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ASSEMBLY — 38TH SESSION

EXECUTIVE COMMITTEE

Agenda Item 17: Environmental Protection

BRAZIL ACTION PLAN ON CO_2 EMISSIONS

(Presented by Brazil)

EXECUTIVE SUMMARY

As per the Resolution A37-19 item 9, ICAO Member States have recognized the proposal to voluntary organize and submit their Action Plans. Action Plans are understood as a valuable instrument to report ongoing efforts and future plans of individual ICAO States to address the environmental impacts of civil aviation. Brazil supports that initiative, highlights its voluntary characteristics and, to the benefit of transparency and information sharing, recommends that States submit their Action Plans publicly.

Action: The Assembly is invited to:
a) note the information provided;
b) encourage Member States to voluntarily submit their action plans and make them available publically.

Strategic Objectives:	This working paper relates to Strategic Objective C – *Environmental Protection and Sustainable Development of Air Transport.*
Financial implications:	No additional funding required.
References:	A37-19, *Consolidated statement on continuing ICAO policies and practices related to environmental protection – Climate change*

1. INTRODUCTION

1.1 The 37th Session of the Assembly encouraged States to voluntarily submit to ICAO their Action Plans outlining respective policies and actions towards the reduction of CO2 emissions from international aviation, and to annually report to ICAO the implementation of such measures (Resolution A37-19, paragraph 9).

1.2 As per the 37th Session of the ICAO Assembly, Action Plans should include information on the basket of measures considered by States, reflect respective national capabilities and circumstances, and identify any specific assistance needs (A37-19, paragraph 10).

1.3 The Action Plans contribute to ICAO's efforts to promote environmental protection and sustainability of international civil aviation, while for States it represents a clear message on their commitment to face the challenges generated by climate change.

2. DISCUSSION

2.1 Brazil recognizes that ICAO has achieved substantial progress in pursuing efforts to address the impacts of aviation on climate. Nevertheless, more effort should be made to assess the feasibility and environmental benefits of the basket of measures devised to deal with the reduction of greenhouse gas emissions from aviation.

2.2 Measures such as operational improvements, aircraft technology and development and adoption of an aircraft CO2 standard must remain a priority to ICAO. Particularly, concrete actions to support States in the development and deployment of sustainable alternative fuels are highly desired, since alternative fuels, in comparison to the other items of the basket of measures, have the largest potential to reduce greenhouse gas emissions from aviation.

2.3 As broadly recognized by the sector, the development of a global market-based measure scheme might be necessary. However, such scheme must be regarded as one of the various available measures and indeed, a temporary and limited one. Any discussion involving the development of MBMs must observe the principles and provisions on common but differentiated responsibilities and reflect the negotiations under the UNFCCC and its Kyoto Protocol.

2.4 Bearing that information in mind, Brazil recommends that States submit and update their voluntary Action Plans every three years. In order to promote the transparency and effectiveness of the Action Plan initiative, Brazil also recommends that Action Plans should be made public to other Member-States, while maintaining the voluntary character of its submission.

2.5 Based on the aforementioned information, Brazil presents its Action Plan included as Attachment A to this Working Paper. The purpose of the Brazilian Action Plan is to share information with ICAO's Secretariat and Member States with a view of contributing to the global effort of reducing GHG emissions from international civil aviation. It also has the purpose of gathering information on civil aviation emissions, while mapping actions that might contribute to its reduction. It does not constitute a domestic Sector Plan for the Brazilian Civil Aviation, as defined by article 11 of the Law no 12.187, 2009.

2.6 The formal and final version of the Action Plan shall be submitted to ICAO´s Secretariat at a later stage.

3. CONCLUSION

3.1 Brazil strongly supports the preparation and submission by States of their Action Plans as a positive contribution to the overall efforts of reducing CO2 emissions and mitigating the climate change phenomena.

3.2 While recognizing the importance of the submission of Action Plans, with a view of contributing to the global effort of reducing GHG emissions from international civil aviation, Brazil also stresses the voluntary character of the documents, which must not be misunderstood as national or international commitments.

3.3 In order to promote transparency and increase the effectiveness of the initiative, Brazil supports that States submit their Action Plans publicly through ICAO's public website.

4. RECOMMENDATIONS

4.1 The Assembly is invited to:

a) note the information provided;

b) encourage Member States to voluntarily submit their action plans and make them available publically.

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APPENDIX A

Brazil's Action Plan on the reduction of Greenhouse Gas Emissions from aviation

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Summary

1. Introduction

Brazil is a country with continental dimensions which underwent significant economic growth and substantial reduction of social inequalities in the last decades. Not to mention other aspects of this processes, poverty reduction and the growth in the general population purchasing power resulted in a sustained growth on the demand for air transportation in the country. Liberalization of domestic and international markets, while promoting competition and removing obstacles to the establishment of services and routes, resulted in substantial reductions on average air fares, thus also strengthening demand for air transportation.

As happened in other countries which liberalized their aviation sectors and experienced economic growth, established passengers were able to fly more frequently, while new passengers had the opportunity to fly for the first time in their lives. Recent data shows that the number of travels per capta in Brazil in 2011 was 0.42, indicating that, despite the recent changes in the dynamics of the Brazilian civil aviation sector, and the relative maturity of it as an economic activity, there is still substantial potential for growth.

Being a continental country, civil aviation displays a key role in the Brazilian economy and in the lives of its citizens. The transport mode connects the country, promotes regional integration, is essential for business, for the full development of tourism throughout the country and for permitting dynamism to the Brazilian economy. Furthermore, the accessibility to isolated regions can only be made by air, highlighting the strategic importance of civil aviation to connect more isolated segments of the country to the national transportation network.

Brazil has historically been doing its fair share in combating climate change, and is prepared to sustain its leading role in the context of the global effort to tackle the problem. Brazil was the first country to sign the United Nations Framework Convention Climate Change, resulting from the United Nations Conference on Environment and Development - Rio-92, held in Rio de Janeiro, in June 1992. The Framework Convention was ratified by the Brazilian National Congress in 1994.

The latest and one of the most effective initiatives by Brazil in this arena was the establishment of the National Policy on Climate Change - PNMC, by means of Law no 12,187/09. The voluntary mitigation actions at national level included in it had been announced in Copenhagen, in December 2009, during the High Level Segment of the 15th Conference of the Parties to the Convention on Climate Change - COP-15 and the 5th Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol - CMP-5. In accordance with this law, Brazil will pursue voluntary actions for the mitigation of greenhouse gas emissions with a view to reducing its projected emissions by 36.1%-38.9% by 2020.

As a result of domestic programs and initiatives, Brazil has a comparatively "clean" energy mix, with low greenhouse gas emission levels per energy unit produced or consumed. Around 50% of the Brazilian energy matrix are obtained from sustainable sources (biofuels, hydroelectric power etc). Other initiatives, such as the fight against deforestation, as well as the case for biofuels and energy efficiency, also help to achieve development goals, with a sharp deviation in the trend of greenhouse gas emissions curve in Brazil.

Internationally, Brazil has demonstrated outstanding engagement with a view to strengthening the multilateral response to climate change and to ensuring the full, effective and enhanced implementation of the UNFCCC, in accordance with its principles and provisions, in particular the principles of equity and common but differentiated responsibilities and respective capabilities. Actions to tackle greenhouse gas emissions from international civil aviation must be, thus, considered in the context of results already delivered as part of its contribution to the international response to climate change and in light of countries' historical responsibilities.

It is essential to bear in mind that this Action Plan does not constitute a domestic Sector Plan for the Brazilian Civil Aviation, as defined by article 11 of the Law nº 12.187, 2009. This document has the purpose of gathering information on civil aviation emissions, and actions planned or already in place that might contribute to its reduction. The purpose of the Brazilian Action Plan is to share information with ICAO's Secretariat

and Member States with a view of contributing to the global effort of reducing GHG emissions from international civil aviation.

2. Brazil's Action Plan Scope

During the 37th ICAO Assembly, performed in October 2010, it was approved, by the Member-States, Resolution A37-19 endorsing a range of measures to address the international civil aviation contributions for climate change. The Assembly Resolution requests ICAO's member-countries to submit, in a voluntary way, their Action Plans. These Plans are an opportunity given to the States for showing the specific voluntary measures that they intend to adopt with the purpose of improving the fuel efficiency of the sector and thus contributing with the desirable environmental objectives agreed during the Assembly.

Hence, this Action Plan for the reduction of the greenhouse gases emissions of the Brazilian civil aviation has the intention of presenting the sector's evolution and the greenhouse gases emissions which followed this evolution in the last decade. First, the economic data and the evolution of the national air fleet are analyzed. From these data, the fuel consumption evolution and the Brazilian air sector CO_2 emissions along the period under analysis will be presented.

It is also presented the actions already in course and others that are intended to be implemented for the improvement of the civil aviation fuel efficiency. These actions are initiatives from public and private institutions which aim at reducing the airlines operational costs and decreasing the greenhouse gases emissions volume. These initiatives, besides being implemented by different players, will contribute to the common objective of the Brazilian civil aviation sustainable development and the reduction of anthropic GHG emissions associated to the sector.

2.1 Domestic and International Concept

The methodology used in this document follows the orientations of IPCC Intergovernmental Panel on Climate Change. According to IPCC Good Practice Guide (2006), for a multiple stage flight, each stage shall be separately classified as domestic, if involving passengers and freight transportation between two points of a same country. Under any other circumstance, the stage is considered as an international flight. The system assumes that, for international flights operated by Brazilian companies, the stages inside Brazil are considered, by the IPCC methodology, as domestic stages.

Besides, foreign companies operating flights from or to Brazil cannot, by force of the national legislation and bilateral agreements, perform operations which are characterized as domestic stages, thus, all the stages operated by foreign companies are considered as international stages. There are few routes operated by Brazilian companies abroad where the Fifth or Sixth Freedoms of the Air are applied, with the right of embarking and disembarking passengers and freight between two points out of Brazil. These routes are, in general, operated between countries of South America and Caribbean and are not computed by the system. However, due to the small quantity of these flights, their total impact is considered worthless.

No attempt was made for conciliating the data generated by the system with the data from the ICAO'S M form, compiled, filled, and submitted by the National Agency of Civil Aviation – ANAC to ICAO based on information on the fuel consumption provided by the operators. It is understood that, according to provision from the "Guidance Material for the Development of States' Action Plans" the methodology for differing between the domestic and international flights converts with the one recommended by IPCC and not with the one proposed by ICAO. The data were compiled like this bearing in mind the procedure already adopted for the sector's emissions inventory calculation, which is part of the national communication to UNFCCC. However, with the purpose of providing the necessary data to ICAO in order to consolidate the information on the international civil aviation emissions, this document also makes the differentiation between the international operations performed by Brazilian companies and international operations performed by foreign companies.

It is known that the ICAO's activity is focused on international civil aviation and, therefore, the Action Plan scope shall be centered on the actions related to international stages. However, it was chosen presenting, in informative character, the information on the domestic aviation, segregated from the information on the international aviation. This happened because the actions for reducing the emissions have impact both in the domestic and international civil aviation and the domestic stages represent great part of the Brazilian airlines' activity.

2.2 Methodology for fuel consumption and emissions volume calculation

The data presented in this document were generated from a system developed by the National Agency of Civil Aviation – ANAC for computing the Brazilian civil aviation fuel consumption and CO_2 emissions. The system is based on aircraft movement data provided by the Department of Airspace Control – DECEA. These data were used to produce the Reference Report for the aviation sector which is part of the 2nd National Communication on GHG Emissions and Removals, submitted to the United Nations Framework Convention on Climate Changes – UNFCCC, in 2010, as part of the commitments assumed by adhesion to the Kyoto Protocol.

The fuel burn and emissions calculation were made, on a flight-per-flight bases of all commercial scheduled, non-scheduled and general aviation flights (IPCC tier 3a level) based on the distance flown (great circle distance) and on the emissions factors available at the CORINAIR and ICAO Emissions Databank. For turboprop engines was used the FOI database maintained by the Swedish Civil Aviation Authority.

The system does not calculate APU (Auxiliary Power Units) emissions from aircrafts and also helicopters. Due to these peculiarities, conciliation was made at the end of the calculations with the total aviation kerosene distributed in the country, per year, according to official data divulged by the National Agency of Petroleum, Natural Gas and Biofuels – ANP.

According to the data from the 2nd National Report on GHG Emissions and Removals, the aviation gasoline-type fuel is responsible for less than 1% of the total CO_2 emissions from the sector in Brazil, and was not included in this Action plan. At last, the emissions from non-aircraft ground operations such as the people transportation, ground support equipment, generators, airports air conditioning, among others, were not considered in this document.

