Ethanol what's it all about?

Ethanol has crept into our petrol, the media, and our lives, and is a confused issue. **Steve Davidson** looks at why it's on the agenda, who's behind it, and whether it is really a viable green fuel.

Although alcohol was blended into road transport fuel in Australia as early as 1929, fuel ethanol use is now equivalent to a miniscule 0.2% of this country's petroleum and diesel consumption. Yet, in the last few years, fuel ethanol (normally a blend of ethanol and petrol) has catapulted into prominence as an alternative, renewable fuel for our motor vehicles. Why the sudden interest in ethanol fuel? Why is it so contentious? And what are the pros and cons?

There has been heated debate on the benefits or otherwise of fuel ethanol use and, to help guide policy in this somewhat fraught area, in July 2003 the Commonwealth Government asked CSIRO, the Bureau of Transport and Regional Economics and the Australian Bureau of Agricultural and Resource Economics to produce a report. Their job was to investigate the appropriateness of maintaining the Howard government's objective that biofuels (mainly ethanol but also biodiesel), produced in Australia from renewable resources, contribute at least 350 million litres (ML) to the total fuel supply by 2010.

So what can be gleaned from the final report – *Appropriateness of a 350 Million Litre Biofuels Target* – and from other literature, especially *Fuel Ethanol – Background and Policy Issues* (a Parliamentary Library Current Issues Brief) and other viewpoints? How green is ethanol in reality? What are the economic and regional benefits, if any, and can a viable fuel ethanol industry prosper in this country?

A high profile

The sudden interest in fuel ethanol has been driven largely by low prices in the Australian sugar industry, an interest in diversification in the grains industry and perhaps by the growing realisation that our known crude oil reserves are likely to start running low in the not too distant future. Then there is the strengthening consensus that global warming is a reality rather than a possibility.

Some parts of the sugarcane industry see use of ethanol–petroleum blends such as E10 (10% ethanol, 90% petroleum) as an opportunity to diversify, given that sugars in sugarcane can be fermented to create ethanol. Here, it is usual to use C molasses, the syrup-like

Can ethanol really be a viable alternative product for the sugar industry?

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by-product of sugar refineries, often fed to livestock, but any sugar product in the production chain can provide ethanol. Some grain-growing regions also see opportunities for new industries to stimulate local employment and economic activity.

Ethanol companies, notably Manildra, which produces 87% of our ethanol at its Nowra plant from wheat starch, would also like to see mandatory use of ethanol in Australian petroleum, preferably blended at 20%. However, the suggestion that such blends become the norm at the bowser has caused uproar from motoring organisations, car manufacturers and many consumers.

This in turn generated a lot of negative publicity for ethanol, given that some independent service stations in NSW have been selling blends well above 10% since 1994. The Federal Government has, for now, imposed a 10% cap on ethanol content of transport fuel sold in Australia.

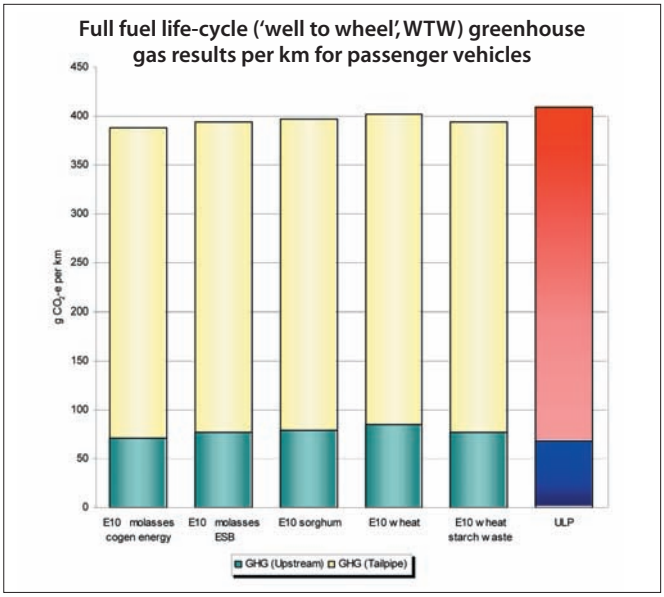
Does ethanol really damage cars? The jury is still out on this, but virtually every stakeholder in the motor vehicle industry has stated that warranties on motor vehicles and bowsers could be at risk if ethanol blends above 10% are used. One Commonwealth Government review on the impacts of a 20% ethanol blend on vehicles found that there is conflicting information on this. However, it identified a number of problems, especially in older cars. These include the possible perishing and swelling of materials in fuel systems and the potential for corrosion of engine components. A new government study into this is underway and will report this year.

