CONFERENCE ON AVIATION AND ALTERNATIVE FUELS

Mexico City, Mexico, 11 to 13 October 2017

Agenda Item 4: Defining the ICAO vision on aviation alternative fuels and future objectives

AVIATION BIOFUELS EFFICIENCY IN TERMS OF CO_2 EMISSIONS REDUCTION

(Presented by the Russian Federation[1])

SUMMARY

According to members of UN Intergovernmental Panel on Climate Change (IPCC) anthropogenic CO_2 emission is the main driver of the global temperature increase. Hence, the most efficient option aimed at a real CO_2 emissions reduction at the global level should be identified for international civil aviation.

This working paper presents some technical data enabling CAAF2 to consider a potential of aviation biofuels for achievement of the global aspirational goal of carbon neutral growth from 2020 (CNG 2020) as well as other aspects of the early introduction of these types of fuel in conformity with the UN Sustainable Development Goals while taking into account the issues of flight safety, food and water security.

Action by the Conference is in paragraph 7.

1. INTRODUCTION

1.1 Although not only biofuels are theoretically considered among potential aviation alternative fuels at ICAO level, in most cases jet fuels produced out of conversion of a broad range of renewable sources of biomass into sustainable jet biofuel are examined.

1.2 Along with that there is a widespread view that aviation alternative fuels are key element for achievement of the global aspirational goal CNG 2020. Moreover, as believed by some well-recognized international associations, broad replacement of the fossil fuels with alternative fuels will enable to reduce the volume of CO_2 emissions in international civil aviation by 50 % as compared to 2005 base line. However, these views are not supported by the real facts.

[1] The Russian translation of this paper was provided by the Russian Federation.

2. PRODUCTION CAPACITY OF ALTERNATIVE FUELS

2.1 According to some estimates every day our civilization utilizes as much oil as Earth can accumulate by using solar energy for one thousand years. Even, if this assessment is not completely correct, apparently a biofuel industry cannot sufficiently meet global energy demands, even in the aviation sector.

2.2 "It is estimated that up to 2 per cent of this fuel consumption could consist of sustainable alternative fuels in 2020. Significant uncertainties exist in predicting the contribution of sustainable alternative fuels in the long-term…" (para 2.1.3 of A39-WP/55 presented by the ICAO Council). Despite the fact that third-generation biofuels, less dependent on food crops, are mostly considered to date, sufficiency of land resources required for their production still poses the main problem. Few facts clearly illustrating this problem are listed below.

2.3 Land Use and Biofuels

2.3.1 The lack of land resources required in order to meet the world's energy needs using biofuels is a major concern. Depending on the feedstock required for biofuel production adequate to fuel demand such land resources can be enormous. The following figures indicate the area of land that must be utilized for the purpose of satisfying only the demands of **the global aviation industry**: *Jatropha* would need to be planted over 2.7 million sq. kilometers, i.e. an area approximately equal to 1/3 of the territory of **Australia**; *Camelina* would require an area of 2 million sq. kilometers; and *Algae* would need 68,000 sq. kilometers, i.e. an area approximately equal to the entire territory of **Ireland**.

2.3.2 The aviation industry accounts only for 13% of all fuel consumption, and therefore, the figures listed above would need to be increased ten times in order to encompass **global fuel demands:** *Jatropha* plants would need to cover 27 million sq. kilometers, i.e. an area even bigger than all the territories **of Russia and the United States**; and *Algae* would require an area of 680,000 square kilometers, i.e. an area bigger than the entire territory of **France**.

2.3.3 Even if entire 1,79 million sq. kilometers of US cropland were used for production of ethanol from corn, it would provide only the fuel sufficient to power cars and trucks in the United States for 81 days.

2.3.4 Obviously, there is not enough land currently in use to meet fuel needs. Thus, since forested areas need to be cleared, vast amounts of carbon will be released by creating a carbon debt **requiring centuries to repay**.

2.3.5 In 2013 Exxon Mobil has come to the conclusion that algae-based biofuels will not be viable for at least 25 years.

2.3.6 It should be noted that this calculation is purely economical and does not take into account the environmental impacts, which still have to be addressed.

3. ISSUES OF FOOD AND WATER SECURITY

3.1 According to the United Nations Population Fund's "medium scenario" the world's population will approximately increase by 2 billion, reaching the level of nearly 10 billion people by 2050.

3.2 Biofuel has a significant impact on food production potential of the Earth. Millions of people pushed into poverty each year due to increase of food cost. "Replacing only five percent of the nation's diesel consumption with biodiesel would require diverting approximately 60 percent of today's soy crops to biodiesel production," says Matthew Brown, an energy consultant and former energy program director at the National Conference of State Legislatures.

3.3 According to some estimates, it is expected that due to doubling of biofuel production, as compared to its 2006 figures, 90 million people at risk of starvation will appear in addition to those already at risk by 2020.

3.4 The increase of the number of individuals facing the risk of starvation due to such extension of biofuel production will mainly occur in Eastern Asia, however, still 20 million people from "developed" countries can be also put at risk.

