BIOFUELS AS ALTERNATIVE SOURCES OF ENERGY

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Abstract

Biofuel production from renewable sources is widely considered to be one of the most sustainable alternatives to petroleum sourced fuels and a viable means for environmental and economic sustainability. Concerns about shortage of fossil fuels, increasing crude oil price, energy security and accelerated global warming have led to growing worldwide interests in renewable energy sources such as biofuels.

I. BIOFUEL DIVISION

Biofuels are referred to solid, liquid or gaseous fuels derived from organic matter. They are generally divided into primary and secondary biofuels. While primary biofuels such as fuelwood are used in an unprocessed form primarily for heating, cooking or electricity production, secondary biofuels such as bioethanol and biodiesel are produced by processing biomass and are able to be used in vehicles and various industrial processes.

The secondary biofuels can be categorized into three generations: first, second and third generation biofuels on the basis of different parameters, such as the type of processing technology, type of feedstock or their level of development.

II. BENEFITS AND DRAWBACKS TO BIOFUEL ENERGY

The reasons of widening popularity of biofuel among the public and scientists are found in increasing crude oil price, necessity in expand of energy security and occurrence of a problem of the greenhouse effect caused by use of fossil types of fuel.

Biofuel serves as a possibility for some developing countries to provide with necessary energy independently themselves, as well as export diversification and reduction of poverty level. Considering the highest efficiency of biofuel production to be reached in the tropics, a great number of developing countries located in this zone would participate in development of the alternative energy market.

On the other hand, development of biofuel production creates certain problems. First- generation production systems have considerable economic and environmental limitations. In particular, serious increase of a price level for agricultural goods, foodstuffs basically, is connected with reorientation of many farms to cultivation of the cultures necessary for biofuel.

It should be taken into consideration that some regions of the world have not completely got through hunger yet. From this point the most common concern related to development the first generation biofuel technology is totally. And so doubts concerning sufficiency of rural economy potential have appeared, whether both demand for food, forages, industrial cultures and demand for biofuel be satisfied at the same time. The sharp increase of arable land used for biofuel production can lead to serious environment consequences; hence nullify all ecological advantages of biofuel using. In addition, the intensive use of land with high fertilizer and pesticide applications and water use can cause significant environmental problems.

Second-generation biofuels are produced using the straw inedible part of plants (straw, wood, plant waste). Unlike first-generation biofuels, they do not compete with the use of raw materials as food. They can be used directly by traditional vehicles and considerably reduce CO_2 emissions.

Therefore, third generation biofuels derived from microalgae are considered to be a viable alternative energy resource that is devoid of the major drawbacks associated with first and second generation.

Microalgae are able to produce 15 – 300 times more oil for biodiesel production than traditional crops on an area basis. Furthermore compared with conventional crop plants which are usually harvested once or twice a year, microalgae have a very short harvesting cycle ($\approx$ 1 – 10 days depending on the process), allowing multiple or continuous harvests with significantly increased yields. Microalgae have

broad bioenergy potential as they can be used to produce liquid transportation and heating fuels, such as biodiesel and bioethanol.

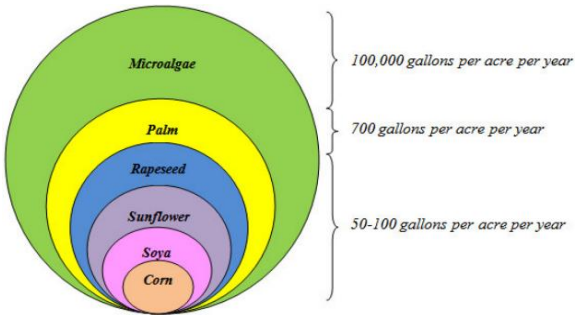

Fig. 1. Oil content in micro algae and conventional crops
Source: Oilgae Report

Microalgae are currently being promoted as an ideal third generation biofuel feedstock because of their rapid growth rate, CO2 fixation ability and high production capacity of lipids; they also do not compete with food or feed crops, and can be produced on non- arable land.

III. BIOFUEL FOR VEHICHLES

These days the world vehicle fleet consists for 99 % of cars working at products of processing of fossil natural resources. In some countries natural or liquefied petroleum gas are considered to be an alternative energy source, which is also based on fossil sources. But this type of fuel is expected as a short-term solution only.

In long-term prospect biofuel plays a predominating role, firstly, because of existing oil price exaltation. Secondly, transfer of auto fleet at this type of an alternative power source occurs with the minimum expenses, in comparing, for example, with electricity and hydrogen engines implementation. The reason is that sizable changes of infrastructure, the equipment or engines are not required.

In vehicle sector both bioethanol and a biodiesel are used as the basic or as an additive to traditional fuel. Due to high agricultural efficiency and manufacture process of ethanol, significant results in their quality characteristics have been reached. A ratio of the spent and received energy is already much more than one.

The most widespread type of biofuel is bioethanol, ordinary ethyl alcohol, the best-known combustible liquid with a non-oil origin. Cultures with the high content of sugar, such as reed, corn, potatoes, are used as a feedstock for its production.

