Prospects for Biofuels in Australia: Regional, Economic and Other Issues

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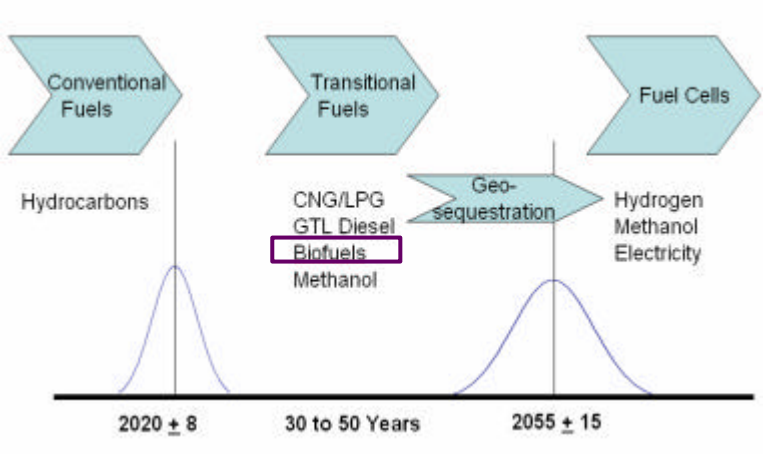
Today's Agenda

- International Markets involving Biofuels
- Biofuels Production, Capacities and Limits
  - *Australia*
  - *Western Australia*
- Comparative Costs
- Market and Consumer Resistance
- Lifecycle Analysis of GHG emissions
- CSIRO's Alternative Transport Fuels Ready Reckoner
- Australia's future transport needs
  - *A broader set of strategies*

Expected Transport Futures

We cannot afford to move from an existing, unsustainable fossil fuel dependence, to another system that may be unsustainable.



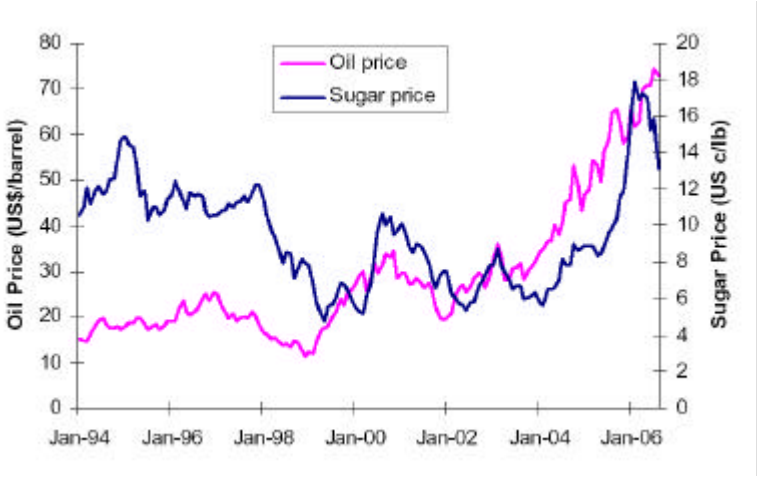
International Markets involving Ethanol

- **In world commodity markets, *food*, *livestock* and *ethanol* producers are competing for crops**
- **Ethanol = 94% of global biofuel production**
  - 61% of ethanol comes from ***sugar*** (beet, cane, molasses)
  - Most of the rest comes from ***grains*** - mainly U.S. corn
- **Ethanol from U.S. corn is relatively inefficient**
  - More than twice the cost of Brazil's sugar-based ethanol
  - Yields less ethanol per hectare than sugar beet or cane
  - GHG emissions are lower for all sugar pathways
  - Brazil is energy-efficient: bagasse to produce power

International Markets involving Ethanol

- **In ethanol's early days in the USA:**
  - grain prices were low and government assistance high
  - ethanol prices were high and facilities highly profitable
- **So much corn-based ethanol has changed this**
  - U.S. corn prices doubled in 12 months (but are lower now)
  - Wheat futures rose to their highest in 10 years
  - Ethanol production costs have risen
- **Persistently high grain prices could:**
  - hurt food and livestock industries in the USA
  - drive up food prices elsewhere (e.g. Mexico, China, India)
  - turn the tide on subsidy support for the US ethanol industry

Are Oil, Sugar and Ethanol Prices linked?