3.5 The major reason for this starvation risk is increase of food prices resulting from the fact that agricultural land can "earn more" if it is planted with biofuels. Thus, farmers will demand higher prices for food to offset theirs loses, occurring from not planting biofuel feedstock. (http://biofuel.org.uk/disadvantages-of-biofuels.html)

3.6 It is clear, that large water resources are used to grow and process biofuels. Even without biofuels, the world is experiencing water shortages. Problems are particularly severe in parts of Africa, South-East Asia, South and Central Americas. Pursuant to the estimates, approximately only one-third of less developed countries will have enough water to meet their needs by 2025.

3.7 Apparently, the struggle for water resources will become one of the main causes of inter-State conflicts in the coming decades. Thus, unbalanced increased production of biofuels will be one of the factors increasing political tensions in the world.

4. BIOFUEL POTENTIAL FOR CO_2 EMISSIONS REDUCTION

4.1 Even in case of full replacement of the fossil fuels, a biofuel usage will not provide the carbon neutrality in aviation sector just because of the “life circle emission” of its production. Taking into account the processing and fertilization of fuel crops the level of CO_2 emitted by some biofuels exceeds the emissions of fossil fuels.

4.2 In many cases biofuels production actually requires more energy than they can generate. For instance, the study conducted by Cornell University researcher David Pimental in 2005 has discovered that producing ethanol from corn requires 29 percent more energy than the end product itself can generate. Similarly, troubling numbers have been found in respect of the process used to make biodiesel from soybeans. “There is just no energy benefit to using plant biomass for liquid fuel,” Pimentel says.

4.3 “Most recently, a study by the Joint Research Centre (JRC) - the Commission's in-house research body - confirmed the findings of earlier EU studies that biodiesel made from crops such as rapeseed does more harm to the climate than conventional diesel” (http://www.reuters.com/article/eu-biofuel-idUSL6N0FH1QK20130711).

4.4 Energy efficiency of the biofuels

4.4.1 “E85 bio gasoline has less energy per volume than fossil gasoline, flex-fuel vehicles can get up to 30 percent fewer miles per gallon when fueled with E85. This means you will get fewer miles per dollar spent”. (https://www.thoughtco.com/e85-compatible-vehicles-85320)

4.4.2 **Energy Content of Biofuels**:

- The energy content of biodiesel is about 90% that of petroleum diesel.
- The energy content of ethanol is about 50% that of gasoline.
- The energy content of butanol is about 80% that of gasoline.

4.4.3 The lower energy content of biofuels means that vehicles travel shorter distances on the same amount of fuel. In terms of commercial aircraft flights such low energy content leads to decrease of available commercial payload. These factors should be taken into account when considering emissions metrics.

4.4.4 There is an opinion that most types of biofuels can be considered as “low carbon fuel”. In average, CO_2 emissions from combustion of biofuels equal to CO_2 emissions from fossil fuel in relation to one unit of energy output. This is the standard biochemical pattern. Therefore, the expression “low carbon fuel” just means CO_2 absorption by fuel crops in the process of vegetation, but against the backdrop of a biofuel “life circle emission” this expression loses its meaning.

4.4.5 In fairness, it must be noted that the numbers might positively differ in respect of the **biofuel generated from agriculture waste products**, which would otherwise end up in a landfill. For example, biodiesel can be manufactured from poultry processing waste. Once fossil fuel prices increase again, those types of waste-based fuels might become attractive from economic point of view and will be likely developed further.

5. AVIATION BIOFUEL CERTIFICATION ISSUES

5.1 Physical characteristics of biofuels differ from fossil fuel, especially in terms of a temperature stability (for instance, under the low temperature conditions) and aircraft engine wear effects. Consequently, all types of biofuels must be certified for the safe use in aircraft engines. In some cases, very costly modification of aircraft engine type design can be required.

5.2 A few thousand of test scheduled flights with passengers on board have been performed to date with use of a drop-in biofuel (mainly, the mixture of 30% of jet biofuel with 70% of Jet A-1 kerosene). Of note, detailed technical reports with results of these test flights are still not publicly available. Furthermore, no cross-polar flights have been conducted using the jet drop-in biofuel simply due to additional risks for flight safety (especially, when temperature of on-board fuel drops below -60°C).

5.3 Apparently, costly certification procedures of diverse types of the drop-in biofuels have significant negative influence on prices of the jet biofuel while taking into account a very limited production capacity of a biofuels at the moment.

6. COST BENEFIT ANALYSIS OF IMPLEMENTATION OF AVIATION BIOFUELS

6.1 Aviation jet biofuels cost four times more than Jet A-1 kerosene and at the same time pose additional risks to flight safety. Meanwhile, operation of new generation of jet aircraft leads up to 25% of fuel efficiency while raising significantly the flight safety level.

6.2 As it has been already mentioned above, only biofuels generated from bio-waste, including agricultural residues, have a capacity for the real CO_2 emissions reduction. However, for obvious reasons the amount of such biofuels is extremely limited and can hardly be sufficient for achievement of the CNG 2020 aspirational goal.

