

THE LIMITED CASE FOR BIOFUELS

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ABSTRACT

This paper presents arguments for and against the use of biofuels as an energy source. An analysis is made of the given arguments and the conclusion is that there is a limited case for biofuels. There is a place for biofuels but they should be used responsibly. The paper argues that the quest for energy security will not so much be answered by biofuels but by a holistic look at the energy sector. Enormous savings could be accrued by optimising the use of energy currently available.

Keywords: Biofuels, energy demand, sustainable energy, food security.

1. INTRODUCTION

Biofuels refer to fuels derived from *organic* matter obtained directly from plants or indirectly from agricultural, commercial, domestic or industrial wastes. Biofuels are distinguished from fossil fuels in that biofuels are considered renewable - for all practical purposes they cannot be depleted.

Biofuels may be classified as:

- Biologically produced alcohols, e.g., ethanol, methanol, propanol and butanol.
- Biologically produced gases, or biogas.
- Biologically produced oils, e.g., biodiesel.
- Solid biofuels, e.g, wood, charcoal and dried dung.
- Algae fuel, a biofuel from algae

The two major biofuels are bioethanol, or simply ethanol, and biodiesel. Biofuels have applications in transportation, cooking and heating.

2. THE CASE FOR BIOFUELS

2.1 Economics

The economic case for biofuels is related to the growth in energy demand. Developing countries are experiencing economic growth. Also, within developing countries, there is a steady pattern of rural-urban migration. A modern lifestyle brings with it additional demands for energy.

One report states that the worldwide investment in biofuels was \$5 billion in 1995, \$38 billion in 2005 and is expected to rise to \$100 billion in 2010. [Grunwald] The fact that the biofuels industry continues to attract increased investment is worthy of investigation. What do the investors know that other people do not?

Two other sources also point to the increase in the production of biofuels – see Figures 1 to 3. Fig. 1 depicts an overall increase in world biofuel production from 1981 to 2006. According to the Potash Corporation of Saskatchewan Inc. [Potash Corp], in 1981, the world produced 1.35 billion gallons of ethanol ($5.1 \times 10^6 \text{ m}^3$) and 14.3 billion gallons ($54.1 \times 10^6 \text{ m}^3$) in 2006. This represents more than a tenfold increase in 25 years. Significant amounts of biodiesel only started being produced in 1991 and rose to 1.6 billion gallons ($6.1 \times 10^6 \text{ m}^3$) in 2006. We also see that the amount of ethanol produced is much more than that of biodiesel.

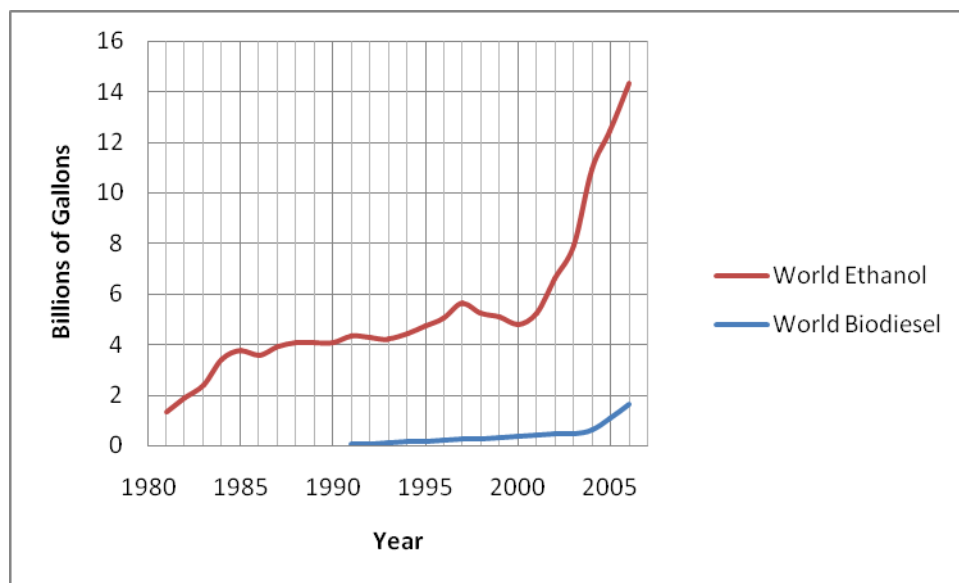


Fig. 1: Trend in World Biofuel Production [Potash Corp]

From Fig. 2, we see that the leading producers of biofuels in 2006 are the United States of America, Brazil, China and India, in that order.

