Australian Biofuel Feedstock Roadmap…

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Ethanol

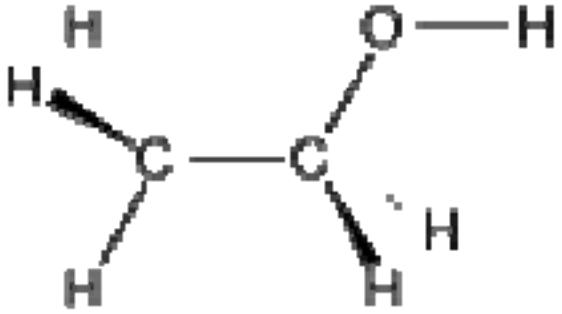
Fermentation of carbohydrates to form alcohol…

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

glucose — ethanol — Carbon dioxide

Four basic steps involved :

1. Microbial fermentation of sugars (using yeast)
2. Distillation
3. Dehydration
4. Denaturing



Fermentation processes can be performed on any material that contains sugar. These include three types of agricultural raw materials:

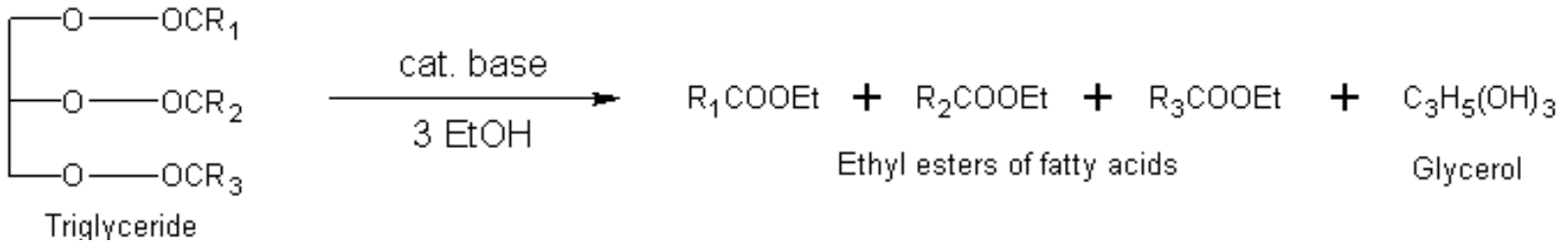
1. sugar
2. starches
3. cellulose materials

Biodiesel

Transesterification

Four basic steps involved :

1. Purification
2. Neutralization of free fatty acids
3. Transesterification
4. Separation



Fat Alcohol + Catalyst Biodiesel Glycerine

The energy content of biodiesel varies between 88 and 99 per cent that of regular diesel


Biodiesel
Glycerine

Biofuels vs Crude Oil

Ethanol

+ Lower GHG and particulate emissions
+ Made from renewable resources
+ Higher octane
- Lower energy per litre (2/3 energy of petrol)
- Associated with engine damage

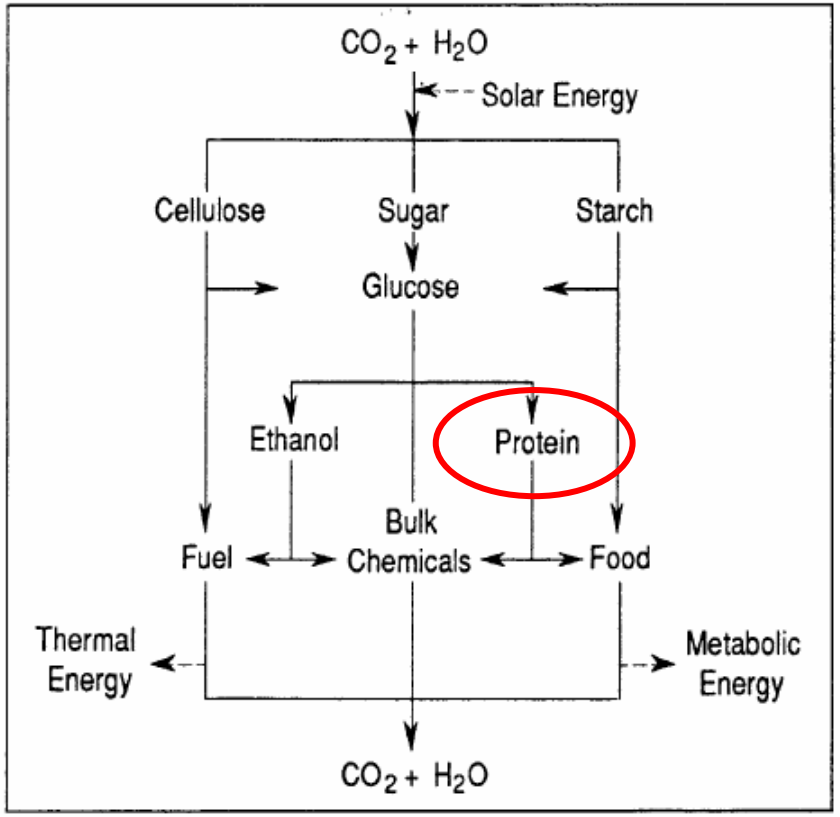
Biodiesel

+ Lower sulfur emissions
+ Better lubricity
- If B100 is used, Nitrous Oxide emissions are 10% higher than regular diesel
- Is a solvent, and if put in an old motor can cause the filter to clog
- Certain feedstocks result in solidification of the oil in cold temperatures

