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RECENT DEVELOPMENT ON BIODIESEL-A REVIEW

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ABSTRACT

This paper represents the recent development done in biodiesel. It's also highlighting the global trend in biofuel demand and supply, its economic viability, environmental issue and about the next generation biofuel which may overcome alarming issue related to depletion of conventional fossil reservoir. sThe biodiesel is an alternative diesel fuel that can be produced from renewable feed stock such as vegetable oil waste fry oil and animal fat, however due to technical deficiency they are rarely used purely or with high percentage in unmodified diesel engine. The paper also shows the global trend in bio fuel demand & supply its economic viability its implication for GHG emission and about the next generation bio fuels which will overcome the scientific, technical and sustainability barrier which will result in significant green house gas saving compare to fossil fuels.

Keyword: Global trend, Blends, Cost, Economic viability & Next generation bio fuels

INTRODUCTION

High economic growth, underway for several decades in most developing countries across the globe, has resulted in robust demand for various energy sources. A greater need for mobility and peoples' aspirations for improved living conditions have together become the main driver for increasing primary oil demand, which is projected, according to most recent energy "outlooks" by the IEA (International Energy Agency) and OPEC (Organization of Petroleum Exporting Countries), to rise by about 1.0% per year, reaching approximately 105 million barrels per day (mb/d) level by 2030.

The transport sector, in particular, relies almost entirely on oil supplies for fuel. Several factors, including energy price increases, increased market volatility, in particular during 2008 and 2009; heavy dependence of many countries on imported oil; lingering debate about the ultimate size of remaining, recoverable fossil fuel reserves; and, not least, growing concerns about the environmental impact of fossil fuel usage have provided the impetus for the current strong interest in, and support for, biofuels in many parts of the world. The contribution of biofuels as an alternative energy source is currently very small, but this may change, should the high growth rates of the last few years be sustained in the coming years and decades. Because biofuels are seen as a clean alternative to fossil fuels, several countries have initiated policies to provide generous government support to biofuel development and production. A number of countries have also established a regulatory framework to promote and facilitate the use of biofuels in the domestic transportation sector. However, there are growing concerns about the overall energy efficiency of different feedstocks, the life cycle environmental benefits of biofuel production and use, the economic rationale of these alternative sources of energy, and the implications for food security and prices. Considering that most of the present generation of biofuels use agricultural commodities such as sugarcane, sugar beet, maize, wheat, barley, rapeseed, soybean, palm oil, and cassava as feedstocks, any developments in the biofuel sector – and formulation of government policies promoting them – are bound to have considerable impact on agricultural production, availability and food prices. This, in turn, raises important questions about food security and poverty across the globe.

This study is a synthesis of recent development on the status of biofuels. It provides an overview of the global trends in biofuels supply and demand, as well as a review of the policies that are being implemented or considered in major countries to promote current (first) and next generation biofuel development. The study also discusses the potential of biofuels to address energy security concerns and reduce greenhouse gas emissions, as well as the ongoing debate over the implications of biofuel development on food security and rural development, biodiversity, deforestation, water resources and air quality. It also assesses the status of next generation technologies and their potential role in minimizing the sustainability problems associated with first generation biofuels. The analysis points out remaining uncertainties and open questions and outlines policy directions which can best promote the development of biofuels, while addressing, among other concerns, those of oil producing and consuming countries.

Global trends in biofuel supply and demand

Current production and the medium- to long-term outlook

Global production of biofuels has been growing rapidly in recent years, more than tripling from about 18 billion litres in 2000 to about 60 billion litres in 2008. Supply is dominated by bioethanol, which accounted for approximately 84% of total biofuel production in 2008. Despite this exponential increase, biofuels still represent a very small share of the global energy picture. Total biomass accounted for 3.5% of total primary energy supply in 2007, according to the OPEC World Oil Outlook (OPEC WOO 2009), with liquid biofuels accounting for about 0.28% of total energy demand and about 1.5% of transport sector fuel use (IEA WEO 2009)

Currently, production is concentrated in a small number of countries (Table 1). Together the US and Brazil account for about 81% of total biofuel production and about 91% of global bioethanol production Since 2005, the US has surpassed Brazil as the largest bioethanol producer and consumer, accounting for 50% of global production in 2008 (SCOPE 2009). The EU follows as the third major producer with 4.2%. In contrast, about 67% of biodiesel is produced in the EU, which is also the largest consumer, with Germany and France combined accounting for 75% of total EU production and 45% of global production.