The estimated number of alternative fueled vehicles (AFV) in use is provided in detailed data table below.

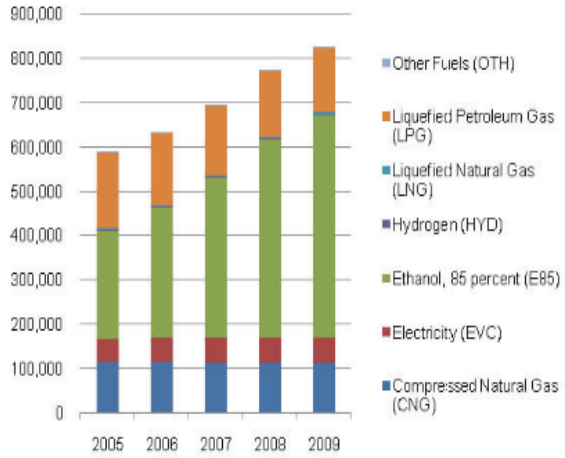

Fig. 1. Vehicles in use
Source: EIA

The supply of E85 fuel vehicles dominates the market with nearly 75% of the total AFV and hybrid vehicles made available. In Brazil vehicles on bioethanol make 85 % of all fleet. In Europe sales of cars on bioethanol are held at 20000 annually. The main producers of vehicles on bioethanol are Ford and Saab.

The alternative for diesel fuel is biodiesel one, produced on vegetative and animal fats. Any vegetative culture comprising oil can serve as feedstock for this type of biofuel. The most popular components are rape, soybeans and palm-oil. National Biodiesel Board[1] claims that dedicated biodiesel plants with a total capacity of 60 to 80 million gallons per year (3,414 to 5,219 barrels per day) have already been built. Today biodiesel is produced worldwide by nearly 400 plants. [[2]]

The biodiesel is practically harmless for environment. Seeping into the soil or water, it brings no harm to plants, animals and decays completely in 28 days. But it also has some performance disadvantages. The performance of biodiesel in cold conditions is markedly worse than that of petroleum diesel. At low temperatures, diesel fuel forms wax crystals, which can clog fuel lines and filters in a vehicle's fuel system.

Table 1.
Biodiesel overview (Mbbl)

Year	Production	Consumption
2006	5962.838	6204.374
2007	11662.499	8527.531
2008	16145.382	7518.947
2009	12054.158	7536.871
2010	7365.773	5446.908
2011	17668.818	28805.024

Source: EIA

[1] National Biodiesel Board (NBB) a commercial trade association representing the biodiesel industry

Within 6 years output of biodiesel had been increasing in 2 – 3 times. However in 2010 biofuel production sharply decreased because of global world crisis of 2009. By 2011 accumulation of productivity rates had occurred, and now the current indicators of biofuel production and consumption surpassed pre-crisis ones considerably. the main producers of biodisel have become ehe USA and Brazil.

By far the largest companies of automotive industry, such as Ford and SAAB, are engaged in development all of new models of the vehicles working at biofuel. The main projects are Saab Aero-X, Saab 9-3 (with engine BioPower), Ford Focus и Ford C-MAX Flexifuel. DaimlerChrysler AG& Mercedes Car Group run into production VW Jetta TDI Bluetecand E320 Bluetec which use biofuel as power supplies. Investment of German automakers is already more than €10 billion.

At the beginning of 2012 the world oil prices kept at the level of $110 per barrel, and prospects of decrease isn't observed. According to a forecast of International Energy Agency, regarding to world market development of the automobile fuel, by 2050 approximately 1/3 cars will use non-polluting biofuel in case of automakers of to reduce the future expenses.

IV. PROSPECTS OF BIOFUEL USAGE BY AIRCRAFT INDUSTRY

Without any doubts the main advantages of biofuel use in commercial jet aircraft are decrease in emissions of greenhouse gases and improvement of ecological indicators of modern commercial aviation. However at this moment the air-transport industry as automobile one is being compelled to look for alternative energy sources because of constantly increasing cost of aviation fuel.

Several years ago aviation biofuel was considered only as a scientific product, but nowadays airlines of the different countries show high interest to such projects. 2011 appeared plentiful with receiving of necessary certification by alternative types of fuel. Therefore some air-companies have already organized the wide-ranging campaigns directed on demonstration of biofuel possibilities at regular flights.

The BurnFair project realized by German Lufthansa airline has became the longest demonstration program. Within this program (July 15- December 21, 2011) 1187 flights were held. Lufthansa had used more than 1500 tons of fuel mix consisted of usual kerosene and bioethanol. For Lufthansa- airline biofuel was delivered by Neste Oil company and it was made of saffron milk caps (80 %), jatropha (15 %) and fats of an animal origin (5 %). [[5]] According to the Lufthansa company use of biofuel reduced gas emissions to atmosphere by 1471 ton, that is less 60 % in comparison with usual kerosene.

