MINISTÉRIO DA
INFRAESTRUTURA

Brazil's Action Plan on CO_2 Emissions Reduction from Civil Aviation

4th edition

BASE YEAR **2021**

Brazil's Action Plan on CO_2 Emissions Reduction from Civil Aviation

4th Edition | Base Year 2021

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This document is also based on the following regulations published by ANAC: Resolution No. 496/2018 and Ordinance No. 4005/ASSINT/2018.

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4th Edition | Base Year 2021

ANAC

MINISTÉRIO DA INFRAESTRUTURA

This is the 4th Edition of the Brazil Action Plan, updated and submitted to the International Civil Aviation Organization (ICAO) every three years, in line with the recommendations set forth in Resolution A40-18: Consolidated statement of continuing ICAO policies and practices related to environmental protection - Climate Change.

Summary

Executive Summary

Brazil's Action Plan on CO_2 Emissions Reduction from Civil Aviation

This is the **4th** Edition of the Brazil Action Plan, updated and submitted to the International Civil Aviation Organization (ICAO) every three years, in line with the recommendations set forth in Resolution A40-18: Consolidated statement of continuing ICAO policies and practices related to environmental protection - Climate Change. It describes measures adopted by Brazil to limit or reduce CO_2 emissions from civil aviation, base year 2021.

As a continuous work, constantly being improved, it reflects the collaborative effort of various players and reaffirms the commitment of the Brazilian civil aviation industry to the environment.

In 2021, amended by Ordinance No. 123/2021, created a Working Group to coordinate the elaboration of this Action Plan. The Working Group, composed by representatives of the Government and the private sector, became a forum for debates and knowledge exchange that contributed to the proper formulation of policies and guidelines to the specificities of the Brazilian civil aviation industry.

The first two editions of the Action Plan followed the guidelines of the Intergovernmental Panel on Climate Change (IPCC) for the definition of international flights.

According to these guidelines, the previous Actions Plans accounted for emissions from international flights operated by both Brazilian and foreign airlines departing from aerodromes located in Brazil and its territories ("State of origin" criteria).

With the entry into force of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) since the 3rd Edition, this Action Plan adopts the methodology proposed by ICAO and reports emissions from international flights operated by aircraft registered in Brazil ("State of registration" criteria).

Therefore, the current methodology only accounts for international flights operated by Brazilian airlines bound to or from Brazil.

Despite most mitigation measures having effect on both domestic and international flights, this Action Plan seeks to segregate their data to the greatest extent. Chapters 3 to 6 describe several ongoing initiatives in the domestic market that further extend the global aspirational goals set by ICAO.

Inventory and projections

The first section of the Action Plan presents both historical data from years 2005 to 2021, and projections up to the year 2050 concerning fuel consumption, CO_2 emissions, fuel consumption/RTK[1] ratio, mitigation measures and Emission Intensity (IE[2]).

The data reflect the implementation of a basket of measures aimed at reducing the sector's environmental footprint. The idea of a basket has its origins in the understanding that no initiative – be it operational, technological, air traffic management, or market-based – will be able to adequately address the adverse effects of air transport on the environment on its own.

Responsive Regulation

In the search for a more cooperative regulatory action, which promotes a favorable environment to the sustainable and safe development of the sector, the National Civil Aviation Agency (ANAC) launched the Responsive Regulation Project.

In this scope, the Sustainable Airports and SustentAr programs stand out, aimed at recognizing and encouraging good environmental practices by airports and air operators, respectively. The results of both initiatives are detailed in Chapter 3 of the Action Plan.

Sustainable Aviation Fuels

Brazil has extensive experience in the biofuels sector, especially with ethanol and biodiesel.

Its favorable climatic and territorial characteristics make the development of this production chain an important socioeconomic pillar for the country. In the transport sector, the need for efficiency gains is combined with the objectives of energy security and emission reduction, generating substantial incentives for the substitution of energy sources.

In that regard, the program called "Combustível do Futuro" (Fuel of the future in free translation) was created, which, among other initiatives, established a strategy for introducing sustainable aviation fuels into the Brazilian energy matrix.

The entire process of conducting the work, which had the broad participation of the government and society, as well as the premises adopted, are described in Chapter 4.

1 Revenue Tonne Kilometers. It refers to the sum of the product between the loaded mass paid in tons and the transported distance in kilometers. In Brazil, an average of 75 kilos is adopted for each passenger transported, including hand luggage.

2 Ratio: CO_2/RTK.

Technological Development of Aircraft

Technological developments in aircraft, such as aerodynamic improvements, engine efficiency and the use of lighter materials, contribute to the energy efficiency of air operations.

Chapter 5 of this document describes the initiatives of Empresa Brasileira de Aeronáutica SA (Embraer) related to research and innovation, especially for the development of aircraft with lower fuel consumption. Also noteworthy is the ongoing technological cooperation for electrification and hydrogen tests.

As part of its commitment to building a sustainable future, the company also announced ambitious new ESG targets and a path to achieving carbon neutral operations by 2040.