Table 1 Bio fuel production in 2008, by country

Billon litres(world)	Bioethanol	Biodiesel	Total biofuel	Share in total
WORLD	67.0 (32.8)	12.0 (9.4)	7.9 (42.2)	100%
U.S	34.0 (16.7)	2.0 (1.6)	36.0 (18.2)	45.6%
BRAZIL	27.0 (13.2)	1.2 (0.9)	28.2 (14.2)	35.7%
E.U	2.8 (1.4)	8.0 (6.3)	10.8 (7.6)	13.7%
CHINA	1.9 (0.9)	0.1 (0.1)	2.0 (1.0)	2.5%
CANADA	0.9 (0.4)	0.1 (0.1)	1.0 (0.5)	1.3%
INDIA	0.3 (0.1)	0.02 (0.0)	0.32 (0.2)	0.4%

According to a recent study by Hart's Global Biofuels Center (Hart/GBC 2009), global demand for ethanol and biodiesel combined is expected to nearly double between 2009 and 2015 from 95.3 to 183.8 billion litres. Ethanol, while accounting for 80% of this latter figure, will only represent 12% to 14% of total global gasoline demand. Although global ethanol supply generally matches demand in 2009 and 2010, it is expected to exceed it in 2015, reaching 168.6 billion litres compared to expected demand of 147.3 billion litres. Similarly, biodiesel supply is projected to almost double by 2015, reaching 94 billion liters. Hart/GBC estimates supply based on current capacity and projected capacity to be in place by the 2015 time frame. Hart/GBC based on the assumption that policy requirements and targets will be implemented and fulfilled and by using gasoline and on-road diesel demand figures estimated in another Hart/GBC study. The apparent supply/demand imbalance, according to Hart/GBC, will be taken care of by 2015 through some or all of several expected routes; 1) governments increasing blending limits; 2) many proposed projects cancelled; 3) continued low utilization rates; and 4) many existing plants scrapped. Interestingly, projected supply is well above targeted demand, which increases uncertainty in the motor fuels market, and creates a disincentive to invest in both the upstream and downstream of this domain. The supply/demand medium-term outlooks (2009, 2010 and 2015) for major ethanol and biodiesel producers and consumers are summarized in table 2

Table 2 Global biodiesel medium- term supply/ demand outlook

Billion litre (country)	2009		2010		2015	
	Supply	demand	supply	demand	Supply	Demand
WORLD	48.2	13.1	59.6	18.3	94.4	36.5
USA	2.8	2.8	3.1	3.1	8.4	8.4
BRAZIL	2.9	1.0	4.5	1.8	6.0	2.1
E.U	18.6	9.6	21.5	12.8	28.1	16.1
INDIA	1.8	0	2.0	0	4.2	4.1

Over the medium term, the US and Brazil are likely to continue to dominate ethanol supply and demand. However, their combined share of production may decrease to 73% of the global total, as the role of countries in the Asia-Pacific region, mainly China, India, Indonesia and Malaysia, rapidly increases. By 2015, the latter region's total production could represent about 22% of global supply.With respect to biodiesel, the EU is assumed to continue dominating consumption in 2009 and 2010, but its share is also projected to decrease, from 60% to 40%, by 2015 as consumption in Asia-Pacific grows steadily.

BIO FUEL TYPE

Different biofuels types can be produced from biomass in a number of ways. Generally, biofuel conversion technologies are categorized as first and second (next/advanced) generation biofuels. First generation biofuels, ethanol from sugar and starchy crops and biodiesel from oilseed crops and animal fat, use well-established and simple conversion technologies. Second (next) generation biofuels, from cellulosic biomass and algae, use less proven technologies. The most common types of biofuels are ethanol and biodiesel. Key aspects and requirements of the main production technologies, as well as uses of each, are briefly described below.

ETHANOL

Ethanol is currently produced from sugar crops (sugarcane, sugar beet, sweet sorghum) or starchy crops (corn, wheat, cassava) through a process of fermentation and then distillation, employing first generation technology. The basic production process of ethanol from both types of crop is similar. However, the energy requirement for starch-based ethanol is significantly more than that of sugar-based ethanol due to the additional process involved in converting starches into sugar. Energy and GHG balances are, therefore, more favourable for ethanol production from sugar crops than from starch crops.

