ECONOMIC ANALYSES OF THE USE OF BIOFUELS IN AVIATION

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This article addresses the problem of implementation and sustainability of biofuels. It deals with issues of cost of production, the transport of biofuels and their impact on aircraft engines and aircraft fuel systems. The main problem is the economic analysis of the possibilities of using biofuels producers, it means appreciation of biofuels from an economic standpoint and to quantify the total cost of the biofuel.

K e y w o r d s: biofuels, biofuel production, biofuels transportation, aircraft engines

1 INTRODUCTION

Air transport in terms of emissions of nitrogen oxides and carbon monoxide production high causes consumption of aviation gasoline, but still is just a small part of the total emissions from transportation. Air transport is currently responsible for the 4-9% triggers climate change caused by human beings. Greenhouse gas emissions of the world's airlines in Europe have doubled since 1990. In spite of the fact that the technical improvements to aircraft engines can reduce fuel consumption and thereby reduce emissions, there is the problem of increasing demand for air transport, which means that the emissions from aircraft engines will be rather than reduce. [1]

Options for reducing emissions of greenhouse gases are alternative fuels. Alternative fuels we mean natural gas, liquefied petroleum gas, hydrogen, electricity and various fuel mixtures, containing less than 85% ethanol or methanol, and fuel mixtures contain less than 20% of the vegetable oil. The reduction of greenhouse gas emissions from the use of fuels from renewable and sustainable resources is the result of a reduction in emissions from mining, production and combustion of the fuel. Biofuel is the alternative fuel, which was targeted in the manufacture or preparation of biomass and bio-waste, and is one of the ways to use biomass. [2]

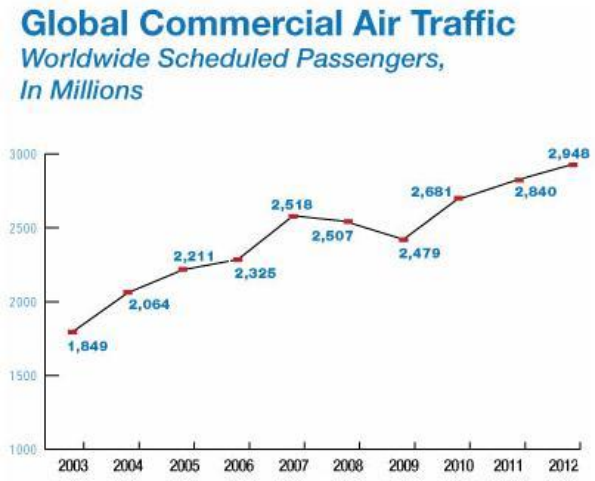

Figure 1 Global commercial air traffic

There are some options for reducing emissions from air transport and through these biofuels.

The main problem with the introduction of biofuels in aviation is to their economic advantage. If these fuels will not be economically advantageous to not being able to keep the aviation fuel market either. Under the economic advantageous of biofuels means effective production, lower costs for transportation and affordable prices of these fuels in the fuel market. The main advantage of biofuels is their recoverability. Biofuels can eliminate dependence on imports of oil and natural gas. An important fact is, that are helping to alleviate the effect of global warming. Each plant is during your growth absorbs CO_2. If this gas from the combustion of biofuels gets back into the air, and are not, therefore, an increase in the total amount of greenhouse gas in the atmosphere. Into the atmosphere thus returns only what it originally was.

Support for government and non-governmental aviation organizations in the development and production of biofuels is very important. The most important organization, which deals with the issue of the introduction of alternative fuels in civil aviation, is the International Civil Aviation Organization (ICAO).

The International Civil Aviation Organization develops a wide range of standards, policies and guidelines for the application of the inclusion of provisions relating to noise and emissions from engines. Increasing knowledge bases brings new aspects at work, how to minimize the impact of aviation on the environment.