Environmental pros and cons

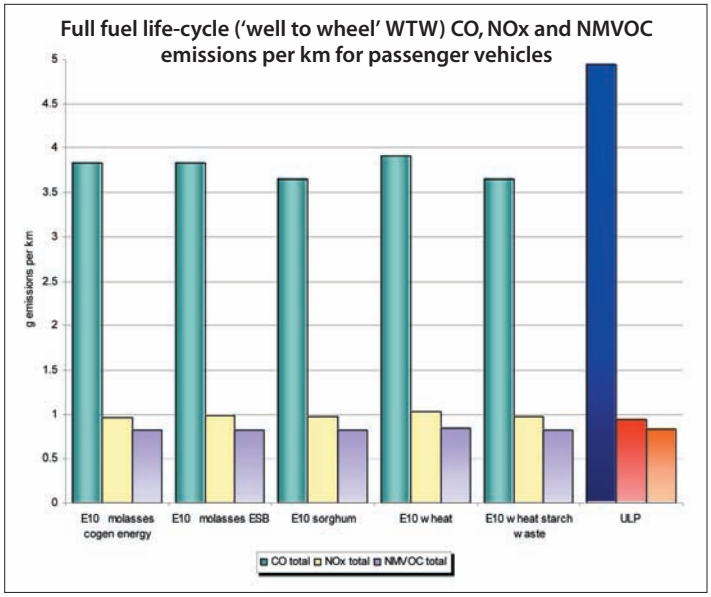
While it is indisputable that ethanol from crops has the advantage of being a renewable fuel – unlike fossil fuels, which are a finite resource – a range of other environmental benefits and offsets of fuel ethanol production and usage emerge.

One of ethanol's credentials is that it is a good substitute for the toxic compound MTBE, an oxygenate added to fuel to make it burn cleaner. Petroleum normally contains no oxygen. MTBE has caused environmental concerns in relation to contamination of groundwater supplies in the United States. It has now been banned in some states in Australia and strict volume limits for MTBE fuel additives now apply, enhancing the prospects for ethanol. Similarly, Australian fuel standards are to be progressively tightened after 2006 and this could increase opportunities to use ethanol as an octane enhancer.

Does ethanol reduce air pollution? This simple question has proved difficult to answer with certainty because so many variables come into play. However, it is safe to say that, compared to petrol, ethanol-blended



Appropriateness of 350 Million Litre Biofuels Target, December 2003



Appropriateness of 350 Million Litre Biofuels Target, December 2003

Greenhouse gas (GHG) emissions (CO_2 equivalents per kilometre) for passenger vehicles showing the full fuel life-cycle emissions partitioned into upstream (farm and factory) and tailpipe emissions. Total GHG emissions for E10 ethanol fuel blends, from various ethanol feedstocks, were 1.7% to 5.1% less than those of unleaded petrol (ULP).

Comparison of full fuel life-cycle emissions of various air pollutants, namely CO (carbon monoxide), NOx (oxides of nitrogen) and NMVOC (non-methane volatile organic compounds), for E10 from various ethanol feedstocks and for ULP (unleaded petrol) in a passenger car.

petrol reduces tailpipe exhaust emissions of toxic carbon monoxide, hydrocarbons, 1-3 butadiene, benzene, toluene and xylenes. On the down side, emissions of aldehydes (such as formaldehyde) are increased, while the effect on ozone emissions is still unclear.

