Biofuels – An Eco-Friendly Energy Source

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Abstract: Biofuels are liquids that derive from bio mass, both from plant materials and animal fat. Biofuels are products that can be processed in to liquid fuels for either transport or heating purposes. The most popular forms of biofuel are bioethanol, biodiesel and methanol. Bio ethanol is an alcohol derived from sugar or starch crops by fermentation. A second generation of bio ethanol-lignocelluloses includes a range of forestry products such as forestry coppices and energy grasses. Bio ethanol can be used in pure from or blended with gasoline. Bio ethanol is produced from agricultural products including starchy and cereal crops such as sugarcane, corn, beets, wheat and sorghum. Bio diesel is derived from vegetable oils by reaction of the oil with methanol. A second generation of bio diesel technologies synthesizes diesel fuel from wood and straw to a gasification stage. Biodiesel can be used in pure form or blended with automotive diesel. Biodiesel is made from oil or tree seeds such as rapeseed, sunflower, soya, palm, Pongamapinnata, Andiroba(Carporaguianensis), Babassu(Orbigniasp), barley, Camelina(Camelina sativa) coconut(copra), Jatropha curcas, Cumary (Dipterus odorata),groundnut, mustard, peanut, fishoil, and animal fat. Biodiesel derived from green algae and cyanobacteria biomass has the potential for high volume and cost effective production. It is carbon neutral.

In recent years, bioenergy has drawn attention as a sustainable energy resource that may help cope with rising energy prices, but also provides income to poor farmers and rural communities around the globe. Developing countries with tropical climate have a comparative advantage in growing energy with biomass. Advantages of using bio fuel are renewable fuel, low toxicity, biodegradable, lower emissions of contaminants, lower health risk, no sulfur dioxide emissions and higher flash point and also decreases the country's dependence on imported petroleum.

Biofuels represent important opportunities and challenges for sustainable development, both globally and domestically. Bio fuels can help to tackle climate change and improve rural employment and livelihood. Their reduced carbon emissions compared to conventional fuels and their positive impacts on rural development, together with the current high oil prices are key elements behind their market development. Thus bio diesel is a potential replacement for petroleum based liquid fuels. Biomass for fuel production is gaining importance in terms of its productivity, practicality and innovative potential to create a cost competitive, environment friendly and renewable source of liquid fuel.

Keywords: *Biomass, Renewable energy, Greenhouse gases, Sustainability and Eco- friendly.*

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I. Introduction

The world is entering a period of declining non-renewable energy resources, popularly known as 'Peak Oil', while energy demand is increasing. The world's energy consumption is estimated to be 3.36 x 1020 per annum and is projected to increase to up to 6.3 x 1020 J in the year 2050. Due to this high demand, energy shortage poses specific risks on the transportation sector and some industries that are depend on liquid diesel. This considerable demand for petroleum also implies significant levels of air pollution. The world's oil production is expected to decline in between one and ten decades (Crookes, 2006). As a result of this impending energy crisis, both governments and private industry are examining alternative sources of energy. The renewable energy initiatives are focused on electricity generation, while the majority of world energy consumption, about two thirds, is derived from liquid fuels (Hankamer et al., 2007). The need for renewable sources of portable, liquid fuel is starting to receive greater attention, and much of this attention has been focused on biomass-derived liquid fuels, or biofuels (Schneider, 2006; Haag, 2006). Government organizations and major corporations are beginning to seriously invest in the biofuels market, in both research and commercial production (Scott and Bryner, 2006).

Definition of Biofuels

Biofuels are liquids that derived from biomass, both plant materials and animal fat. It comprises mainly wood, agricultural crops and products, aquatic plants, forestry products wastes and residues and animal wastes and fats.

Types of Biofuels

Biofuels are all types of solid, gaseous and liquid fuels that can be derived from biomass.

(a) Examples of solid biofuels- Wood, charcoal and bagasse.

(b) Examples of gaseous biofuels- Methane gas and producer gas.