3. The Brazilian Civil Aviation

3.1 Economic Data

Data compiled up to 2009, show that the civil aviation sector contributes with around 32 billion Reais or 1.0% of the Brazilian GDP. The air sector generates around 684,000 jobs, which means around 0.7% of the Brazilian labor market. In case we take into account the aviation contribution to the tourism sector, the numbers rise to 1.3% of the GDP and around 938,000 jobs, or, 1.0% of the Brazilian labor market. [1]

In Brazil, the air transportation is growing faster than the global average. Studies indicate that Brazil is already the world 3th domestic air traffic market. In 2010, the Brazilian aviation sector transported around 71 million passengers and 870 thousand tons of air freight. The Brazilian demand for aviation fuel in 2011 was 7 million cubic meters, around 2,8% of the global demand. It is important to highlight that 75% of the fuel consumed was produced by Brazilian refineries and the rest was imported. [1]

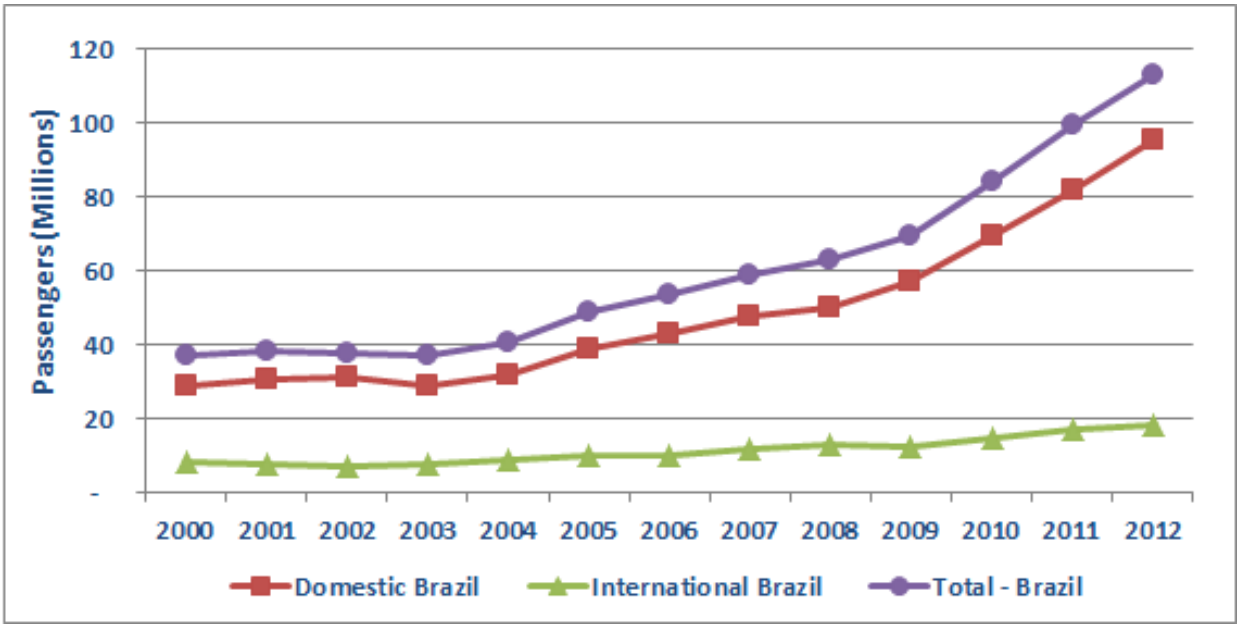
In the last thirteen (13) years, the domestic market prevailed in the Brazilian air sector scenario, in comparison with the international market (Brazilian and foreign airlines included). In average, 81% of the Brazilian market consists in domestic flights. The passengers' transportation in 2012, for example, was around five times higher in the domestic market (95,347,421) than in the international market (17,997,831). The domestic traffic was characterized by a strong growth from 2000 to 2012 (of 10.4% per

[1] Source: Economic Benefits from Air Transport in Brazil – Oxford Economics 2011

year and 228% accrued), higher than the international traffic growth (6.9% per year and 122% accrued) in the same time period.

Figure 1 shows the number of transported passenger's growth in the country, in domestic flights (red line), international flights (green line) and the total passengers transported evolution (purple line) from the year 2000 to 2012.

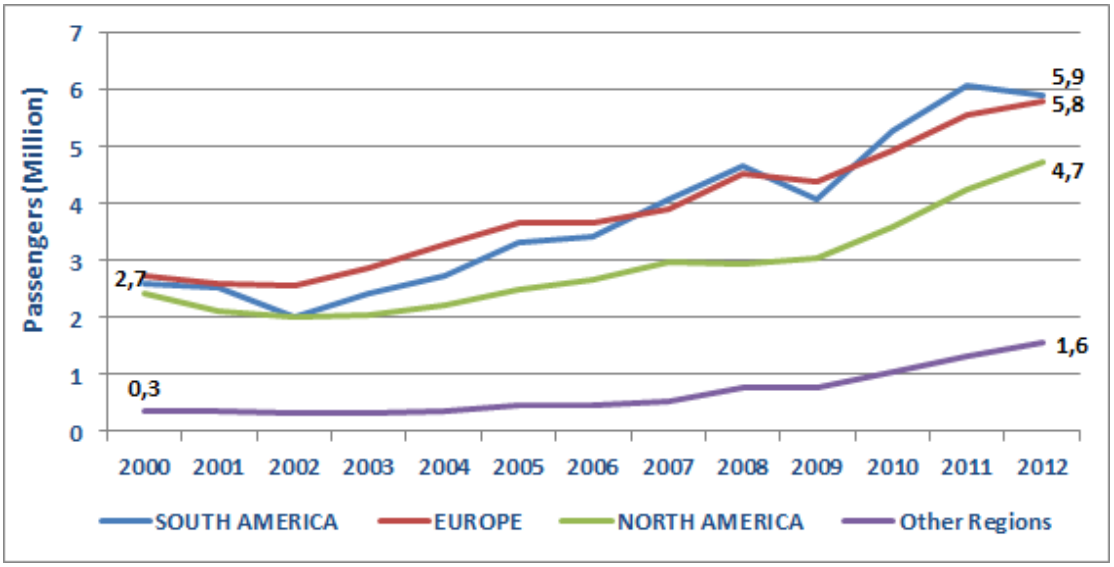
Figure 1: Air traffic of domestic and international passengers



Source: ANAC – National Agency of Civil Aviation

Regarding the Brazilian international air transportation, Figure 2 shows the passengers' transportation evolution for the main destination regions, which are: North America, South America, Europe, and others. According to Figure 02, the region of most interest in the Brazilian international air traffic was South America, with 5.9 million passengers in 2012. The second main destination region was Europe with 5.8 million.

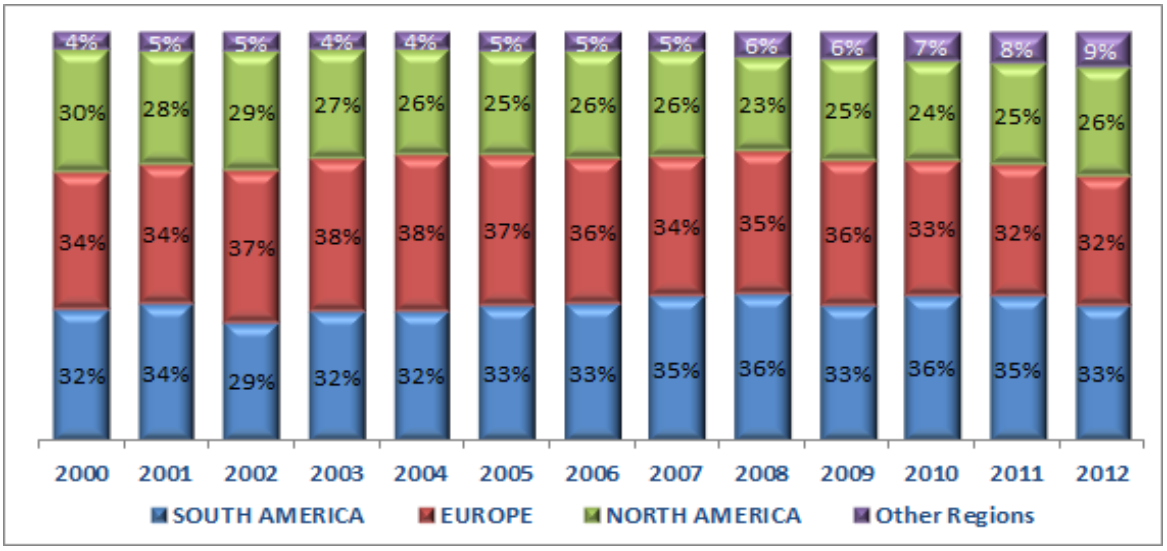
Figure 2: Passengers' Traffic per Region



Source: ANAC – National Agency of Civil Aviation

From the evolution analysis of the number of passengers transported to the main international destinations, it is verified that Europe and North America have reduced their participation in the market in the last 13 years. On the other hand, other regions increased their participation in the market, mainly Africa and Central America. The South America region kept its "market share", according to Figure 03.

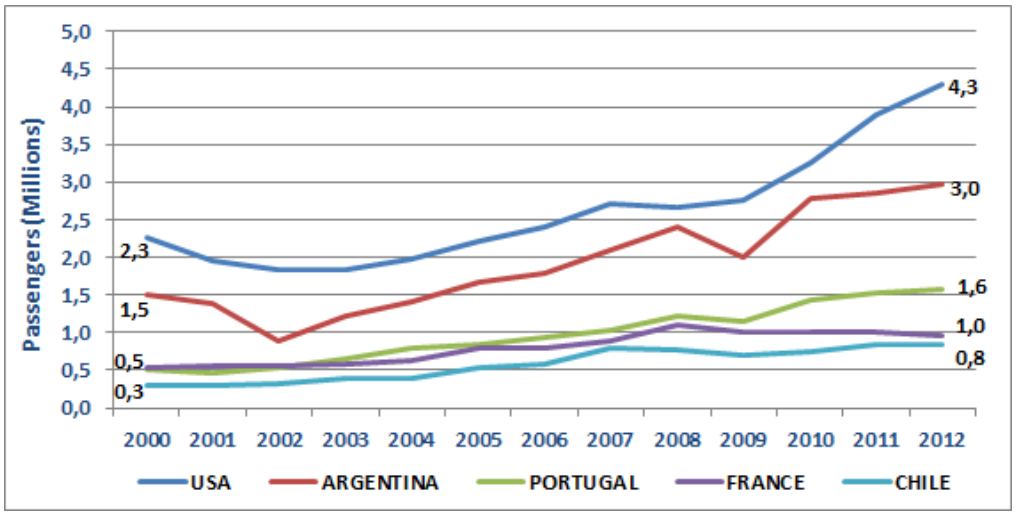
Figure 3: International Traffic of Passengers – Market Share per Region



Source: ANAC – National Agency of Civil Aviation

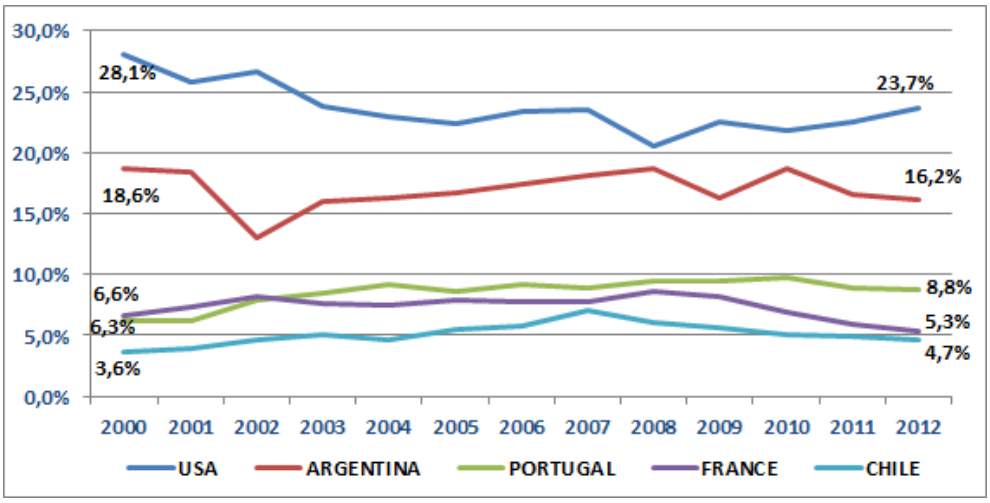
Besides the analysis of the number of passengers transported in international flights per region, it was also verified the main international destinations from Brazil, per country, according to figures 04 and 05. In this case, it can be observed that the United States were the leaders, during the last 13 years, in terms passengers volume, with around one fourth of the Brazilian international market (23.7%), in 2012. Other important markets were: Argentina, with a market share of 16.2% in 2012; Portugal with 8.8%; France with 5,3%; and Chile, with 4.7%.