Source: Howden et al (2006)

International Biodiesel Markets

- **In Europe, a rising share of the food industry's raw materials are being used for biofuels**
  - predominantly ***biodiesel***, *a little* ***hydrogenated diesel***
- **The EC wants biofuels to reach a target of 10% of all vehicle fuel by 2020**
- **Biodiesel is attracting an increasing share of Europe's vegetable oil supplies**
- **Rapeseed oil prices have doubled in 5 years**
- **Prices of cereals, starches and glucose have increased recently by about 20%**

Biofuels production and capacity in Australia

	Feedstocks	Estimated Production (ML/yr)	Current Capacity (ML/yr)	*Proposed Capacity (ML/yr)*
Ethanol	Waste starch, C-molasses, ***Various grains***	75* [Manildra 80%]	148	***1,155***
Biodiesel	Used cooking oil, Tallow, ***Oilseeds***	50	323	***1,122***
Total		**125**	**471**	***2,277***

*Production of fuel ethanol: 23 ML in 2004-05 (Biofuels Taskforce, 2005)
40 ML in 2005-06 (DITR)
75 ML in 2006-07 (CSIRO estimate based on DITR figure of 43 ML after 7 months)

Current/proposed capacities: O'Connell et al (2007), p 22.

The ATO and Capital Grants office monitor some statistical trends in the production, stocks, imports and exports of biofuels

Biofuels production and capacity in W.A.

	Feedstocks	Estimated Production (ML/yr)	Current Capacity (ML/yr)	*Proposed Capacity (ML/yr)*
Ethanol	***Wheat***	0	0	***160*** Primary Energy (Kwinana)
Biodiesel	Canola and Tallow	?	45 ARF (Picton)	***45***
Total		**?**	**45** (**9.5%** of nation)	***205*** (**9%** of nation)

Proposed capacities: O'Connell et al (2007), p. 22.

***"A number of ethanol projects have been proposed for this State, including facilities at Kwinana, Esperance and Bunbury"* (WA Biofuels Taskforce Interim Report, 2007, p. 8)**

Physical limits from Australian agriculture - Ethanol

Feedstock	Conv factor (L/t)	Australian production (Mt)	Volume of ethanol from all feedstock (ML)	% of 05-06 petrol equiv.	Australian Exports (Mt)	Volume of ethanol from exports only (ML)	% of 05-06 petrol equiv.
Sugar	620[E]	5.1 (4.2 - 5.5)[A]	3,193	**11%**	4.0 (3.6 - 4.2)[A]	2,480	**8.5%**
C-Molasses	280[D]	1.0 (0.6 -1.2)[B]	280	**1%**	0.5[B]	140	**0.5%**
Wheat	360[D]	21.5 (10.1-26.1)[A]	7,740	**27%**	14.8 (9.1-17.9)[A]	5,337	**19%**
Coarse grains	360	12.4 (6.9 -15.6)[A]	4,466	**16%**	5.6 (3.8 -7.2)[A]	2,028	**7%**
TOTAL for Australia			**15,679**	**55%**		**9,985**	**35%**

[E] Sited preliminary calculations (unpublished)
[A] ABARE Australian Commodity Statistics 2006, 2001-02 to 2005-06 data used.
[B] CSIRO/BTRE/ABARE 2003 350ML report p 49
[D] DEUS (Bioenergy Handbook) 2005
[E] Enecon

Physical limits from W.A. agriculture - Ethanol

Feedstock	Conv factor (L/t)	Western Australian production (Mt)	Volume of ethanol from all feedstock (ML)	% of 05-06 petrol equiv.	Western Australian exports (Mt)	Volume of ethanol from exports only (ML)	% of 05-06 petrol equiv.
Sugar	620[E]	0.057[A]	35.12	**1%**	0.057	35.12	**1%**
C-Molasses	280[D]	0.011[B]	3.17	**0.1%**	?	?	**~0**
Wheat	360[D]	8.2 (4.0 -11.1)[C]	2,950	**104%**	6.56[F]	2,360	**83%**
Coarse grains	360	2.9 (1.8 - 4.0)[C]	1,033	**36%**	1.72	620	**22%**
TOTAL for W.A.			4,021	**141%**		3,015	**106%**