What about greenhouse gases? Production of ethanol from sugar or wheat is sometimes thought to have no net greenhouse emissions to the atmosphere – because each crop locks up CO_2, the main greenhouse gas, as carbohydrate while the previous crop is powering cars, but this is overly simplistic. For example, what if you include the fuel use and emissions of farm machinery, fertilisers, the transport of raw materials to ethanol plants and so on? And what about other emissions?

To take all these factors into account, scientists can compare net emissions during the full fuel life-cycle of different fuels (in the case of ethanol, from farm to ethanol factory to tailpipe). Over the full fuel life-cycle, ethanol blends appear to produce slightly lower overall emissions of greenhouse gases than conventional petroleum.

Ventura of north Queensland are running two buses on 100% ethanol. Reactions from drivers and passengers are 'very positive.'

Ventura bus lines

An analysis of CO_2, CH_4 (methane) and N_2O emissions by Dr Tom Beer of CSIRO Atmospheric Research, shows that, over the full fuel life-cycle, E10 blended fuel reduced overall greenhouse gas emissions by 3.7%, relative to unleaded petrol (see graph). This is for ethanol produced from molasses or wheat starch waste, the two methods currently employed by Australian ethanol companies. Of course, blends containing more ethanol would give different results, but E10 is currently the standard alternative mix.

The level of greenhouse gas reduction depends on the precise nature of the ethanol factory; in particular, the source of energy for these factories. Reductions of 5.1% in greenhouse gas emissions have been estimated for E10 blends on a full fuel life-cycle basis when factory energy is obtained by co-generation of sugarcane bagasse (the fibrous residue remaining after sugar is extracted). On the other hand, greenhouse reductions could be as low as 1.7% if coal or oil was used in the production of ethanol from wheat crops.

Analysis of other air pollutants revealed that over the full fuel life-cycle, E10 fuel (derived from molasses or wheat starch waste) significantly reduced carbon monoxide (CO) emissions by 22–26%. If coal was used in the ethanol factory, particulate matter emissions were increased by 32–34%, but there were lesser effects on other air pollutants relative to unleaded petrol. So it's a mixed bag with some air quality benefits and some negatives from ethanol use.

What does this mean for human health? If an extra 205 ML of ethanol were to be used in 2010 to meet the 350 ML biofuels target (the balance would come from current production and from biodiesel), the change in total life-cycle pollution would provide some health benefits. But these would be small in dollar terms – about $1.8 million if a monetary value is put on mortality and morbidity, given certain assumptions about ethanol production. These benefits are mostly due to reduced air pollution in urban areas, primarily from reduced production of petrol at refineries in cities.

Air pollution is not the only environmental issue. The report states that to meet the 350 ML target, other land, water and biodiversity impacts from production, distribution and use of biofuels, principally ethanol, appear to be insignificant if distillery wastes are disposed of using established best practice.

What, then, is the bottom line on environment and ethanol? The '350 ML by 2010' report concluded: *Particularly with the prospect of significantly cleaner petrol and diesel in use in the vehicle fleet by 2010, the net environmental impacts of biofuels, while positive, are small, in overall terms.*

Regional impacts

Ethanol enthusiasts argue strongly that ethanol production will stimulate the local agricultural industries, increase employment, and revitalise rural communities. Authors of the report say that the regional employment benefits have often been overstated. Nonetheless, if non-urban ethanol plants do proceed, some regional benefits, especially employment, will certainly result. These will be concentrated in parts of Queensland and New South Wales.

Using the proponents' figure of 36 direct jobs for each biofuel plant of 60 ML capacity, to produce an additional 235 ML of biofuel, four such plants would need to operate, providing 144 jobs. If we assume that each of these jobs leads to two additional indirect jobs, total employment attributable to the 350 ML biofuels target (whether ethanol, biodiesel or both) would be a maximum of 432 jobs.

However, these would come at considerable cost. The estimated government subsidy required to induce sufficient investment to meet the 350 ML target is equivalent to government expenditure per direct job (in 2010) of between $210 000 and $303 000. If indirect jobs are included in the calculation, each job will cost between $70 000 and $101 000.

