

Economic analyses and policy implications for microalgae biofuels in Australia.

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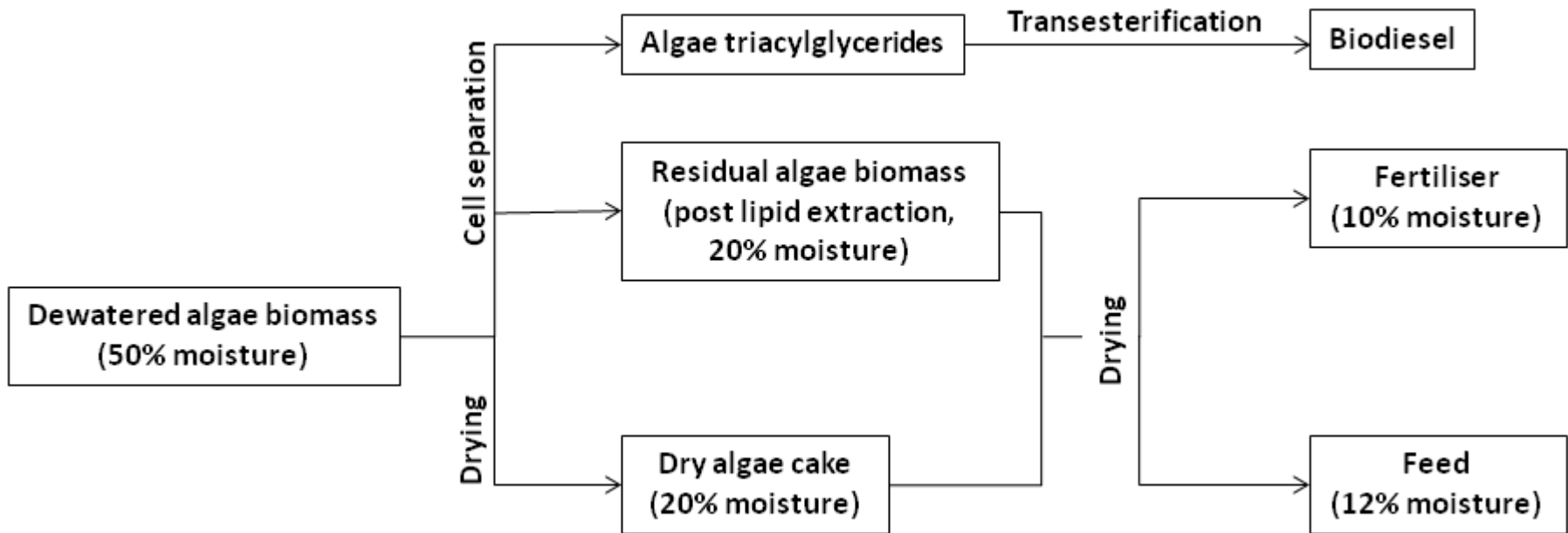


Current microalgae biofuel literature

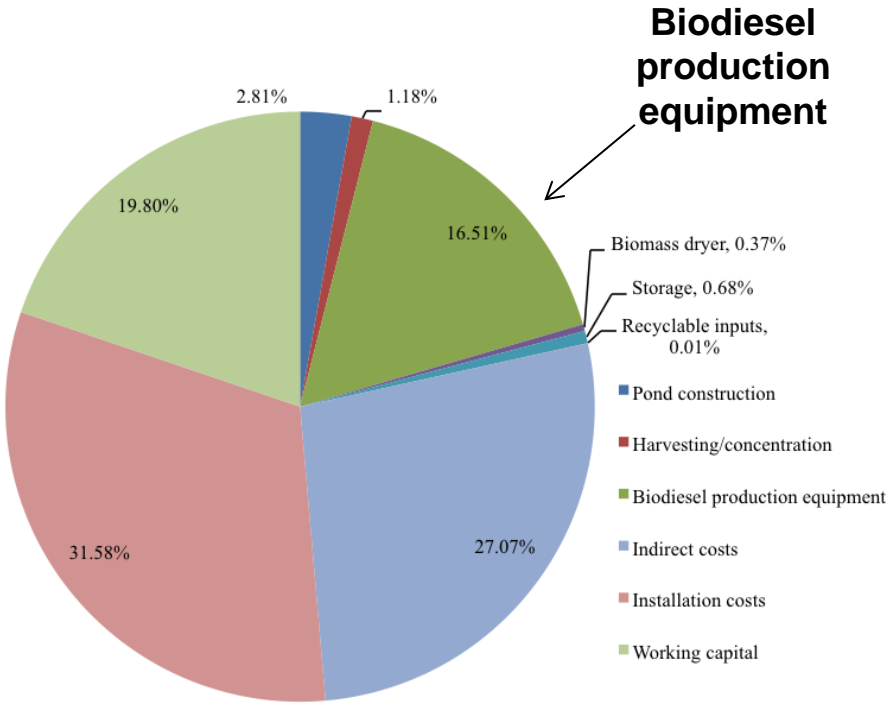
- Dominated by science and engineering literature
 - Techno-economic and sensitivity analyses
 - Life-cycle accounting
 - Energy ratio studies
- Gap in broader economic literature
 - Feasible complementary industries
 - Consumer preferences
 - Potential in policy framework