ICAO regularly organizes meetings and trying to find advice on emerging issues such as the impact of alternative fuels for the future of the industry and its growing potential, which will reduce the emission of pollutants traces. ICAO cooperates with many governmental and non-governmental organizations such as the United Nations, with IATA (the International Air Transport Association), the ECAC (European Civil Aviation Conference) and other organizations.[3]

For the introduction of biofuels in aviation, it is necessary to carry out their economic analysis to justify the economic sustainability in the global aviation industry.

2 ANALYSIS OF THE COSTS THAT ARE ASSOCIATED WITH THE PRODUCTION OF BIOFUEL

An analysis of the costs that are associated with the production of biofuel, covers the cost for the production of raw materials, their processing and the production of biofuels. The analysis is focused on the biofuel, which is based on unsaturated fatty acids methyl esters of vegetable origin.

This alternative fuel is produced by purification process in which methanol is mixed with sodium hydroxide and then with oil from seeds of oilseed rape, sunflower or from soybeans.

The cost of biofuels are calculated from the cost of production, but the financial incentives and subsidies are excluded from the calculations. The calculated cost of production of biofuels shall be equal to the value of the starting material in a given period, plus the calculated conversion costs and minus the value of the product in a given period.

The most important variable parameter, which must be taken into account in the calculation of production costs are the costs for the purchase of raw material, which is needed for the production of biofuel. The production costs are very sensitive to the cost of raw materials for the production of biofuels, which have been determined by the prices of commodity raw materials.

To produce the necessary quantity of biofuels for aviation, it is necessary to allocate approximately 231 million hectares of land, which makes up 16% of all arable land in the world. Furthermore, it is estimated more than 386 million hectares of marginal land all over the world. Crop residues have a certain value and that such a large proportion of them are mostly returned to the soil.

Some remnants of agricultural crops are used as animal feed and in a few developing countries are the remains of a burnt as fuel. Jatropha and other oil can flourish on the fringe soils with low rainfall. However, economic questions remain on the required inputs and yields in the production of these perennial vines for the production of biofuel.[4]

A large amount of soy production and its use for various products in the United States may have the effect that soybean oil may become the predominant raw material for the production of biofuel, despite the low oil content in soybeans, which means that this crop is not the most effective as regards the production of biofuel per hectare.

Many factors contribute to the use of the soya-bean oil as the dominant raw material in the production of biofuel in the United States, including the widespread availability of high levels of domestic production, previous subsidies and grants. The five-year average cost of raw materials are 753 u.s. dollars per tonne, which corresponds to the previous pricing trend of the oil from soybeans.

Sugar and ethanol are produced on the basis of a comprehensive distribution and production is constantly adjusted so as to maximise the profit on the basis of the world's oil and sugar prices. In 2007-2008 was the production ratio of 45.5% sugar for 54,5% ethanol, and forecasts for the year 2008-2009 should be at a rate of to of 43.5% the 56.5% sugar ethanol. As a result of strong demand for ethanol in the Brazilian domestic market has increased the share of ethanol.[5]

The average price of raw palm oil calculated and used for biofuel production for the last 5 years is $ 597. In spite of the fact that the prices of palm oil have decreased dramatically in 2008, so the selling price of the product even though it looks to be significantly higher. The estimated cost of palm oil for biofuel production suggest that a healthy profit margin realized by producers of palm oil. The fall in prices of palm oil will not have a major impact on production in the future viability of palm oil in Malaysia.

Cellulose biomass is used in the production of ethanol, a wide range of plant species and types. Agricultural residues such as corn feed, wheat straw and forest remnants of events in the manufacture of products of wood, mining accounts for the largest volume of raw material cellulose biomass.