Production of ethanol from sugar cane results in a variety of by-products (co-products) including bagasse, a residual fibre which is used as a primary fuel source for sugar mills. According to the OFID/IIASA study (OFID/IIASA 2009), this makes a sugar mill more than self-sufficient in energy, allowing sugarcane-based ethanol to achieve energy balances ranging from two to eight times more energy output, when compared to fossil use input. Often co-generation of heat and electricity is possible and surplus electricity can be sold on to the consumer electricity grid, thus offering an additional source of income. Surplus bagasse has industrial applications and can also be used as livestock feed. Ethanol production from starchy crops produces high-value livestock feed and distillers' grain.

Ethanol can be used in blends of up to 10% in conventional spark ignition engines or in blends of up to 100% in modified engines (this is the practice only in Brazil; other countries using high blends go up to 85%). Though ethanol energy content is 66% of that of gasoline, it has a higher octane rating and, when mixed with gasoline, ethanol improves vehicle performance and reduces CO_2 emissions. Ethanol also has very low sulphur content, thus its use reduces SO_2 emissions, a component of acid rain. On the other hand, ethanol use could increase nitrogen oxide (NO_x) emissions, which play an important role in the formation of ground ozone and acid rain.

BIO DIESEL

Conventional biodiesel is produced from vegetable oil and animal fat through a process known as esterification. Major feedstocks are rapeseed, soybean, palm and jatropha. The production process provides additional co-products, typically bean cake, an animal feed, and glycerine, which can be used in several industries.Biofuel blend with diesel or used in pure form in compression ignition engines without engine or infrastructure modification. Its energy content is only about 88 – 95% that of diesel, but the fuel economy of both are generally comparable as biodiesel raises the cetane level and improves lubricity.

LITERATURE REVIEW

Mallikappa D.N , Rana Pratap Reddy, Ch.S.N. Murthy (2011) has conducted a test on double cylinder direct injection compression ignition engine they have test on cardonal as an alternative fuel for the diesel engine. Brake specific energy consumption decreases (25-30%) & increased in brake power, HC emission up to B20 and more at B25, The CO emission increased with higher blend

Huseyin Aydin, Cumali Ilkılıc(2010) used ethanol as an additive to research the possible use of higher percentage biodiesel in an unmodified diesel engine. Commercial diesel fuel, 20% biofuel & 80% diesel fuel called B20 & 80% biodiesel & 20% of ethanol is BE20 effect being tested on fuel the engine torque , power & brake specific fuel consumption & brake thermal efficiency. The experimental result showed that performance C I engine improved with use of BE20

K. Sureshkumar, R. Velraj, R. Ganesan(2008) has carried out the performance analysis in an unmodified diesel engine with pongamina pinnata methyl ester and blend with diesel BSEC,BSFC has improved at B40.The CO for diesel is more as compared to PPME blend under different load condition. The CO_2 emission increased with increased in load.

DEEPAK AGARWAL, AVINASH KUMAR AGARWAL(2007) has conducted using various blend of jatropha oil with mineral diesel to study the effect of reduce blend viscosity and various parameter such as thermal efficiency , BSFC was improved. Smoke capacity is improved in preheated jatropha.

DEEPAK AGARWAL, LOKESH KUMAR, AVINASH KUMAR AGARWAL(2007) has conducted a performance test on linseed oil, mahua oil, rice bran oil & linseed oil methyl ester (LOME) in a stationary single cylinder engine , four stroke diesel engine compared it with mineral diesel. Economic analysis was also done & it is found that the use of vegetable oil & it derivative as diesel fuel substitute & has similar cost as that of mineral diesel.

M. Pugazhvadivu, K. Jeyachandran(2005) has conducted experimental investigation on waste frying oil an non edible vegetable oil was used as an alternative fuel for diesel engine. The high viscosity of waste frying oil was reducing by preheating. The waste frying oil is preheated to 135◦c could be used as diesel fuel substitute for short term engine operation.

