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CONFERENCE ON AVIATION AND ALTERNATIVE FUELS

Rio de Janeiro, Brazil, 16 to 18 November 2009

Agenda Item 2: Technological feasibility and economic reasonableness

TECHNICAL FEASIBILITY AND ECONOMIC VIABILITY OF SUGARCANE ETHANOL

(Presented by Brazil)

SUMMARY

The paper discusses the technological feasibility and the economic viability of sugarcane ethanol. Applications of ethanol as an energy source, including in aviation, are presented and its main characteristics are briefly evaluated. Also it is shown that sugarcane ethanol can be produced and used competitively in a large scale in Brazil.

The conference is invited to approve the conclusion/recommendation in paragraphs 2 and 3.

1. INTRODUCTION

1.1 It has been known since the start of the last century that it is technically feasible to use ethanol in Otto cycle engines. More recently, it has also been shown possible to use the product in a vaporized form in small boilers that were originally built to use liquefied petroleum gas and natural gas. The use of ethanol in Diesel cycle engines has also been studied. Ethanol is currently being evaluated in Brazil and abroad for use in thermoelectric power stations, mainly because of its excellent environmental performance, in particular with respect to the emission of carbon dioxide (CO_2). The aeronautical sector is coming under pressure to reduce its emissions of greenhouse gases, and has invested heavily in R&D activities aimed at developing alternative aviation fuels. In Brazil, however, the use of alternative fuel in airplanes is already a reality, as shown by the ethanol-powered agricultural planes produced by Embraer. In this context, it should be possible to expand the evaluation of the use of ethanol to other types of aircraft equipped with piston engines, and in the future to aircraft equipped with Brayton cycle engines.

1.2 In comparison with fossil fuels, which are normally composed of hydrocarbons, ethanol has some specific characteristics:

1) It is a homogenous fuel, characterized by the presence of simple chains of the same molecule, each of which contains two carbon atoms. On the one hand, the

low level of carbon results in reduced calorific energy; on the other it implies less potential for emission of regulated pollutants and CO_2;

2) Ethanol is a product from a renewable origin. This gives ethanol enormous strategic and environmental importance;

3) It offers low toxic levels for living beings, meaning that it can be used on a large scale. Where there is a risk of human consumption, this problem can be avoided by adding minimal quantities of denaturizing substances that give the ethanol an unpleasant taste or smell. Even fossil fuels like gasoline or aviation kerosene can be used for this purpose;

4) Ethanol is biodegradable under normal environmental conditions, so avoiding the need for expensive and sophisticated procedures to treat soil or water in the case of accidental spills or leaks;

5) It is infinitely mixable with water. Depending on the circumstances, this can favor or limit its use;

6) Ethanol has a high octane rating and so does not require lead-based additives like those used in aviation gasoline;

7) When ethanol is produced it naturally contains a certain amount of water, as a function of the distillation process. When necessary, the existing water can be removed by using a dehydration process;

8) Unlike conventional aviation fuels, ethanol contains oxygen. This contributes to cleaner combustion; and

9) Depending on the raw material and the productive process, ethanol may contain a few contaminants; and depending on the use to which it will be put, these may need to be eliminated.

1.3 The potential of ethanol to reduce the emission of pollutants depends principally on its properties and those of the fuel that it substitutes, together with the technical characteristics of the propulsion system. In general, we can say that ethanol offers the following advantages in relation to fossil fuels, with respect to the pollutants generated:

1) Lower emission of organic vapors and compounds, and reduced toxicity of these emissions;

2) Virtually zero emissions of particulate matter and sulfur oxides;

3) Reduction in the photochemical reactivity of organic compounds;

4) While the emission of carbon monoxide, organic compounds and nitrous oxides can be significantly reduced, this will depend mainly on the characteristics and calibration of the propulsion unit; and

5) The emission of aldehydes can be efficiently controlled in a cost-effective way and therefore should not be viewed as a limiting factor to its use.