Market-based Measures

Within the framework of the ICAO, States have worked together to develop mechanisms to reduce and mitigate the environmental impacts of international civil aviation.

Collaborative work aims to prevent the proliferation of unilateral initiatives, which contribute to raising the transactional and operational costs of international civil aviation, harm the business environment and affect industry standardization.

In this context, CORSIA - Carbon Offsetting and Reduction Scheme for International Aviation was created as a transitory measure and complementary to the sector's internal mitigation actions.

Brazil will start its offset measures in 2027. Nevertheless, CORSIA's obligations related to the monitoring, reporting and verification (MRV) of emissions are already in place. These rules were internalized to the domestic regulatory framework through ANAC Resolution No. 496/2018 and Ordinance No. 4005/ASINT/2018.

According to ANAC estimates, Brazilian airlines will have to offset approximately 15 million tons of CO_2 during the period the scheme will be in place.Furthermore, to promote the adequate expansion of renewable fuels in the country, the RenovaBio Program was instituted. Considering that the production and import of biokerosene can also benefit from the Program, RenovaBio, together with CORSIA, has the potential to contribute to the development of the aviation biofuels chain in Brazil.

CHAPTER 1

Introduction

Air transport has been a major factor in supporting globalization and the quintessential means of national integration in countries with continental dimensions such as Brazil. Over the past 30 years, the Brazilian civil aviation industry has undergone a gradual process of deregulation that has contributed to the sector's rapid response to the changing socioeconomic profile of the country, allowing millions of users to be included in the modal.

This liberalization movement extends to the main structural aspects of a strong airline industry: free pricing and supply; broad and flexible international agreements; adequate airport infrastructure; and diversification of funding sources for airlines. This regulatory framework has transformed Brazil into one of the most open countries in the world for foreign investment in airlines.

The Brazilian airport infrastructure continues to undergo significant improvements to meet the demand of the domestic aviation market. By promoting agility in the provision of capacity, the airport concessions program helps to avoid bottlenecks, reduce congestion and the waiting time for landings and takeoffs, which reduces unnecessary fuel consumption.

In fact, the advantages perceived from the public-private partnership extend beyond investments of great financial amount and complexity, since it also allowed significant gains in productivity in terms of management, best sustainability practices, efficiency and celerity in the purchases and contracting necessary for the operations.

In all, 44 airports are already being operated by the private sector. By 2021, around BRL 27 billion (actual values as of March 2022) have already been invested in the 22 airports granted to the private sector until the fifth round of concessions.

Soon, another 15 airports should be granted to the private sector, preparing Brazil for the projected demand growth in the coming decades.

It is worth noting that, since 2020, the air transport sector has been facing its most serious crisis in 93 years of commercial aviation in Brazil, due to the declaration of a pandemic state by the World Health Organization (WHO). Amid the exponential spread of the novel coronavirus, civil aviation was one of the most affected segments in the world economy. This is because, in addition to the border restrictions imposed on international travel, the fear of contamination by passengers led to a significant drop in demand for air transport.

In Brazil, the demand for national and international flights suffered a strong retraction. In 2020, the number of paid passengers transported on domestic flights dropped by 54.3%, while internationally, the retraction was 72.0% - both values compared to data for the same period in 2019.

This scenario of a sudden drop in air transport services, both nationally and internationally, resulted in strong pressure on the cash flow of companies in the civil aviation sector, which had their revenues considerably reduced. The crisis required support from the Federal Government, which, through Law No. 14,034/2020, approved emergency measures for Brazilian civil aviation, such as postponing the payment of airport grants and changing the deadlines for reimbursement of amounts owed by airlines. In parallel, exemptions from some contractual penalties were established for consumers who wish to rebook or cancel their flights.

Currently, the domestic movement shows recovery from pre-pandemic levels. International transport, on the other hand, still shows a negative variation of 39.27% compared to 2019, and the expectation is that the volume of previous traffic will recover only between 2023 and 2024.

In view of the above, it is expected that, with the resumption of investments and economic growth, combined with public policies to improve the regulatory environment and reduce costs and the tax burden in the sector, there will be an increase in supply and competition in air transport.

Brazil believes that the sector's recovery must be conducted in the light of the best environmental practices and guided by policies that guarantee growth on a sustainable basis. Recent experience has shown that reducing emissions based solely on emptying operations leads to significant losses in social welfare and economic development.

It is in this context that this Action Plan seeks to present a portrait of the Brazilian airline sector, its impact on climate change and the main mitigation measures - in progress and planned - to deal with emissions.

CHAPTER 2

Growth Forecast in the Air Sector and Emissions Reduction

This section presents historical data for the period between 2005 and 2021 and projections until 2050 concerning fuel consumption, CO_2 emissions, consumption/RTK ratio, mitigation measures and Emission Intensity (IE).