CSIRO preliminary calculations (unpublished)
[A] Assumed to be 1.1% of the Australian crop (according to DAFWA).
[B] Assumed to be 20% of sugar production.
[C] ABARE Australian Commodity Statistics 2006: 2001-02 to 2005-06 data used.
[D] DEUS (Bioenergy Handbook) 2005
[E] Enecon

Physical limits from Australian agriculture - Biodiesel

Feedstock	Conv factor L/t	Australian production (Mt)	Biodiesel volume, all feedstock (ML)	% of 05-06 diesel	Australian exports (Mt)	Biodiesel exports, all feedstock (ML)	% of 05-06 diesel
Used cooking oil	870[A]	0.10 (0.09 – 0.11)[A]	85	**0.5%**			
Tallow	894[A]	0.50[A]	447	**3%**	0.34[A]	304	**2%**
Oilseed crops (canola, cottonseed and others)	400	2.41 (1.52 -3.10)[B]	965	**6%**	1.28 (0.89 -1.92)[B]	513	**3%**
TOTAL for Australia	n/a	n/a	1,497	**9.5%**		817	**5%**

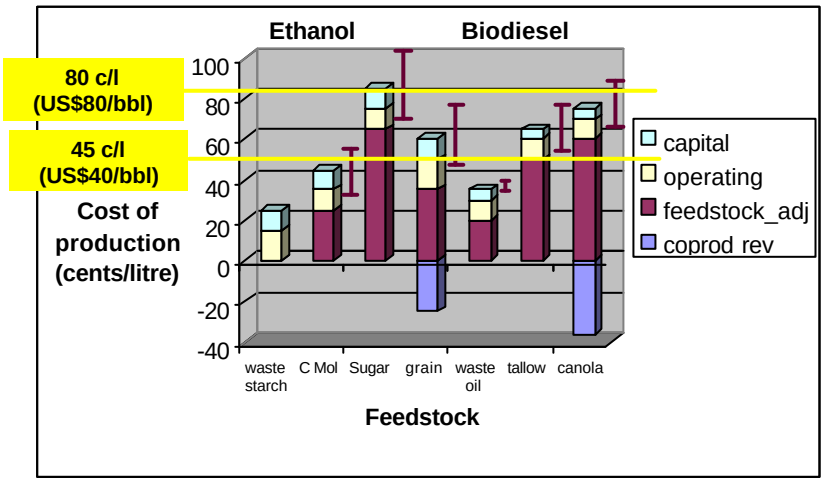
[A] Based on CSIRO calculations (unpublished)
[B] ABARE Australian Commodity Statistics 2006: 2001-02 to 2005-06 data used.

Physical limits from W.A. agriculture - Biodiesel

Feedstock	Conv factor L/t	Western Australian production (Mt)	Biodiesel volume, all feedstock (ML)	% of 05-06 diesel	Western Australian exports (Mt)	Biodiesel exports, all feedstock (ML)	% of 05-06 diesel
Used cooking oil	870[A]	0.01[A]	9	**0.3%**			
Tallow	894[A]	0.04[A]	36	**1.2%**			
Oilseed crops (Canola)	400	0.472 (0.30 - 0.63)[B]	189	**6%**	0.425[A]	170	**5%**
TOTAL for W.A.	na	na	1,538	**7.5%**		170	**5%**

