Is ethanol fuel the answer to our environmental problems?

Queensland's 1.7 million cars use nearly 3 billion litres of petrol per year. In December 2001, Environment Minister, Dean Wells, announced that a greener fuel was coming to Queensland, called E10. As its name implies, E10 is a blend of 90% unleaded petrol and 10% ethanol (Ethyl Alcohol), derived from homegrown sugar.

It sounds good, but are the environmental and economic claims made for this wonder fuel really all they are made out to be?

The Government spin

"We are going to kick-start an ethanol market in Queensland", Minister Wells said as the first E10 bowser was delivered to the South Brisbane headquarters of Q-fleet, the State Government's 7,500 vehicle fleet arm. E10 can be used in all engines suited to lead-free petrol without modification.

"I have been running my car on E10 since June and two of my senior managers have been using this fuel for a similar period", he said. "Environmentally, the widespread use of E10 will ultimately reduce greenhouse gas emissions. When these bowsers are installed, the EPA's 85 fleet cars will then start using E10, and the facility will be available to vehicles from other government departments and agencies."

"E10 production will allow primary producers to produce high-grade sugar as a saleable product and use low-grade sugar for ethanol production."

E10 is made at BP's Bulwer Island refinery from ethanol produced at the Rocky Point Distillery, south of Brisbane, using molasses as a feedstock. The project is being supported by an $8.8 million Federal Government subsidy through the Australian Greenhouse Office's Greenhouse Gas Abatement Program.

The economics

First let me make the point that mixing ethanol with petrol is nothing new. From 1929 to 1957 all gasoline sold in Queensland contained 10% ethanol, and E10 is currently available from a number of outlets in New South Wales and Victoria, where the ethanol is derived from wheat starch.

The general technology is well worked out, and the economics of ethanol are well understood too. It's widely recognised that its cost-effectiveness changes with the economic and political times.

Brazil produces a lot of sugar cane and its currency is often worthless on the international markets, so it would seem to make sense for them to be making their own alcohol fuel rather than importing expensive petrol.

In 1987 they made a staggering 4.2 billion litres of ethanol and all gasoline sold contained about 22% ethanol. But the industry was heavily subsidised by the government, and as 'economic rationalism' drove out the subsidies in the 1990s, so its popularity waned.

In the U.S., the ethanol tax subsidy is widely criticized as a wasteful example of 'corporate welfare', particularly favouring ethanol producer, and major political contributor, Archer Daniels Midland.

In Queensland in 2002, ethanol's future seems to rely on government subsidies too. The decision on whether to tax alcohol fuel or not could alter pump prices by 3.6 cents per litre.

In a report commissioned by the Environmental Protection Agency, *Report on Ethanol production for fuel use in Queensland,* (Hardin, M., June 2001) the author states, "*Production costs of ethanol are* [sic] *make it commercially marginal as it stands although greenhouse gas rebates and more efficient plants using co-generation technology will lower the production cost.*"

The E10 fuel now available from limited outlets in Queensland is selling at the same price as straight petrol, but of course there is currently no tax on the ethanol component.

Whatever the local factors, E10's economic future will also be dependent on international factors beyond our control. Who can predict the twists and turns of OPEC politics, especially with a war in Iraq in the air?

Cane expansion

E10 may prove to be economically viable, but is it really a greener fuel?

Coordinator of Queensland Conservation Council, Felicity Wishart, says that while the Council welcomes the new fuel, it has concerns that sugar cane farming has its own environmental problems. "We have to work to ensure that sugar cane growing is as environmentally sound as possible", Ms Wishart said.

Cane fields are often carved out of environmentally sensitive coastal lowlands and wetlands. In the Cardwell/Tully area of Far North Queensland the only remaining land not under agriculture is tropical rainforest. This forest has the highest bio-diversity of any ecosystem in Australia, and is home to the endangered Mahogany Glider and the Southern Cassowary, icon of the Wet Tropics World Heritage Area.

But surprisingly, the Queensland Government's Vegetation Management Act does not prevent the clearing of most tropical rainforest on freehold land because a Regional Vegetation Management Plan is not expected to be in place before 2004. In the interim, Queensland Herbarium maps show the bulk of this forest as being 'not of concern' because more than 30% of the pre-European extent is still intact, mostly in the Wet Tropics World Heritage Area.

Ironically there is nothing to prevent farmers clearing the last of this spectacular tropical rainforest on freehold land to grow cane to make supposedly 'green' fuel.

Water quality

Cane farming also has big impacts on water quality in our rivers, watertables and coastal areas.

A recent report by the Great Barrier Reef Marine Park Authority, *Water Quality Action Plan*, states, "*Decades of scientific research and evaluation has now clearly and unequivocally established that land use activities in the catchments adjacent to the Great Barrier Reef are directly contributing to a decline in water quality*."

The report cites sediment exports

from the Tully River as being 587% of pre-1850 levels, Total Nitrogen - 294%, and Total Phosphorus - 627%. It also identified diuron, dioxins, dieldrin, mercury and cadmium in sediments within the Marine Park.

Diuron is a herbicide only licensed for use in the cane industry, and its impact on sensitive sea-grass beds is un-researched, but likely to be significant.

Air quality

What does using E10 do for car exhausts and air quality? Well, it's a mixed bag.

Hardin claims that the use of E10 will decrease emissions of Carbon Dioxide at the tailpipe by 10%, but this is simply not credible since that would mean the ethanol produces no CO_2 at all. What he is referring to is fossil CO_2 at the tailpipe. This error is being perpetuated by our politicians.

Ethanol molecules contain an Oxygen atom that help them burn very cleanly, so levels of harmful Carbon Monoxide should be reduced by 13%. The levels of unburnt organic fuel additives in exhaust emissions should also decrease.

