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SUSTAINABLE AVIATION FUELS ENVIRONMENT IN BRAZIL

(Presented by Brazil)

SUMMARY

This information paper presents a broad overview of the Brazilian biofuels sector, including opportunities for the production of biomass feedstocks, regulatory framework, R&D&I, and biofuels production and promotion environments, focusing on sustainable aviation fuels (SAF).

1. BACKGROUND

1.1 The earliest record of use of renewable fuels in Brazil dates from the year 1925[1], regarding a 267-mile (430 km) trip from the city of Rio de Janeiro to the city of São Paulo, using an ethanol-powered car. Since then, there have been various initiatives and campaigns to promote the use of biofuels, but it was only 50 years later that the first national program was ready to start operating.

1.2 The Brazilian Ethanol Program (Proálcool) was implemented in the 1970s. It promoted the use of sugarcane ethanol as fuel for light vehicles in Brazil (Otto cycle vehicles). Since then, the program underwent several modifications, and today it operates based on an official order to mandatorily add 27% of ethanol to gasoline of fossil origin. Since mid-2002, the national automotive industry started the manufacturing of flexible-fuel vehicles (that is, vehicles that can be powered by gasoline, ethanol or a mixture of the two in any proportion), resulting in the increased use of this renewable fuel. The installed production capacity for ethanol (both hydrous and anhydrous) in Brazil is nearly 23 billion gallons (90 billion liters) annually, and the current annual traded volume is about 7.6 billion gallons (29 billion liters). Ethanol plants also cogenerates bioelectricity and supplies it to the integrated national electric power grid. There are approximately 408[2] ethanol and sugar plants in Brazil.

1.3 In 2004, a national program for biodiesel use was implemented in Brazil[3]. At first, it worked with a system of voluntary mixture, which was later turned into a system of mandatory mixture. The Brazilian biodiesel market is structured in periodic auctions. Currently, the mixture is obtained with

[1] UNICA – União da Indústria de Cana-de-açúcar (Brazilian Sugarcane Industry Association), (2008) Combustível do Brasil (Brazil's Fuel) (video) http://www.unica.com.br/multimedia/
[2] https://www.novacana.com/usinas-brasil/mapa/
[3] PNPB – Programa Nacional de Produção de Biodiesel (National Program of Biodiesel Production and Use) (http://www.mme.gov.br/programas/biodiesel)

the addition of 8% of biodiesel to diesel oil (B8), and there are projections to increase this percentage to 9% and 10% in 2018 and 2019, respectively. The installed biodiesel capacity in Brazil is 1.9 billion gallons (7.4 billion liters) annually, and the current annual traded volume is 1.1 billion gallons (4.3 billion liters). The main feedstock for biodiesel in the country is soybean (approximately 70% of the market), followed by animal fats (20%) and complemented by residual oils and fats, fatty acids and cotton. There are currently approximately 58[4] biodiesel plants in Brazil.

1.4 The first flight in Brazil using biokerosene as fuel was operated on October 23, 1984. The Embraer Bandeirante (EMB-110) turboprop aircraft took off from São José dos Campos, with Brasília as its destination, with 100% biokerosene fuel (Prosene)[5], produced from the babaçu (Attalea speciosa), in a joint project among researchers and the Brazilian General Command for Aerospace Technology (CTA).

1.5 In 2005, Embraer certified the EMB-202A Ipanema (agricultural application), the first ethanol-powered aircraft in the world that was mass-produced. In 2015, a new version of Ipanema (EMB-203) was launched, available only with ethanol-powered engine. This production meets market demands specific to Brazil, due to the availability of plentiful fuel at much lower costs than aviation gasoline (AV-GAS). Approximately 500 out of the 1,200 aircraft with active registration by ANAC (National Civil Aviation Agency) are ethanol-powered, which means 40% of the Embraer "Ipanema" fleet today is ethanol-powered.

2. BIOMASS PRODUCTION

2.1 Due to its territorial dimensions, climate, and natural resources, Brazil presents extremely favorable conditions for the large-scale production of biomass for bioenergy, including biofuels[6].