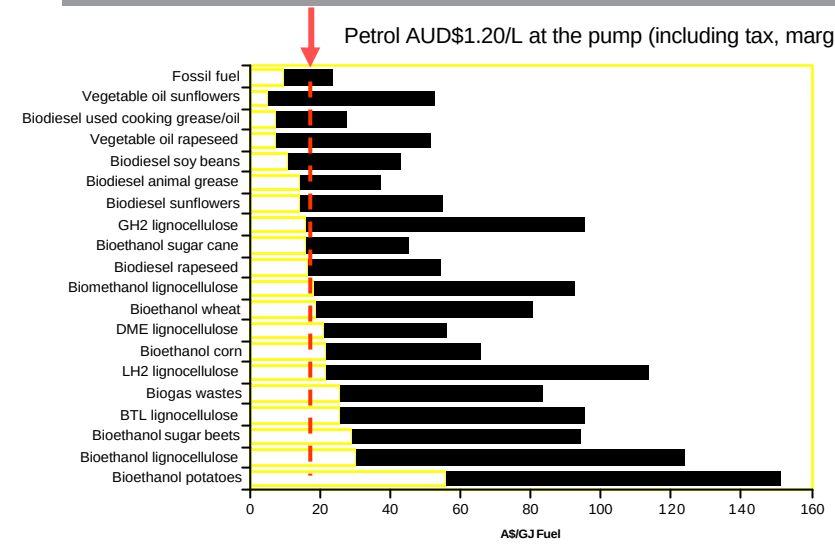
[A] Based on CSIRO calculations (unpublished) and WA Biofuels Taskforce Interim Report (2007)
[B] ABARE Australian Commodity Statistics 2006: 2001-02 to 2005-06 data used.

Estimates of current cost competitiveness



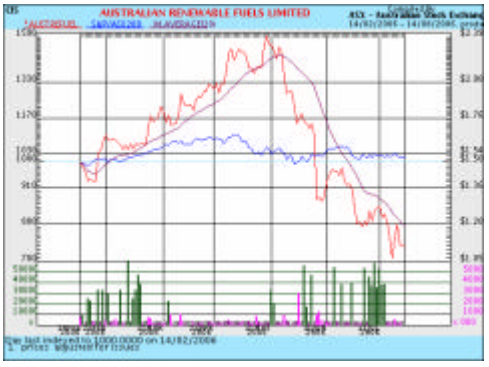
CSIRO calculations, AltTransFuels team, 2006 draft data

Costs of new conversion technologies and fuels



Adapted from IFEU (2004), based on the average annual exchange rate between Euros and Australian Dollars for 2004. Reference point for petrol calculated by CSIRO

Lack of Market Confidence in Biofuels



In 2007, the share price of Australian Renewable Fuels & other biodiesel producers have fallen further, with ARF currently trading in the 30-40 cents range.

Low Demand from Oil Majors

- In 2001, Fed Govt. set a biofuels target of **350ML by 2010** but this target was not mandated (i.e. legislated)
- In 2005, industry projections in Govts. ***Biofuels Action Plan*** showed that, collectively, **oil majors expected to exceed the biofuels target of 350 ML by 2010 – *???***
- **Only about 5% of the 8,000+ service stations across Australia are selling ethanol or biodiesel blends.**
- **Very slow rollout** of biofuels by the oil majors
- **Our fuel ethanol industry is sustained mostly by independent, small-scale fuel providers (e.g. Gull)**
  - *Manildra (2006): sold 23ML in 6 months, 9ML to oil majors*
- **Limited availability of E10 in southern and western states** remains a major barrier stifling growth in demand.

Lack of Consumer Confidence in Ethanol?

Attitudes to Buying Petrol Containing Ethanol

Motorists were asked whether they are happy to buy petrol with ethanol in it or not. They were then asked their reasons in an open-ended question.

Petrol with ethanol:	2005 TOTAL %	2005 Urban %	2005 Regional %	COMPARE 2003 TOTAL %
Happy to buy	25	22	31	22
Not happy to buy	35	37	30	44
Have reservations	21	21	22	19
Unsure	19	20	17	15
Total not happy/have reservations	56	58	52	63

Queensland = 35%

W.A. = ?

Sources: ANOP (2005) and WA Biofuels Taskforce (2007)

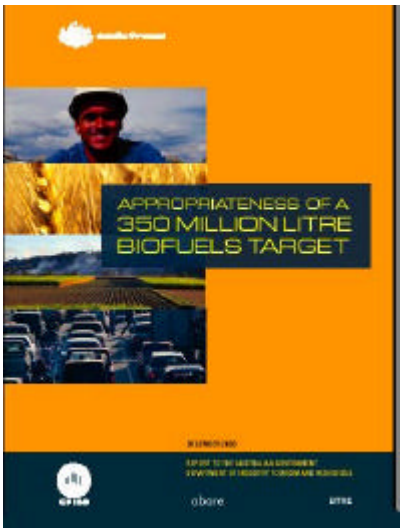
Appropriateness of a 350ML Biofuels Target