Byproducts of Biofuel Production…

…Increases profitability

- Wet and dry distillers grain – high protein byproduct of ethanol distillation, good protein source for animal feed
- Glycerine is byproduct of biodiesel, can be converted to glycerol which is used extensively in the cosmetics and drug industries
- Glycerine can also be used as a diet supplement for animals
- Technology exists for the conversion of byproducts into excellent soil conditioners and fertilizers

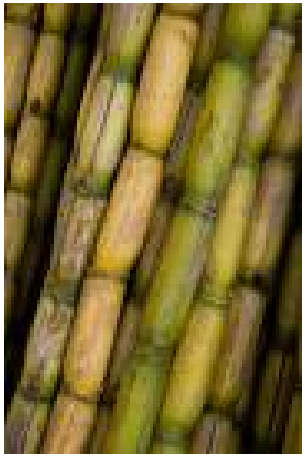


First Generation Feedstock

Current Production Base

Biodiesel

Tallow
Used Cooking Oils
Canola
Mustard



Ethanol

Maize	Barley
Sugar	Wheat
C-molasses	Sorghum
Oats	Sugar beet

Future Production Base

GM crops
Jatropha
Oil Mallee
Algae

Environmental Impacts

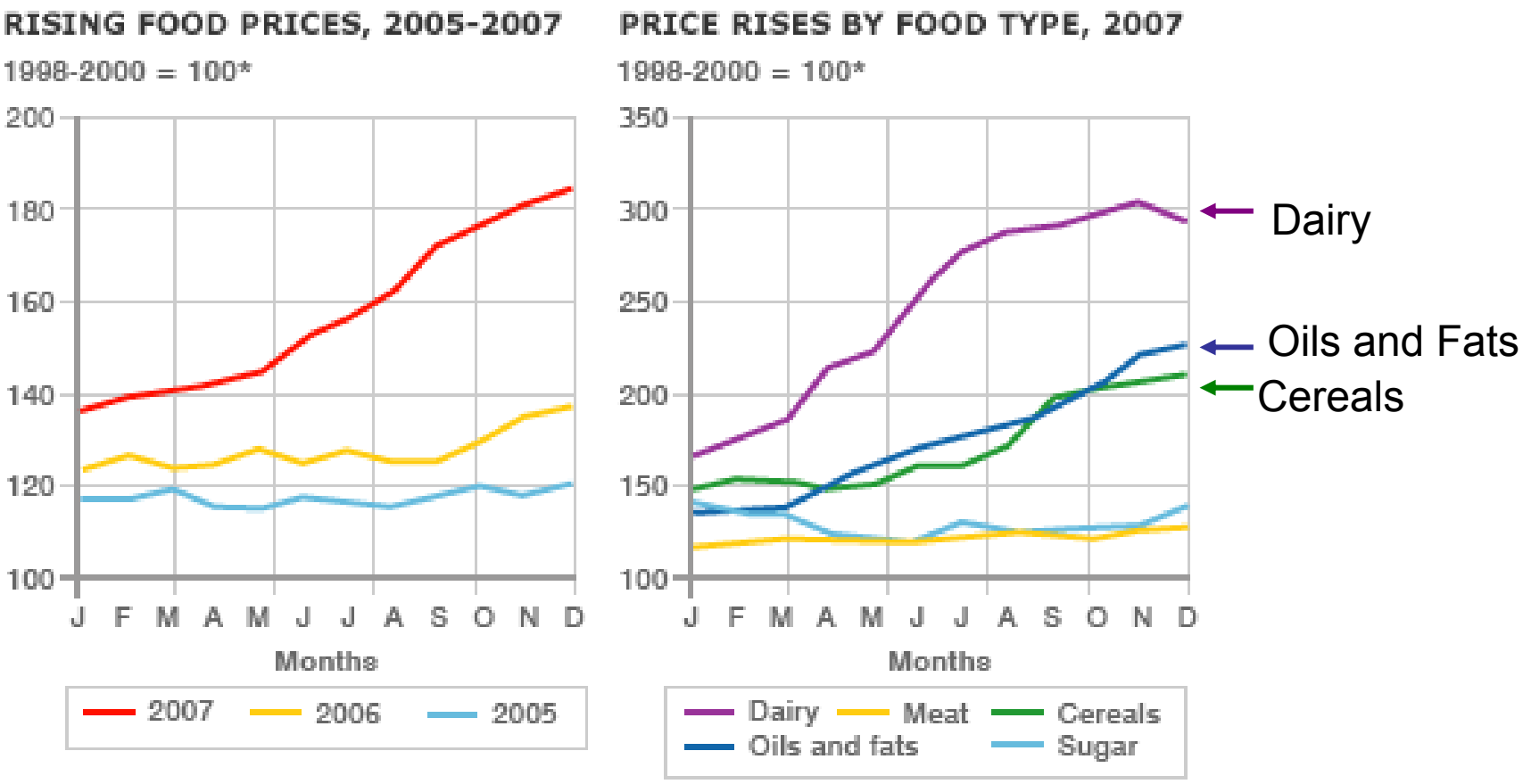
+ Forestry based products, such as oil mallees reduce salinity
- Deforestation and monoculture farming occurring, especially in developing world
- Loss of habitat and biodiversity
- Large amounts of CO2 released from clearing of swamps in Indonesia and Malaysia

Economic Impact

+ Job creation
+ Offers economic opportunities for rural people
- Impact on other rural industries – competition for land, labour, water
- Price of feedstock affected by many external factors which limits fuel security
- Feedstock accounts for 60-70% of total costs, so price changes have big impact