Figure 4: International Traffic of Passengers – Five main destinations



Source: ANAC – National Agency of Civil Aviation

Figure 5: International Traffic of Passengers – Market Share per Country



Source: ANAC – National Agency of Civil Aviation

3.2 Fleet Evolution

According to data from the time period between 2000 and 2011, the number of commercial airplanes for passengers that operate in Brazil grew 4%, from 452 aircrafts to 468 aircrafts. On December 2011, 87% of this total was equipment with turbofan propulsion and 13% turboprops; while in 2000, the turbofan percentage was 77% and turboprops 23% of the total fleet. The Brazilian airlines experienced in the last decade a new aircrafts acquisition moment, both for their capacity expansion and for their fleet renovation.

Table 1: Fleet Evolution

	2000	2001	2002	2003	2004	2005	2006	2007	2008	...	2012
Average seats (Narrow Bodies)	117	123	128	130	133	139	147	156	161	...	146
Average seats (Wide Bodies)	240	242	250	256	272	280	268	231	235	...	257
Qty of airplanes (Narrow Bodies)	181	226	231	195	196	194	206	221	243	...	338
Qty of airplanes (Wide Bodies)	38	43	40	34	36	32	31	30	31	...	31
Total airplanes (jets + turboprops)	340	348	321	281	288	270	285	316	347	...	469

[2]Source ANAC' Statistic Annual, 2010

Regarding the seats average per aircraft, it is possible observing a small decrease on the Narrow Bodies-type aircrafts, mainly due to the beginning of *Azul Linhas Aéreas* operation, in 2008. *Azul* operates mainly with Regional Jets aircrafts, such as Embraer E190 and E195, with lower seats capacity (106 and 116 seats respectively).

On the other hand, it is possible observing an average increase on the seats capacity of Wide Bodies aircrafts used in international stages, due to large aircrafts

incorporation in TAM fleet, such as Boeing 777, and the gradual Boeings 767 return from VARIG fleet and, further, from GoI fleet. Taking into account the 2012 data, Brazil has a relatively new aircrafts fleet, with an average age of around eight years. The country´s largest airlines are operating almost entirely with last generation equipment. Aircrafts with 20 years or more represent less than 3% of the fleet in operation, according to 2012 data.

The average size aircrafts growth, from 2000 to 2004, was due to the entrance of GOL in the market, using new B737-700NG (with a larger capacity then the B737-500 used by VARIG) and the fact that TAM has received for the first time Airbuses A319/A320.

In 2006, GOL started replacing the old B737-300 by the new 737-800 and TAM started the retirement process of Fokker 100, with the arrival of more A320 aircrafts, which became the main type of equipment in service at this company. In the same period, TAM promoted an alteration on the seats configuration of their A320 aircrafts, which increased the seats capacity in around 15%.

During Varig's bankruptcy process, the biggest part of its airplanes gradually stopped flying. From 2005-2006, VARIG started its large-size jets return. GOL Linhas Aéreas, which bought VARIG, on April 2007, has also promoted the aircrafts replacement, which made the average size of their aircrafts gradually reduce until the end of 2007. In 2008, TAM started operating with the new B777-300, intensified the use of Airbus A330 and started operating with the A340 in some international routes.

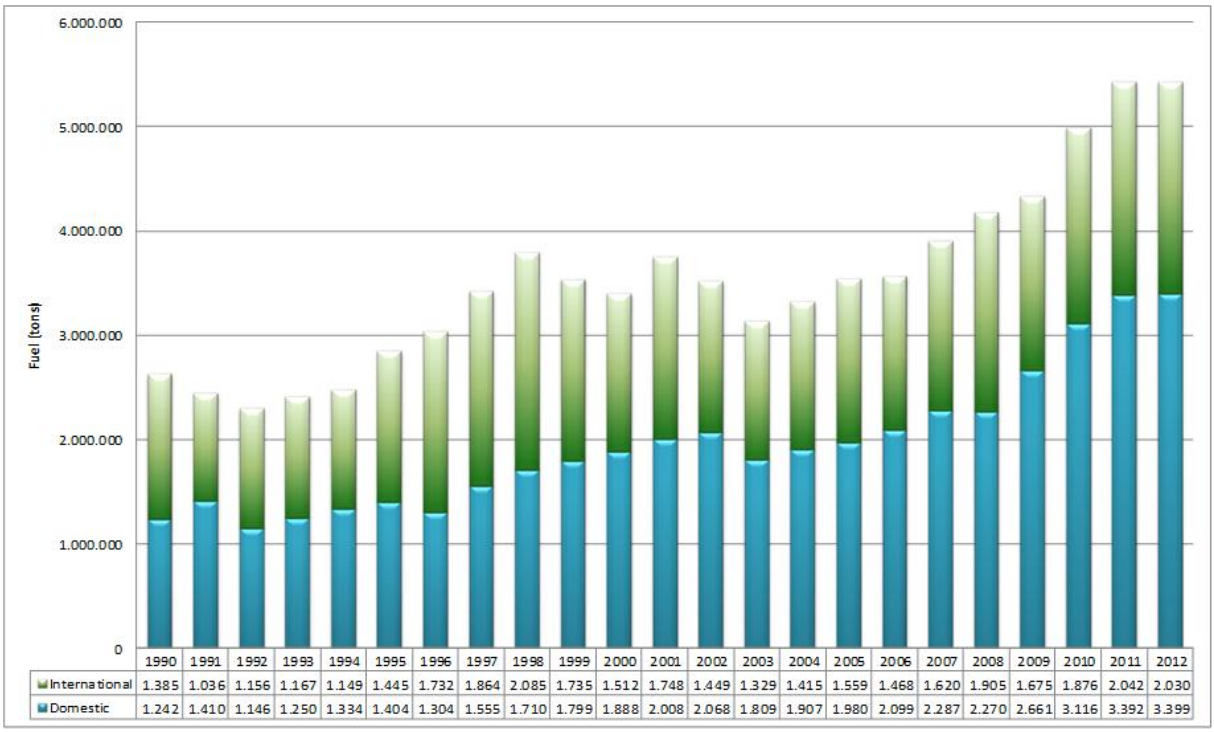
The described aircrafts fleet renewal process had a direct impact over the fuel efficiency and, therefore, over the emissions *per capta* in air travels. The following topics present an analysis of these indicators.

4. Fuel Consumption and Associated Emissions

Last decade has witnessed an intense domestic traffic growth in Brazil. The international segment has also grown, but in a slower rhythm than the domestic one. Nowadays, more than 80% of the regular flights are domestic flights. However, the fuel

consumption and the volume of emissions do not reflect this difference in the same proportion, as it is shown in Figure 06.

Figure 6: Evolution on the fuel consumption - QAV



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
International	1.385	1.036	1.156	1.167	1.149	1.445	1.732	1.864	2.085	1.735	1.512	1.748	1.449	1.329	1.415	1.559	1.468	1.620	1.905	1.675	1.876	2.042	2.030
Domestic	1.242	1.410	1.146	1.250	1.334	1.404	1.304	1.555	1.710	1.799	1.888	2.008	2.068	1.809	1.907	1.980	2.099	2.287	2.270	2.661	3.116	3.392	3.399

Source: National Agency of Civil Aviation – ANAC

In 1990, around 47% of the aviation fuel consumption was due to domestic operations, while 53% was due to international operations (including overseas airlines servicing Brazil). In 2012, this proportion changed to 63% of the fuel consumption in domestic flights and 37% in international flights. These data confirmed the domestic operations fast growth.

The somewhat high international segment participation on the fuel share can be explained by the relatively long distance between Brazilian airports and the main traffic attractors, notably North America and Europe what makes a relevant part of the international flights necessarily very long.

Table 2 lists the domestic operations, the international operations performed by Brazilian companies and the total international operations (which include the international stages performed by national and foreign companies). The fuel

consumption separation between national and foreign companies in international stages has the objective of meeting the ICAO need of obtaining data specifically on the GHG emissions of Brazilian companies, on the international flights operation. The Brazilian air carriers' international operations fuel burn is included on the total international operations fuel burn.

Table 2: Evolution on the fuel consumption from 2009 to 2012

Kilograms of Jet A	2009	2010	2011	2012
Domestic operations	2.661.972.652	3.116.979.892	3.392.101.829	3.399.994.766
International operations Brazilian airlines	416.980.982	443.654.063	488.658.657	422.852.328
International operations Total	1.675.306.164	1.876.851.049	2.042.512.335	2.030.051.096

Source: National Agency of Civil Aviation – ANAC

Table 3 in turn, uses the data on the fuel consumption for presenting the GHG emissions growth from 1990 to 2010.

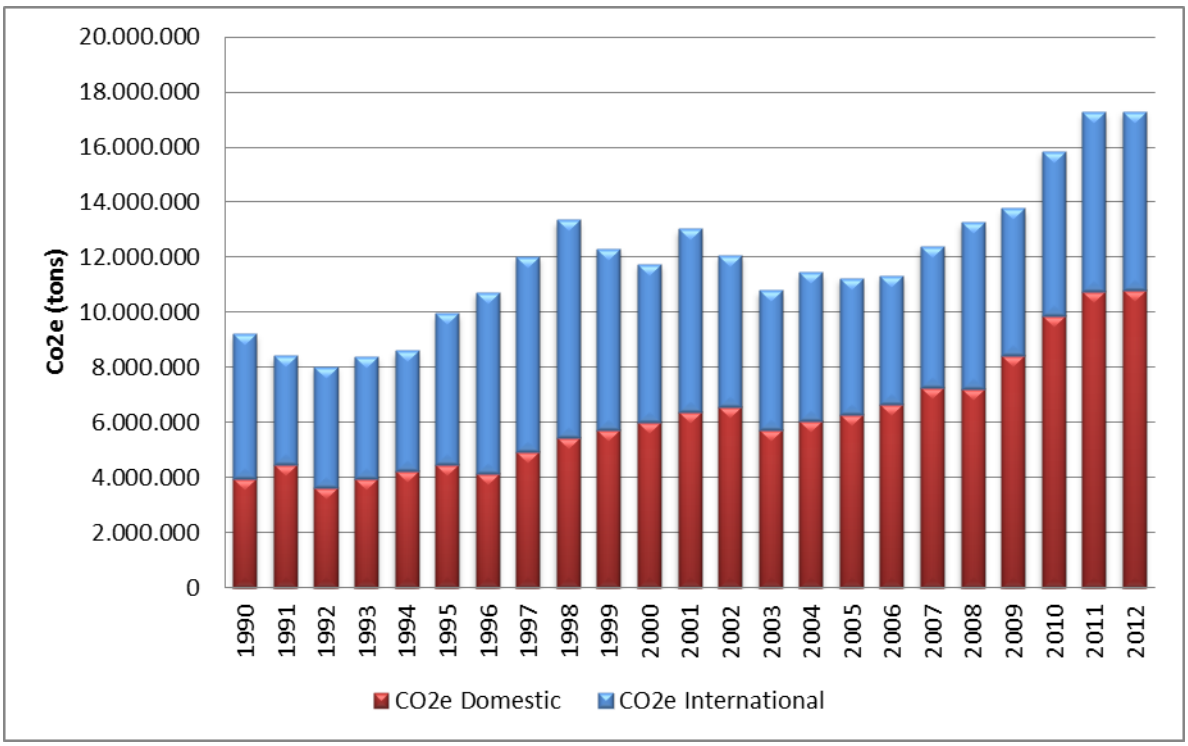
Table 3: CO_2 Emissions Growth Rate

	CO_2e (kg) Emissions			Growth Rate (%)	
	1990	2000	2010	1990 - 2000	2000 - 2010
Domestic	3.912.135.696	5.946.536.038	9.853.974.043	34,2	39,7
International	5.267.328.683	5.747.817.783	6.051.976.209	8,4	5,0

Source: National Agency of Civil Aviation – ANAC

According to the 2nd National Communication on GHG Emissions and Removals, it is verified that, although the aviation sector is responsible by only around 0.5% of the total GHG emissions in Brazil, the sector's emission volume has grown faster than most of the other sectors of the economy. In line with the numbers presented, it is possible to conclude that the domestic air traffic growth was the main contributor to the CO_2 emissions volume elevation, within the sector.