A joint study by **CSIRO** with **ABARE** (Australian Bureau of Agricultural Research and Economics and **BTRE** (Bureau of Transport Research Economics)

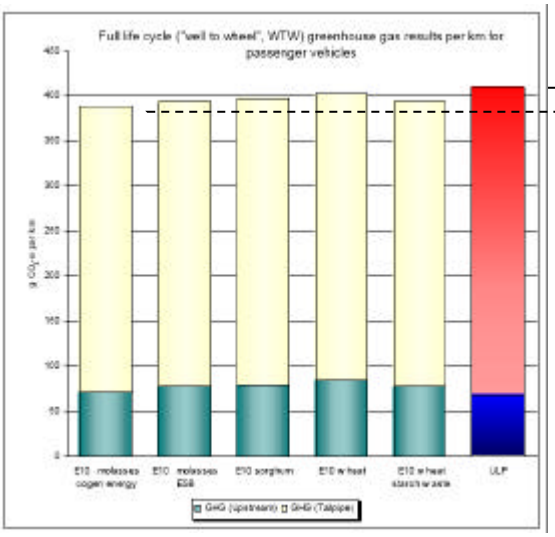
Environmental focus on **GHG** emissions and urban air pollutants from Lifecycle analysis

Included economic modelling by **ABARE** & regional development objectives from **BTRE**

Modest environmental benefits associated with use of **E10** and greater benefits associated with use of pure ethanol or biodiesel



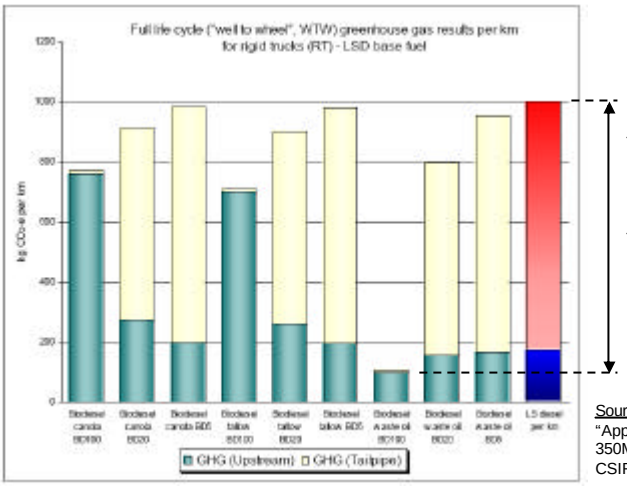
Lifecycle GHG emissions per km for passenger vehicles running on E10 (various feedstocks) and ULP



GHG SAVINGS:
From **1.7%** (for wheat) to **5.1%** (for molasses using co-generation)

Source: Beer et al (2003), "Appropriateness of a 350ML Biofuels Target", CSIRO/ABARE/BTRE

Lifecycle GHG emissions per km for rigid trucks running on Biodiesel (B100, B20, and B5) compared to LSD



GHG SAVINGS:
From **2%** (for B5 from canola) to **90%** (for B100 from waste oil)

NOTE: The upstream processes of growing and harvesting canola lead to high GHG emissions (4.4 times higher than LSD and 3.7 times higher than XLSD)

Source: Beer et al (2003), "Appropriateness of a 350ML Biofuels Target", CSIRO/ABARE/BTRE

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- **Biofuels Production, Capacities and Limits**
  - ***Australia***
  - ***Western Australia***
- **Comparative Costs**
- **Market and Consumer Resistance**
- **Lifecycle Analysis of GHG emissions**

Take-home messages?