Social Impacts

Rising Food Prices



*Changes in price are indexed against costs dating from 1998-2000

SOURCE: FAO

Food for Fuel Debate

200kg corn = 100L ethanol

100L ethanol = enough to fill a 4WD tank

or

Food to feed one person for a year

American Biofuel Target = 36 billion L

36 billion L = 720 million kg of corn

720 million kg of corn = 360 million tanks of petrol

or

Food to feed 350 million people for a year

Second Generation Feedstock

Crop Residues

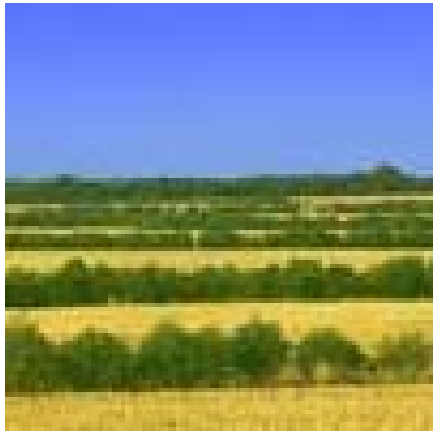
- Sugar bagasse
- Cereal stubble

Waste Steams

- Waste from wood processing
- Urban wood waste
- Black liquor (byproduct of pulping)
- Municipal solid waste

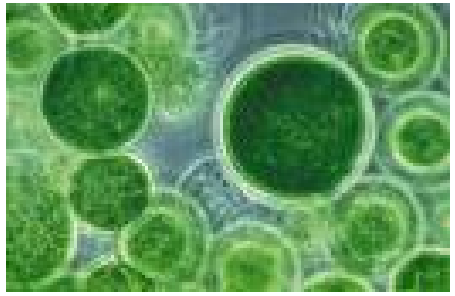
Other

- Algae
- Grasses
- Yet to be identified



Genetically Modified

- Crops
- Grasses
- Trees
- Yeasts & bacteria



Farm Forestry

- Oil Mallee
- Short rotation coppicing trees

Forestry

- Sawlogs and pulpwood
- Firewood
- Native forest residues
- Plantation residues

Second Generation Feedstocks

Economic

+ In some instances it uses wastes – minimizes costs of waste disposal, as well as creating additional revenue
- Conversion technology can be expensive

Environmental

+ doesn't require any further inputs such as fertilizers, herbicides etc
+ in some instances, potentially harmful wastes (eg. methane) are used, which reduces the environmental impact

Social

+ not competing for use as food
+ opportunities for rural Australia

Factors Affecting the Choice of Feedstocks

- Feedtock security of supply
- Feedstock cost of supply
- Feedstock energy value
- Water security
- Feedstock storage
- Impacts and costs of growing, transporting and converting into fuel
- Feedstock harvest
- Co-products market or disposal
- Processing inputs
- Transport systems
- Waste disposal
- Government policy

The Rise of Biofuels

Greenhouse Gas Emissions

- Under the Kyoto Protocol, agreement made by Australia to cut GHG by 60% by 2020
- Biofuels have lower GHGs and particulate emissions, therefore are considered to be
- The objective is bioenergy that is environmentally sustainable and socially equitable

Peak Oil

- Demand for stationary and transportation fuels has increased since the industrial revolution
- Since 2002, the price of oil has trebled
- Uncertain about how close ‘peak oil’ might be

Life Cycle Analysis

The emissions depend on the complete lifecycle of the agricultural production system. For example, the LCA of ethanol made from wheat….

- fossil fuels used in the preparation of land, maintaining the crop and harvesting the wheat
- fossil fuel content of fertilizers and herbicides and the transport of these
- the transport of harvested grain to the ethanol facility
- inputs used in the conversion process of wheat to ethanol, including electricity water, gas, and the electricity which has gone into producing other inputs such as enzymes and other catalysts
- the blending and distribution of the ethanol
- the combustion of the fuel in the engine

GHG Emissions

Figure 1-3 Full life-cycle greenhouse gas emissions per km for biodiesel and biodiesel blends in a rigid truck compared to Ultra Low Sulfur (ULS) diesel (sulfur content < 50 ppm). Numbers at the top of the bars represent the percentage change, compared to diesel [1].