(c) Examples of liquid biofuels- Methanol, ethanol, plant oils and the methyl esters produced from these oils commonly referred to as biodiesel.

Popular forms of Biofuel

The most popular forms of biofuels are (a) bioethanol (b) biodiesel and (c) methanol.

Bioethanol

Bioethnol is a distilled liquid produced by fermenting sugars from sugar plants and cereal crops (sugarcane, corn, beet, cassava, wheat, sorghum). A second generation of bioethanol lignocelluloses also includes a range of forestry products such as short rotation coppices and energy grasses. Bioethanol can be used in pure form in specially adapted vehicles or blended with gasoline. Bioethanol can be blended with gasoline in any proportion up to 10 per cent without the need for engine modification. Blends of 5 percent or 10 per cent of bioethanol in gasoline are denominated B5 and B10, respectively.

Biodiesel

Biodiesel, an alternative diesel fuel, is made from renewable biological sources such as vegetable oils and animal fats. It is biodegradable and nontoxic, has low emission profiles and so is environmentally beneficial (Krawczyk, 1996). Similar to bioethanol, biodiesel can be used in pure form in specially adapted vehicles or blended with automotive diesel. A blend of 5 per cent of biodiesel is denominated as B5.

Sources of Biodiesel

Biodiesel is produced from oily crops or trees such as rapeseed, sunflower, soya, palm, coconut(copra), Pongamapinnata, Andiroba (Carporaguianensis), Babassu, barley, Camelina (Camelinasativa), Jatrophacurcas, Cumary(Dipterusodorata), groundnut, mustard, peanut,
fish oil but it can also be produced from animal fats, tallow and waste cooking oil. Similar to bioethanol, biodiesel can be used in pure form in specially adapted vehicles or blended with automotive diesel. A blend of 5 per cent of biodiesel is denominated as B5.

Biodiesel produced from green algae and Cyanobacteria biomass has the potential for high volume and cost effective production. It is carbon neutral also.

Feedstock for Biofuels

The various feed stocks that can be used for the production of biofuels maybe classified into three groups (a) cellulosic biomass,(b) sugar and starchy crops, and (c) oil-containing or oil-producing plants.

(a) cellulosic biomass - Agricultural residues, forestry wastes, municipal solid wastes, food processing and other industrial waste, and energy crops grown for fuel purpose.

(b) Sugar and starchy crops - Sugarcane and sugar beets.

(c) oil-containing or oil-producing plants - Organic oils, plant or animal.

Biofuel as an alternative fuel

Biofuel proponents believe that these alternative fuels offer a number of economic and environmental benefits over traditional oil-based fuels. Because biofuels are derived largely from plants, these fuels are a renewable resource that can be replenished naturally with the passage of time, unlike crude oil. They can be produced in the United States, which reduces our dependence on foreign oil and helps to shield American consumers from fluctuating global oil prices. Moreover, proponents assert that biofuels may offer an environmentally friendly option for fueling our nation. Depending on which feed stocks are used and how they are converted, biofuels may produce fewer greenhouse gases (GHGs) than oil-based fuels.