- **CSIRO's Alternative Transport Fuels Ready Reckoner**
- **Australia's future transport needs**
  - ***A broader set of strategies***

Some "take-home" messages (so far)

1. There is growing conflict between food, fuels, energy, water, livestock and a livable, sustainable environment

2. There is a slow rollout of biofuels by the oil majors and some consumer resistance to ethanol

3. 1st-generation biofuels could play a small role in our transitional fuels mix (as a stepping stone to 2nd-gen)

4. Can we rank feedstocks for ethanol production? e.g.

- BEST = Waste starches and waste biomass
- NEXT BEST = C-molasses from sugar production
- WORST = Grains

Not that simple! **DGs**

5. Can we rank feedstocks for biodiesel production? e.g.

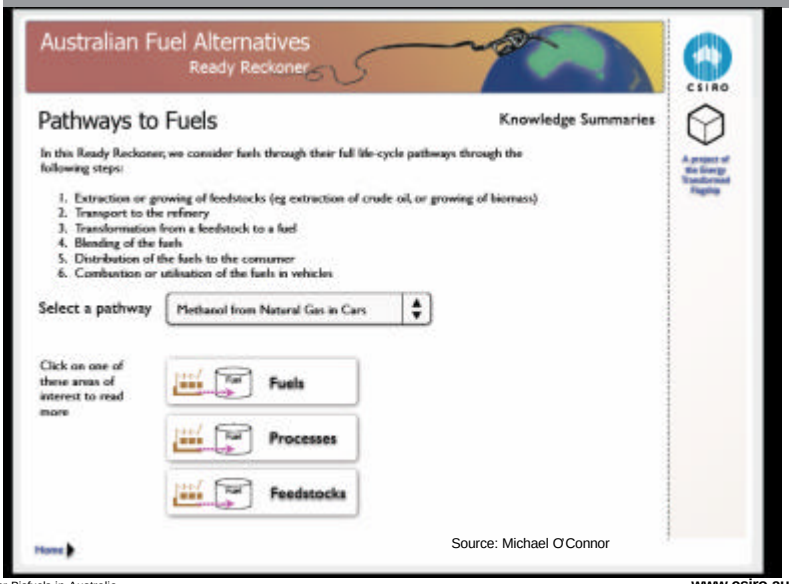
- BEST = Used cooking oil
- NEXT BEST = Tallow
- WORST = Oilseed crops

Not that simple! **Quality**

CSIRO's Alternative Transport Fuels Project: The Ready Reckoner

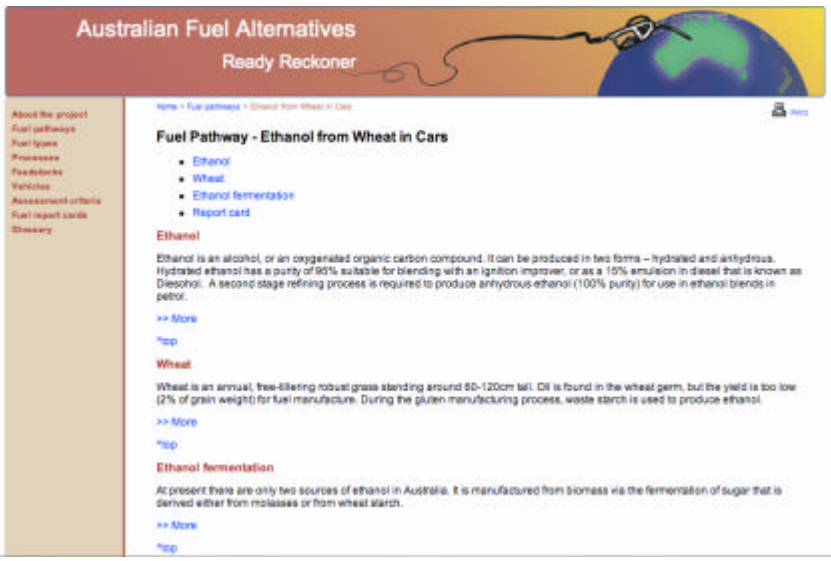
- **In complex debates about multiple candidate technologies, together with high political and public interest, we must**
  - **Go beyond development, assessment and debate of single technologies (e.g. nuclear, ethanol)**
  - **Assess the relative merits of competing feedstocks and technologies using a consistent approach**
  - **Summarise the best of our knowledge in accessible and defensible ways for a range of audiences with different levels of understanding**
  - **Provide the information to underpin decisions and investment in research by CSIRO, as well as by government policy makers and industry**

Summarising our current knowledge:
Ready Reckoner report cards



Source: Michael O'Connor

Summarising our current knowledge:
Ready Reckoner report cards



Summarising our current knowledge:
Ready Reckoner report cards

Report card

Data are based on a mixture of measurements and modelling. These assessed values derive from passenger vehicles (maximum weight 3.5 tonnes) running a wheat-derived E10 (10% ethanol) petrol blend and operating on the European Drive Cycle (EDC) 2003.