Territorial division	Acres (hectares)	Total area %	Area suitable for agriculture %
Brazil	2,1 G (851 M)	100.0%	-
Area suitable for agriculture	815 M (329.9 M)	38.8%	100.0%
Planted area (annual and perennial)	178 M (72.2 M)	8.5%	21.9%
Grains	123 M (49.9 M)	5.9%	15.1%
Soybean	59.7 M (24.2 M)	2.8%	7.3%
Corn	34 M (13.8 M)	1.6%	4.2%
Other grains	29.4 M (11.9 M)	1.4%	3.6%
Sugarcane	22.7 M (9.2 M)	1.1%	2.8%
Planted forest	16 M (6.5 M)	0.8%	2.0%
Other crops	16.3 M (6.6 M)	0.8%	2.0%
Pasture	425 M (172 M)	20.2%	52.1%
Area available for agriculture	211.7 M (85.7 M)	10.1%	26.0%

2.2 Brazil has over 200 million acres (80 million hectare) of land available for agriculture, apart from the existing forest areas, natural reserves and other protected areas. Future efficiency gains in

[4] https://www.biodieselbr.com/usinas/mapa/
[5] http://sistemas.mre.gov.br/kitweb/datafiles/NovaDelhi/pt-br/file/Biocombustiveis_10-entrevistaexpedito.pdf
[6] http://www.unica.com.br/download.php?idSecao=17&id=9218077

the biomass production process, through crop-livestock-forest systems (ICLFS) and low-carbon agriculture (LCA), are also means for increasing bioenergy production.

2.3 Listed below are some of the key economic and social benefits of the wide-scale commercial biomass feedstocks industry for the production of energy in Brazil:

a) Sugarcane[7]:

- 380 operational production units;
- Approximately US$ 40 billion gross domestic product from the sugar energy chain;
- Over 840 thousand formal jobs in the production sector;
- Approximately 70 thousand biomass independent suppliers;
- US$ 11.3 billion generated in foreign exchange value;
- Sugarcane Ethanol represents 16.9% of Brazil's energy matrix;
- Cogeneration of 24 thousand GWh of electrical power, connected to the integrated national power grid.

b) Soybean[8]:

- 96 operational production units (soybean processing);
- Approximately US$ 65 billion gross domestic product from the soybean chain;
- Over 1.5 million direct formal jobs in the production sector and over 70 thousand family farmers;
- Approximately 220 thousand biomass independent suppliers;
- US$ 30 billion generated in foreign exchange value;
- 1.0% is the participation of soybean biodiesel in Brazil's energy matrix (which represents 1.3% of total diesel).

c) Future commercial biomass feedstocks

- Brazilian diverse climate and natural resources availability allows for the production of a wide variety of biomass feedstocks, including foreign species. Embrapa[9], by means of the NextBio project[10], promotes medium and long term research in the fields of genetic improvement and biotechnology, including researches on feedstocks that are more suitable to meet the demand of SAF, such as canola, jatropha, macaúba (Acrocomia aculeata) and microalgae.

- Reforestation with perennial plants used for bioenergy production, such as macaúba in Central Brazil, is part of an important project, which is more thoroughly discussed in CAAF/2-IP/08.

[7] http://ubrabio.com.br/sites/1800/1891/PDFs/EXPANDMG/30Ago2SIFAEGeSIFAAA%C2%BAcarDesenvolvimentoSu.pdf
[8] http://ubrabio.com.br/sites/1800/1891/PDFs/EXPANDMG/30Ago3UbrabioBiomassaspromissorasinvesti.pdf
[9] https://www.embrapa.br/agroenergia
[10] http://www.agricultura.gov.br/assuntos/camaras-setoriais-tematicas/documentos/camaras-setoriais/oleaginosas-e-biodiesel/2017/29a-ro/nextbio_embrapa.pdf

3. CONVERSION

3.1 Brazil has only one installed operational plant capable of producing renewable fuel for aviation. Amyris[11] has an installed plant in Brotas, São Paulo, with capacity to produce approximately 44,000 ton (40,000 metric tonnes of renewable hydrocarbon compatible with aviation kerosene through a proprietary process certified by ASTM and ANP.

3.2 Brazil's oil company (Petrobras) owns a proprietary process for the co-processing of vegetable oils (H-BIO[12]) used to obtain renewable diesel through the hydrogenation of a vegetable oil and petroleum current mixture. This process was tested in 2006 and can technologically be expanded to aviation kerosene in the future. It still has to achieve technological maturity to generate aviation kerosene and meet ASTM and ANP (Brazil's national petroleum, natural gas and biofuels regulatory agency) technical certifications for aircraft operation.