Biofuel markets, production and trade

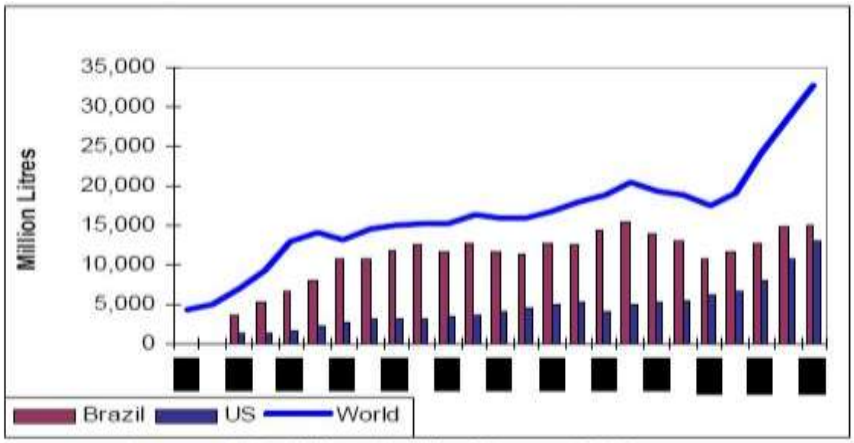
Trends in global Biofuel production

Interest in biofuels has been reflected in the rapid expansion of global biofuel markets in the last five years or so. Commonly cited driving forces behind the current market development of biofuels include current high oil prices, opportunities for greater energy security, and currency savings through a reduced oil bill. But what is new about this interest and what makes biofuels a serious option for partially replacing oil as transport fuel are their alleged reduced greenhouse gas (GHG) emissions. This would help countries to combat the global warming problem and would enable them to comply with the commitments under the Kyoto Protocol. In addition, the Brazilian experience shows that biofuels can deliver export opportunities and rural development.

Bioethanol and biodiesel can be mixed with the petroleum products (gasoline and diesel) they are substituting for and can be burned in traditional combustion engines with blends containing up to 10 per cent biofuels without the need for engine modifications. Flexi-fuel vehicle (FFV) technology is now sufficiently well developed to allow the gradual introduction of biofuels in any country. FFV cars can run with any type of fuel blend from pure gasoline to up to 85% biofuel blend. The biofuels are an important challenge to the oil industry, and explain the rapid increase in global production and use in recent years.

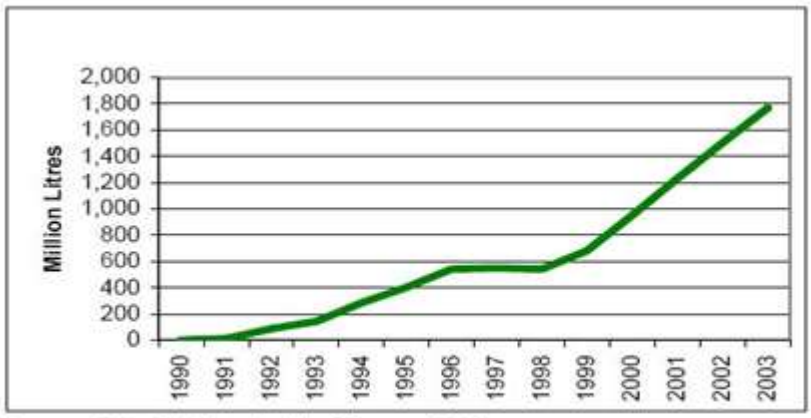
Global biofuel production is estimated to be over 35 billion litres. Bioethanol and biodiesel are both produced around the world, but more bioethanol is produced than biodiesel. The former is mainly produced and consumed in the Americas while the main market for the latter is the EU. . in the US, on the other hand, show that it generates about two units of energy for each unit required in production.

Other lesser-known energy crops such as jatropha and some new technologies based on perennial crops such as lignocelluloses are proving to have the best energy balances. Jatropha, for instance, is alleged to have the highest energy balance of any biofuel. Unlike corn or sugarcane, jatropha is a perennial, yielding oil seed for decades after planting. It can grow without irrigation in arid conditions where corn and sugarcane could never thrive. Differences in energy efficiency balances imply that there are better opportunities for crops such as sugarcane, sweet sorghum, palm oil and Jatropha to become global energy resources.



Source: F.O. Licht, cited in Murray 2005.

Figure.1 Global bioethanol production



Source: F.O. Licht, cited in Murray 2005.