Blend

E10

Assessment ***15 December 2006***

Category	Component	Rating	Reliability of Evidence	Assessed Value (Range)	Units
1. Surety of supply					
1a. Future	% of current transport fuel market which can be supplied	Neutral	Medium	15 (10 - 20)	%
	Likely duration of supply at this annual rate	Advantage	Low	>50	years
	Uncertainty associated with supply (e.g. political, seasonal)	Disadvantage	Low	>30	%
2. Sustainability					
2a. Greenhouse gases	GHG (full life cycle) for cars	Neutral	High	236.09	g CO_2 equiv/km
	Energy Output / Energy Input	Disadvantage	High	0.93	Ratio
2b. Air quality	PM10	Disadvantage	High	10.04	mg/km
	CO	Neutral	High	2.26	g/km
	HC	Advantage	High	0.40	g/km
	NO_x	Advantage	High	0.33	g/km
2c. Land and water quality	Land usage	Neutral	Medium	0.04	ha/GJ
	Water extracted from water supplies	Disadvantage	High	8333	Litres/GJ
	Water uptake by feedstock growing cycle	Disadvantage	High	21920	Litres/GJ
	Impact of cultivation practices (fertiliser and pesticide usage, tillage practices)	NA	Varies	Varies	Impact/GJ
2d. Biodiversity	Impact on natural environment and habitat	NA	Varies	Varies	Impact
2e. Social	Impact on quality of life and economic well-being of rural Australia	Neutral	Low	Neutral	Impact
2e. Social	Impact on quality of life and economic well-being of rural Australia	Neutral	Low	Neutral	Impact
3. Cost of supply					
3a. Supply of feedstock	Cost of extraction and delivery of feedstock materials (car)	Advantage	High	5.2	c/km
3b. Transformation of feedstock	Cost of transformation of fuel and distribution costs (car)	Advantage	High	2.1	c/km
3c. New capital requirements	Processing facilities	Disadvantage	High	Entirely new infrastructure	Infrastructure change
	Distribution	Neutral	Medium	Significant modification to infrastructure	Infrastructure change
	Vehicles	Advantage	High	None to minor mods	Infrastructure change
4. Health and safety					
4a. Production storage and distribution	Refuelling and distribution	Neutral	Low	Similar	Performance relative to petrol
	Accidents and on board mishaps	Neutral	Low	Similar	Performance relative to petrol
5. Consumer acceptance					
5a. Fuel consumption habits	Refuelling and distribution	Advantage	High	No or little change	Scale of change
	Vehicle	Advantage	High	No or little change	Scale of change

>> References and further information (PDF file)

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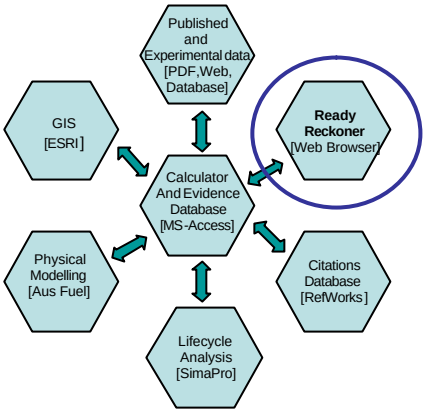
Summarising our current knowledge:
Ready Reckoner report cards