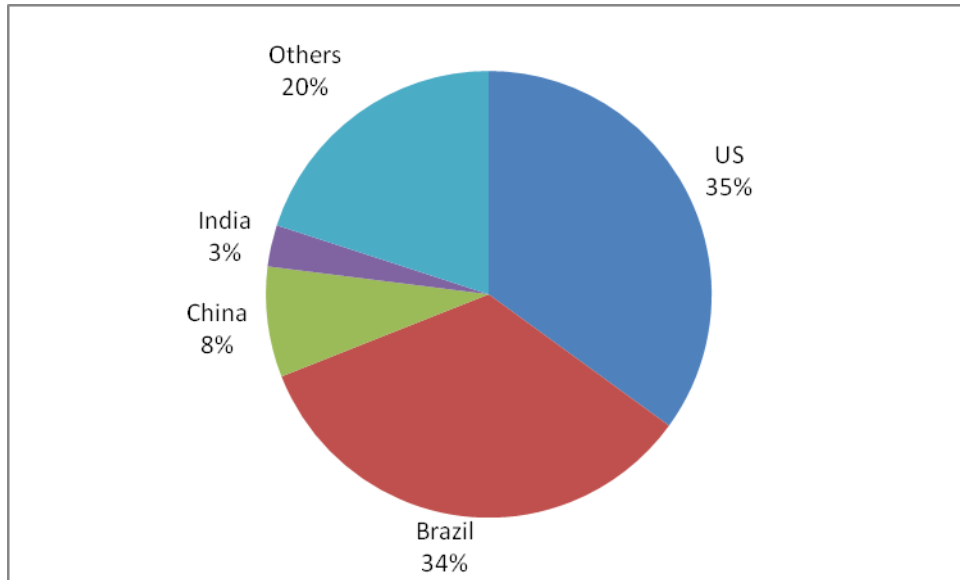


Fig. 2: World Biofuel Production in 2006 by Country [Potash Corp]

A graph from a different source is presented in Fig. 3. In this graph, the amount of ethanol produced in 2006 is 33.3 Mt. Given that the density of (100%) ethanol at 20 °C is 0.789 g/cm³ [Perry], 33.3 Mt translates to 42.2 * 10⁶ m³. Assuming that the initial value posted in Fig. 1 for the same year is correct, there is a 22 % difference between these two values, a difference possibly due to variations in source data. Considering the case of biodiesel, the amount produced in 2006 according to Fig. 3 was 2.9 Mt which translates to 3.7 * 10⁶ m³, resulting in a 39 % difference.

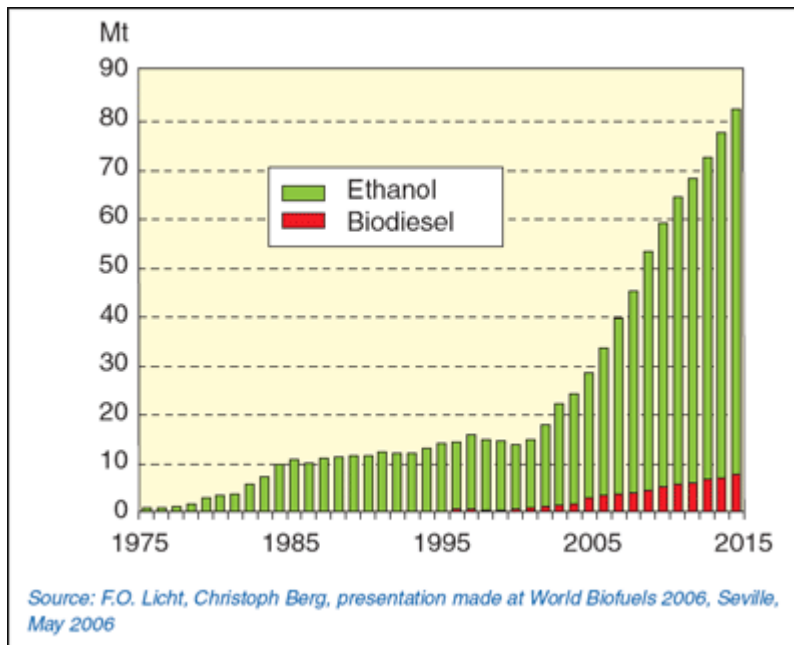


Fig. 3: Projected Trends in World Biofuel Production [Du Pont]

The Accelerated and Shared Growth Initiative for South Africa (ASGISA), South Africa's macro-economic programme, has identified a number of key interventions to achieve the objective of halving poverty and unemployment by 2014. A special project identified that would have a major impact on accelerating and sharing growth is a biofuels initiative that would span Northern Cape, Free State, KwaZulu-Natal, Eastern Cape and Mpumalanga. [Government of South Africa]

