Inquiry into Australia's future oil supply and alternative transport fuels

Submission to Senate Rural and Regional Affairs and Transport Committee

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The recent escalation in the world oil price appears to reflect a structural change in the world market. Some of the major factors driving this change are:

- Rapid economic growth in China and other developing nations has stimulated demand.
- Supply is increasingly compromised by political issues in major source areas.
- There have been few major new oil discoveries for some decades and production from established fields appears to be levelling out.

This emerging structural change indicates the need for both a national and regional response to security of transport fuel supply in Australia. This submission will provide a brief review of the opportunities and impediments to developing a biofuels industry in Western Australia, with a particular focus on building the foundation for secure, affordable transport fuel supplies for the medium and long term.

Based on current and emerging technologies there are only two main transport fuel or biofuel options, i.e. ethanol and biodiesel.

Ethanol is already produced on a large scale from grain (maize in the United States) and sugar cane (Brazil). Ethanol is readily blended with both petrol and diesel and can be used in low (<20%) proportions with little modification to conventional motors. Motors able to use any proportion of petrol and ethanol are now in large scale production in US and Brazil. Low cost woody materials are a promising alternative feedstock for the production of ethanol. The cellulose and hemi-cellulose (cellulosic) fraction of woody plants (ranging from 50 and 70% of woody plant biomass) are made up of long chains of sugars that can be separated and converted to ethanol. Woody biomass is also described as a ‘lignocellulosic’ feedstock.

Biodiesel is made from vegetable oils or animal fats to produce a fuel that can be used as a direct replacement for conventional diesel or used in blends. This can be done on a small scale so that individual farmers or small regional groups can manufacture their own fuel. The most likely vegetable oil sources in WA will be the common annual crop canola. More productive but non-food quality relatives of canola are under development as alternative sources of ‘fuel-grade’ vegetable oil.

How might the opportunities and impediments for development of these options be compared and what might the Biofuels Taskforce do to assist with development in WA?

This submission presents and briefly discusses several criteria by which assessment and comparison of the options for application in WA can be based.

1. Feedstock supply: cost, current supply, future potential and security of supply

WA is a large producer of cereals (12 million tonnes/year) and oil seeds (0.5 million tonnes/year). The cereal grain supply if converted to ethanol would be more than enough to meet the state's current petrol demand, while the oil seeds supply would meet some 10% of diesel demand. While the current relative prices of grains and transport fuels makes fuel production look attractive, this may not always be the case. Hence there are potential problems with security of supply of grains for transport fuel production – growers will want to place their production in the market that will give the highest price. Therefore, if large scale transport fuel production facilities are to be established they would need to have binding contracts for supply of grain feedstocks. It seems likely that to initiate and develop stable arrangements for new industries would require some form of Government intervention. This was the case in comparable situations overseas, e.g. maize ethanol in the US and cane ethanol in Brazil. In contrast, small local scale biodiesel production could be readily turned on and off according to market prices.

There are already significant un-utilised cellulosic feedstocks in WA, including cereal straw and forestry residues. Furthermore, there is also substantial potential to create new supplies based on planted woody crops like mallee (Eucalyptus spp.). The advantage of building transport fuel industries around these feedstocks is that they have fewer alternative uses, likely lower prices and greater security of supply. Bartle et al (2006) indicate potential supply of mallee feedstocks in WA, at what is likely to be a commercially viable delivered price of $70/dry tonne, would be about 10 million dry tonnes of biomass per year. Such bulk woody biomass feedstocks have the potential to also provide selected fractions for higher value uses, thereby reducing the residue to effective costs well below $70/dry tonne.

2. Life cycle analysis

Life cycle analysis (LCA) is used to estimate the energy and carbon balances of whole production systems to enable comparison of their energy or carbon efficiencies. This is useful because conventional economic analysis does not yet allocate real costs and benefits to the energy and carbon balances of production systems.