1.4 Ethanol is produced on a commercial scale employing what is generally seen as first-generation technology, basically using the sugars that are present in the raw material. In the Brazilian case, it is possible to produce roughly 7,000 liters of ethanol per hectare of land planted with sugarcane. However, it is possible that this productivity can be increased by using new varieties of sugarcane and more advanced production techniques. Should the so-called second-generation processes become viable, allowing for production of ethanol from cellulosic materials, this volume could be increased by at least 30% and under favorable conditions it could even double. In this context the use of sugarcane bagasse offers enormous advantages over other raw materials for the following reasons: this waste product is available in the production unit at practically zero cost; and the process of converting cellulose into ethanol can take advantage of the availability of locally-produced energy and of integration with other existing processes.

1.5 In spite of the financial crisis that has recently shaken the world, the production and consumption of ethanol has continued to rise and investments in the sector have gradually resumed in Brazil. The following projections for production and exportation of ethanol were prepared by Unica[1], the Brazilian Sugarcane Industry Association, and indicate that the sector should continue to grow strongly in Brazil:

	Harvest 2008/09	**Harvest 2015/16**	**Harvest 2020/21**
Sugarcane production (millions of tonnes/year)	562	829	1,038
Ethanol production (billions of liters)	27.0	46.9	65.3
Ethanol exports (billions of liters)	4.8	12.3	15.7

1.6 Sugarcane ethanol has been judged to be commercially competitive with petroleum when the price of the latter is at least US$45 per barrel. In Brazil, ethanol has for many years been shown to be commercially competitive and the product is a success with consumers. This is particularly relevant when we recall that Brazilian consumers have a choice of product – drivers of Flex-fuel vehicles can choose between ethanol, gasoline or any mixture of the two. Based on the current energy efficiency of Flex-fuel vehicles, the market has adopted 70% as the pump price threshold for a liter of ethanol, relative to a liter of gasoline, when deciding which fuel to buy. It is cheaper to use ethanol when this costs less than 70% of the price of gasoline; when the difference is 70% this is indifferent for the consumer; and when ethanol costs more than 70% then gasoline represents a better choice.

1.7 Currently ethanol is traded and marketed under free market conditions in Brazil and its price fluctuates as a function of supply and demand.

[1] UNICA, the Brazilian Sugarcane Industry Association, is the largest organization in Brazil representing sugar, ethanol and bioelectricity producers. It was created in 1997, following a consolidation process involving regional organizations in the State of São Paulo after government deregulation of the sugar and ethanol sectors. UNICA members answer for more than 50% of all ethanol produced in Brazil and 60% of overall sugar production.

1.8 Unlike petroleum, whose reserves are concentrated in a relatively small group of countries, sugarcane ethanol can be produced in over 100 countries worldwide that have the right conditions of climate and soil to grow sugarcane. This helps to democratize the access to energy.

2. CONCLUSION

2.1 The conference is invited to conclude:

a) That using sugarcane ethanol as a fuel offers both technological feasibility and economic viability. It could therefore be used more widely in general aviation, both in the short term in airplanes equipped with Otto cycle engines, and in the longer term in airplanes using Brayton cycle (gas turbine) engines, following research and development for their adaption;

b) Various countries already have the infrastructure needed for large-scale production of sugarcane;

c) There is availability for sustainable expansion of sugarcane plantations in various countries, including Brazil. This offers potential for the creation and expansion of the biofuels industry;

d) There is significant potential for creating second-generation biofuels from sugarcane bagasse, and this could allow for increased production of ethanol for use in general aviation; and

e) Recent studies have demonstrated that it is technologically possible to produce “aviation kerosene” or even sulfur-free “diesel” using new technological options based on the bioprocessing of sugarcane. This could meet at least part of the fuel requirement for airplanes equipped with Brayton cycle engines and/or ground-based support equipment.

3. RECOMMENDATION

3.1 The conference is invited to:

a) Recommend the expanded use of sugarcane as one of the principal biomasses for the production of aviation biofuels.

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