Annie Sugrue of Citizens United for Renewable Energy and Sustainability (CURES) reports that an independent study commissioned by Earthlife Africa revealed that investment in biofuels results in a lot more jobs than a similar investment in fossil fuel energy production. [Sugrue]

2.2 Environment

The notion that biofuels are "carbon-neutral" implies that the amount of carbon dioxide released when the fuel is burnt is supposedly offset by the amount of carbon dioxide absorbed from the atmosphere as they grow. Carbon neutrality is something that a number of organizations and states aspire to. [Wikipedia – Carbon neutral]

According to Bradley and Baumert, the implementation of a biofuels programme in Brazil has resulted in a saving of about 600 million tons of CO₂ between 1975 and 2005. [Bradley and Baumert]

The carbon neutrality of biofuels was provided as one of its major advantages in previous years but the calculation methods used then have now come into question and new reports present energy balances that are more holistic. For example, one of the tools in current use is a life cycle assessment, i.e., the determination of the total energy utilised in the production of an energy commodity.

2.3 Security of Supply

Nations that are net importers of petroleum should perceive biofuels as an opportunity with regards to energy security. The use of biofuels should reduce the dependence on petroleum and hence enhance energy security.

It has been reported that Brazil is no longer dependent on imported oil – this thirty years after launching a crash program to replace motor fuel with ethanol from sugarcane. [Bourne] Another report states that ethanol now accounts for a third of Brazil's transport fuel; savings in oil imports amount to around US \$ 100 billion; and the industry has created more than a million jobs. [Bradley and Baumert]

2.4 Sustainable Energy

A target and commitment set out at the conclusion of the World Summit on Sustainable Development in Johannesburg in 2002 on renewable energy was "diversifying energy supply and substantially increasing the global

share of renewable energy sources in order to increase its contribution to total energy supply.” [United Nations as cited by Obwaka] Therefore, development of the biofuels industry should aid in the ideals of sustainable development and sustainable energy.

2.5 Market

There is a ready market for biofuels. It has been reported that the Congress of the United States of America requires that 7.5 billion gallons of the nation’s fuel come from ethanol or biodiesel by 2012. [Bourne] Similarly, the European Union is reported to require that the biofuels’ share in diesel and gasoline consumption be 10% by 2020. [Cendrowicz]

3. THE CASE AGAINST BIOFUELS

3.1 Food Security

The increase in world-food prices has, in some measure been attributed to biofuels. Energy crops compete with food crops for land, water, fertilizers, labour, infrastructure, etc., so that the perception is created that, following the implementation of a biofuels programme, resources that would go to alleviating world hunger are instead utilised in running, say, motor vehicles.

The increase in food prices in 2007 - 2008 led for calls from some quarters to “stop the biofuels nonsense.” Indeed, Jean Ziegler, the U. N.’s Special Rapporteur on the Right to Food, has been reported to have called for a five-year moratorium on the use of food crops for biofuels, decrying the practice as a “crime against humanity”. [Mok]

Supporting the views above, economist and special adviser to the U. N. Secretary General, Jeffrey Sachs urged that the U. S. and Europe abandon their policies of subsidising the conversion of food into biofuels. He added that there may be a case for biofuels produced on lands that do not produce foods, e.g., palm oil, grasses and wood products, but there was no case for dishing out subsidies to “put the world’s dinner into the gas tank”. [Sachs]

Not everyone agrees that biofuels were the only cause of the increase in the price of food. Other reasons proposed for the increase in food prices include a decrease in food production due to climatic reasons and rampant inflation fuelled by increased oil prices. [Biswas]

3.2 Deforestation

A major problem related to biofuels is that forests often have to be cleared to allow for the growing of biofuel crops.

According to Michael Grunwald, “The basic problem with most biofuels, largely ignored until now, is amazingly simple: using land to grow fuel leads to the destruction of forests, wetlands and grasslands that store enormous amounts of carbon.” [Grunwald]

A website reports that Bob Watson, chief scientist at the UK’s Department of Environment, Food and Rural Affairs, has called into question the idea of switching to biofuels. His concern is that more carbon is emitted in producing some biofuels than is saved by burning them in place of fossil fuels. The same website reports that a former UK chief scientist David King has denounced biofuels that displace food crops and tropical rainforests. [New Scientist: Environment]

A report by Grunwald states that Brazil is the fourth largest emitter of carbon dioxide in the world, with most of its emissions coming from deforestation. [Grunwald]