Figure.2 Global biodiesel production

Advantages of Biofuels

Adopting biodiesel has a number of advantages. Firstly, because the fuel is derived from biomass, it does not contribute to atmospheric CO2 emissions. Second, biodiesel emissions are, on the whole, lower than petroleum diesel. Substituting biodiesel for petroleum diesel results in substantial reductions of soot, sulphur, unburn edhydrocarbon, and polycyclic aromatic hydrocarbon emissions (Rakopoulos et al., 2006; Aresta et al., 2005; Demirbas, 2007).Third, the infrastructure needed for biodiesel already exists. Biodiesel can be used in existing diesel engines blended with petroleum diesel, or, can be run unblended in engines with minor modifications(Crookes, 2006;Rakopoulos et al., Bowman et al. 2006). Because biodiesel has twice the viscosity of petroleum diesel, its lubrication properties can actually improve engine life (Bowman et al., 2006). Fourth, biodiesel has low toxicity and is biodegradable. (Aresta et al., 2005; Demirbas, 2007). Fifth, like petroleum diesel, biodiesel has a more complete combustion than gasoline, giving a cleaner burn (Bowman et al. 2006).

Greenhouse gas (GHG) emissions

One of the greatest advantages associated with biofuels and one of the main driving forces behind worldwide biofuel uptake are their alleged reduced GHG emissions, and hence their potential to help minimize climate change. Estimates vary according to the type of feedstock, cultivation methods,

conversion technologies, energy efficiency assumptions and disparities regarding reductions associated with co-products. Bioethanol shows the widest variations. A recent article published in the journal Science, which evaluated six studies on GHG reduction of corn-based bioethanol found a variation from a 33 per cent decrease to a 20 per cent increase, averaging a 13 per cent reduction in GHG emissions compared to petrol. The study also argued that the reduction could actually be improved. Estimates for wheat-based bioethanol point to reductions ranging from 19 to 47 per cent, while for sugar beet-based bioethanol estimates vary between a 35 to 53 per cent decrease. One estimate for sugarcane-based bioethanol in Brazil shows a 92 per cent reduction compared to standard fuel. Estimates for newer technologies such as lignocelluloses ethanol typically suggest a 70 – 90 per cent reduction but can achieve a 100 per cent reduction compared to conventional gasoline.

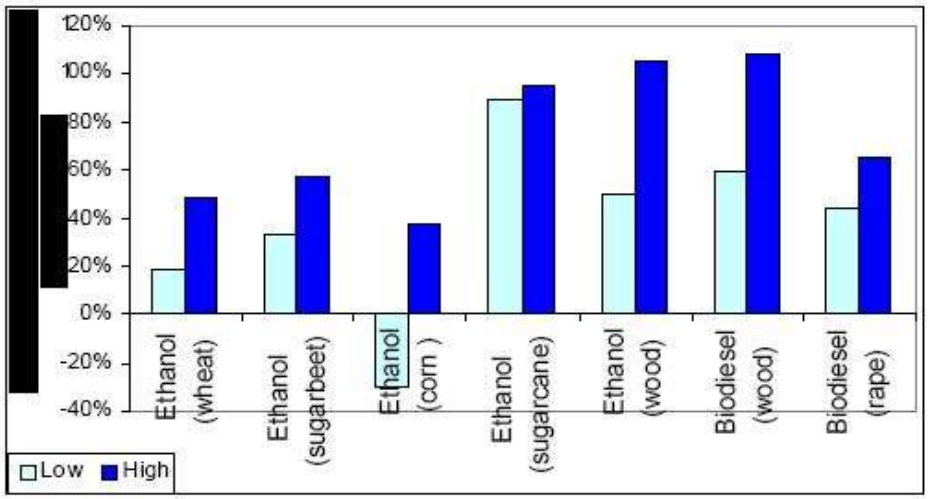


Figure 3 GHG reductions for different biofuels

Source: based on E4 Tech, et al 2005 'Feasibility Study on Certification for a Renewable Transport Fuel Obligation', Final Reports

