted perennials they stabilise land, require low amounts of nitrogen fertiliser and can be continually cropped.

Overall the use of biomass ethanol can produce large volumes of biofuels without disrupting current grain supply and trade, while giving improved energy and greenhouse gas results.

**Figure 8 – Potential forestry biomass feedstocks**