Sukumar Puhan, N.Vedaramann, G.Sankaranarayanan, Boppanna V. BharatRam (2004) Has investigation , Mahua oil Ethyl ester was prepared by transterification using sulfuric acid (H_2SO_4) as catalyst and tested in 4 stroke direct injection natural aspiration diesel engine. It is showed that brake thermal efficiency of engine for MOEE was compared with diesel is 26.36%whereas 26.42 for MOEE & Emission of CO, HC, oxide of nitrogen are reduced.

F.K Forson, E.K Oduro, E Hammond-Donkoh (2003) has represented a test on a single cylinder direct injection engine operating on diesel fuel & jatropha oil and blends of diesel and jatropha oil in proportion of 97.4%/2.6%, 80%/20%, 50%/50% by volume. The test showed the jatropha oil could be conveniently used as diesel substitute in diesel engine and it mainly increased in BTE ,BP and reduced in specific fuel consumption.

M. Abu-Qudais, O.Haddad, M. Qudaisat (1999) has shown the effect of ethanol fumigation and ethanol diesel fuel blend on the performance and emission of a single cylinder diesel engine. The result show that both fumigation and blend method have same behavior and it mainly increased in BTE and reduce in emission.

O.M.I Nwafor, G. Rice (1996) has shown that vegetable oil have substantial prospect as long term substitute for diesel fuel. The result show improvement in BTE of engine and emission output of engine improved

RESEARCH AND DEVELOPMENT

Many biofuel producing countries fund R&D for biofuel technology. Current funding is particularly directed towards second generation biofuels, mainly cellulosic ethanol and biomass to liquid biodiesel. Comprehensive and accurate data on the level of expenditure on biofuel R&D are not available, but what is available from the EU Commission does indicate accelerated expenditure, especially by industry. A recent EU report, estimates the total expenditure by EU countries, both public and private, in 2007 to be around 347 million Euros, with industry contributing the lion share at 269 million Euros.

COST, ECONOMIC VABILITY OF BIOFUEL

Liquid biofuels compete directly with gasoline and diesel. Given the relative size of energy markets in comparison with agricultural markets, energy prices tend to drive the prices of biofuels and biofuel feedstocks. Since feedstocks account for the largest share of total biofuel production costs, the relative prices of agricultural feedstocks and fossil fuels will determine the competitiveness of biofuels. The relationship differs according to crops, locations, and technologies used in biofuel production.

According to an OECD-FAO study (2008), estimated average production costs of biofuels in major producing countries, using different feedstocks, are lowest for Brazilian sugarcane ethanol. For this feedstock, energy costs are negligible because Brazil uses the sugarcane co-product, biogases, as a process fuel. In Europe and the US, this is not the case but revenues from selling other co-products offset some of the costs. The net production costs, however, after subtracting co-product values, still remain lowest for Brazilian ethanol. The OECD-FAO study also found that Brazilian ethanol is the only biofuel which is consistently priced below its fossil fuel equivalent. For all other biofuels, net production costs exceed the price of fossil fuel

Table 3 & Table 4 provide recent compilations of production costs for ethanol and biodiesel from different sources.

Table 3 Production cost for ethanol, in main producing countries

	World watch institute 2006 (euro/I gasoline eq)	OECD directorate for trade and agricultural ($/I gasoline eq)	OECD –FAO 2008(US$/IGE)
Ethanol from sugar cane (brazil)	0.21-0.3 0.263-0.375 (US$/I GE)	0.331	0.29
Ethanol from corn (US)	0.33-0.52 0.413-0.65(US$/IGE)	0.437	0.75
Ethanol from grain (EU)	0.41-0.66 0.51-0.825(US$/IGE)	0.869	1.25
Ethanol from sugar beet(EU)		0.848	0.5
Ethanol for cellulose	0.66-0.99 0.826-1.24(US$/IGE)		

Table 4 Production cost in biodiesel, in main producing countries

	World watch institute 2006(euro /I Diesel eq)	OECD directorate for trade and agriculture($/I diesel eq)	OECD- FAO 2008 (US $/IDE)
Biodiesel from waste grease(US EU)	0.21-0.38 0.263-0.475(US$/IDE)		
Biodiesel from soya bean (US)	0.33-0.62 0.413-0.775(US$/IDE)		0.75
Biodiesel from rapeseed (US)	0.33-0.66 0.413-0.825(US$/IDE)	1.75	1.75