Expanding techno-economic analysis

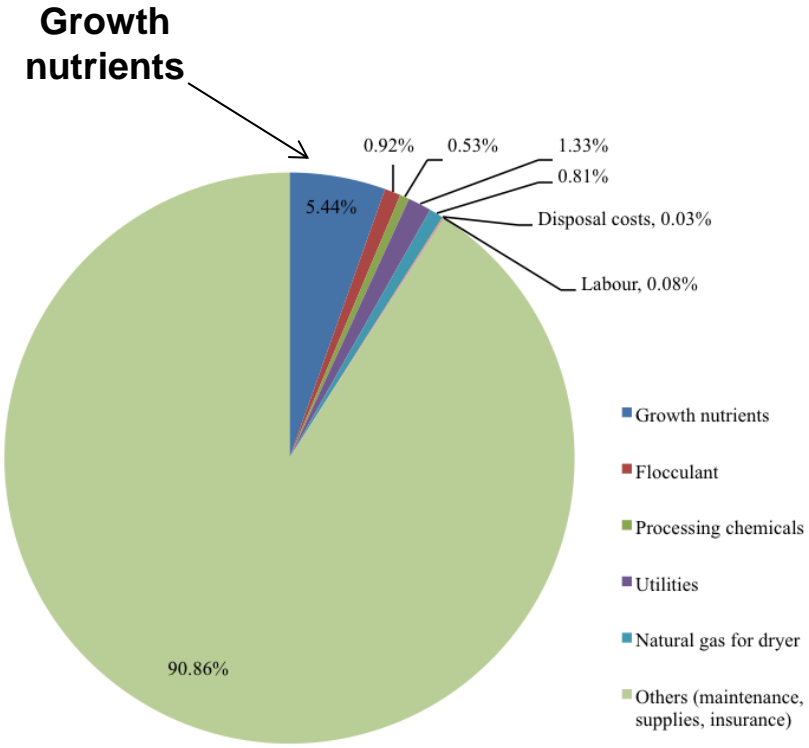
- Model incorporates production of agricultural fertiliser and aquaculture feed
 - Working off Darzins et. al. (2010)