Figure 7: CO_2 Emissions – domestic and international flights



Source: National Agency of Civil Aviation – ANAC

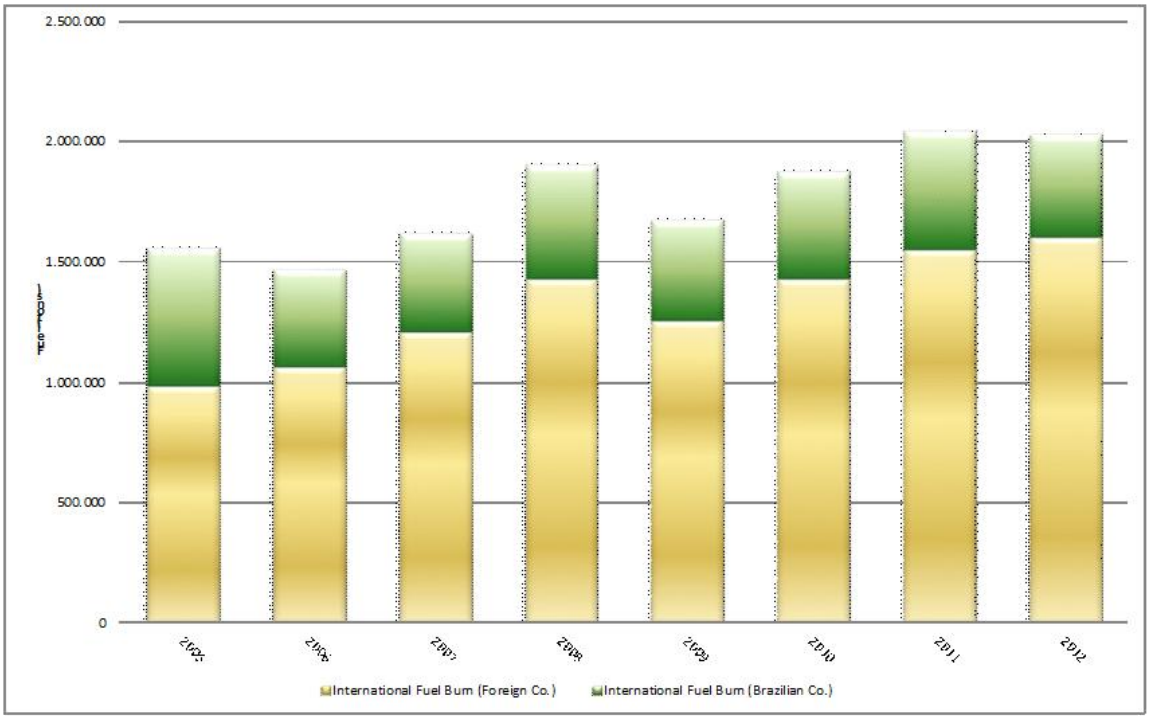
Figure 7 reflects the increase on the volume of CO_2 emissions for domestic and international aviation, from 1990 to 2012, which mirrors the fuel consumption data presented on Figure 6. Also according to the data presented on Figure 7, the absolute national and international emissions grew in an annual average rate of 3% from 1990 to 2012. The graphic shows the acceleration of the domestic operations participation on the total emissions, in the last two decades.

On international operations, the aggregated fuel consumption data, including Brazilian and foreign operators, shown on year-per-year basis, huge oscillations that are associated to both domestic and international economics downturns. Besides, in the last decade, the bankruptcy process of the former Brazilian flag carrier, VARIG, which finished its operations in 2005, has contributed to the observed oscillations.

From the data on Figure 07, it was calculated the emissions projected growth for domestic and international operations in Brazil in 6.1% and 2.5% respectively, in an annual basis, between 2010 and 2020. This projection was obtained through a simple linear extrapolation of the data on fuel consumption from the years of 2005 to 2012 (Figure 8). Given the reduced size of the series of data available, it was not possible to use of a robust method for estimating the fuel consumption from 2020 until 2050.

However, a forecast using a simple linear extrapolation can provide some useful results. The result of the linear extrapolation leads to an approximated value of fuel consumption of 2.6 million tons in 2020 and 4.8 million tons in 2050, with a scenario without great alterations in airlines' business environment. These estimations shall be refined in the future.

Figure 8: Growth trend of the fuel consumption in the international operations



Source: National Agency of Civil Aviation – ANAC

5. Emissions Intensity and Fuel Efficiency

5.1 Calculation Methodology

This section purpose is to present an historical trend of the Brazilian Civil Aviation CO_2 emissions evolution and, notably, present the Fuel Efficiency and the Intensity of Emissions variation, regarding civil aviation domestic and international operations.

The intensity of emissions calculation is made based on the emissions per kilometer, by passenger transported. Thus, the following variables were isolated: the increase on the number of passengers transported, and the growth on the number of routes and distances flown.

The fuel efficiency calculation is based on the fuel consumption per weight (paying passengers and cargo) and distance travelled. This way it is possible to analyze the efficiency of the air services. The Brazilian Civil Aviation Statistic Annual, elaborated by ANAC, has information available on the RPK[2] *Revenue Passenger Kilometer* and RTK[3] *Revenue Tonne Kilometer* for the Brazilian companies. In order to calculate the emissions intensity it is divided the total CO_2 emissions by the sector's RPK. Thus, the volume of emissions per kilometer per transported paying passenger is obtained.

For the fuel efficiency calculation, the fuel consumption volume is divided by the RTK. It shall be recorded that for the international stages, the RTK is calculated only for flights departing from Brazil. Tables 4 and 5 below present, respectively, the evolution of RPK and RTK for the Brazilian airlines. The data are divided in domestic and international operations.

[2] Revenue Passenger Kilometer is a measure which demonstrates the number of passengers transported per kilometer flown.
[3] Revenue Passenger Kilometer is a measure representing the paid weight (passenger + paid load) per kilometer flown). For calculating the weight of the passenger, the passenger weight calculation of 100 kilograms per person is used.

Table 4: RPK Series

(x1000)	2005	2006	2007	2008	2009	2010	2011	2012
RPK intern stage Brazilian airlines	11.576.938	8.233.942	7.275.923	9.565.195	9.683.426	11.804.322	13.032.906	13.075.117
RPK domestic stage	35.561.273	40.556.504	45.911.269	49.563.781	56.731.273	70.238.141	81.452.344	87.005.961

Source: National Agency of Civil Aviation – ANAC

Table 5: RTK Series[4]

(x1000)	2005	2006	2007	2008	2009	2010	2011	2012
RTK intern stage Brazilian Airlines	1.625.962	1.114.336	946.743	1.048.003	1.008.181	1.280.636	1.609.857	1.588.198
RTK domestic stage	3.709.205	4.280.856	4.625.431	4.931.610	5.599.076	6.989.039	8.016.456	8.428.886

Source: National Agency of Civil Aviation – ANAC

In order to distinct domestic and international stages and segregate operations between local and overseas carriers is necessary the ATC operations database records. The database available started in 2005 so the series, for international stage, presented started in 2005, segregated by domestic and international operation.

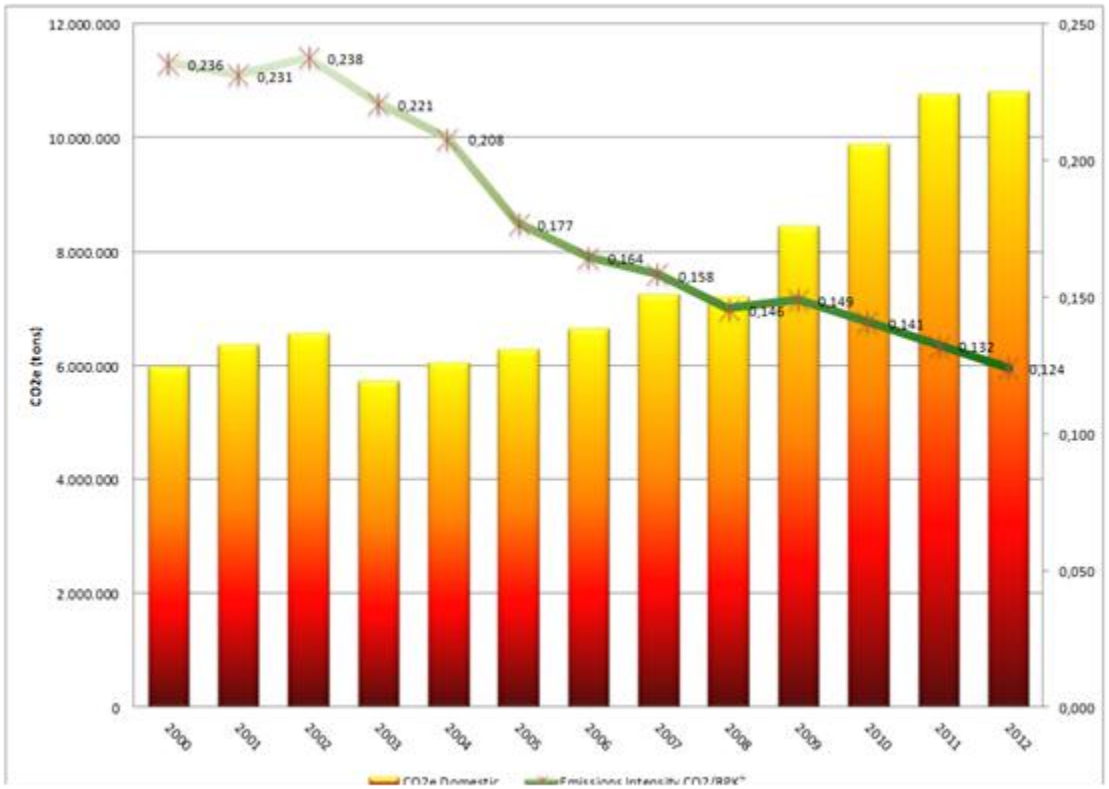
[4] Both for the RPK and for the RTK related to international stages of Brazilian companies, the numbers only include flights leaving Brazil.

5.2 Emissions Intensity and Fuel Efficiency: Domestic Operations

Although it is not this Action Plan main scope, the data on the Brazilian domestic civil aviation emissions intensity and the fuel efficiency are compiled.

Figure 9 consolidates information on the emissions intensity. In this graphic, the CO_2 emissions evolution on domestic operations for the time period 2000 to 2012 is presented. The vertical bars show the annual emissions volume and the line present the **emissions intensity** for each year.

Figure 9: Domestic Operations – CO_2 Emission and Emissions Intensity

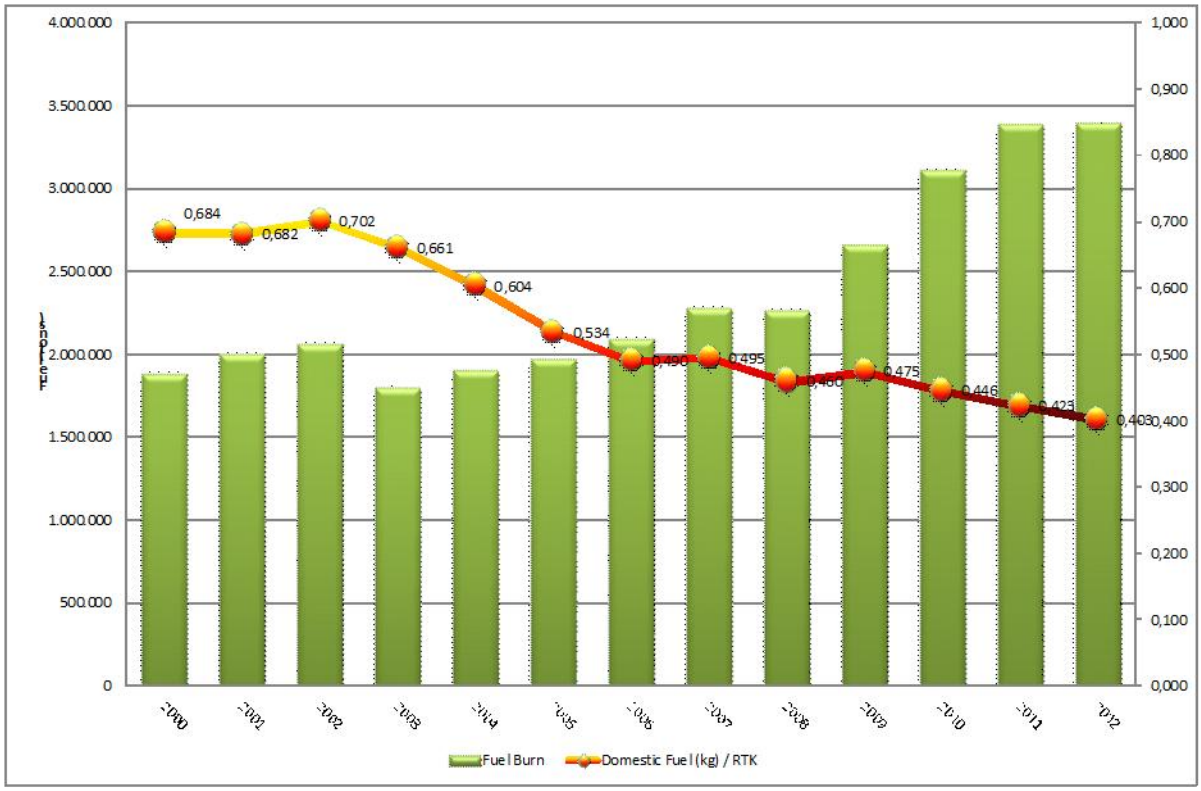


Source: National Agency of Civil Aviation - ANAC

Domestic aviation CO_2 emissions increased on an annual average rate of 5.4% since 2000, and they have grown more than 79% on the accumulated from 2000 to 2012. However, the emissions intensity presented significant reduction, on an annual average rate of 5.1% in the same time period. Thus, in 2011, the emissions intensity was 13.2 kg CO_2 per 100RPK, value considerably lower than the one verified in the year 2000, which was 23.6 CO_2 per 100RPK.