Wu et al (2005) conducted a partial LCA on mallee. They considered only the balance of energy inputs and outputs in growing, harvesting and delivering mallee biomass to a central location. Mallee biomass production can be sustained indefinitely on regular short cycles of harvest of the entire above ground parts, with regeneration occurring by coppice from the retained root stock. Since the initial establishment of a mallee crop is expensive and energy intensive, accounting for this cost can reasonably be distributed across a number of coppice crops. For this reason a term of 50 years was chosen as the production period over which this assessment was made. The first harvest or sapling crop takes 5 years to reach harvestable size and subsequent coppice crops take 3 years. Hence the 50 year production period consists of the initial sapling crop (5 years) and 15 coppice crops (45 years), making 16 harvest overall.

All activities occurring during the mallee production period that involve direct non-renewable energy inputs (liquid fuels and lubricants, heat, electricity) and/or indirect energy inputs (fertilisers, agrochemicals, tractors, agricultural machinery, transport equipment, labour, capital) were specified. For each input, the energy amount was converted back to a common base, i.e. the equivalent non-renewable primary energy required to supply the energy used. The energy output is the primary energy contained in all mallee biomass components, i.e., wood, bark and twig, and leaf (see Table 1).

The energy ratio (output of energy in biomass/input of energy in production) was found to be 41.7. This high ratio reflects the strong competitive position of coppice crops in energy capture compared to annual or other short-lived agricultural crops, that typically have an energy ratio lower than 10. Coppicing avoids regular replanting inputs after every harvest. A high energy ratio is also favoured by the complementary position mallee occupies with annual agricultural crops, i.e. higher mallee yields can be achieved through capture of surplus water and nutrients.

Table1: Overall energy balance in MJ/ha for a 50 year production period (16 harvests)

Input or output component		Total energy	%
Energy Input	Seed	2,265	0.9
	Seedling	4,827	2.0
	Crop establishment	4,543	1.8
	Sapling and coppice management	42,765	17.3
	Harvest	106,400	43.0
	Biomass transport	86,630	35.0
	Total Energy Input	247,429	100.0
Energy Output	Wood	3,971,463	38.5
	Bark	2,681,499	26.0
	Leaf	3,655,131	35.5
	Total Energy output	10,308,093	100.0
Energy Ratio (R)	**41.7**		

Wu (2006) further estimated the overall energy balance of liquid transport biofuels production through three different scenarios: corn-to-ethanol, canola-to-biodiesel and mallee-to-ethanol. The corn-to-ethanol scenario results in little energy gain (R is around 1.0) although it produce a high energy productivity (3,110 L ethanol/ha, equivalent to 72.8 GJ/ha). Canola-to-biodiesel scenario delivers a slightly positive energy gain (R = 1.2 – 1.4) but its energy productivity is very low (337 – 438 L biodiesel/ha, equivalent to 11.1 – 14.4 GJ/ha). Mustard, which is a more productive but non-food quality relatives of canola and still under development, has a higher energy ratio (R = 1.9) and relatively better energy productivity (606 L biodiesel/ha, equivalent to 19.9 GJ/ha). However, under alley farming, mallee-to-ethanol has a much higher energy ratio (R = 6.2) yet still deliver a high energy productivity (3,159 L ethanol/ha, equivalent to 73.9 GJ/ha). The high energy ratio and productivity of mallee and other coppice crops indicates that they are best placed to become competitive sources of biomass feedstocks for conversion to ethanol.

3. Collateral environmental benefits and climate change issues

The development of new biofuel industries based on agriculture offers the option to use conventional annual plants and/or to develop new woody crops. Conventional annual crops are the cause of major environmental problems in agriculture whereas woody crops offer the potential to achieve significant improvement in the environmental performance of agriculture and to establish substantial carbon sinks. While there appears to be a strong case for proceeding with small scale development of annual crops based biofuel production, there is a strong environmental incentive to also pursue woody crop options.