Carrying out similar programs needs in considerable cost, therefore the governmental financial support for the manufacturers is necessary for biofuel implication to aviation industry. This support would help to increase volumes of biofuel output and as a result to lead its prices at competitive level. As an example such support to Lufthansa project should be mentioned. German government granted the company with $3,2 million in a total project cost of $8,5 million. These actions allowed to compensate expenses for purchase of biofuel which practically more expensive than usual kerosene twice. As a whole, demonstration flights of German airline have shown fuel consumption during performance reduced by1 %.

The contribution to development of the biofuel industry is brought by the International association of air transport (IATA)[1]. Due to its operation, in 2011 activity in this sphere has increased in 5 times in comparison with previous year and the first transatlantic flights Frankfurt am Main – Washington by Boeing 747-400 have been executed.

Performance of demonstration flights with biofuel use in Europe has urged on interest to such projects from the governments of Mexico and the USA. At the beginning of November 2011 flights with use of a fuel mix were made by United Continental, Alaska Airlines and Horizon Air. These companies are planning to execute 80 flights in total on routes from Seattle to Washington and Portland.

Despite unstable situation of world economy in this moment, the largest energy enterprises are engaged in negotiating and signing perspective contracts on biofuel delivery with well-known aviation companies.

Table 2.

Business cooperation

Buyer of biofuel	Supplier of biofuel
Alaska Ailrines (USA)	Dynamic Fuels (USA)
United Airlines (USA)	UOP- Honeywell (USA)
Qatar Airways (Qatar)	Byogy Renewables (USA)
Virgin Atlantic (GB)+ LanzaTech (NZ)	Biofuels (SWE)
Boeing (USA)	BioEnergy (Hawaii)
FAA (USA)	Honeywell UOP (USA)

Naval Forces of the USA also takes participation in development of biofuel use. In current 2012 1,7 million liters of biofuel on the advanced technologies is made for USN needs. Biofuel is produced of unsuitable for food items comprising vegetable oil. Chosen biofuel suppliers are Dynamic Fuels, Tyson Foods and Syntroleum. It should be taken into consideration that annual fuel consumption by fleet makes 4,8 million liters. Thus, the new contract will actually provide ¼ fuel needs of fleet.

[1] IATA – International association of air transport representing, leading and serving the airline industry

At these days an attraction of large investments into various projects of this industry occurs. For example, in the nearest future in Mexico four biofuel plants will be built. So by 2015 it will have allowed to produce 40 million liters of non-polluting fuel, and by 2020 to bring biofuel production to 700 million liters. It attracts $180 million of investment. In addition, it is planned to expand areas of plantings for biofuel manufacture.

V. FUTURE FOR ALGAE BIOFUELS

Long before algae were explored for their use as biofuel feedstocks, they have been used in a variety of industries – ranging from fish feed, cosmetics, health foods and more. Nowadays, algae fuels present an exciting opportunity. While the mechanism of photosynthesis in these microorganisms is similar to that of higher plants, they are generally more efficient converters of solar energy because of their simple cellular structure.

There is a strong view among industry professionals that algae represent the most optimal feedstock for biofuel production in the long run. There are several ways to convert microalgal biomass to energy sources, which can be classified into biochemical conversion, chemical reaction, direct combustion, and thermochemical conversion. Thus, microalgae can provide feedstock for renewable liquid fuels such as biodiesel and bioethanol.

Efforts into algae fuel research have accelerated in the past few years. Over a hundred universities explore possibilities of algae fuels. And now it is also widely accepted that algae alone – and no other biofuels – have the ability to replace the entire global fossil fuel requirements. Such a significant opportunity has resulted in companies both large and small investing in algal energy.

Table 3.

Approximate number of companies directly involved in producing fuels from algae

Year	Number of Companies
2001	1
2002	2
2003	4
2004	5
2005	10
2006	15
2007	25
2008	50
Mid 2009	100
End 2009	150
Mid 2010	200
2011	225

Source: Oilgae Estimates

The high cost of converting fuel from algae is main problem. The table below implies that fuel from algae represents a market that is worth hundreds of billions of dollars.

Table 4.

Biofuels potential in 2014 (billion gallons)

Total Oil Consumption	1500
Total Projected Supply by Traditional Biofuels	41
Total Ethanol Production in 2014	26
Total Biodiesel Production in 2014	15
Share of Traditional Biofuels in Total Oil Consumption	2.73%
Projected Market Size for Traditional Biofuels	$ 123 billion

Assumption: One gallon of oil = $3
Source: Oilgae Estimates

From the table, it is clear that even by 2014, less than 3% of total fossil fuels will be replaced by biofuels from traditional sources. Even this small % represents a market size of over $100 billion. Algae have the potential to replace a much larger percentage of fossil transportation fuel than can traditional feedstock.

VI. CONCLUSION

To sum up, biofuel has a great potential in both aviation and vehicle industry. Although its share in the world fuel market doesn't exceed 3% level, high speed of biotechnologies implementation in fuel sector is considered to increase the share of non-polluting fuel up to 30 % in 50 years. This would result decrease of carbonic gas emissions by 2,1 billion tons. Development of new technological processes, such as algae converting, would be the main reason growth of manufacture of this kind of fuel.

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