If the market price is in excess of the cost of production, so the biomass market principles point out that a significant volume of these materials will be available to producers of cellulosic biofuel. For the purposes of this analysis, the production cost is calculated on the total price and the average of the three basic types of lignocelulosic biomass: wood biomass, agricultural residues and energy crops. Each type is given the same weight, on average, and the total price in the price of raw materials for biomass lignocelulosic is roughly 72 u.s. dollars per tonne, and that of drought. The concept of forest biomass includes all raw materials obtained from trees harvested. It includes the main trunk of the tree, as well as branches and branches, which are mostly from logging. Other reports have come to the conclusion that the delivery price should be $ 30 per tonne, and in the future would be to reduce the cost of the collection method, the supply lines, and that therefore, in order to increase the attractiveness of forest residues. Among the most prolific crop residues in feed events without the United States, and it has become a very attractive raw material. Testing as an input to the production of heat, the use of electricity as well as input feedstock for cellulose ethanol. Corn can be used as well as potential raw material feed events for a range of bio-products.[5]

The production of biofuels, however, requires special technological equipment, which will also generate harmful emissions. Biofuels can be produced from a variety of plant sources such as camelina, jatropha plants, soya, maize, wheat, sugar cane, and many others. Some plants can be grown only in specific places, such as in tropical areas, subtropical or marginal areas. The production of such fuels requires a considerable expense, but it is necessary to compare the production of ordinary of aviation kerosine fuels. Although the production of biofuels will exceed over the production of fuels, biofuels may still bring some so classic savings may be cheaper on fuel markets, it will be after them surely greater demand than conventional kerosine fuels, as they will mean for the

airline industry will want to try something new that any airline.

Table 1. 1 litre of biofuel production costs of the raw materials

	$/liter
Corn	0,46
Soy beans	0,87
Sugar cane	0,18
Palm oil	0,73
Celulose biomass	0,6

3 ANALYSIS OF THE COSTS THAT ARE ASSOCIATED WITH THE TRANSPORT OF BIOFUEL

Currently, the production of biofuels is usually concentrated in regions dominated by growing corn and palm trees. This means that markets are growing and production expands absorbing the capacity of local and regional markets, where pohlcovaním must be transported over longer distances, biofuels. Almost all of the etanol fuel and FATE fuels are currently transported by trucks, rail or by ship. Dedicated pipe for biofuels may bring substantial savings, as they allow you to carry large volumes of ethanol at a much lower cost. In addition, it is also a more convenient mode of transport in terms of emissions of greenhouse gases. Trucks, boats and railways can take advantage of a wider network of existing transport infrastructure, which allows enormous flexibility in the car transporting ethanol between the large number of production and distribution sites. Biofuels and blended biofuels are mainly transported in tank-vehicles and railway wagons. If it was a road tanker or railway car used for transporting diesel fuel previously, so it is not necessary prior to transport biofuel to wash. However, if they were transported to another type of fuel, so it is necessary to transport biofuel tank wash. [6]

There are a few basic ways to transport, which could be used to transport the biofuel, ethanol and their mixtures into target stores. Biofuels today are primarily transported by rail cargo cars or sea freight, but those modes of transport have a greater adverse impacts on the environment and higher costs than the transport via pipelines. Some of the information and suggestions, however, argue that rail transport can be more cost-effective and can produce less carbon dioxide emissions than transport via pipelines. Compound biofuels are usually distributed to the kamiónmi of the mixing and storage terminals, as well as gasoline and diesel. The original points of the fuel pipe of petroleum products are not always linked with the places where biofuels are produced as well. One of the ways to solve this problem, it will be the construction of a new pipeline dedicated to biofuels, which would facilitate greater distribution of biofuels into the retail stores. This could especially benefit consumers and the environment.

The pipes can be an effective way for the transport and distribution of biofuels, but there is a certain volume threshold needed for economic viability. In the case that the pipe may be transported only in certain biofuels, then the development of such pipes is less attractive. The construction of a pipeline for the biofuels is only possible with the exception of when special guarantees can ensure long-term market. Have a smaller diameter pipe reserved since the total volume of fuel is less compared to the pipe, which carried a large amount of products. The pipe is facing problems due to the terrain and the environment as well, which might compel you to use more gas stations, if the terrain is mountainous or if there are bridges in large valleys and rivers. Pipeline transport must therefore be assessed on a case-to the economics of the case, taking into account the intended volume market, the topography and roads. [6]