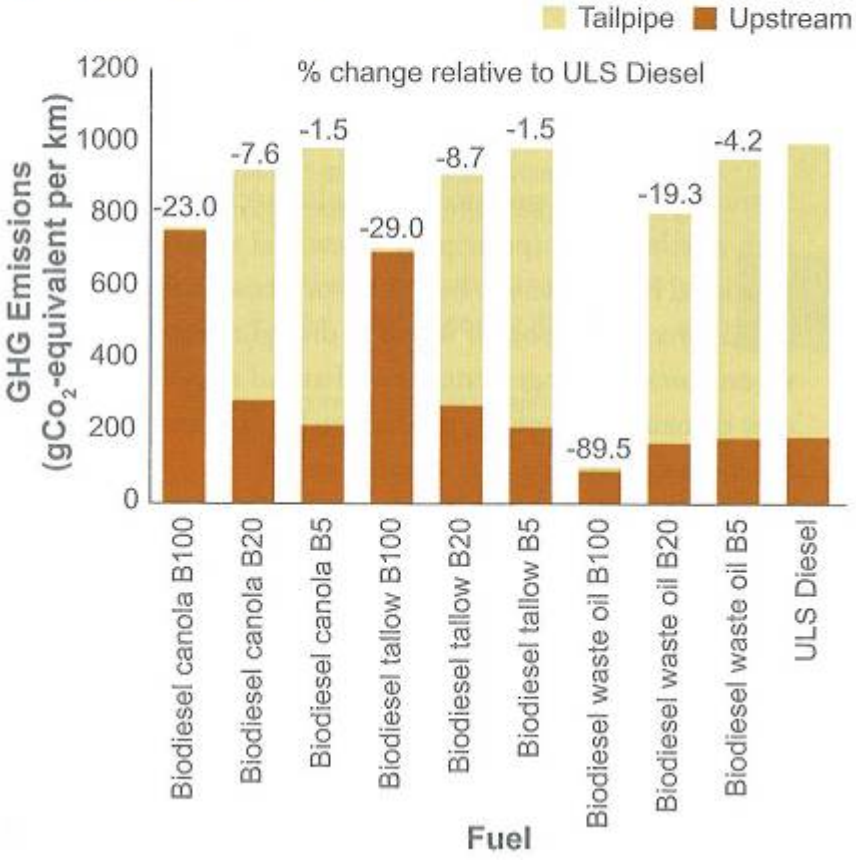
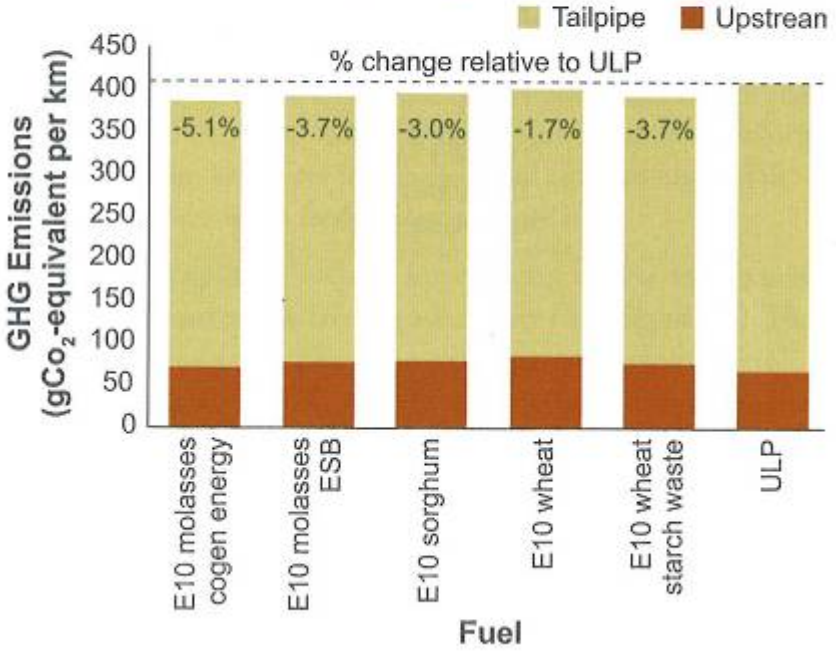


Figure 1-1 Life-cycle greenhouse gas emissions per km from the use of ethanol blends from various feedstocks and unleaded petrol (ULP) in a light passenger car[1]. Upstream begins with biomass production; Tailpipe begins at the bowser.



Source: CSIRO, 2007

Economics of Biofuel Production

Depends on…

1. World oil prices

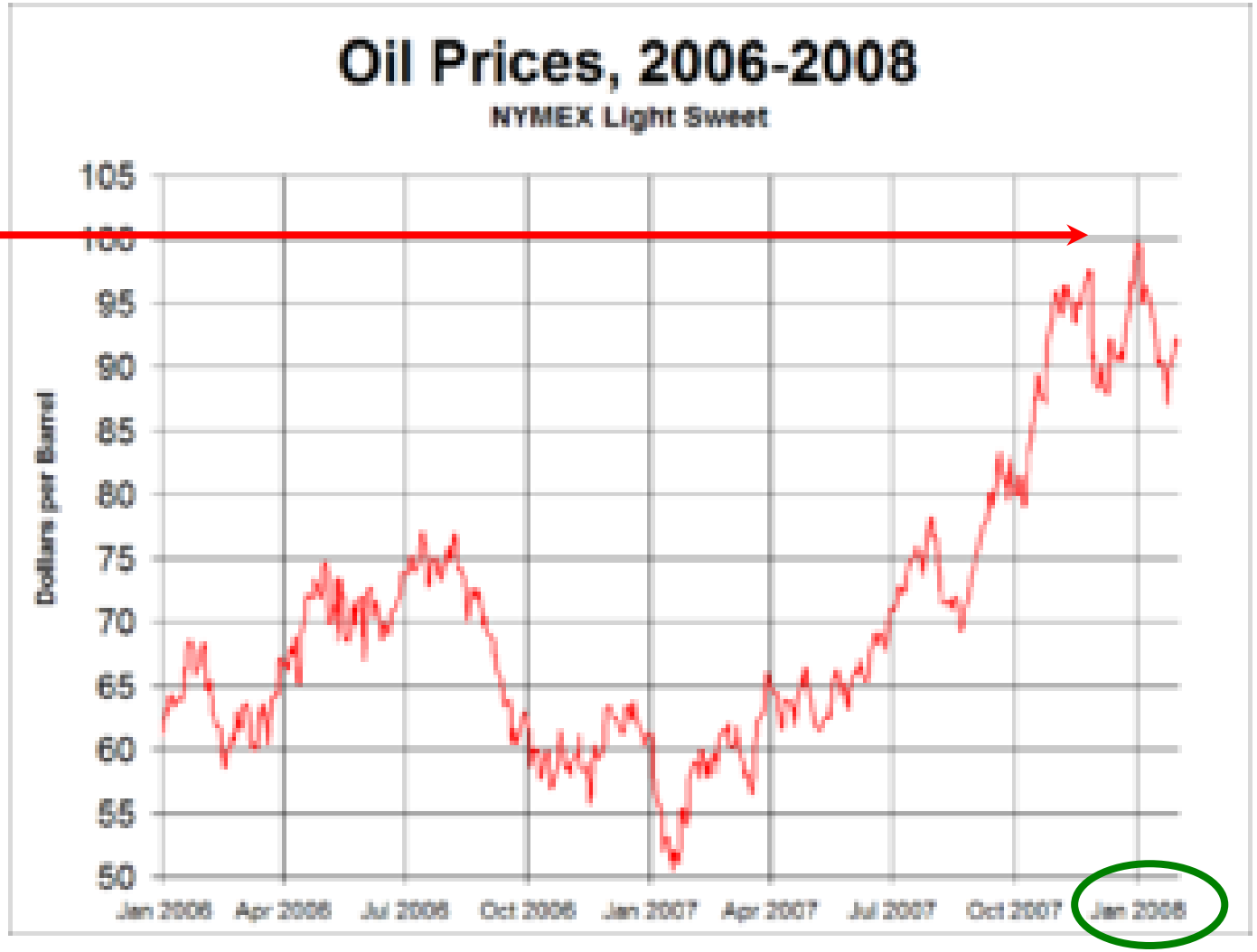
2. Costs of production, especially feedstock costs