4. AIRLINES IN BRAZIL

4.1 Brazil has already operated hundreds of flights fuelled by mixtures of renewable fuels. All four major Brazilian airlines have some link to renewable fuels. LATAM operated an experimental flight in Brazil in December 2011, with an A330 aircraft, which took off from Rio de Janeiro and was fuelled by biofuels produced from jatropha. In April 2012, during the Rio+20 Conference, Azul Linhas Aéreas operated an experimental flight from Campinas to Rio de Janeiro (Santos Dumont Airport), fuelled by a mixture produced from sugarcane. Also during the Rio+20 Conference, GOL Linhas Aéreas operated its first experimental flight, from São Paulo (Congonhas Airport) to Rio de Janeiro (Santos Dumont Airport), as part of *Flight Path to a Sustainable Future*, fuelled by a mixture produced from residual oil and fats and inedible corn oil. In October 2013, the same company operated the first Brazilian commercial flight powered by biokerosene, after being approved by ANP. During the 2014 FIFA World Cup, the company operated over 360 flights among the cities hosting the competition, including transportation of Brazil's national football team. In the same year, GOL operated the first Brazilian international flight fuelled by a mixture produced from sugarcane, which took off from Orlando (USA) to Santo Domingo (DR) then São Paulo (BR). Avianca Brasil and Byogy Brasil[13] share an agreement for the development of renewable fuels produced from ethanol.

5. AVIATION KEROSENE MARKET AND CO_2

5.1 Based on the total sales of aviation kerosene in national territory, the market in Brazil yields about 7.7 million ton (7 million metric ton), base year 2016.

5.2 In 2016, future scenarios of development were outlined, together with the needs for neutralizing CO_2 emissions, based on conservative projections for the national economy and growth rates for the aviation industry.

5.2.1 Meeting CORSIA: neutralization of emissions resulting from international operations with the regular aviation Brazilian flag above the neutral growth line as of 2020, in line with the ICAO-CORSIA requirements. This scenario preliminarily points out the need to avoid about 1.5 million tCO2e in 2030, which will represent approximately 747 thousand tons (678 thousand metric tons) of SAF.

[11] Amyris Brasil Ltda (https://amyris.com/)
[12] http://www.investidorpetrobras.com.br/pt/comunicados-e-fatos-relevantes/fato-relevante-petrobras-desenvolve-nova-tecnologia-para-producao-de-oleo-diesel
[13] Byogy do Brasil Ltda (http://www.byogy.com/)

5.2.2 Neutral growth of the emissions from the Brazilian aviation industry: this scenario includes, in addition to the ICAO-CORSIA requirement of Carbon-neutral growth as of 2020, the compliance with the guidelines and recommendations from the Paris Agreement (COP-21), contributing to the basket of measures included in the Brazilian INDC (Intended Nationally Determined Contribution) and preventing the increase of compensations needed by other sectors. This scenario preliminarily points out the need to avoid about 8.3 to 12.4 million tCO2e in 2030, which will represent approximately 4,130 to 6,170 thousand tons (3,750 to 5,600 thousand metric tons) of SAF.

6. RESEARCH, DEVELOPMENT AND INNOVATION

6.1 Research institutions such as UFRJ[14], PROCAT[15], UFMG[16], CTBE[17], UFPB[18], UFRN[19] and others have published market researches, technical and economic feasibility studies and new and alternate paths for the production of renewable kerosene. In May 2017, the Rede Brasileira de Bioquerosene e Hidrocarbonetos Renováveis para Aviação (RBQav, Brazilian Network of Renewable Biokerosene and Hydrocarbon for Aviation)[20] was launched. Its goal is to produce feasible research projects for aviation renewable fuels, with the help of partners and the Federal Government through MCTIC.

6.2 The Brazilian Biojetfuel and Renewables Platform has been promoting the concept of "from research to fly" since its launch on Aviation Day during the RIO+20 to promote highly integrated, logistically optimized regional value chains. The Minas Gerais Biojetfuel and Renewables Platform is promoting use of residues and reforestation as base biomass to produce SAF[21].

7. REGULATORY FRAMEWORK AND PROMOTION INITIATIVES

7.1 There is currently no regulatory framework established to encompass the production of SAF (biokerosene) in Brazil. Since December 2016[22], the Brazilian Ministry of Mines and Energy has been discussing RenovaBio, a new regulatory framework for biofuels, which will encompass advanced biofuels.