6.3 Considering low CO_2 emission reduction capacity, significantly higher price of aviation biofuels, logistic issues (aviation biofuel has to be stored in a separate fuel storage depots), as well as additional safety risks related to using drop-in bio-fuels it can be recommended that aircraft operators should rather invest into expeditious aircraft fleet renewal which brings real and considerable CO_2 emissions reductions and leads to flight safety and commercial attractiveness of global air transport.

6.4 At the same time, the escalation of investments into an aviation biofuel production will unavoidably lead to slowdown of technological development of international civil aviation and consequently will contribute to its CO_2 emissions growth.

7. ACTION BY THE CAAF/2

7.1 The CAAF/2 is invited to:

a) support a bio-waste based biofuel production for aerodrome service vehicles in order to provide a real CO_2 emissions reduction and environmental protection;

b) recommend the ICAO Council instruct its CAEP to reconsider the issue of the early introduction of biofuels for international civil aviation in terms of its environmental efficiency, cost benefit analysis, including its certification cost, and flight safety challenges, while considering the issues of food and water security in conformity with the UN Sustainable Development Goals; and

c) recommend the ICAO Council instruct its CAEP to summarize and publish technical reports on test and scheduled flights performed with use of a jet biofuel, first of all taking into account the analysis of the impact of use of a biofuel on flight safety and airworthiness of aircraft and aircraft engines.

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APPENDIX

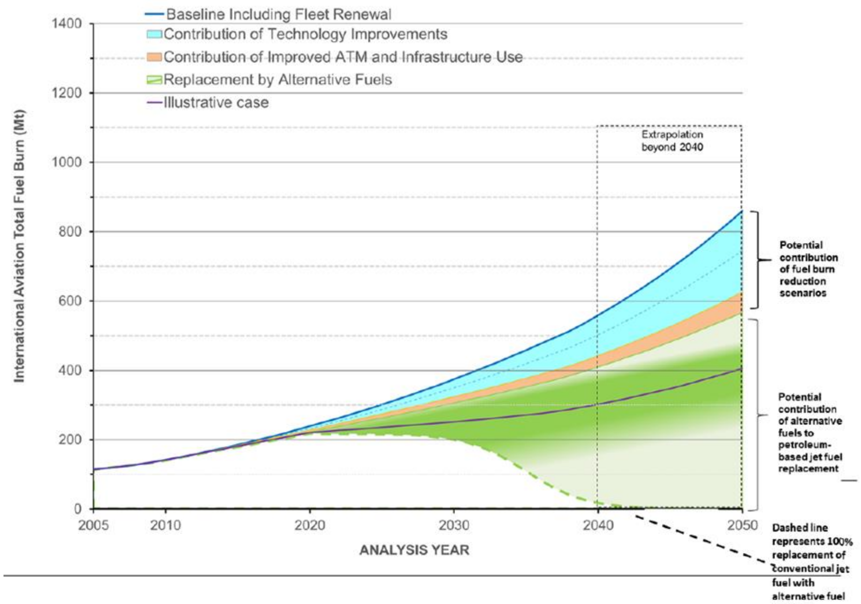
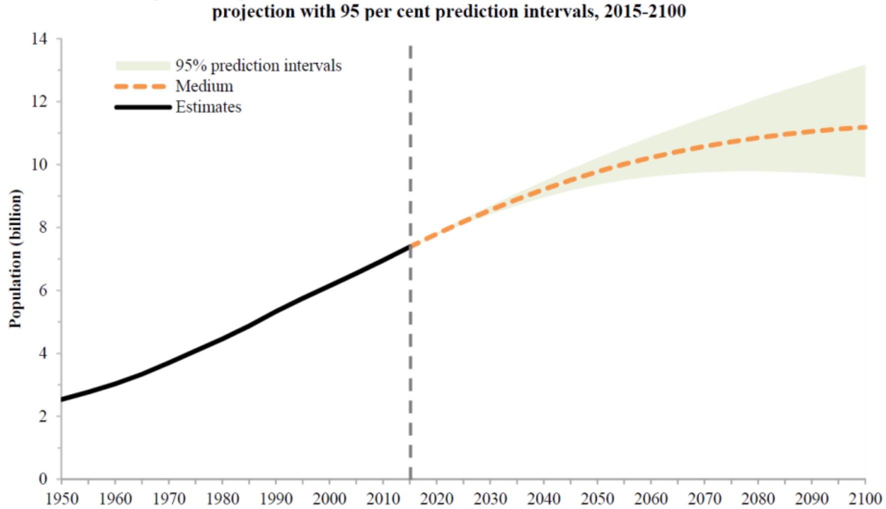


Figure 1. Potential Replacement of Jet Fuel with Alternative Fuels

Figure 2. Population of the world: estimates, 1950-2015, and medium-variant projection with 95 per cent prediction intervals, 2015-2100



Source: United Nations, Department of Economic and Social Affairs, Population Division (2017). *World Population Prospects: The 2017 Revision*. New York: United Nations.

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