Baseline valuation - Costs



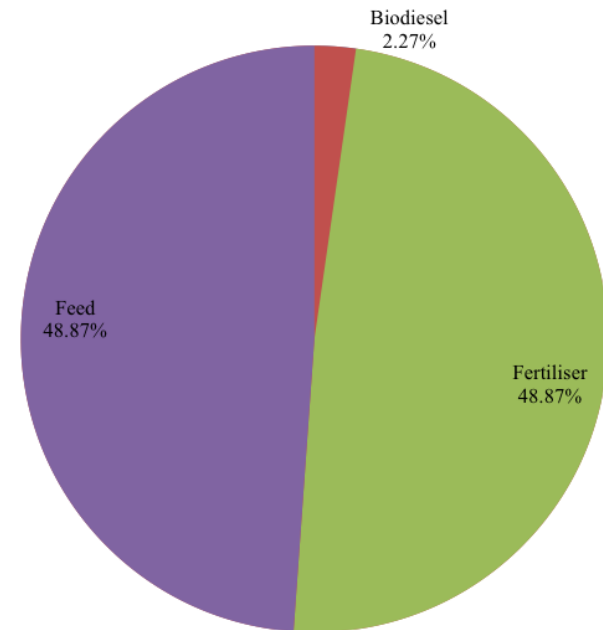
Capital costs



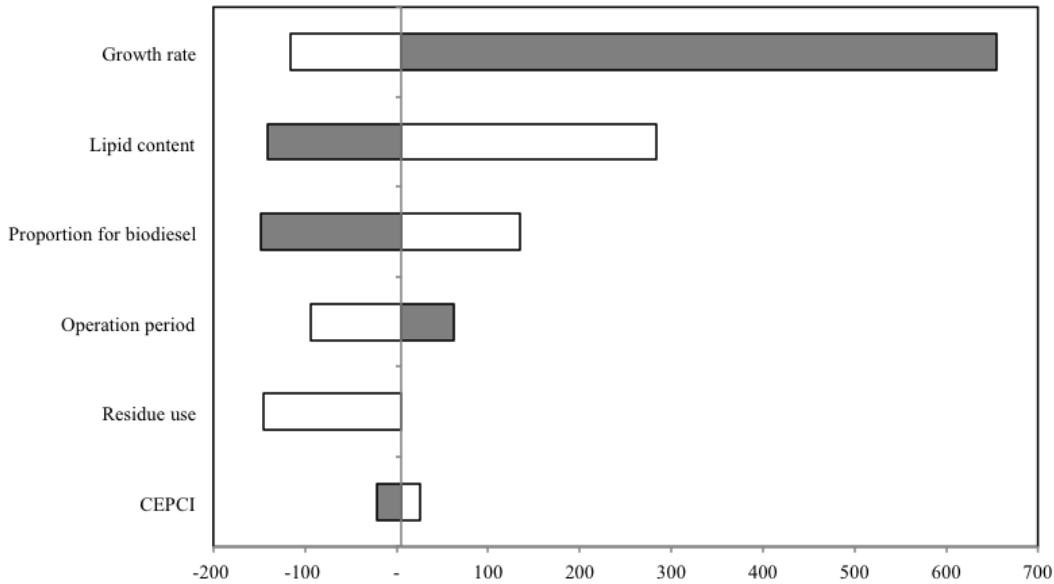
Annual operating costs

Baseline valuation – Revenue & NPV

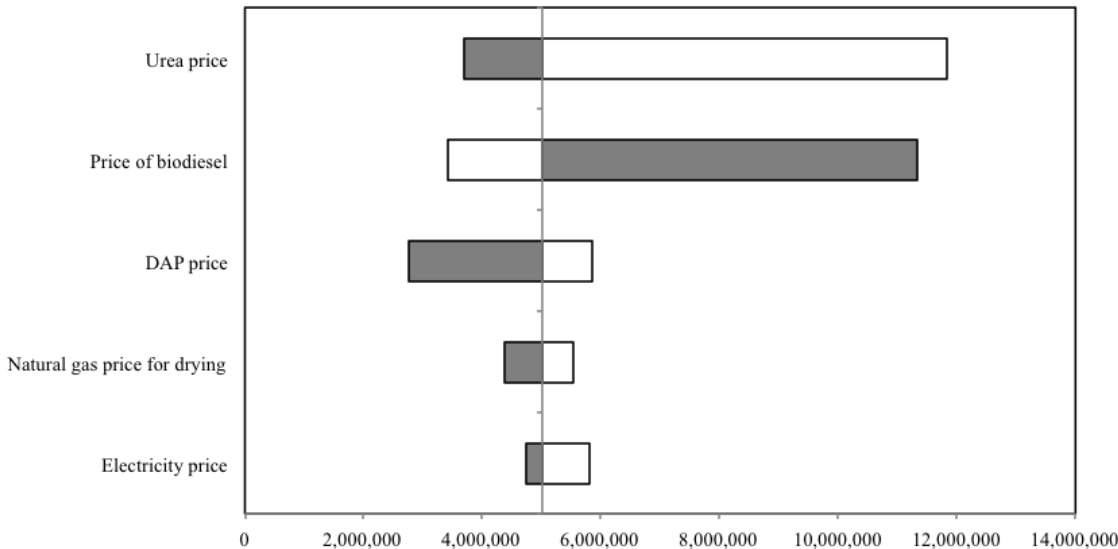
Output	Output allocation		Cost	Unit
	Primary	Residue		
Biodiesel	0.4		1.50	\$/l
Fertiliser	0.3	0.5	12.00	\$/kg
Feed	0.3	0.5	12.00	\$/kg
NPV (US\$)			5,011,000	
IRR (%)			10%	
Payback period (years)			20.2	



Sensitivity analysis



Baseline	Range
20 g/m ² /day	10 - 60
40 %	10 - 60
40 %	25 - 60
20 y	10 - 50
100 %	0 - 100
580.2	555.79 - 609.99



US\$ 750 /t	121.46 - 870.49
AUD\$ 1.50 /l	1.30 - 2.30
US\$ 550.89 /t	227.39 - 1409.90
AU\$ 7.99 /GJ	5.02 - 11.56
AU\$ 0.51 /kW	0.34 - 0.57

Findings and further analysis

- Growth rate has largest potential impact on feasibility and return of production
- Cost of biodiesel production equipment a major drawback even with co-product revenues
- Monte-Carlo simulations – NPV/Profit function
 - Squires (1987) profit function for multi-product firms
 - Efficient output allocation given input/output prices

Consumer willingness to pay

- Estimate the **economic value of benefits** of alternative biofuels over conventional biofuels using consumer **willingness to pay** values.
- Determine **socio-demographic and psychographic characteristics** of likely supporters of alternative biofuels.

