

Future Biofuels for Western Australia

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Outlines

- **Background**
- **Biofuels options**
- **Potential biomass resources in WA**
- **Mallee as a good option for WA**
- **The way ahead...**



Background

- **Depletion of finite fossil fuel reserve**
- **Growing energy demand**
- **A carbon-constrained world and sustainable development**
- **Impacts of such developments on WA being significant due to our**
 - large area
 - small but dispersed population
 - heavy reliance on energy-intensive industries including mining and agriculture
- **A Challenge but also an opportunity**



Biomass and Biofuels

- **Energy security**
- **Biomass being the only sustainable source of carbon-based materials in the future**
- **Environmental benefits**
 - Biomass being an important source of renewable energy (?)
 - Lower emissions of GHG and other pollutants (?)
 - Potential integration with a sustainable agriculture
- **Economic considerations (?)**
 - reducing impact of oil imports
 - adding value to low-value products

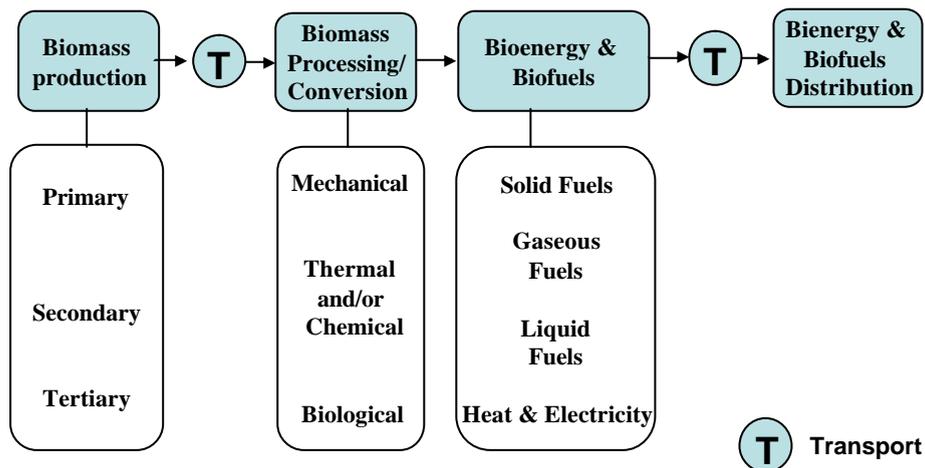


The Big Questions Are...

- What options do we have in WA?
- How should we do strategically to establish a sustainable biomass and biofuels industry for future sustainable development of WA?



Biomass and Biofuels Production



Biofuels Options

• Ethanol

- Ethanol is readily blended with both petrol and diesel 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.
- Ethanol is currently mainly produced from sugar and grains through matured technologies. However, there have been debates on whether the full life cycle is truly sustainable.
- Low cost woody materials are a promising alternative feedstock for the production of ethanol. This is also called lignocellulosic feedstock.
- Advanced lignocellulosic ethanol technology has been greatly advanced in the past 5 years and is expected to be commercialised within the next 10– 15 years.



Biofuels Options

• Biodiesel

- 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.
- Production technologies are mature and 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.
- Overall life cycle analysis indicates that energy gain of oilseed-to-biodiesel is positive but small, unless waste oils are used as feedstock.



Biofuels Options

- **Hydrogen**

- Hydrogen is a potential transport fuel used for fuel cell vehicles.
- For example, the Perth Fuel Cell Bus Trial, known as STEP, has been undertaken in conjunction with the CUTE and ECTOS trials in Europe, started in 2003.
- Hydrogen itself is a clean fuel as the only product after use is water.
- **However, hydrogen is an energy carrier but not energy source.**
- At present, hydrogen is mainly produced from non-renewable energy resources, dominantly fossil fuels, including natural gas, petroleum and coal.
- For future sustainable development, hydrogen must be produced from renewable sources, especially biomass.



Other Biofuels and Bioenergy Options

- **Biogas**
- **Bio-oil**
- **Wood pellets**
- **Heat**
- **Electricity**



Potential Biomass Feedstock Supply in WA

There are three categories of biomass resources:

- **Primary (direct from photosynthesis)**
 - Agric residues
 - Forestry residues
 - Energy crops
- **Secondary (residue from central processing)**
 - Food processing
 - Forestry milling and wood manufacture
 - Animal industry wastes
- **Tertiary (salvage after secondary use)**
 - Post-consumer wastes



Primary Biomass Resources in WA

Crop	Biomass fraction	Crop area 10 ³ ha	Supply 10 ³ dry t	Biomass type	Estimated Energy content, TJ	Energy ratio	Reference
Cereals (mean annual for 1999-06)	Grain	6,122	10,492	Starch	210	<10	ABARE2006
	Straw		4,000	Cellulose	74		McGhie et al 2006
Oilseeds (mean 99-06)	Grain	480	526	Oil	21	~7	ABARE2006
Bluegum and pine forestry	Log/chip	360	3,000	Cellulose	57	<20	McGhie et al 2006
	Tops		1,500	Cellulose	29		
Mallee (potential)	Whole biomass	608	9,600	Cellulose	190	~40	Bartie et al 2007
Cane (projected expansion)	Sugar	15	150	Sugar	3	~10	ECS2007
	Bagasse		470	Cellulose	8		