Trucking can be cost competitive at shorter distances, in particular where the railways are not available. However, over longer distances are less attractive because they are trucks, higher costs for fuel and wages. Most of the regions has already formed rail infrastructure, but many of them have a lack of tankers or rail transport units. Train a unit of 100 cars could carry 3 million US gallons of biofuel. On an annual basis, each the tank wagon could pass around 750,000 gallons of biofuel. Environmental protection agency says the cost of 90,000 dollars for the tank wagon, while the company rail wagons indicates a cost of 114 000 USD. During a typical lifetime of railway wagon 30 to 50 years, could be transported to 22 to 37 million gallons of biofuel. The price for the car would be ranged around the rail bio transported 0.3 to 0.5 cents per gallon.[6]

The main economic cost of maritime transport of biofuels should be the cost of buying a boat or boats, which are designed for the transport of bio-fuels and the cost of construction of transport terminals. It is only a small difference in the cost between the maritime terminals and tanks on rail tanks. However, the sea terminals would need to recover equipment, pipes, pumps and valves at an estimated cost of $ 3.5 million for a single device. Tank for 200 000 barrels will bring the total cost of US $ 12 million for facilities. If the Maritime Terminal needed for distribution of the railway infrastructure, so the total cost would be increased by a further 0.5 million us $.

The trucking and shipping services with the lowest cost for rebuilding of biofuel is less than 500 km away. However, transport ships, which is often combined with costly biofuel using less truck traffic as well. As a result, are the real economic costs of maritime transport maritime transport truck and cost summary often. For distances up to 500 miles by rail, sea and truck transport costs are comparable. When the transmission distance of more than 500 km on the economic cost of truck transport is rapidly stepping in, while the cost of rail transport are at the lowest level compared with those three modes of

transport. The economic costs of shipping are competitive with the costs of rail transport over a distance of up to 2,000 km and if combined transport is not necessary. However, when more than 1 500 km by pipelines transport is able to compete with rail and maritime transport, with the economic cost of 4.2 to 5 cents per litre of biofuel. [6]

Retail storage of biofuels can take several forms. Some biofuels blended with fuels may require the exchange of containers due to incompatibility or an unsatisfactory status of some of the older tanks. Some pumps can have problems with the compatibility of materials of pump and the surface of the mixture depending on the age of biofuel, because of the specific properties of biofuel. The so-called hydrocarbon fuels could be able to take advantage of the existing infrastructure with little or no modification.

Storage of biofuels at the airport is possible only in the short term, because the long-term storage contracts shall break down the ingredients of biofuel. It follows that these fuels have a lower shelf-life, and is therefore needed more frequent delivery of fuel to the airport.

Table 2 Comparison of different types of transport biofuels

	Transport cost per litre		
Distance, km	Truck	Ship	Railway car
200	1,6	1,3	-
500	3,2	2	3
1 000	5,9	3,2	3,6
1 500	-	4,5	4,1
2 000	-	5,7	4,7
2 500	-	7	5,2
3 000	-	8,2	5,8

On the basis of published information, which can evaluate the types of transport biofuels, is probably the least expensive rail transport. The only serious problem that arises in the transport of biofuels is limited by the duration of long-term storage of biofuels in the fuel tanks because of the potential degradation of the herbal ingredients of biofuel. It follows that the airports, which frequently must order these fuels, biofuels are aircraft to refuel their vehicles in order to reduce the duration of their storage.

4 ANALYSES OF THE COSTS THAT ARE ASSOCIATED WITH THE ADJUSTMENT OF THE FUEL SYSTEM OF AIRCRAFTS AND JET ENGINES

The world's manufacturers of aircraft engines are constantly trying to design and manufacture the most perfect, the most secure and effective as jet engines. Manufacturers are trying to take advantage of these engines for the propulsion of unconventional fuels that reduce greenhouse gas emissions. The trend of the use of biofuels will depend on the gradual erosion of conventional oil reserves and from increasing the price of classic aviation fuels.

The replacement of conventional aviation fuels for all existing aircraft engines is possible with certain security risks. Some types of biofuels harm rubber sealing elements (FAME) in the construction of the fuelling of aircraft and engines and have inappropriate properties at low temperatures.