It is important to point out that woody crops like mallee can only be successfully cultivated on a small proportion of the land in order to be able to gain access to enough extra water (i.e. water in addition the rainfall falling on the planted area) to achieve commercial yields. In the wheatbelt this will usually be less than 10% of any farm or catchment (Cooper et al 2005). Hence farmers can continue to enjoy their current agricultural practices with tree crops most likely present in the form of narrow belts within cropland. This integration of a small proportion of tree crops into conventional agriculture will make a significant contribution to conservation of biodiversity and the development of a more sustainable agriculture in WA.

4. Economic diversification for farmers

Australian wheatbelt agriculture is currently locked into a narrow range of crops and products that suffer from a long standing problem of declining terms of trade, i.e. the ratio of prices received for products compared to the costs of inputs to production, has been declining at more than 2%/year for some decades (ABARE, 2003). Biofuels offer the opportunity for significant diversification of farm activities into products that do not have adverse terms of trade.

The extent of such diversification would be greatly enhanced by adopting woody crops as the mainstream source of feedstocks for ethanol. This is because a profitable low value residue use like ethanol production would underwrite the commercial development of other higher value products from woody biomass. This is the concept being pursued at the Western Power Corporation (now Verve Energy) Integrated Wood Processing demonstration plant at Narrogin (Enecon 2001), although the energy product in this case is electricity. The higher value products at the Narrogin plant are activated carbon and eucalyptus oil. There are other higher value products that might be derived from woody crops, including charcoal, panel board products, paper and pulp, chemicals and manufactured animal feeds.

Another major potential advantage of woody crops is that they sequester carbon, both in the form of the average biomass of the standing crop and in root systems. If tradable carbon rights are formally adopted in Australia this will provide an additional income stream at no additional cost.

5. Regional development

Ethanol production based on woody feedstocks could only be viable in the form of regional industry. This is because the woody feedstocks do not have sufficient value to be transported to coastal processing centres. Given that woody crops will have multiple products there is theoretically potential for multi-billion dollar regional processing industries in rural WA.

6. New technologies

Enecon (2002) review the status of the technology and undertake cost/benefit analysis of alcohol fuels derived from woody biomass. This study preceded the recent steep rise in oil prices but indicated that current cellulosic technology could produce ethanol for 82 cents/L in a 200ML plant using a woody feedstock cost of $30/green tonne delivered (a price that Enecon 2001 showed would be profitable for wheatbelt growers). It also showed that the current high level of investment in wood to ethanol conversion technologies was likely to make substantial improvement on this cost of production within 15 years. They concluded that Australia should carefully consider current overseas R&D to enable national development to focus on pertinent issues.

Conclusion

This brief exposition of the opportunities and impediments to developing a biofuels industry in Western Australia indicates the potentially significant role that woody crops and new technologies for conversion of cellulosic feedstocks to ethanol may play. Ethanol from cereals and biodiesel from canola may offer important immediate opportunities to introduce new transport fuels in the market place and develop familiarity among the consumers in the transition to future sustainable biofuels supply.

However, woody crops offer the potential of much greater substitution or adoption of biofuels in the longer term for WA. The advantages of woody crop conversion to biofuels centres around being able to meet the triple bottom-line objectives of sustainability:

- Economic: woody crops appear likely to be commercially viable and able to supply a range of products within production systems that are compatible with the current agriculture. Coppicing species like mallee deliver a high energy ratio so that it is possible to produce more net energy with less input; it also has a high energy productivity so that it is possible to have high total net energy output per unit land;
- Social: woody crops for bulk biomass production have to pass through local value-adding to be commercially viable, thereby locking in regional economic and social development.
- Environment: even with a modest proportion of land planted woody crops can make a substantial contribution to conservation in rural WA.

The strength of the woody crop prospect provides strong support to the first conclusion of the Australian Government's Biofuels Taskforce (2005), i.e.

The Taskforce notes the potential for lignocellulosic ethanol technology to impact materially on the economics of the ethanol industry in the coming decade. Policy interventions based on current industry technologies and feedstocks should be limited without further assessment of the impact of lignocellulosic technology.

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