Besides emissions intensity, it was also calculated the fuel efficiency for the Brazilian domestic operations. Figure 10 analyses the efficiency on the fuel consumption per RPK. According to this analysis, the domestic aviation presented an improvement of the fuel efficiency of 4.3% per year, in average, since 2000.

Figure 10: Domestic Operations – fuel consumption and Fuel Efficiency.



Source: National Agency of Civil Aviation – ANAC

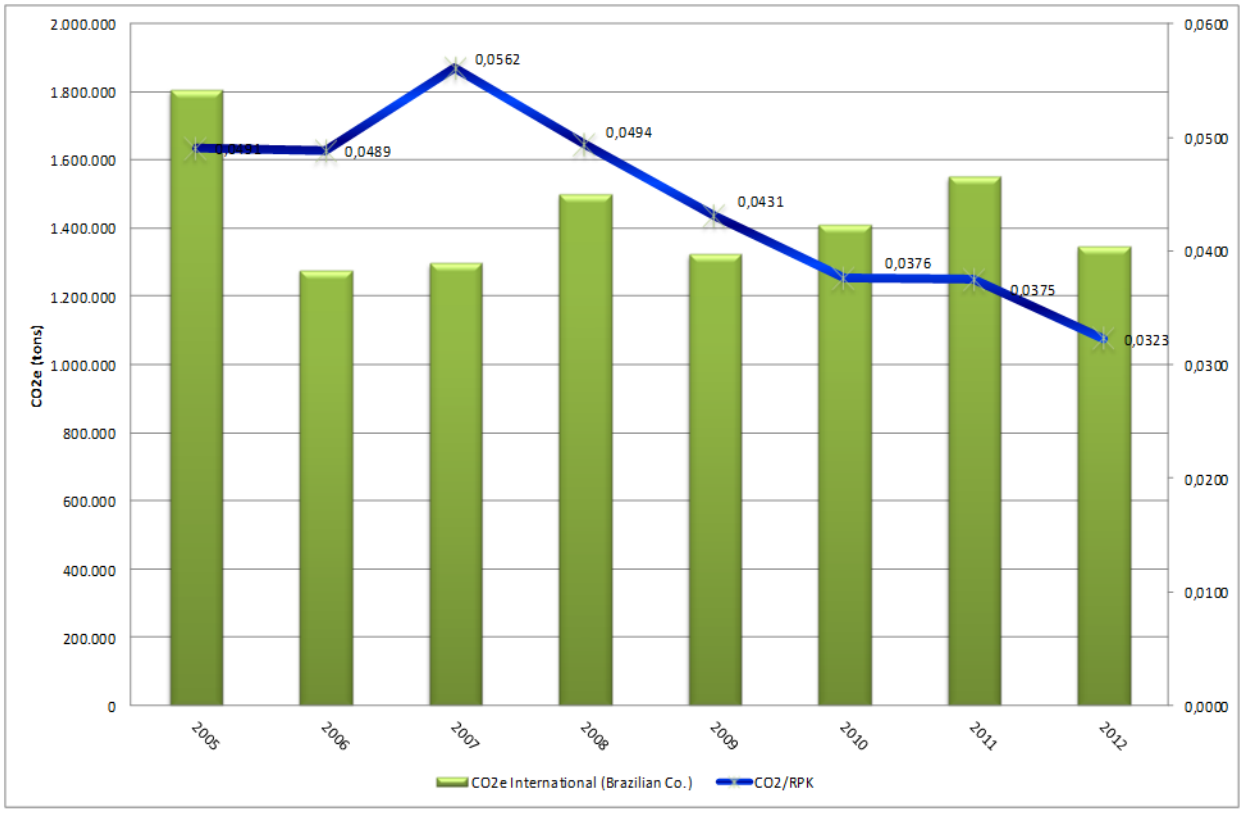
Taking into account that the emissions for this segment had a faster growth than the international one, it is possible concluding that the improvement on the domestic

operations **fuel efficiency** had positively contributed to the reduction on the total Brazilian emissions growth rhythm. Those efficiency improvements are mainly due to fleet renovation, operational improvements and improvements on air traffic management.

5.3 Emissions Intensity and Fuel Efficiency: International operations

The graphic below (Figure 11) shows the **emissions intensity** evolution of the Brazilian airlines international operations from the year 2005 to 2012. The vertical bars represent the annual emission volume in these operations, while the line indicates the **emissions intensity** per year.

Figure 11 : International Operations – Brazilian Companies – CO_2 Emissions and Emissions Intensity (EI)



Source: National Agency of Civil Aviation – ANAC

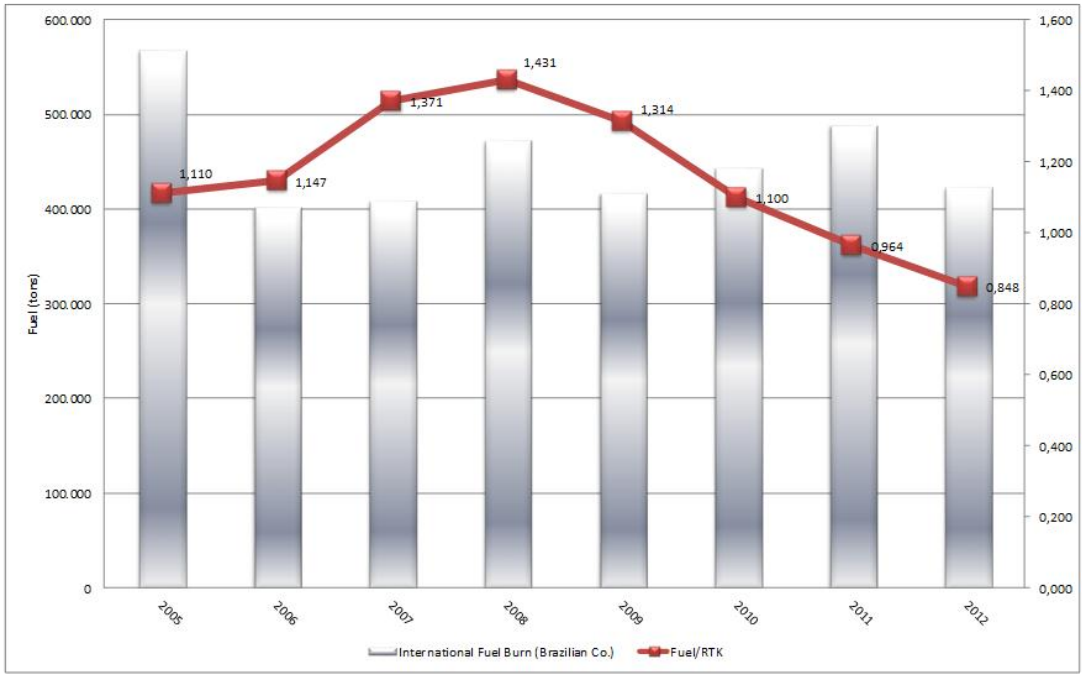
Figure 11 shows that in 2006 and 2007 there was an increase on the emissions intensity of the Brazilian airlines international operations. This elevation was due to an international sector reorganization period caused by the end of VARIG flag carrier operations. The new operators passed through an adjust process between seats offer and demand and this is reflected on the emissions intensity increase in 2006 and 2007.

In 2009, the sector had already been adjusted and the emissions intensity fell to values close to 2005. Also, during 2008, it is possible observing a significant increase on the emissions caused by the international traffic rise in that year. In 2009, it is verified an emission volume reduction produced by the fell on the demand for international air travels, consequence of the international economic crisis experienced in that year.

Thus, the global result was the Brazilian airlines international operations emissions intensity annual reduction of 4.4% between 2005 and 2012. It shall also be highlighted that there was a decrease on the net emissions of 2.5% in the same period. For the years 2010 and 2011, although it is possible observing an increase on CO_2 net emissions, the emissions intensity was kept constant, which denotes an improvement on the efficiency in this time period.

The international operations **fuel efficiency** was also calculated based on the fuel consumption per RTK. Figure 12 shows the evolution of the fuel consumption (vertical bars) and the f**uel efficiency** (line) for the Brazilian carriers in international operations.

Figure 12: International Operations – Energetic Efficiency



Source: National Agency of Civil Aviation – ANAC

From the data presented on the Brazilian airlines international operations (figure 12 above), it is observed an average improvement on fuel efficiency of around 2.3% per year, between 2005 and 2012, slightly higher than the desirable goal of 2% established by ICAO. The fuel efficiency improvement could have been even bigger if it was not the accommodation of the sector to the VARIG bankruptcy, as it was previously described. However, in 2010, the fuel efficiency returned to the 2005 level, and currently, the system has reached even better results. Regarding the fuel net consumption, in the same time period it is possible observing an average reduction of 2.5% in an annual basis.

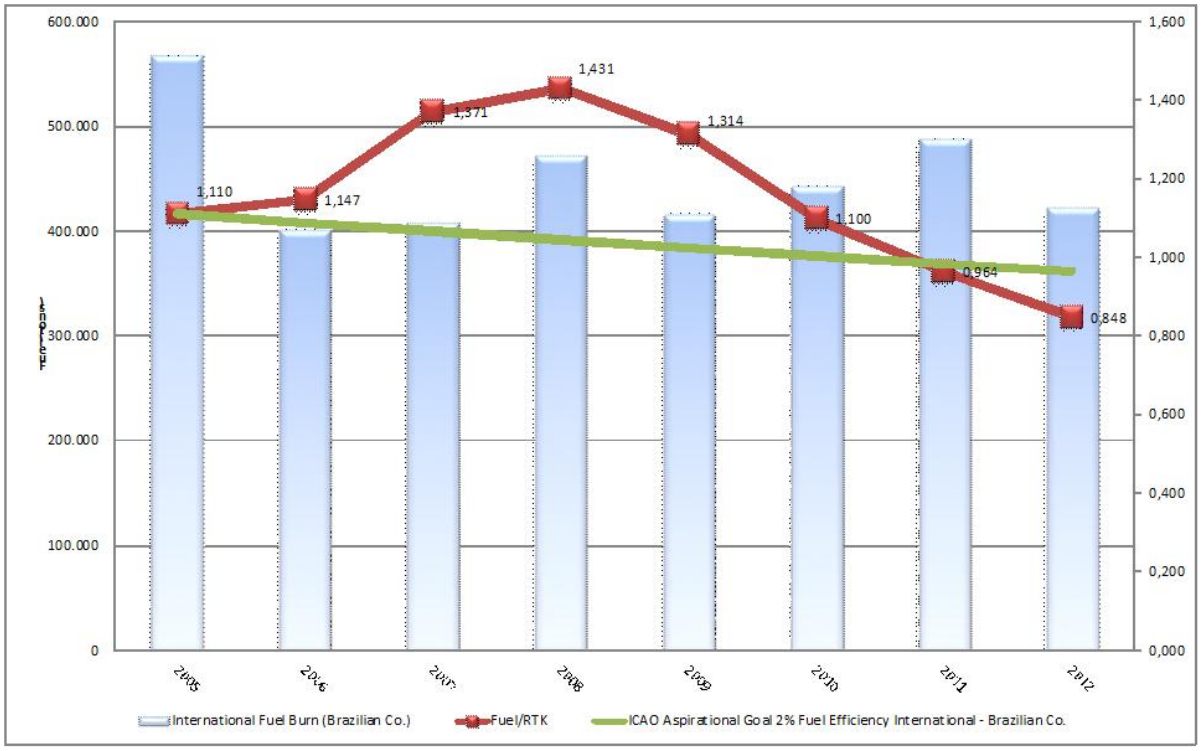
5.4 ICAO's Fuel Efficiency Goal

Resolution A37-19, approved by ICAO's 37th Assembly, establishes the continuity of ICAO's policies and practices related to environmental protection and specifically address the subject of civil aviation and climate change. The referred resolution defines, in item 4, that the States shall work through ICAO for reaching a

global fuel efficiency improvement goal, of 2%, in average, per year up to 2020 and a desirable fuel efficiency improvement goal of 2% per year from 2021 to 2050.