Indeed, a study by Searchinger et al. reveals that, as farmers respond to higher prices and convert forest and grassland to new cropland, it was estimated that maize-based ethanol resulted in a doubling of greenhouse-gas emissions over a thirty-year period. [Searchinger] This team cited reports indicating that more substantial reductions in greenhouse gases are accrued when ethanol replaces motor fuel where the ethanol is derived from cellulose or sugar than where it is derived from maize. [*Science*, Farrell, Wang et al., Wang, Argonne, Macedo and Commission of the European Communities as cited by Searchinger]

4. ANALYSIS

4.1 ‘Good and Bad Biofuels’

Consider Table 1 below which makes comparisons of various biofuel crops using a number of criteria:

Table 1: Biofuel Data [Bourne]

	Maize ethanol	Cane ethanol	Biodiesel	Cellulosic ethanol
Production	4.86 billion gallons (US – 2006)	3.96 billion gallons (Brazil – 2005)	0.5 billion gallons (Germany – 2005)	
Production cost ^a	\$ 1.09 (US)	\$ 0.87 (Brazil)	\$ 6.73 (Germany)	
Retail price ^b	\$ 3.71 per gallon (US – July, 2007)	\$ 3.88 per gallon (Brazil – June, 2007)	\$ 6.73 per gallon (Germany – June, 2007)	
Energy balance ^c (input: output)	1:1.3	1:8	1:2.5	1:2-36
Greenhouse gas ^d emissions (lb/gallon)	16.2	9	7.6	1.9

^a – Production cost per gallon

^b - To get an energy equivalent of a gallon of gasoline

^c – Fossil-fuel energy used to make the fuel (input) compared with the energy in the fuel (output)

^d – The volumetric flow rate of greenhouse gases emitted by gasoline is 20.4 lb/gallon

From the table, the following are apparent:

- (i) Maize results in the largest volume of biofuel;
- (ii) Sugar cane results in the least production costs;
- (iii) Sugar cane provides an excellent energy balance (ratio of input to output) while cellulosic ethanol can provide even higher returns;
- (iv) Cellulosic ethanol results in the least greenhouse gas emissions.

Perhaps the Brazilian situation should be looked at more closely. It has been reported that biofuels provide 45% of Brazil's fuel on only 1% of its arable land. [Grunwald]

The distinction should possibly be made in the crops that biofuels are sourced from: arable versus semi-arable land; food crops or non-food sources, etc.

According to a New Scientist report, John Pickett, co-author of a Royal Society report on biofuels, says that, "There are good and bad biofuels." Maize is reported to require most energy while sugar cane requires amongst the least. [New Scientist: Environment] Joel K. Bourne of the National Geographic also reports that maize requires large doses of herbicide and nitrogen fertilizer and could cause more soil erosion than any other crop. [Bourne]

Biofuels using waste matter, such as wood chips, the left over sections of maize stalks, or perennial plants such as switch grass provide the "carbon neutral" advantage often touted for biofuels because they do not require the clearing of additional land. Other excellent alternatives to plant material other than foods would be fast-growing trees or algae. Indeed this should be the way to go.

4.2 Closed-loop system

Ordinary ethanol plants burn natural gas or coal to create the steam that drives the distillation process to separate alcohol from water. Growing maize often requires the use of machinery that runs on diesel. Also, nitrogen fertilizers that are added to soil are made using natural gas. The three processes above result in emissions of carbon dioxide which do not augur well for the carbon-neutral credentials that biofuels are supposed to provide. A closed loop system has been suggested to overcome these drawbacks. [Bourne] The plan is to fire boilers with methane from biodigesters fed with cattle manure. Tractors and other farm machinery can be adapted to run on ethanol or biodiesel. Wastes could be converted into compost.

In Brazil, the *usinas*, or sugar mills, burn cane waste (or bagasse) to generate heat and power. The cane trucks and agricultural machinery run on a blend of diesel and ethanol. Related distilleries recycle their wastewater into fertilizer and some crop dusters, such as a plane called the *Ipanema*, run on pure alcohol. [Bourne]

5. CONCLUSION

Biofuels in themselves cannot provide the sum total of world energy requirements. They represent a growing energy sector for which it is anticipated that capital costs would decrease as associated technologies gain currency. There is a limited, but useful, case for biofuels. They are and can be useful in some rural or small-scale settings.

The need to consider the case for biofuels was brought about because of, amongst other issues, the impression that the reserves of fossil fuels are not infinite. There then arose the need to seek *alternative* fuel sources. Perhaps, the answer may not lie so much in alternative energy sources but optimal use of available energy.

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