However oxides of Nitrogen can be expected to increase, according to a field study done in Albuquerque, New Mexico, by Gaffney in 1997. This is not what governments and the ethanol companies want to hear, so it is not surprising to find that other studies come to the opposite conclusion. Hardin summarises the position thus: "*Close monitoring of nitrogen oxides after the introduction of E10 is recommended to minimise environmental damage and to contribute to this sparse and contradictory literature.*"

Whilst we are on oxides of nitrogen, another major source of these compounds in the air is nitrate fertilisers, heavily used (you've guessed it) in the cane industry.

The energy ledger

Another way of looking at E10 fuel is to work out how much energy it takes to produce it, and how much energy it produces.

Growing sugar cane requires tractors and specialised harvesting machinery. These take a lot of energy to build, and then of course they need diesel fuel to make them go.

Cane farming removes approximately 80 tonnes of organic matter per hectare per year from the land, and if this is not replaced by fertilisers, the soil will quickly become exhausted.

Fertiliser manufacture is a heavy user of energy, both in the form of natural gas as a feedstock to make Ammonia, and as process heat.

Then the cane needs to be protected from pests by pesticides, and from competition by selective herbicides. These are also the products of the oil/chemicals industry that use a lot of energy in their manufacture.

Once harvested, the cane makes its way to the sugar mills on cane trams and in bulk road transporters. Some cane harvested 20 kilometers south of Tully is trucked past the Tully Mill and the South Johnstone Mill, and 50 kilometers on to the new mill on the Atherton Tablelands. The syrup is then trucked back down to a railhead at Babinda. The fuel used in such cartage must make the sugar a very energy-intensive product.

At the mill the cane is crushed and boiled using heat from burning bagasse, which is the fibrous material left over from earlier crushings. Indeed there is a surplus of bagasse, which can be burnt to generate electricity for the grid. This is called 'green power', but in reality it is a waste of a valuable material that could be used for making fibre-board.

The sugar at this stage is a brown colour with a rich flavour – too rich for most peoples' tastes, so it then goes through several separation stages to produce refined white sugar and a dark treacle called molasses.

This molasses is a useful feed supplement for cattle when fodder is scarce, so it is surprising that it is being suggested that molasses should be the basic ingredient for the production of ethanol. Just because its economic value is low ($60-80 per tonne) doesn't necessarily mean that it makes good sense to use it for fuel. What are the cattlemen going to do without molasses?

The final steps in ethanol production are taken by specialist distilleries. Facilities at Sarina, Bundaberg and Rocky Point already produce 60 million litres of alcohol. The molasses is dissolved in hot water (more energy again), and fermented by yeasts to produce 8.3% alcohol, and then distilled (more energy again) to separate the alcohol from the water.

Ethanol has a natural affinity for water, so producing 100% pure (anhydrous) ethanol is much more difficult (energy intensive) than producing rum. Dehydration is achieved by a process called 'ternary azeotropic distillation' with cyclohexane as the azeotrope breaker. I don't understand the details, but this sounds energy expensive to me.

And in case you didn't spot the sleight of hand over the greenhouse gas emissions, I should point out that for every molecule of Sucrose converted to ethanol, four molecules of Carbon Dioxide are given off:

$$C_{12}H_{22}O_{11} + H_2O \rightarrow 4C_2H_5OH + 4CO_2\uparrow$$

Is this taken into account in the greenhouse gas calculations? I cannot find any reference to it in the government literature.

So the question is this: does the entire process (of planting the cane, fertilising it, applying pesticides, harvesting it, transporting it to the mill, converting it to sugar and molasses, fermenting and distilling it) use up more energy than the ethanol itself contains? If it does, then the whole idea contributes to the Greenhouse Effect, rather than solving it.

Working out the true energy cost of a process with multiple outputs (white sugar, bagasse-powered electricity, rum, molasses and ethanol) is a somewhat arbitrary calculation.

The issue has been analysed in depth by the CSIRO Division of Atmospheric Research, and the results published in a comprehensive report "Lifecycle analysis for alternative fuels". Selectively quoting from this could be seen to be self-serving, so let me quote from a letter I have received from Dean Wells' Office:

"*Specifically, total exbodied greenhouse gas emissions for passenger cars driven on conventional petrol have been calculated to be 0.21 kilograms CO2 per kilometre travelled. For ethanol made from sugar cane, total emissions are 0.10-0.16 kilograms CO2 per kilometre, depending upon the assumptions made for the replacement*

of molasses as a stock feed. Even the most conservative assumptions give a greenhouse impact which is 25% less than for petrol."

Thus the Queensland Government agrees that using 10% ethanol reduces fossil CO2 emissions by only 2.5%.

Simpler green alternatives

If you are seriously looking to help the environment, you could just buy a smaller car and drive it around a bit slower. It saves money too. I wonder what kind of car the Minister uses.

If you decide to go the green way, then the land that would be cleared to grow more cane to make more ethanol could be left as natural bush that acts both as a carbon sink and as wildlife habitat, without any expenditure of energy at all. And if the uncleared land was adjacent to a river or wetland, then it would act as a sediment and nutrient trap, improving water quality on the Great Barrier Reef.

At the same time there would be a considerable saving in wear and tear on our roads if there was less cane hauling, and less air pollution from the chimney stacks at the sugar mills.

All in all, there would be much greater environmental gains if the sugar industry was to be wound back by retiring cane production on riparian strips, poor soils and flood-prone land, and refusing all permits to clear more native vegetation.

The economics of sugar in 2002 mean the export industry cannot compete with Brazil and the rest, and should now be contracting, not expanding.

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