The project "BIOPAL" (Biofuel for aviation), which examined the properties of biofuel FAME was focused on the long-term follow-up effects of mixtures of kerosene and rubber seals and on the properties of biofuel on the FAME of biofuel at low temperatures. The results of the experiments, the following conclusions emerged:

1. Biofuel energy value is lower than that of kerosene FAME, which reduces the performance of the engine and the transmission capacity of the aircraft. Reduced traffic capacity of negatively affecting the economic cost of the air carrier.
2. Thus FAME is much fatty than kerosene, biofuel leads to friction wear of engine parts and prolongs the life of fuel injection nozzles.
3. The biofuel FAME can be stored in the same metal fuel tanks as kerosene.
4. The biofuel FAME reacts with rubber and is detrimental to the rubber parts. For this reason, it is necessary in the construction of aircraft and engine fuel system parts (rubber seals, sealing paste, rubber tanks, etc.) to replace the parts that are resistant to the agresive action of biofuel. This modification of the structure of the aircraft and engine fuel system requires a large economic cost, which may not be the case for an earlier air techniques effectively incurred.
5. In the combustion of biofuel FAME reduces the smokiness of the engine and the content of carbon dioxide, sulfur and hydrocarbons.
6. The biofuel FAME releases carbon and clean fuel system of the engine.
7. The downside of FAME is a limited storage period due to decomposition of biofuel plant part of the biofuel. Frequent replacement of biofuel increases the economic cost of the air carrier.
8. The FAME biofuel density increases with decreasing temperature. Begins to solidify at temperatures around 0 °C. For use at low atmospheric temperatures is unusable. The use of biofuel FAME during the flight and in winter conditions it is necessary to ensure that the heating of the fuel in the fuel system. The following technical adjustments to the fuelling of the aircraft and the engine require a large economic cost.

5 CONCLUSIONS

On the basis of economic analysis it can be concluded that the introduction of biofuels in aviation is real. However, biofuels are economically less advantageous than classical kerosene. Classic aviation fuels are more efficient in spite of the high prices. Complete replacement of conventional fuels, biofuels will require technical adjustments to the aeronautical and airport infrastructure. The economic cost of adaptation aviation techniques for the use of biofuels are very high. For this reason, it is more efficient to use biofuel in air technology, which has been on this fuel design.

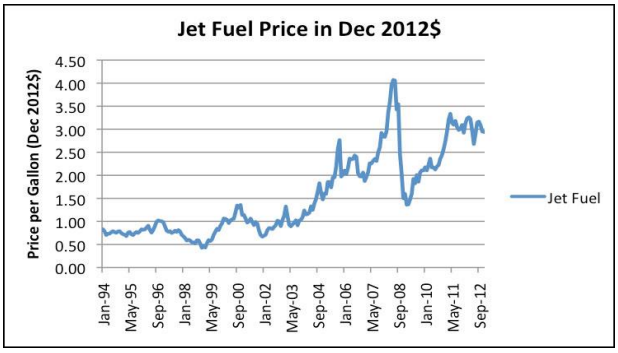

Figure 2 Jet fuel price

The use of bio-fuels in aviation will be dependent on the prices of kerosene and the prices of different types of bio-fuels on the world market (fig. 2 and Fig. 3). Kerosene prices will be influenced by the overall stocks of crude oil in the world.

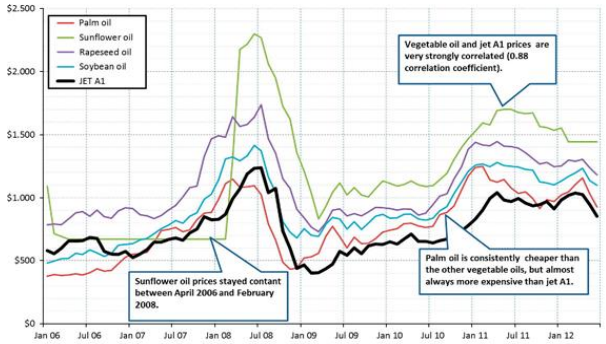

Figure 3 Biofuel price

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