3. Government support

1. Price of Crude Oil

$US 100 per barrel

Biofuels become Competitive at $US 60-70 Per barrel

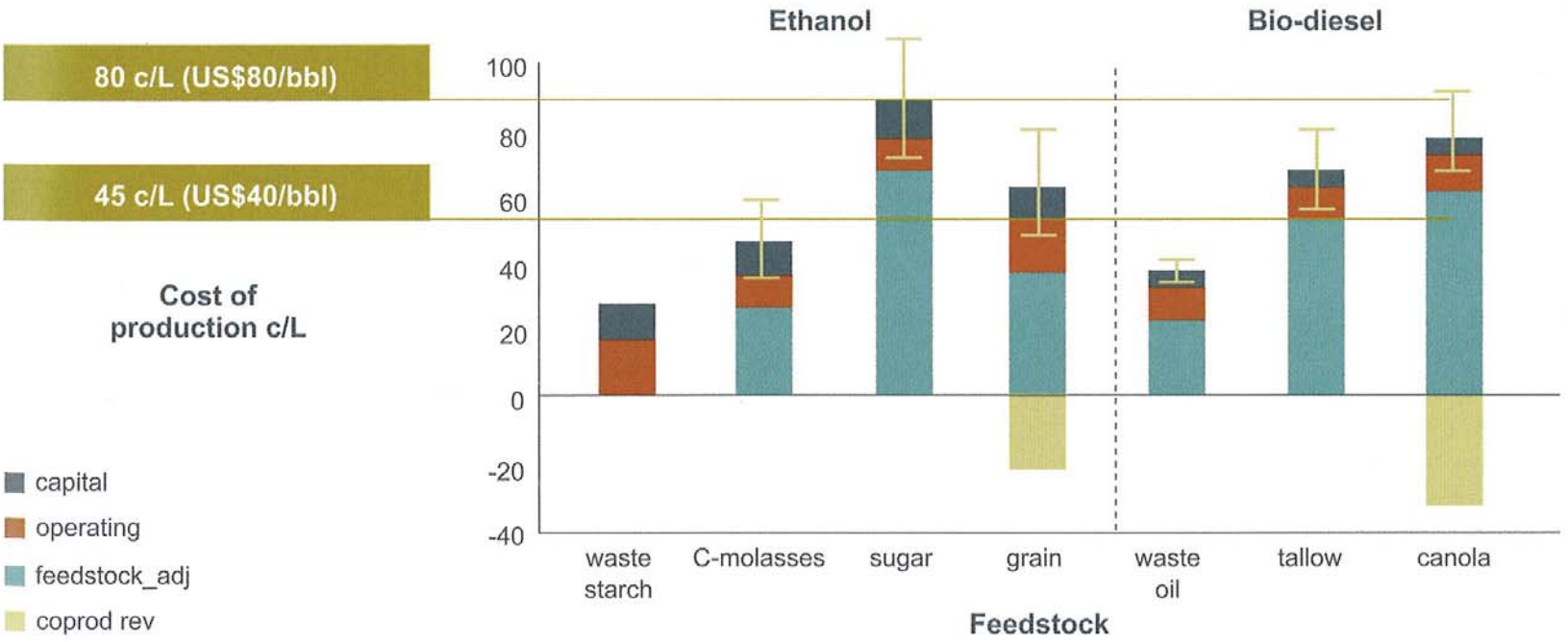


Source: Nymex, 2008

January 2008

2. Cost of Production

Figure 2-1 Indicative production costs in Australia, showing capital costs, operating costs, feedstock costs. The co-product revenues are shown as a negative cost [30].



Source: CSIRO, 2007

How would this be affected if there was another serious drought in Australia?