Figure 13 below repeats the information on Figure 12 and adds a straight line representing ICAO's goal of 2% fuel efficiency improvement per year, based on 2005 levels. It is observed a hump from 2006 to 2010, however, in the last year, the fuel efficiency improvements reaches values below ICAO's desired goal. It is important to notice that the straight line was plotted randomly beginning in 2005, but the Resolution mentions 2010 as the baseline for this calculation. In this case, the fuel efficiency improvements would be even higher.

Figure 13: Ful Efficiency x ICAO objectives



Source: National Agency of Civil Aviation – ANAC

The behavior observed suggests that the Brazilian civil aviation is evolving in a friendly environmental way and, although the international operations have been strongly affected by airlines entering and leaving the market, the sector as a whole will reach the desirable fuel efficiency goal recommended by ICAO.

6 Mitigation Measures

6.1 Introduction

The civil aviation impact on greenhouse gases emissions increase and, consequently, on the global warming phenomenon, has been widely debated by public and private players in Brazil.

The International Civil Aviation Organization points out the necessary measures for reducing the sector's emissions and they are: the adoption of alternative fuels, improvements on the air Traffic management, improvements on the infrastructure, and operational, regulatory and economic measures.

This section presents the actions in course or planned in Brazil, which will impact over the greenhouse gases emissions reduction through the enhancement of the Brazilian civil aviation fuel efficiency.

6.2 Alternative Fuels

The development of alternative fuels for aviation is a strategic element for the aircrafts refueling future, due to two main reasons: decreasing the dependence regarding fossil fuels and reducing the greenhouse gases emissions. The international oil price oscillation has a strong impact over the airlines costs structure in Brazil. Thus,

the alternative biofuels availability, mainly as drop-in (mixed to the main fuel), could contribute for the fuel supply and prices stabilization.

Furthermore, the biofuels for aviation development would result on a decrease of civil aviation impact on the world total greenhouse gases emissions. Currently, the civil aviation has contributed with around 2% of the total emissions. Aeronautic engineering improvements, technological and operational advances, shall contribute to the aircrafts fuel burn reduction and also for the decrease of the carbon emissions.

However, the gains with technology and operational improvements will not be enough for compensating the global emissions increase expected as a consequence of air traffic growth. Biofuels produced from renewable oils biomass offer the potential to reduce the greenhouse gases life cycle and, therefore, decrease the aviation contribution to climate change.

Brazil is internationally recognized by its experience on biomass use for energetic purposes, such as wood, sugarcane ethanol and biodiesel. The modern bioenergy represents around 30% of the countries' energetic matrix. Brazil is a country with a long history of conciliating biofuel production, food safety and rural development[5]. In this context, the aviation biofuels production represents as a new challenge.

With this challenge in mind, on May 06th, 2010, the Brazilian Alliance for Aviation Biofuels – ABRABA was created. The alliance has the purpose of promoting public and private initiatives for sustainable aviation biofuels development and certification. ABRABA gathers the following institutions: Algae Biotechnology, Amyris Brazil, ABPPM, AIAB, Azul, Embraer, GOL, TAM, TRIP and ÚNICA.

Another important initiative undertaken in Brazil related to aviation biofuels development was the Boeing and Embraer project in collaboration with the Research Foundation of the State of São Paulo (FAPESP). The project had the objective of performing a national assessment of technologic, economic and sustainability challenges and opportunities, associated with the aviation biofuels development and commercialization in Brazil. The State University of Campinas – UNICAMP, chosen for coordinating this study, was responsible by heading a research team. The project's

[5] SABB

team performed eight workshops with the active participation of more than 30 stakeholders from the private sector, from governmental institutions, from NGOs and from the academy. The assessment included the following topics: agriculture, conversion technology, logistics, sustainability, commercialization and policies. As a result, on July 2013, in São Paulo, it was released a document entitled: "Flight Plan for Aviation Biofuels in Brazil: Plan of Action". It was a report on the Workshops main conclusion which provides a diagnosis on the current situation and recommendations of measures for the biofuels development in Brazil.

The report identified soy, sugarcane, and eucalyptus as promising raw materials for the aviation biofuel production, arising from these biomasses great availability and low productions costs. The research group also assessed the refinery technologies including the gasification, fast pyrolysis, liquefaction by solvent, enzymatic hydrolysis of cellulosic and lignocellulosic biomass, alcohol oligomerization for aviation fuels (ATJ), hydroprocessed esters and fatty acids (HEFA), as well as the fermentation of sugars and waste (in other words, urban solid residues, combustion gases, industrial waste) in alcohols, hydrocarbons (DSHC) and lipids. According to the report, in Brazil, several of these technologies have been tested for producing biofuels used in new demonstration flights as possible sustainable biofuels alternatives.

However, besides the technical difficulties, issues of economic feasibility and demonstration of environmental benefits, such as the reduction of GHG emissions shall be faced. The report concludes that it is necessary improving research for establishing biofuels refinement technologies and commercial and distribution strategies which may contribute to the biojetfuels economic feasible. It also concludes that this economic feasibility depends on investments in transports logistics and public policies.

The main Brazilian airlines have already performed experimental flights with the use of biofuels for aviation. TAM and Airbus were the first ones to flight with biofuel based on *Jatropha Curcas* in Latin America, on November 23rd, 2010, using an Airbus A320 aircraft. The biofuel was used as drop-in with a mixture of 50% biokerosene based on *jatropha curcas* produced in Brazil and 50% of conventional aviation kerosene.

The airlines Gol and Azul performed experimental flights on June 19th, 2012, during the environment summit (Rio+20), in Rio de Janeiro. The flights had as destination Santos Dumont Airport, in Rio de Janeiro. Gol flight departed from Congonhas Airport, in São Paulo, and Azul flight departed from Viracopos Airport, in Campinas, São Paulo. Azul used renewable sugarcane-based fuel, created by the company Amyris, on the rate of 50% related to the conventional fuel. “Azul+Verde” project was also developed in partnership with the aviation engines manufacturer GE and Embraer. Gol used, in Boeing 737/800, the biokerosene imported from the American company UOP, produced from the mixture of ICO (inedible corn oil coming from the corn ethanol production) and OGR (oils and residual fats).

Embraer and General Electric – GE also performed a series of tests flights with the objective of establishing a reference for the operational characteristics of the airplanes with GE CF34-8E engines when filled with HEFA (Hydro-processed Esters and Fatty Acids) fuel, inside a wide range of specific flight conditions.

Notwithstanding the advances in research, development and certification of aviation biofuels, the commercial use of the product faces the challenges of economic feasibility. The final biokerosene for aviation price is considerably higher than the conventional kerosene price. Taking into account the airlines lower profit margin and the high percentage that the fuels represent in the air carriers total costs (above 30%), it is not likely that biofuels are going to be used in large scale as long as the price is not competitive.

Thus, public and private players in Brazil have studied mechanisms to reduce biofuels production costs, such as: research on abundant raw materials and with lower costs, analysis of refinery methods, more efficient production and transportation logistics, among others. In this sense, Brazil and the United States signed a Memorandum of Understanding for cooperation on biofuels for aviation development. The Brazilian government believes that this partnership can be very useful for technology and information sharing aiming at the development of aviation biofuels.

The most recent initiative regarding the Biofuels for aviation development in Brazil was the creation of the Brazilian Biojetfuel Platform[6], in August 8th, 2013. The Platform involves the following partners: Curcas, Amyris, Boeing, RSB Services, GE, UFRJ, IICA, Byogy, Bioeca, GOL, ABEAR[7] and UBRABIO[8].

According to a Report[9] delivered to the aviation governmental authorities, the Brazilian Biojetfuel Platform represents a general agreement on the high level conclusions derived from the outcomes of the parallel works carried out by different organizations or corporations in the frame of the study, particularly the SAB study funded by Boeing, Embraer, and FAPESP. The stakeholders involved are committed to undertake collaborative actions to promote the implementation of a multi feedstock and multi process biojetfuel value chain in Brazil.

It is presented bellow some parts of this Report in order to inform on the work planned to be carried out by the Platform in Brazil on bringing together key stakeholders to promote the implementation of a highly integrated biojetfuel and renewables value chain, “from R&D to the wing”, to fill in the gaps identified by the Sustainable Alternative Biojetfuel study sponsored by Boeing, Fapesp and Embraer.

“ Due to the continental dimensions of Brazil, the Platform has divided the country into four production hubs in order to better address the regional opportunities, based on a balanced scorecard evaluation of land and labor availability, climatic conditions, local inputs and logistic integration.

a) North/Northeast – sustainable feedstock production hub, optimal export logistics to USA, Europe and Asia.

[6] Formal Structure: Advisory Board: Mr. Adalberto Febeliano, ABEAR. Mr. Adilson Liebsch, UBRABIO, Mr. Al Bryant, Boeing, Mr. Pedro Scorza, GOL Airlines. Steering Committee:, Mr. Adilson Liebsch, Amyris (DSHC), Mr. Donato Aranda, UFRJ (Technology), Mr. Fernando Correa, Byogy (ATJ), Mr. Jamil Macedo, IICA(Feedstock); Mr. Luís Rodrigues, Solazyme (DSHC); Mr. Mario Fontes, Bioeca (Camelina); Mr. Mike Lu, Curcas (coordinator/integration); Mr. Santiago Giraldo, SGB (Jatropha); Mr. Sergio Zuqim, GE (R,D&I-ATM) .

[7] ABEAR (Associação Brasileira das Empresas Aereas) is the Association of the Brazilian Airlines (AVIANCA, AZUL, GOL, TAM e TRIP), founded in 2012 to represent the Brazilian Civil Aviation.

[8] The Brazilian Biodiesel and Biojetfuel Union (Ubrabio) is a national private non-profit trade association, acting as a interface to engage stakeholders and policy makers to develop the Brazilian biofuels sector.

[9] Report on the Bio Brazilian Biojetfuel Platform elaborated by Mr. Javier Mate – Curcas, Mr. Mike Lu – Curcas with the collaboration of: Mr. Adilson Liebsch – Amyris, Mr. Al Bryant – Boeing, Ms. Aurea Nardelli – RSB Services., Mr. Daniel Fischer – GE., Prof. Donato Aranda- UFRJ, Mr. Jamil Macedo – IICA, Mr. Kevin Weiss – Byogy, Mr. Mario Fontes – Bioeca, Mr. Pedro Scorza – GOL., Mr. Priscila Gatti – GOL., Mr. Rodrigo Gabizo – GE, Mr. Sergio Zuquim – GE.

b) East – integration into the infrastructure of Polo Petroquimico de Camaçari, availability of Hydrogen, downstream consumption of green naphtha and renewables, and export facilities through the Port of Aratu.
c) Center/West – addressing the demand of central hub of Brasilia, consolidating grain production of Center/West States.
d) Southeast – pilot multi-feedstock, multi-process value chain to address the major demand of biojetfuel of Southeastern Airports of Brazil.

The Biojetfuel Production Matrix

There is no single pathway for transforming biomass to aviation biofuel. Instead, there are currently several different pathways and there will be more in the future. Based on the SABB study sponsored by Boeing, Embraer, and IADB, the Brazilian Biojetfuel Platform will establish Green Economy projects to cover the gaps identified by the study, onto a highly integrated multi feedstock, multi process value chain. The Platform is technology agnostic, providing a supportive, open and collaborative framework for all feedstock and processes.