Table 1Typical biofuels toxic emissions compared to standard fuels

BIOETHANOL (E85)	BIODIESEL (B20 & B100)	FISCHER-TROPSCH
• 15% reductions in ozone-forming volatile organic compounds. • 40% reductions in carbon monoxide. • 20% reductions in particulate emissions. • 10% reductions in nitrogen oxide emissions. • 80% reductions in sulphate emissions. • Lower reactivity of hydrocarbon emissions. • Higher ethanol and acetaldehyde emissions.	• 10% (B20) and 50% (B100) reductions in carbon monoxide emissions. • 15% (B20) and 70% (B100) reductions in particulate emissions. • 10% (B20) and 40% (B100) reductions in total hydrocarbon emissions. • 20% (B20) and 100% (B100) reductions in sulphate emissions. • 2% (B20) and 9% (B100) increases in nitrogen oxide emissions. • No change in methane emissions (either B20 or B100).	• Nitrogen oxide reductions due to the higher cetane number and even further reductions with the addition of catalysts. • Little or no particulate emissions due to low sulphur and aromatic content. • Expected reductions in hydrocarbon and carbon monoxide emissions.

Source: USPA 2002a' Clean Alternative Fuels': Biodiesel'; USEPA 2002 b 'Clean Alternative Fuels'; Ethanol' USEPA 2002c.Clean Alternative Fuels : Fisher – Tropsch'. All available at : www.epa.gov

Expansion of the agricultural frontier and forest conversion

One of the greatest concerns associated with increased biofuels production is the impact on the agricultural frontier. Biofuels are expected to contribute around 20 to 30 per cent of global energy demand by 2030, clearing of some of the most unique and biodiverse regions on the planet, including the entire natural habitat of thousands of islands, and thousands of hectares of fragile coastal wetlands.

Social benefits of biofuel production

Employment creation and quality

In addition to the environmental benefits of biofuels, a primary motivation for the promotion of biofuels in the EU is rural economic development. Biofuel production can also have a positive impact on agricultural employment and livelihoods, especially when the cultivation involves small-scale farmers and the conversion facilities are located near the crop sources in rural areas. Most bioethanol-related jobs involve low skilled and poor workers in rural areas.

Improved livelihoods

In addition to the income generated by job creation, biofuels production offers opportunities for better livelihoods. As production of biofuels requires many of the crops as inputs, policymakers see the promotion of biofuels as a viable option to change the composition of agricultural output from surplus food commodities that must be exported under subsidies to fuels that can be consumed domestically. This increased demand for agricultural commodities and shifting supply away from other agricultural outputs could significantly increase the price of agricultural commodities, and therefore farmers' incomes.

Jatropha trees once establish themselves and fertilize the soil, their shade can be used for intercropping shade-loving vegetables such as red and green peppers, tomatoes, etc, which would provide additional income for the farmers.

Future prospects for Biofuels

While ten years ago there were only a handful of countries producing biofuels, by 2006 many countries around the world are using biofuels on a large scale. Forecasts for the future of this market are very optimistic as all types of countries, industrialized and developing, large and small, are implementing or planning to implement directives to promote greater use of biofuels. Accordingly, production capacity is expected to rise as suggested by the establishment of many new projects around the world.

According to IEA (2004), with the entering into force of the Kyoto Protocol in 2005 and the first target period under the EU Biofuels Initiative coming into effect in December 2005, world biofuel production is expected to quadruple to over 120,000ML by 2020. A more recent estimate from IEA increased this figure to 10 per cent of world fuel use for transport by 2025.

II. Conclusion

Biomass for fuel production is gaining importance in terms of its productivity, practicality and innovative potential to create a cost competitive, environment friendly and renewable source of liquid fuel. Biofuels represent important opportunities and challenges for sustainable development, both globally and domestically. Biofuels can help to tackle climate change and improve rural employment and livelihoods. On the social side, there are important concerns about the impacts of biofuels production on labor practices and on food security.

The benefits and costs of biofuels vary widely, according to the type of feedstock, cultivation method, conversion technology and geographical area. Energy crops differ in terms of their energy efficiency, their impacts on GHG emissions and other environmental effects, and their impacts on employment creation. The second generation of biofuels are likely to have a huge impact on the biofuels market as they have a much better energy balance and are more energy-efficient than the existing generation of biofuels and will therefore require less land. Their reduced carbon emissions compared to conventional fuels and their positive impacts on rural development, together with the current high oil prices are key elements behind their market development. Thus biodiesel is a potential replacement for petroleum based liquid fuels.

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