3. Government - Australian Context…

..in 2007, under Liberal Government

Commonwealth Government Mandatory Renewable Energy Target

- 350ML by 2010
- 148ML from ethanol
- 202ML from biodiesel

Assistance for Producers

- Production grant of 38.1c/L (offsets 100% of excise)
- This is set to fall to 12.5c/L for ethanol and 19.1c/L biodiesel by 2015 (will offset excise 50%)
- Capital grant for new facilities – 1c/L over the lifetime of the plant

Fuel Tax Act 2006

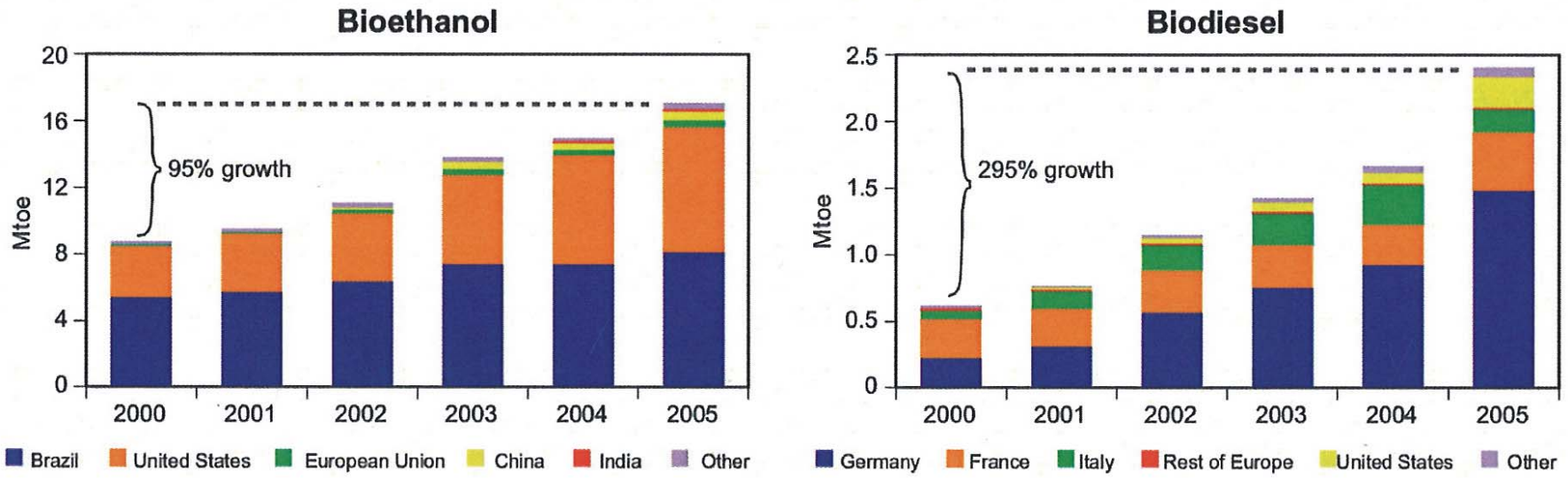
- Ethanol imports are subject to 5% general tarrif and 38c/L excise
- A banded excise system will impose rates on fuels - classified according to energy value
- Payment of a producers grant extinguishes the fuel tax liability – if producers of the fuel get a grant, the purchasers cannot claim a fuel tax credit.
- Government makes it difficult for small scale producers to sell to oil majors due to lack of incentives and changes to the fuel tax act.

International Context

Current World Production

- 18Mtonne of ethanol per year
- 2.5Mtonne of biodiesel per year

Figure 1 Global ethanol and biodiesel production (from IEA Energy Tech Essentials Jan 2007)



Source: CSIRO, 2007

International Context

Brazil

- Biofuel target: 44 billion litres by 2016
- The world's largest producer and exporter of bioethanol (from sugarcane)
- 45% of total transport fuel is from bioethanol
- Strong government support – mandatory blend, and investment in infrastructure
- Strong support from motor vehicle industry – production of FlexiFuel cars
- Closely linked with sugar production in Brazil and as sugar prices rise, many manufacturers choose to switch from ethanol to sugar production

EU

- Biofuel target: 5.75% of transport fuels by 2010
- Majority of current supply comes from biodiesel
- Fuel policies are gradually shifting to be consistent with carbon trading
- Biofuels are exempt from taxes on mineral oil products
- World leaders in renewable energy
- To meet target the European Commission has adopted EU Strategy for Biofuels

USA

- Biofuel target: 36 billion litres by 2020
- The key to the growth of bioethanol in the US has been the 1990 Clean Air Act
- The world's second largest producer of bioethanol
- Subsidies exist at many points in the supply chain – production to consumption
- Total subsidies are estimated to be A$ 9 billion
- Investment in infrastructure and research
- Even if all corn harvested was converted to ethanol, would only cover 16% of USA petrol use

Source: FAO, 2008

Figure 9. Maize utilization and exports in the United States

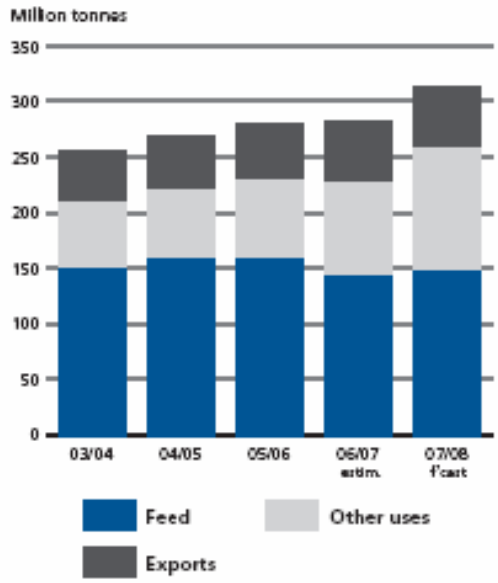
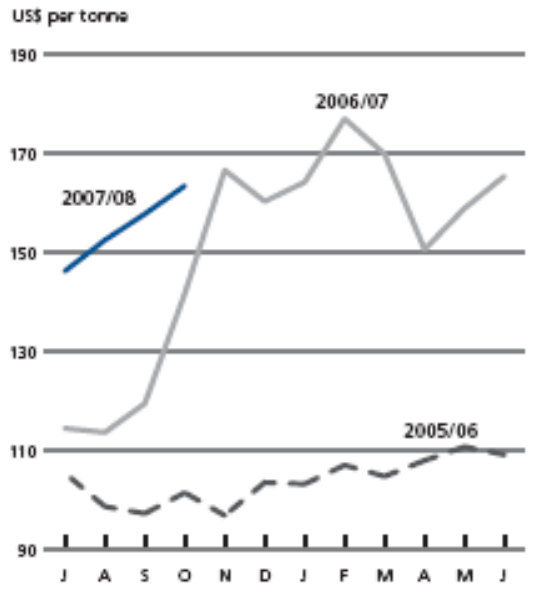