Regional Sustained Development

Aviation is not the only potential user of renewable biomass resources and it will have to compete for these limited resources with the road transportation segment. Furthermore, large land area requirements indicate that it is unlikely that a single region could create sufficient biomass to meet worldwide demand for biofuels. Hence, the Platform's view is that large-scale implementation of biofuels would arise through a combination of regionally appropriate feedstocks. Due to the continental dimensions of Brazil, the Platform has divided the country into four production hubs in order to better address the regional sustained development opportunities. Green Economy biofuel projects will be evaluated and selected through a balanced scorecard evaluation based on land and labor availability, climatic conditions, local inputs, infrastructure, social development and logistic integration.

a. North/Northeast – export oriented sustainable feedstock production hub based on the regional diversity and port infrastructure of Itaqui, MA and Pecem,CE:

- Babassu biomass collection program from the 18 million hectare natural forest of babassu covering primarily the States of Maranhão, Piauí, and Tocantins.
- Dende oil from the Federal Dende Program in the State of Para.
- Jatropha Food+Energy Program in Northern Piauí, intercropping Jatropha with food short cycle crops in 200 Family Farming settlements in a 150 km radius of the 10,000 hectare Fazenda Tiracanga anchor farm, supported by an adjacent crushing unit and Jatropha Excellency Center in Piracuruca, PI.

b. East – integration into the infrastructure of Polo Petroquimico de Camaçari, availability of Hydrogen, downstream consumption of green naphtha and renewables, and export facilities through the Port of Aratu.

c. Center/West – addressing the demand of central hub of Brasilia, consolidating grain production of Center/West States.

d. Southeast – pilot multi-feedstock, multi-process value chain to address the major demand of biojetfuel of Southeastern Airports of Brazil. Sugar cane, Camelina, Jatropha, Tallow, and UCO are the feedstocks considered in Phase I, Amyris 50 million liter DSHC plant in Brotas - SP, Solazyme plant in Orindiuva - SP, ATJ and a two-step 300,000 tons of HEFA biorefinery in Guaratinguetá - SP compose the industrial processes of the Southeastern Hub.

Research, Development & Innovation

The Platform has engaged several high level research institutions in Brazil to pursue the domestication and introduction of alternative feedstocks for the production of biojetfuel and renewables. Ongoing research projects include:

1. Embrapa Agroenergia with a network of research institutions on the BRJatropha program, Macauba, Dende and Jatropha.
2. GE - technical support and alternative fuels landscape and assessment, implementation of new technologies and analytics.
3. IICA - LAC – Latin American and Caribbean Network on Jatropha Research.
4. IAPAR on the Camelina introduction in Paraná.
5. IAC, CTC on the continued research on sugar cane.
6. Federal University of Rio de Janeiro -UFRJ on HEFA process and Algae.

7. Federal University of Minas Gerais – UFMG for Macauba and biomaterials research.
8. University of Florida on Jatropha hybrids, TC propagation protocol, and Jatropha Excellency Center in Piracuruca – PI.
9. SGB – Jatropha Research program, and Jatropha Excellency Center Hybrid trials and pre-commercial plantation pilots in multiple locations within Brazil.

Feedstock

Based on the Brazilian biodiversity, land availability, climate, and labor, the Platform is taking an initial regional approach on the following feedstock supply chains:

a) Jatropha intercropped with food cultures with family farmers, and extensive plantations with agribusiness in Piauí.

b) Camelina introduction as a winter crop, "safrinha", after soy harvest, in Paraná, to make use of 2 million hectares of land available during the Winter.

c) UCO – systematic UCO collection program in Vale do Paraíba, integrating the Metro regions of São Paulo and Rio de Janeiro.

d) Sugarcane for the Amyris and Solazyme plants in São Paulo. Those will be integrated upstream from traditional supply chains, like Tonon Bioenergia, São Martinho and Bunge.

e) Macauba in the State of Minas Gerais.

f) Algae in the States of Maranhão, and Piauí.

g) Babassu as biomass from the 18 million hectares of natural forest in the States of Piauí, Maranhão and Pará.

h) Tallow, and chicken fat in Piauí and São Paulo.

Refining processes

a) DSHC pathway – Amyris has commissioned a 50 million liter/year farnesene plant in Brotas, SP, with finishing process (hydrogenation) in Paulínia, SP for the supply of DSHC biojetfuel. This production unit is less than 250km from the main airports of São Paulo State, and has been producing commercially since Q4 2012, with sugarcane supply by Tonon Bioenergia. The ongoing ASTM DSHC certification process is

expected to be concluded in 2013. Amendment to ANP Resolution 20/2013 will be required in Brazil to allow the use of blend up to 10% of sugarcane derived jet fuel into regular fossil jet fuel.

b) Algae – Solazyme will commission its plant in December 2013 in Orindiúva, SP, to provide basic feedstock for Solajet.

c) HEFA pathway – Curcas is structuring the technical project with UFRJ for a plant co-sited at the BASF chemical plant in Guaratinguetá, SP.

Logistics

The logistics for biojetfuel in Brazil will be structured on two pilot supply chains:

1) The North/Northeastern Hub Jatropha Crude Oil Export value chain to be implemented based on the Jatropha production of Fazenda Tiracanga and future production of the rural settlements in a radius of 150 km from the crushing plant of Brasil Ecoenergia in Piracuruca, PI. Logistics will rely on tanker trucks for the initial low volume Jatropha Crude Oil for export through the Port of Pecem in Ceará.

2) The logistics for DSHC supply chain based on the Amyris Farnesene plant in Brotas, SP is being structured by the Infrastructure Work Group of the Platform for operational kick in June 2014, based on the Flying Green Program of participating airlines. GOL is projecting 200 domestic flights from CGH, GRU, SDU and GIG airports during the games. Following the games, the provisional logistic procedures will be improved for the GOL commercial flights between Sao Paulo (GRU) and Rio (GIG).

Sustainability- RSB/Curcas certification projects for the Brazilian Biojetfuel Platform

RSB Services has joined the Brazilian Biojetfuel Platform to support the sustainability certification of the multi-feedstock and multi-process value chains of the Platform, including the development of a small holders certification process, and also

assist with the GHG calculation engine for the Platform Carbon Footprint Management System. The following requirements are required for each process/operator involved in the supply chain, to allow for sustainability declaration of the value chain related to "green flights" under RSB:

Requirement	Feedstock producer	Feedstock processor	Biofuel producer	Blender/ Distributor	End consumer (airline)
Environmental/ Social	✓	✓	✓		
GHG emissions	✓	✓	✓	✓	
CoC: Mass balance	✓	✓	✓	✓	✓

- Small holders group certification. A pilot of RSB small holders standard and group certification was carried out in Londrina/Rolandia in August 2013 (part of a project of RSB/EPFL, with support of Aidenvironment and, in Brazil with participation of RSB Services and Planapec). The pilot consisted in field evaluation and interviews with small holders involved in soy plantations, to collaborate in the construction of an easier and relevant standard for group certification of smallholders. Additionally, the project will also lead to a set of recommendations for the RSB on how to increase smallholder access to the standard and alternative options for smallholder definitions.

- Camelina value chain certification. RSB Services will support and provide guidance to Planapec for a RSB certification of a group of Camelina producers in the Londrina, PR region. Since this is a new feedstock being introduced in Brazil by IAPAR as a "safrinha" (or winter crop after soy), it is necessary to work closely with this research institute and producers, to define alternatives for the challenges that may impact the certification process. IAPAR will be conducting the Camelina placement trials with cultivars from Camelina Company in 9 sites in the state of Parana in 2014, under a 5 year research program with the Platform. Commercial trials will be conducted with Cooperatives in Northern Paraná, therefore RSB certification of the respective Camelina value chain is planned for May 2014.

- Jatropha value chain certification. Certification of the a value chain of Jatropha oil in Piracuruca, PI will include the Jatropha plantation at Fazenda Tiracanga, the crushing process of Brasil Ecoenergia in Piracuruca, PI, and the delivery of Jatropha Crude Oil to the Port of Itaqui in Maranhao and/or Port of Pecem in Ceara. Export through the Port of Luis Correia will be considered after the retrofitting of the port infrastructure under the Federal Government PAC program. Fazenda Tiracanga is a 10,000 hectare private investment focused on Jatropha, and will serve as the anchor farm to support the Food+Energy Program of the Secretary of Rural Development of the State of Piauí. This Program will to intercrop Jatropha with short cycle cash crops in the rural settlements with a 150 km radius from Piracuruca, PI, where the Fazenda Tiracanga and the Brasil Ecoenergia crushing station are located. In the region there are 200 rural settlements with an average of 25 families each. Family farming will be very important component of the jatropha value chain in Northern Piauí.

- Amyris DSHC value chain certification - This should be the first certified commercial biojetfuel value chain in Brazil. The sustainability certification of this chain will involve:

i. Feedstock producer and processor: Sugar cane certification by Bonsucro for Tonon, including the gaps related to the benchmarking study comparing Bonsucro and RSB standards. It will allow the mill to achieve a dual certification and provide certified feedstock to Amyris that is recognized by the RSB certification scheme.

ii. Biofuel producer: RSB certification of Amyris DSHC plant in Brotas, SP will also include the hydroprocessing finishing step of Farnasene at the Air Liquide plant in Paulinia, SP, since the custody of the product will remain with Amyris.

iii. Blender : Upon definition of the final blending sites, the blenders will be certified to keep the integrity of the value chain. Multisite certification is allowed, in the case of an operator is managing more than one site. Requirements related to GHG emissions and traceability based on mass balance methodology are applied by site. The transportation does not require a separate certificate. The controls of flows (products and documents)

and GHG emissions related to the transport of certified products between an operator to another is under responsibility of the operator which has the custody of the product.
Additional support will be provided to blenders and distributors to complete the value chain. They should be certified to calculate GHG emissions at the end of the chain and to allow final clients (as airlines) to do declarations and claims related to sustainable certified biojet fuel used in the “green flights”.

iv. End users: The airlines interested in doing declarations about use of RSB certified biojet fuel should be certified under chain of custody standards. They should evidence the amounts of biojet fuel they are buying and using.

Carbon Footprint Management System of the Brazilian Biojetfuel Platform.

The system will be based on the RSB GHG emissions calculation tool, with recognized methodology in line with international parameters (including the EU-RED). The GHG emissions related to the flights using sustainable biojet fuels will be calculated for each feedstock and process and will give information about savings and benefits of the initiative in comparison with the fossil fuel. It will provide the carbon footprint of the whole value chain, to be shared with stakeholders of the Platform, ANAC and, other governmental entities and the public in general. The Platform will built the Carbon Footprint Management System prototype based on the jatropha value chain in Piracuruca -PI and the Amyris DSHC value chain in Brotas –SP.”

6.3 Air Traffic Management

The implementation of the Global ATM Operational Concept, announced by ICAO, aims to obtain benefits for all the members of ATM community. One of these benefits is related to environmental protection. The strategic objective is the reduction of the fuel consumption and, consequently, the decrease of GHG emission.

Thus, regarding the international commitments assumed related to environmental protection, particularly in accordance with the resolution A36-23[10], adopted at the 36th session of the ICAO General Assembly, Brazil started, in 2007, the introduction of Area Navigation (RNAV) and Required Navigation Performance (RNP) procedures supported by Global Navigation Satellite System (GNSS) to optimize en route and Terminal Control Area (TMA) operations in accordance with the ICAO PBN concept, providing the implementation of a more flexible and efficient flight path.

Regarding ATS routes, Brazil has implemented and published a total of 111 RNAV5 procedures (54 domestic and 57 international routes). The planned implementation RNAV5 procedures amount to 49 routes (27 domestic and 22 international routes). Additionally, there are also a total of 4 RNAV10 procedures published (for international routes). The information are summarized in Table 5.

Table 5: ***En-route PBN Operations***

Navigation Specification	**Completed (Number of routes)**		**Planned implementation (Number of routes)**	
	Domestic	**International**	**Domestic**	**International**
RNAV 10	-	4	-	-
RNAV 5	54	57	27	22
RNAV 2	-	-	-	-
RNP 4	-	-	-	-
RNP 2	-	-	-	-
TOTAL	**54**	**61**	**27**	**22**

At the TMA, the PBN concept has been implemented through Standard Instrument Departure (SID) and Standard Instrument Arrival (STAR), as well as approaching procedures, based on RNAV and/or RNP. Table 6 presents a summary of the type and number of implemented procedures, as well as the planned implementation for the next years.

[10] Urges all States to implement RNAV and RNP Air Traffic Services (ATS) routes and approach procedures in accordance with the ICAO PBN concept laid down in the Performance-Based Navigation Manual (Doc 9613).