Prospects for Biofuels in Australia www.csiro.au

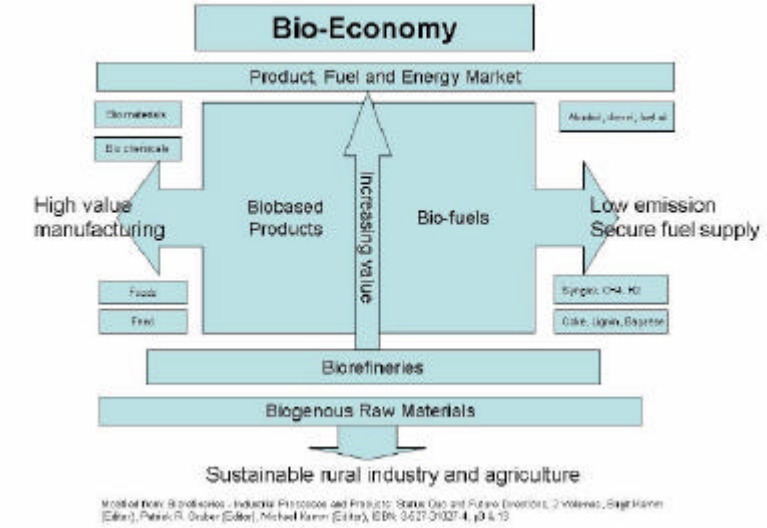
CSIRO's Alternative Transport Fuels Project:
Calculator and Evidence Database

System components and interactions

- Initial interaction between components is manual/managed.
- Over time, the links will transform to semi-live or harvestable.



CSIRO's Alternative Transport Fuels Project:
A broader model for research into "Biofutures"…



Australia's future transport needs
A broader set of strategies

- **Talk has focused on prospects for biofuels in Australia and some implications of their production and use**
- **However, biofuels are only a small part of the necessary solution to our future transport and energy needs**
- **A broader range of responses will be required to address the main drivers: *environment, energy security, health, and regional opportunities***
- **In the case of the major driver – greenhouse emissions and climate change – this will include *mitigation* (reducing emissions) and *adaptation* (preparing to deal with higher CO_2 levels in our socio-ecological systems).**
- **I shall finish with a range of potential strategies, and the drivers that they address:**

Australia's future transport needs
A broader set of strategies

STRATEGY	EXAMPLES	DRIVER ADDRESSED
Reduce overall demand	• Use less processed energy, more human energy • Eco-efficient urban design • Improve energy efficiency and self -sufficiency of farming systems, rural communities and regions • Eco-efficient, closed loop production systems which minimise waste • Efficient engine technologies e.g. hybrid electric, smaller engines • Energy recovery from waste management	• **Climate change, land and water** • **Energy security** • **Regional opportunities** • **Health**
Use or sequester the target gases	• Target most potent GHG emissions e.g. methane. • Geo-sequester (bury) CO_2 at point sources e.g. at power stations • Bio-sequestration e.g. capture in biomass (reforestation; capture CO_2 at point sources and use for algal production of biodiesel; agrichar for long term stable capture of capture CO_2 and improvement in soil condition	• **Climate change, land and water** • **Energy security** • **Regional opportunities** • **Health**

Source: O'Connell et al (2007)

Prospects for Biofuels in Australia www.csiro.au

Australia's future transport needs
A broader set of strategies

Expand and diversify use of fossil reserves	• New fossil fuel discoveries • More cost effective extraction and processing • Greater use of different types of gas (CNG, LPG) • New liquid fuel options - Gas to liquids (GTL), Coal to liquids (CTL)	• **Energy security**
Diversify sources or energy types	• Renewable sources – including solar technologies, wind, tidal and bioenergy for electricity • Fuel extended with bio-based blends: e.g. E10, BD20 • Biomass to liquids (BTL) – use of lignocellulosics • Biogas	• **Climate change, land and water** • **Energy security** • **Regional opportunities** • **Health**
Diversify products	• Bio-based replacements for petrochemical products • Biorefineries to optimise the use of a range of biomass sources in regional areas • Identification of high-value products and markets which may enable the profitable recovery of energy from biomaterial as a lower-order co-product	• **Climate change** • **Regional opportunities** • **Health**
and in the longer term …….?	• Hydrogen from coal with carbon capture and storage • Hydrogen from nuclear or renewable electricity.	• **Climate change** • **Energy security**

Source: O'Connell et al (2007)

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Thank You

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On Fuel Economy – E10 versus ULP

- **Differences in fuel economy are minimal**
- **A 10% ethanol blend contains only about 97% of the energy content of 100% petrol, but this is compensated by the fact that the combustion efficiency of E10 is greater.**
- **The net result is that consumers cannot detect a difference in their fuel economy**
- **On the contrary, many people using E10 fuels have said that their fuel economy has improved**

Source: Beer et al (2001), Comparison of Transport Fuels, CSIRO Report EV45A/2/F3C, page 352.