Figure 6. Maize price (US no. 2 yellow, delivered United States Gulf)



Factors Affecting Demand

In Australia

Intermediate Demand

- purchasing patterns of oil companies, service stations and farming co-ops who process, blend and distribute fuels
- Only 5% of retail service stations sell biofuels - mainly by small, independent
- Lack of investment in harvesting and conversion technology
- Australian Fuel Tax Act 2006

Final Demand

- Purchase by consumers
- Consumer confidence is a major barrier
- Motorists are concerned that ethanol will damage their engine
- Lack of distribution channels,
- Blends not readily available in the southern and western states

Strategies to Stimulate Demand

In Australia

- Industry based information dissemination
- More marketing and promotional activity
- Simplification of the Federal Chamber of Automotive Industries vehicle list on E10 suitability
- Further E10 vehicle operability testing
- Simplification and modification of current fuel information standard
- Removal of demand barriers
- Rollout incentives eg. investment incentives to encourage retail distribition
- Price discounting
- Mandating fuel blends eg. E10 and B5
- Producing or mandating FlexiFuel vehicles

Unsuccessful Attempts

Australian Biodiesel Group

Opened in 2005 in Queensland
Closed in 2007 due to increasing price in tallow

Australian Renewable Fuels

Opened in South Australia in 2005
Closed in 2007 due to increasing price of tallow and canola

Natural Fuels Limited

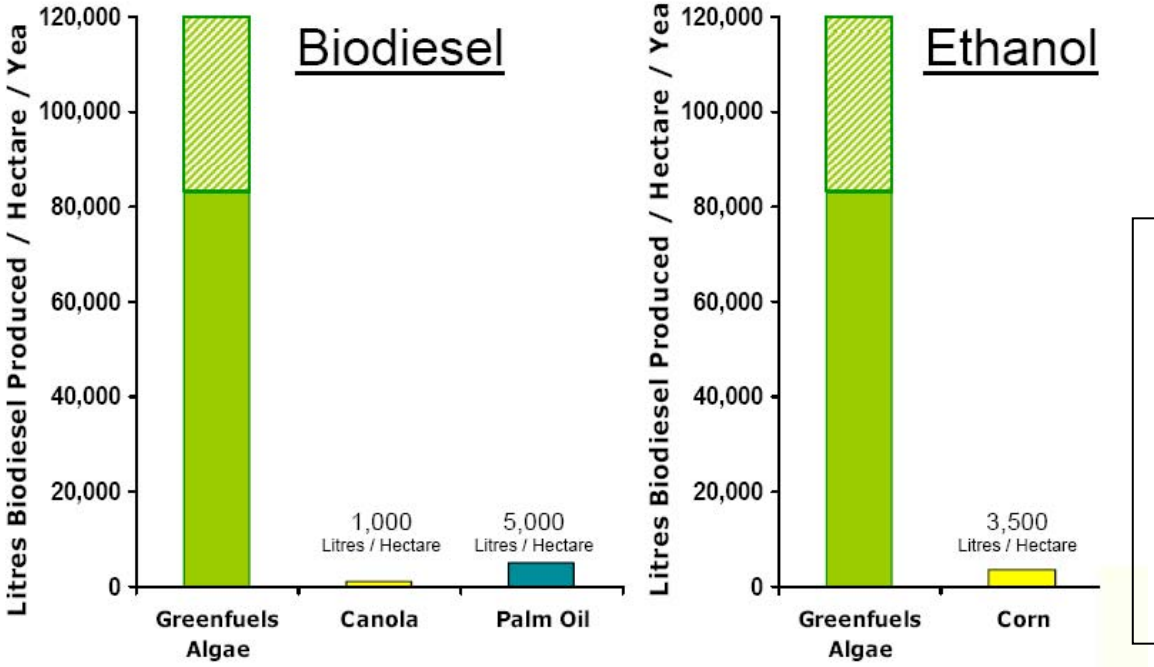
Darwin based operation, opened in February 2007
Using imported palm oil from South East Asia
Exporting biodiesel to USA and Asia

Biodiesel Producers Barnawartha Plant

- Opened December, 2007
- 60ML capacity
- Multi-feedstock technology
- Primary feedstock is tallow, and smaller amounts of canola and used cooking oil
- Meets the Australian, NZ, EU and US Standards
- Strong partnership agreements with feedstock suppliers locally and nationally
- Developing relationships with with major fuel distributors and users

Biomax - Victor Smorgan Group

- 100 ML plant in Laverton Victoria
- Involved in the collection and processing of used cooking oil
- Development of byproducts to supply animal feed industry
- R&D into algae-biofuel for ethanol, biodiesel and protein meal