7.2 RenovaBio has not yet been officially approved, but the bill is expected to come into force in January 1st, 2019. The program is based on the following premises:

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[14] UFRJ/EQ – Tecnologia de Processos Químicos e Bioquímicos (Chemical and Biochemical Processes Technology Graduate Program) (http://tpqb.eq.ufrj.br/)

[15] PROCAT – Unidade Protótipo de Catalisadores (Prototype Unit for the Research of Catalysts (http://procat-ufrj.com)

[16] UFMG/LEC – Laboratório de Ensaios de Combustíveis (Fuel Testing Laboratory) (http://www.lec.qui.ufmg.br/)

[17] CTBE – Laboratório Nacional de Ciência e Tecnologia do Bioetanol (National Bioethanol Science and Technology Laboratory) (http://ctbe.cnpem.br/)

[18] UFPB/LTPB – Laboratório de Tecnologia e Processamento de Biocombustíveis (Biofuels Processing and Technology Laboratory) (http://security.ufpb.br/idep/contents/menu/laboratorios/laboratorio-de-tecnologia-e-processamento-de-biocombustiveis-ltpb)

[19] UFRN/DEQ – Departamento de Engenharia Química (Chemical Engineering Department) (http://www.eq.ufrn.br/portal)

[20] MCTIC – Ministério da Ciência, Tecnologia, Inovações e Comunicações (Ministry of Science, Technology, Innovation and Communication) (http://www.mctic.gov.br/mctic/opencms/tecnologia/tecnologiasSetoriais/biocombustiveis/biocombustiveis/Biocombustiveis.html)

[21] SABR-TCR: a stand alone biorefinery solution for ICAO´s "no country left behind"

[22] MME – Ministério das Minas e Energia, Ministry of Mines and Energy (http://www.mme.gov.br/web/guest/secretarias/petroleo-gas-natural-e-combustiveis-renovaveis/programas/renovabio/principal)

7.2.1 Meritocracy: the use of biofuels as instruments for the reduction of emissions will take into account their environmental performance and sustainability;

7.2.2 Individual accreditation: the energy and environmental performance of biofuels produced and used in Brazil will be measured in accordance with international patterns of accreditation and transparent criteria;

7.2.3 Energy efficiency: based on the results of the energy and environmental performance evaluation, the program aims at individually searching for induction inducing energy efficiency through energy performance.

7.2.4 Improvement of the fuel matrix: gradual "decarbonization" of the matrix in the short, medium and long terms.

7.3 RenovaBio is a federal program that aims at developing a joint strategy to acknowledge the strategic role of all types of biofuels in the Brazilian energy matrix, both to promote energy security and to mitigate greenhouse gases emissions. Unlike traditional measures, RenovaBio does not propose the establishment of taxes on fossil fuels, subsidies, presumptive credit or mandates for the addition of biofuels to fuels.

7.4 At the international level, Brazil launched during UNFCCC COP22 (November 2016) and currently acts as interim facilitator to the Biofuture Platform[23], a new government-led, multi-stakeholder initiative founded by twenty leading nations to promote a sustainable advanced low carbon bioeconomy, which includes the production and use of SAF.

8. BIOKEROSENE PRODUCTION ENVIRONMENT

8.1 Based on the aforementioned conditions, Brazil already produces bioenergy and biofuels and has the potential to expand this production, especially in the area of SAF.

8.2 Some of the possibilities and opportunities for the SAF industry in Brazil are portrayed in the document "Bioquerosene no Brasil[24]", which results from discussions in the seminar "Seminário de Desenvolvimento Sustentável e Descarbonização: oportunidades de negócios e investimentos na cadeia de valor do Bioquerosene[25]", hosted by the Federation of Industries of the State of Minas Gerais (FIEMG) and the Brazilian Union of Biodiesel and Biokerosene (UBRABIO) from August 29 to 30, 2017.

— END —

[23] http://biofutureplatform.org/
[24] http://ubrabio.com.br/sites/1800/1891/PDFs/EXPANDMG/BioquerosenenoBrasil.pdf
[25] http://www.ubrabio.com.br/1891/Noticias/VejaAsApresentacoesDoSeminarioDeDesenvolvimentoSustentavel_269848/