Tabela 6: PBN Procedures

Type of procedure	Implemented (Number)	Planned	
		Number	Year
RNAV STARs	71	135	2014
RNP STARs	-	362	2018
RNAV SIDs	165	215	2014
RNP SIDs	-	156	2018
BASIC GNSS RNAV APPROACH	162	-	-
RNP APPROACH only LNAV	74	227	2016
RNP APPROACH with Baro/VNAV	88	227	2016
RNP AR APPROACH	4	24	2016

The full implementation of the PBN concept in all the Brazilian TMA is presented in the schedule according to Table 7.

Table 7: *PBN Implementation at Brazilian TMA*

Brazilian TMAs	Year of implementation
Brasilia and Recife	2010
São Paulo and Recife	2013
Belo Horizonte and Salvador	2015
Curitiba, Florianópolis and Navegantes	2017
Porto Alegre and Natal	2019
Manaus and Fortaleza	2021
Porto Seguro and Ilhéus	2023
Foz do Iguaçu and Campo Grande	2025

Maceió and Aracajú	2027
Belém and Anápolis	2029
Boa Vista and Porto Velho	2031
São Luiz and Vitória	2033
Uberaba and Bauru	2035
Rio Branco and Teresina	2037
Anápolis and Santa Maria	2039

Source: Department of Air Space Controle

As it can be seen in Table 7, the implementation of the PBN concept was already concluded in the TMA of Brasília and Recife. For the TMA of São Paulo (TMA-SP) and Rio de Janeiro (TMA-RJ), the conclusion is foreseen for November 14th, 2013. Taking into account both TMA, they concentrate approximately 50% of the national air movement. So, it can be verified that, after concluding its implementation, the PBN concept will cover around 50% of the Brazilian airspace.

In general, based on the expected reductions by the application of the PBN concept in the TMA-SP and TMA-RJ, the flight times will be reduced in about 10 minutes. As next steps, it is planned to perform data modeling, using the simulation software known as TAAM (Total Airspace and Airport Modeler), which will accurately calculate the time gains and fuel economy with the implantation of the new procedures.

6.4 Operational Improvements

The Brazilian airlines have implemented some initiatives with the purpose of reducing the fuel consumption and, consequently, the CO_2 emissions. These initiatives include:

- preflight procedures, such as the aircraft's internal weight reduction, flight planning, taxi and reducing the use of APU (Auxiliary Power Units);
- flight procedures: take-off, climbing, sinking, waiting and approaching procedures; and
- maintenance measures.

The Brazilian airline Gol Linhas Aéreas, for example, is implanting a project for reducing the APUs use during its aircrafts night maintenance. According to this project, the maintenance shall be made with the use of GPUs (Ground Power Units). This considerably reduces the fossil fuels burning, because the GPU uses the common diesel as fuel and it consumes much less fuel per hour for producing the same electricity. It shall be highlighted that, besides the CO_2 emissions volume reduction, the use of GPU substantially diminishes the noise in the airport area.

The national airlines are also involved, along with the DECEA[11], on the PBN (Performance Based Navigation) technology implementation which defines more efficient approaching, landing, taking-off and depart procedures. Besides the air navigation infrastructure availability, which is DECEA's responsibility, this project also involves air carrier's initiatives on the installation of technology inside the aircrafts and the aircrafts certification by the National Agency of Civil Aviation. According to what was previously exposed, this project shall provide significant efficiency gains on fuel consumption.

It is highlighted a joint initiative of the airline Gol and GE and the Brazilian Company of Airports Infrastructure – Infraero, for encouraging the use of electric sources and air conditioning generated by the airport. This initiative has the purpose of reducing: the carbon emissions, the aircraft noise and the fuel consumption. Congonhas Airport, in São Paulo, has already performed tests using the airport electricity source to provide power to the aircrafts in one of its parking positions and other Brazilian airports have already studied the adoption of the measure. Although it is still under analysis by

[11] Air Space Control Department – Aeronautic Control.

the airport administrators, the use of electricity and air conditioning provided by the airports has the potential of significantly reduce the sector's emissions.

The Brazilian airlines have shown interest on fuel efficiency improvements, not only for reducing costs, but also for contributing with the sustainable development of the sector. One of the great national companies, Gol Linhas Aéreas, has several projects which aim at improving the fuel efficiency on their operations and it is already trying to quantify the environmental gains arising from the implantation of these projects. These projects include more efficient approaching maneuvers (destination maneuvering), flights' dispatch time reduction (minimum dispatch) and a policy of selecting alternative airports that differ from the one of certain flight destination, based on the operational, infrastructure and weather conditions, involving a certain time period before and after the arrival time foreseen for each flight (alternate selection).

According to the company, besides the economy generated, related to the fuels consumption decrease, such procedures, from the months of January to June 2013, promoted a reduction of 1.055 thousand kg of fuel burn and 2.598 thousand kg of CO_2 emissions.

6.5 Improvements on the Infrastructure and Regulatory Measures

The investments in airport infrastructure have the potential of: increasing the airports capacity efficient use and planning, promoting better passengers and freight processing, reducing the aircraft time in land and reducing the traffic for landings and take-offs. Thus, these measures, while providing more efficient operations for the airlines and airport administrators tend to reduce the unnecessary fuel burning and contribute to improve the fuel efficiency. The Brazilian government has tried to enlarge and modernize its airport infrastructure so that the development of the sector is made in an effective and sustainable way. Besides, some recent Brazilian government

regulatory measures aim to increase the efficiency of the sector. They are: the concession of big airports to the administration of the private sector and slots management rules. The present text tries to present the actions in course in the country for the expansion of the airport infrastructure and for the modernization of its management.

Currently, the Brazilian airport infrastructure is formed by 720 public aerodromes. Among them, there are airports delegated to states and cities, as well as granted to the private initiative, such as Brasília, Guarulhos, Viracopos and São Gonçalo do Amarante. The main infrastructure, serving the capitals, counts on 31 airports with regular flights. Besides, 98 regional airports receive regular aviation flights. So, the Brazilian airport infrastructure is, at the present date, formed by 129 aerodromes receiving regular flights.

The Presidency of the Republic of Brazil launched the “Program of Investment in Logistics: Airports”, which reunites a set of measures for improving the services quality and the airport infrastructure, and widening the air transportation offer to the Brazilian population. The main measures compounding this program are:

- two airports concession - Galeão (RJ) and Confins (MG);
- Infraero Serviços creation, an Infraero’ subsidiary, which, in partnership with an international operator, will offer planning, consulting, administration services, support to operation, workforce training and others related to the exploration of airports in Brazil and abroad;
- strengthening and widening the regional aviation through investments and incentives;
- regulatory improvement for slots (arrivals and departs times) in airports which are already operating in the capacity limit;
- Authorizations for airports dedicated to the general aviation.

The airports concession to the private administration has the main objective of widening and perfecting the Brazilian airport infrastructure, promoting improvements in the services and in the quality levels of the services supplied to the air transportation consumers in Brazil.

The privatization of Brazilian airports administration began in August, 2011, with a greenfield concession of “São Gonçalo do Amarante Airport” (ASGA). The ASGA airport will be located in Natal, Rio Grande do Norte (Northeast of Brazil), and it is planned to be ready by 2015. Later in the same year, Brazil started to organize what is became known as the “first round” of concessions. The airports involved in this round were: Guarulhos International Airport, Campinas International Airport and Brasilia International Airport. The first two serve the metropolitan region of São Paulo and the last is one of the main hubs of the Brazilian airport system. These are the Brazilian airports that concentrate the largest investment requirements for the next thirty years and that is why they were chosen to be part of the first round of the concessions.

Galeão (Rio de Janeiro) and Confins (Minas Gerais) airports are, at the presente date, under a concession process. Regarding ownership structure of privatized airports in Brazil, Infraero remains a minority partner with a share of 49% in all the consortia responsible for the management of granted airports. This participation is aimed to ensure that the best management practices and operating technologies brought by different airports operators can be transferred to smaller airports in Brazil that still are going to be operated by Infraero, ensuring that the gains of introducing competition in the sector are not restricted to granted airports, but also achieve other important airports in the system.

Another objective of the Investments Program is strengthening and widening the regional air transport networks. For such, the Federal Government plans the investment of R$ 7.3 billion in the first step of the regional aviation plan. The measures will allow perfecting the quality of the service supplied to the passenger, aggregating new airports to the regular air transportation network and increasing the number of routes operated by airlines.

The investments foreseen are around R$ 1.7 billion in 67 airports in the North region; R$ 2.1 billion in 64 airports in the Northeast region; R$ 924 million in 31 airports in Mid-West; R$ 1.6 billion in 65 airports at Southeast; and R$ 994 million in 43 airports in the South region. The program aims at increasing the access of the Brazilian

population to air services. The objective is that 96% of the Brazilian population is at least 100 kilometers away from an airport able to receive regular flights.

The projects will promote the improvement, the refit, the reform and the expansion of the airport infrastructure, both in physical facilities and in equipment. The investments will include, for example, reform and building of runways and taxiways, improvements in passengers terminals, , revitalization of signaling and pavement, among others. The resources will come from the National Fund of Civil Aviation (FNAC).

In order to prioritize the investments, it was defined a set of criteria for the analysis of the aerodrome relevance, which includes: the volume of passengers and freight, the regular flights and the operational results. Besides, social and economic aspects, the level of accessibility in Legal Amazon, the touristic potential, and foment of the national integration will be taken into account.

Another relevant action related to the modernization of Brazilian aerodromes refers to the publication of a standard regulating the conditions for the authorization of public civil aerodromes exclusively dedicated to the general aviation. . This modality includes services such as the executive aviation, air taxi, instruction and training (air clubs and aviation schools), specialized (agricultural, advertising, firefighting) services, aero sport, between others.

The standard aims to increase the supply of airport infrastructure in Brazil dedicated to the general aviation, which is of great importance for the economy of the country. According to the Brazilian Association of General Aviation (ABAG), in 2011, the Brazilian fleet in this segment reached 13,094 aircraft, representing an increase of 6.3% over 2010. Thus, airports primarily focused on private air services can be planned and structured with greater speed and efficiency to meet different markets, kept all the rules and safety standards in force for the operation of airports in the country. It is intended, therefore, to add public and private efforts in the provision of airport infrastructure in Brazil.

The described measures are aimed at meeting the large projected growth of the Brazilian civil aviation. From this projection, it is understood as essential to have a long-term planning for the expansion of the Brazilian airport infrastructure. As described

earlier in this document, the sector's growth will naturally be accompanied by an increase in total emissions. However, an effective planning for infrastructure expansion and modernization of its management will avoid congestions and other operative inefficiencies, and will certainly contribute so that the rhythm of growth (or intensity) of the emissions is attenuated.

7 Conclusions

The Brazilian air transport, both domestic and international, tends to grow fast. As exposed earlier in this document, the number of travels per person, per year in Brazil is only 0.42. This means that a Brazilian makes, in average, one airplane travel every two years. Taking into account Brazil's continental dimensions and the countries distance from the main international destinations, this number shall substantially grow. The Brazilian market is not a mature market yet. There is a potential for the incorporation of new passengers, creation of new routes and consolidation of the routes already existent. This reality requires public policies to assure the aeronautic infrastructure to the sector, regarding: airports, air navigation services, and the availability of qualified workforce.

Bearing in mind the strategic importance of the sector in national integration and economic dynamism, the government has adopted a series of measures for promoting the civil aviation development in Brazil, previously described. It shall be highlighted that there is a concern that this development is sustainable, from the economic, social and environmental point of view. Regarding the environmental subject, the National Agency of Civil Aviation regulates the issues of aeronautic noises and emissions affecting the quality of the local air.

The measures related to the civil aviation greenhouse gases emissions reduction are getting great relevance on the Brazilian governmental agenda, mainly from the international debates in the context of UNFCCC and ICAO. It shall also be highlighted the Brazilian private sector initiatives related to technologic development, research and development of biofuels, and deployment of more efficient operations.

The governmental bodies are also involved in actions which shall contribute to reducing the GHG emissions, such as: biofuels research and development (EMBRAPA and FAPESP) and international cooperation on biofuels with the USA (MRE), deployment of new technology which improves the efficiency of the air traffic management (DECEA), and regulatory measures such as the concession of airports to the private administration and SLOTS management (ANAC and SAC). The Brazilian

government is also performing a great effort for measuring the sector's emissions, both for reporting to UNFCCC and ICAO.

In this context, the Brazilian government recognizes the important role of ICAO on the unification of rules and standards allowing the international civil aviation harmonic and safe development. Bearing in mind the international civil aviation eminent global nature, the debates on the sector's GHG emissions shall be made in the scope of ICAO. Thus, the Brazilian government intends to support the Organization's work on the theme in a constructive and cooperative way with the purpose of contributing to the world's civil aviation sustainable development.

— END —