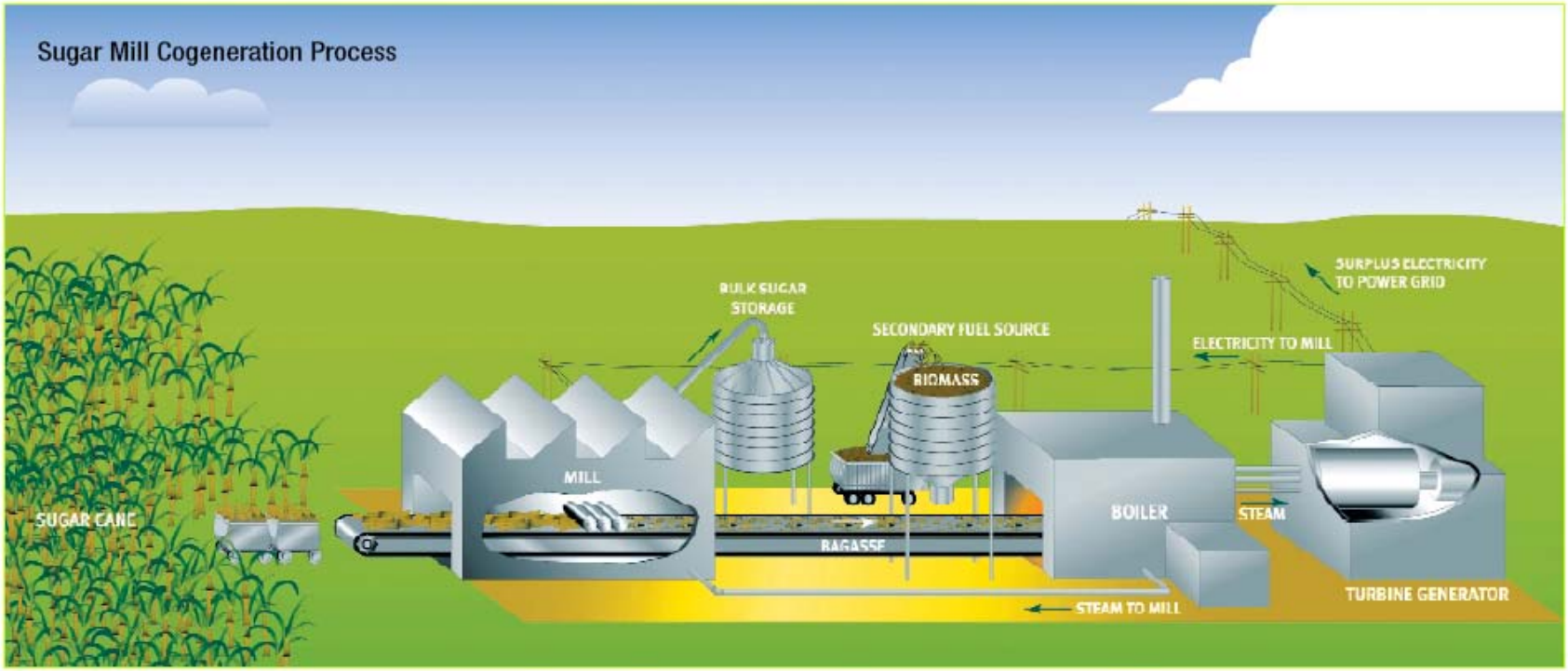
Algae

- excellent CO2 sequester
- grows quickly
- can be grown anywhere
- water source does not have to be good quality – suitable for waste water streams
- doesn't require large areas

Source: Biomax, 2007

Rocky Point Cogeneration Plant

- $55 million co-generation plant, attached to Rocky Point Sugar Mill in Qld
- Has been using co-generation (from bagasse) to power the station for years
- recently underwent refurbishment with government financial assistance
- project was to ascertain whether sugar milling boiler technology could burn biomass sources other than bagasse
- year-round energy supply from the cogeneration plant has made it possible for the sugar mill to undertake value-added products eg. distillation of ethanol



Source:

Macquarie Oil Co.

- The Macquarie Oil Company will spend half a million dollars on a specially designed facility in Tasmania's Northern Midlands.

- The plant will produce more than five million litres of fuel each year for the transport and marine industries.

- The unique blend of feed stock, including poppy seed, will make it more viable than most operations.

Relevance to Rural Australia

- Energy industry will provide new opportunities to develop regional enterprise
- Increased fuel security
- Agricultural sector has the potential to ‘produce and consume’ its own fuel and develop a truly sustainable industry
- Reduction in carbon emissions due to less transportation involved in fuel distribution
- Job creation in rural areas
- Value adding benefits for byproducts such as glycerol, biopesticides, and animal feed
- Opportunities to slow the population migration out of rural Australia
- Formation of partnerships and increased social capital

Future of Biofuels

???

- Can we rely on irregular feedstock supply?
- How do we justify feeding the biofuel industry when so many people are starving?
- Should Australia follow in the steps of the USA, Brazil and EU?
- What government interventions need to be implemented?
- Is Australia's biofuel target too ambitious? Or not ambitious enough?
- Should biofuel production be encouraged in the developing world?
- Is a good idea to invest in distribution and production infrastructure?
- Are there better alternatives? Biobutanol, MTHF?
- How do we overcome barriers to consumer uptake?
- Should we import biofuels? From which countries?
- What feedstocks are the most economically viable?
- Is the industry environmentally sustainable?
- What areas need further research?

The Road Ahead…

- Formed partnership with CSIRO and Clean Energy Council
- Currently developing questionnaire to distribute to farmers regarding the quantity of wastes they produce and alternative uses for these
- In the process of contacting major agricultural bodies to discuss possible partnerships
- Planning visits to farms in the southeast Queensland area to talk with farmers
- Will continue to keep on top of rapidly evolving research on biofuels and potential feedstocks

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