Discrete choice experiment methodology

- Based on economic principles of utility maximisation
- Individual chooses from a given set of alternative based on non-market attributes of each alternative
- Choices are modelled using multinomial logit regressions

Survey design






Attribute	Description	Levels
Emissions	Change in net emissions taking into account cultivation and processing relative to Biofuel C.	50% reduction, 25% reduction, No change , 25% more, 50% more
Source	Indicator of the source of the fuel, either being completely produced in Australia or partially imported.	Local, Imported
Food price	Estimated impact on food prices from the increased production of the fuel and competition for agricultural resources relative to Biofuel C.	20% cheaper, 10% cheaper, No change , 10% more expensive, 20% more expensive
Biodiversity	Impact on species richness as a result of production of the fuel relative to Biofuel C.	50% loss, 25% loss, No change , 25% gain, 50% gain
Price	Price of fuel sold relative to Biofuel C.	20% cheaper, 10% cheaper, No change , 10% more expensive, 20% more expensive

Biofuel C attributes

Example of choice scenario

Scenario 1:

Consider the following three biofuel options. Assuming these are the only options available to you, which one would you choose?

Attribute		Biofuel A	Biofuel B	Biofuel C
Emissions		25% Reduction	25% More	No change
Source		Imported	Local	Imported
Food price		10% Cheaper	No change	No change
Biodiversity		25% Loss	25% Gain	No change
Fuel price		10% More expensive	10% Cheaper	No change

Base choice model

Variable	Coeff.		Std. Error	95% Confidence Interval	
Choice attributes					
Emissions	-1.923 ***		0.111	-2.140	-1.707
Source	0.903 ***		0.084	0.738	1.068
Food price	-4.366 ***		0.269	-4.893	-3.839
Biodiversity	1.368 ***		0.103	1.166	1.569
Price	-4.245 ***		0.258	-4.752	-3.739
Socio-demographic variables					
Age	0.097 ***		0.027	0.043	0.151
Gender (Male=1)	-0.211 **		0.091	-0.389	-0.032
Fuel Industry Assoc.	-0.849 ***		0.288	-1.415	-0.284
Other tertiary	0.305 ***		0.098	0.113	0.497
Income	-0.115 ***		0.022	-0.157	-0.072
Psychographic variables					
Fossil user	0.284 **		0.125	0.038	0.530
Member of environmental group	-0.681 ***		0.212	-1.097	-0.265
ASC	0.844 ***		0.246	0.361	1.327
N	556				
Num of obs.	4448				
Adj. R2	0.190				
LL	-4886.6				
AIC	1.785				

Note: * significant at 10%, ** significant at 5%, *** significant at 1%

Marginal Willingness to Pay

$$MWTP_{a_n} = -\frac{\beta_{a_n}}{\beta_{p_n}}$$

- If made aware, **reducing impacts to food price** will make consumers pay **more than double** for fuel.
- On average, consumers are **least concerned** about if their fuel is produced locally (in Australia).

Attribute	MWTP
Emissions (25%)	-45.3%
Source (Local=1)	21.3%
Food price (10%)	-102.8%
Biodiversity (25%)	32.2%

Policy implications

- Biofuel have received policy attention both in state and national legislation
 - Biofuel mandate in NSW
 - Potential mandate in QLD
 - Discussion of national ethanol mandate
- How would microalgae-specific policies fit into a policy framework?

Microalgae in a biofuel policy framework

- Techno-economic modelling reveals the potential of **complementary production systems**
 - Aquaculture farms in QLD, NSW
 - Subsidising of fuel production equipment can improve feasibility
- Choice modelling illustrates that consumers are willing to pay/support alternative biofuels with **external benefits**
 - Could justify efficiency of subsidy/mandate policies

To conclude...

- Producers and consumers are responsive to policy support for biofuels e.g. Brazil
- Right policy mix to incentivise transition to most efficient biofuel options while managing risk
- Advancement in technology and costs of production can justify policy support

Thank you.

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