IMPLICATIONS FOR GREENHOUSE GAS (GHG) EMISSIONS

Fossil energy balance–the ratio of energy contained in biofuels to the fossil energy used in their production–is usually taken as a measure for evaluating the energy performance of different biofuel production pathways. The balance is also a useful measure of a particular biofuel's relative effectiveness in contributing to energy supply and can be indicative of its GHG emission impact. Studies of the fossil energy balance for different biofuels (summarized in Table 5) indicate that their net contribution to energy supply can vary widely. The variations in estimated fossil energy balances—across feedstock's, fuels and for some feedstock/fuel combinations—depend on feedstock productivity, agricultural production processes and conversion technologies. The high fossil energy balance, sugarcane biofuel, reflects the use of a co-product, bagasse (the biomass residue from sugarcane) as an energy input for its processing, as well as the feedstock's own productivity.

Table 5 Fossil energy balance of different fuel type

Fuel (feed stock)	Fossil energy balance (approx)
Ethanol (corn)	1.3-1.8
Ethanol (wheat)	1.2-4.3
Ethanol (sugarcane)	2-8.3
Ethanol (sugar beet)	1.2-2.2
Biodiesel (rape seed)	1.2-3.7
Biodiesel (palm oil)	8.7-9.7
Bio diesel (soya bean)	1.4-3.4

Biofuels are, in theory, carbon neutral as their combustion releases the carbon dioxide that was sequestered by the plant through photosynthesis back into the atmosphere. In addition, growing biomass can increase soil carbon stock. Therefore, biofuels' potential for reducing GHG emissions is significant. However, emissions occur throughout the biofuel life cycle system: during the harvesting, storage and transportation of raw material production, as well as during biofuel processing, and finished product storage, transportation, distribution, and use. In addition, the possibility of generating co-products could have implications for net GHG emissions as these are considered "avoided emissions". Thus, fossil energy balance is only one determinant of the emissions impacts of biofuels; fertilizers and pesticides, soil treatment, irrigation technology and land use change can also have major impacts.

NEXT GENERATION BIOFUELS

Next (second and third) generation biofuel technologies are considered to offer the solution for the sustainability problems associated with first generation biofuels. Second generation biofuels use cellulosic biomass which include, herbaceous lignocellulosic species such as miscanthus, switchgrass and reed canary grass (perennial crops) and trees such as poplar, willow and eucalypt (short rotation crops), as well as forestry and agricultural residue. Algae are also being evaluated as a more promising advanced feedstock option in the distant future (often referred to as third generation).Feedstock's for second generation biofuels generally produce higher biomass yields per hectare than most first generation crop feedstocks (the exception being sugar cane crop feedstocks). In addition to their fast growth and short-rotation characteristics, essentially the entire crop is available as feedstock. Given their relatively high projected energy conversion efficiency (IEA 2008), second generations feedstocks are projected to have higher overall energy yields. They require less tillage and chemical inputs. They also allow a wide range of land to be used for cultivation including degraded and marginal land, therefore reducing or avoiding the potential for land use competition with food and animal feed production. However, some feedstocks are considered invasive10 (or potentially so) and thus could have negative impacts on water resources and biodiversity. Cellulosic biomass has lower handling costs than first generation biofuel crops and is easier to store, given its resistance to deterioration. On the other hand, it can often be bulky and thus require well developed and costly transportation infrastructure (FAO 2008). Second generation biofuels can also reduce life-cycle GHG emissions because of the higher energy yields per hectare and the potential of leftover plants (mostly lignin) to be used as process energy. The technology, however, is at an early stage of development. Substantial technological and economic barriers impede its commercial deployment, including high production costs, logistics and supply challenges. Another important barrier is the set of agricultural/forestry sector changes needed to regularly supply the lignocellulosic feedstock depend on changes in agricultural management, as well as policy changes, both of which will take time to implement.

CONCLUSION

Various investigation and studies on current production , cost , economic viability of bio fuel & implication of GHG emission impact of bio fuel it has indicate that it offer excellent promises as an alternative fuel for compression ignition engine in its transportation sector. Biofuel has been found to be an alternative fuel for compression ignition engine with different blending ratio it helps in improving the thermal efficiency of engine, reducing the brake specific energy consumption.

Next generation biofuel currently under development hold better promises but require extensive R&D to overcome scientific , technical & sustainability barrier. Future biofuel production and use should meet several essential criteria, bio fuel should result in significant green house gas saving compared to fossil fuel.

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