Some economics

An inherent barrier to using more fuel ethanol is that it costs much more to produce than petrol or diesel. According to international studies it costs about two to five times more to produce a litre of ethanol than a litre of petrol, depending on feedstock costs and prevailing crude oil prices. ABARE data show that ethanol production using C molasses costs about 1.75 times more than petrol. This is why it has been necessary to assist the fuel ethanol industry with a favourable rate of excise, bounty payments to producers and, since September 2002, a subsidy to producers.

The '350 ML by 2010' report estimates that to meet the target, the total net present value of costs to the Australian economy (GDP) from 2004–2010 is between $95 million and $100 million.

On December 16, 2003, the Australian Government announced that an excise rate on ethanol will be phased in over five years, beginning on July 1, 2008, to a maximum of 12.5 cents per litre in 2012 – considerably less than the 38 cents per litre excise on unleaded petrol.

The problem is that, as stated in the '350 ML by 2010' report, ethanol from sugarcane molasses and from whole cereal grains 'will require substantial and ongoing government assistance to be economically viable'. On the other hand, ethanol from waste wheat starch (as produced by Manildra) and biodiesel from waste cooking oil both appear to be viable or close to viable without ongoing financial assistance from the government. But the quantities of ethanol that can be produced from these waste streams are small (about 100 ML).

Ethanol – a renewable fuel

Ethanol (C_2H_5OH) is one of those renewable fuels that you grow in a paddock rather than extract from underground. An alcohol, it has a range of uses apart from fuel, including the manufacture of pharmaceuticals, plastics, paints and thinners, aerosols, cosmetics, foods and alcoholic beverages (where it is the intoxicating component) – but don't try drinking industrial alcohol! It has been denatured to make it undrinkable. Ethanol is usually made by fermentation of grain starch or molasses (from sugarcane), but can also be generated from the lignocellulose in wood and other crops.

Ethanol production from plant material or biomass taps into the huge amount of solar energy fixed by plants on Earth each year. Adherents point out that, like all forms of bioenergy, the CO_2 released during use of ethanol is approximately equivalent to the uptake of CO_2 from the atmosphere during growth of the sugarcane, wheat or other source crops.

James Kelly/James Porteous

Ethanol is the most widely used alternative (non-fossil) transport fuel in the world, but comprises only about 1.4% of petrol consumed in the United States, where its use is mandated in some areas to reduce carbon monoxide emissions. In Brazil, a major sugar producer, vehicles are specially modified to cope with any blend of ethanol and petrol. There, ethanol is normally blended at about 25% but some cars run on 100% ethanol.

In Australia, some fuel blends have been sold in New South Wales for the last decade, while in south-east Queensland, BP began marketing a 10% blend in 2002.

A litre of ethanol actually contains less energy when combusted than a litre of petrol, but it can be used in conventional fuels as an octane booster (to prevent engine knock), as an oxygenate (to prevent air pollution from carbon monoxide and ozone) and as a fuel extender. Ethanol can lead to greater fuel efficiency, but this is offset by its lower energy content.

All of Australia's ethanol is currently produced on the east coast and much of it is used for applications other than fuel. The two main producers are Manildra, using wheat starch feedstock, and CSR, using molasses from sugar mills. Australia's total ethanol production of about 350 million litres a year is a small 'homebrew' by comparison with the 12.2 billion litres produced in 2003 in the United States, now the world leader, and the 6.95 billion litres produced in Brazil. But is this just the beginning of a more substantial industry here?

'The body of opinion is still of the view that it's better for the environment, but even that is not as unanimous in recent times as it has been in the past. One of the problems … is that the science does keep changing and there's always a lot of argument.'

– Prime Minister, John Howard, July 2003

'We do support an ethanol industry but we don't support bad processes and grant schemes that are shrouded in controversy.'

– Leader of the Opposition, Mark Latham, February 2004

'We think in the long term, if we're really going to look at renewable fuels and get away from some of our fossil fuels, we need to mandate a blend of ethanol in fuel.'

– Ian Ballantyne, Canegrowers General Manager, 2003

'Ethanol is well and truly the flavour of the month among politicians with a taste for electoral advantage and businesses keen to drink from the taxpayer's trough.'