Secondary and Tertiary Biomass Resources in WA

Type	Amount (10 ³ t)	Energy content (TJ)
Poultry	58	0.5
Piggery	167	0.25
Tallow	45	1.8
Sewage	140	2.8
Urban waste (MSW etc.)	1,700	25.5

From: McGhie and Associates 2006



Overview of Prospective Biomass Feedstock Options

Primary sources:

- Cereals:
 - readily available in large quantity
 - competes with food
 - poor energy ratio
- Forestry wastes
 - increasing availability, moderate quantity, well concentrated
 - cellulosic - needs technological progress, good energy ratio
 - long rotation
- Mallee
 - large potential supply
 - good collateral benefits for agriculture
 - cellulosic - needs technological progress, good energy ratio
- Sugar cane
 - Small supply, remote

Secondary and tertiary sources:

- Except MSW, others are boutique really!

Biofuels vs Food Production

- There have been debates on the competition in land and water use between biofuels and food production.
- Peak oil vs Peak soil
- In attempting to solve one problem, are we really going to create another big problem?



Biofuels vs Food Production

- **Biofuels feedstock should be produced from marginal lands**
 - Biofuels as energy are low-value products, compared to food;
 - There are agricultural land surplus to food production
 - There are enough marginal lands available
- **A full life cycle analysis must be done to assess a particular biofuel production system**
 - Is it truly renewable?
 - Does it deliver sustainable environmental outcomes?



Percentage Global Agricultural Land Surplus to Food Production by 2050

Type of diet	Vegetarian			Moderate			Affluent		
	low	med	high	low	med	high	low	med	high
Population at 2050									
Intensive agriculture	74	72	66	52	48	38	16	9	3
Low input agriculture	26	20	3	0	0	0	0	0	0

From: Hoogwijk et al 2003

Notes:

- Populations are low (8.7 billion), medium (9.4) and high (11.3). Current FAO estimate is between low and medium.
- Diets are in 'grain equivalents' in kg/day (Vegetarian 1.3, moderate 2.4 and affluent 4.2)
- Intensive agric rapidly adopts new technologies as they develop.
- Food security factor = 2 (i.e. ratio of production to consumption to account for supply chain losses)



Mallee – a Good Option in WA

- **Dryland salinity is a serious environmental, economic and social problem and leads to hundreds millions of dollars productivity loss in Australia**
- **Perennial plants are key components in a suite of strategies for combating dryland salinity and oil mallee stands out as one of the best perennial choices for that purpose.**
- **Therefore, biomass is a by-product and the potential mallee biomass supply is ~10 million dry tonne per annum in WA.**
- **Mallee is planted in the land through “alley farming”, occupying typically <10% of the land.**



Alley Farming

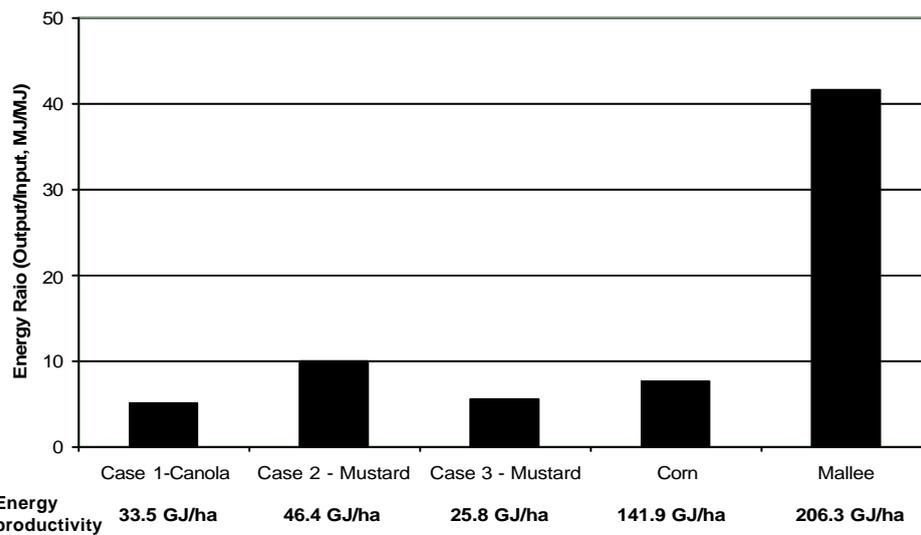


- **In this case**

- There is enough water, in fact, the primary objective of planting mallee is to get rid of excessive water in order to lower groundwater table level;
- Competition in land use between biofuels and food production is minimal;
- Farmers can continue enjoy their conventional farming practice;
- Contribute significantly to the development of a sustainable agricultural system in WA



Energy Balance of Biomass Feedstock



Energy Performance of Biofuels Production