– Ken Willett, Manager of Economic and Public Policy, RACQ, 2002

'The Board of the AIP [Australian Institute of Petroleum] recognise the Government biofuels target of 2% by 2010 and believes highly competitive market forces will achieve this. The industry does not support a mandate…'

– Bryan Nye, Executive Director AIP, 2002

'If you are seriously looking to help the environment, you could just buy a smaller car and drive it around a bit slower.'

– Dave Kimble, Environmentalist, 2002

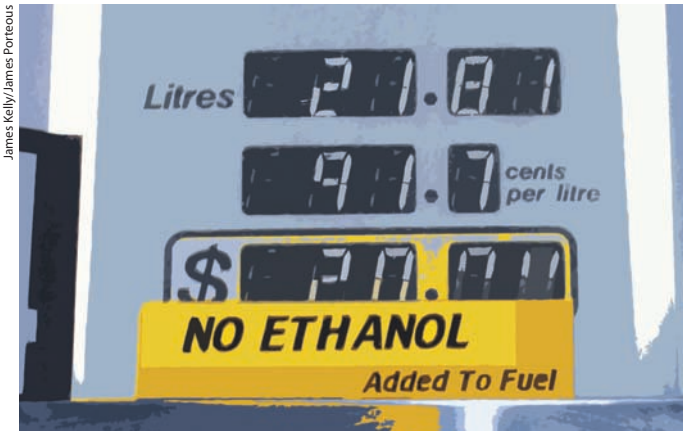
'And expanding sugar production on a promise of a biofuelled future is unlikely to receive much public support given perceptions of sugar as an industry that has resulted in widespread clearing of the wet tropics and environmental damage to rivers, mangroves and the Great Barrier Reef.'

– Editorial, The *Canberra Times*, 2004

'It's no secret that I and many country people believe that ethanol should be given a chance in Australia.'

– Deputy Prime Minister, John Anderson, December 2003

James Kelly/James Porteous



Not all states are running the national ethanol experiment.

Potential ethanol production from C molasses supplies is also relatively small. So can ethanol help save the sugar industry?

If all the C molasses from the Australian sugar industry were to be converted to ethanol, about 300 ML of biofuel would be produced. This would represent approximately four to six ethanol plants and 1–2% of the nation's petrol usage. While a useful diversification for the sugar industry, the overall impact on the industry's profitability would be small.

The '350 ML by 2010' report valued the sugar in C molasses at about $100 per tonne. Sugar industry sources indicate that farmers and millers struggle to remain profitable when world sugar prices fall below $250 per tonne. If ethanol was to have a large impact on sugar industry profitability, sugar feedstocks other than C molasses would have to be used. However, the higher prices for these feedstocks imply still higher ethanol production costs and hence higher levels of government assistance.

The final paragraph of the '350 ML by 2010' report is undoubtedly not what ethanol stakeholders want to hear. The authors, leading scientists and economists, conclude that: *The costs of implementing a policy of assisting the Australian biofuels industry to meet a 350 ML biofuels target are estimated to exceed the benefits.*

The ball is now firmly in the Government's court and it is faced with a hard decision in balancing economic, environmental and social goals. Does it go with the scientific and economic studies, which suggest the economic costs of assistance are high and environmental and social benefits only modest, or does it give ethanol, on the face of it an appealing renewable fuel, a multi-million-dollar leg up?

More information:

Government biofuel initiatives (including the 350 ML report): http://www.industry.gov.au/content/itrinternet/cmscontent.cfm?objectID=A9D9A207-0351-51FB-F20C287758203878

CSIRO, Bureau of Transport and Regional Economics (BTRE) and Australian Bureau of Agricultural and Resource Economics (ABARE) 2003, *Appropriateness of a 350 Million Litre Biofuels Target*, Report to the Australian Government, Department of Industry, Tourism and Resources, Canberra, December.

Roarty M and Webb R. Current Issues Brief no. 12, 2002–03, Fuel Ethanol – Background and Policy Issues, Department of the Parliamentary Library, Canberra.

Contact: Dr Brian Keating, CSIRO, 07 3214 2373