Data are disaggregated by the nature of the flight stage, that is domestic and international stages. Domestic flights are the movements in which the aircraft takes off and lands in the same country, while international flights are those in which the aircraft takes off in one country and lands in a different one. The combined steps, which identify the origin and destination of the air transport object regardless of the existence of intermediate aerodromes, are not considered for the purpose of disaggregation by nature of flight.

In addition, the methodology of the International Civil Aviation Organization – ICAO is used for the allocation of international flights, which requires each State to report emissions related to operators registered in the State itself. Therefore, only flights from Brazilian companies are part of the scope of this section.

The information presented herein comes from the Air Transport Statistical Database3, the National Air Plan (PAN[4]), the ICAO post-COVID-19 Forecast Scenarios[5] and data provided by air operators. The consolidated RTK and fuel consumption data used for the calculations in this section were extracted from the Statistical Database, while the domestic and international RTK growth forecast were taken from the PAN and the ICAO forecast, respectively.

It is important to note that, although there are more recent data available, the year 2019 was used as a reference for the calculation of relative evolutions so that the growth information would not be distorted

3 Historical series of statistical data on Brazilian air transport, regulated by ANAC Resolution No. 191/2011. This base includes operations according to the Brazilian Regulation for Civil Aviation - RBAC 121 and 135. It does not include, however, air taxi operations. The statistical data are provided to ANAC on a monthly basis, until the 10th of the month following the reference month, by Brazilian and foreign companies that operate regular and non-scheduled public air transport services in Brazil.

4 According to the version made available to ANAC on 03/16/2022

5 Available in: https://www.icao.int/sustainability/Pages/Post-Covid-Forecasts-Scenarios.aspx

by the atypical activity in 2020 and 2021 due to the coronavirus pandemic COVID-19.

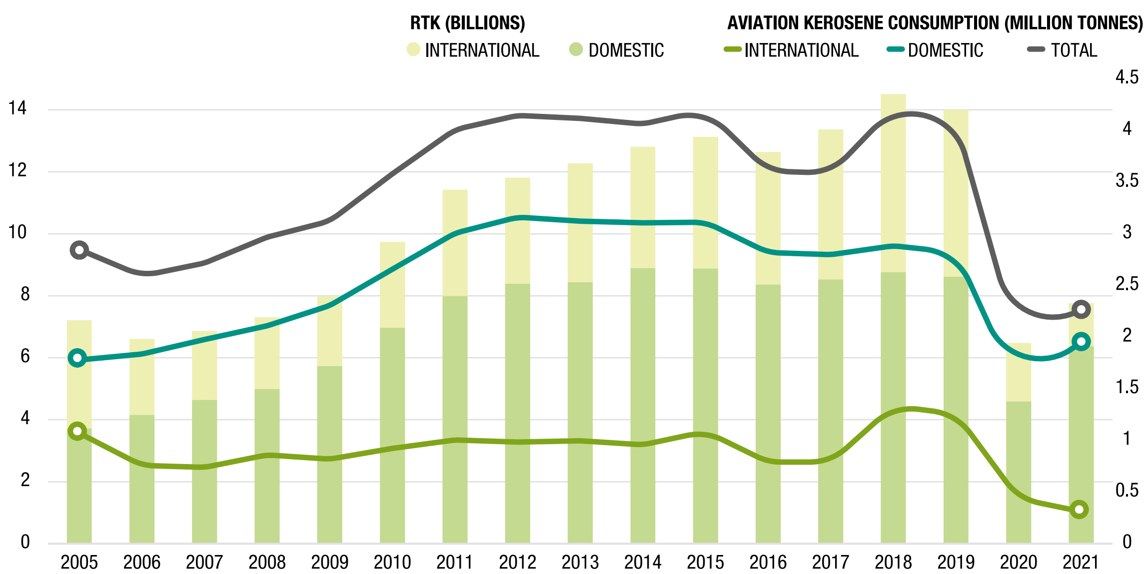
Historical data

Considering the scope delimited above, graph 01 shows the evolution of RTK and fuel consumption between 2005 and 2021. The average annual growth of RTK from 2005 to 2019 was 6.17% in the domestic market and 3.17% in the international market. Likewise, the growth in fuel consumption during the period was 3.34% for domestic flights and 1.15% for international flights.

This growth sequence was interrupted in 2020 due to the impacts generated by the COVID-19 pandemic. In this specific year, total RTK dropped by 54% while fuel consumption dropped by 53%, returning to activity levels below the start of the series in 2005. The year 2021 shows a slight recovery of the domestic market, but a deepening of the crisis in the international market.

It is worth mentioning that, in the years 2016 and 2017, there is a significant drop in fuel consumption not accompanied by the same drop in RTK. This is largely due to an inaccuracy in the statistical data provided by LATAM airline during the period. The reported data show consumption much lower than expected for some aircraft on all flights and for others only on international flights. These records were

GRAPH 01. HISTORICAL FUEL BURN AND RTK FOR DOMESTIC AND INTERNATIONAL OPERATIONS - 2005 TO 2021.



not used for the purposes of accounting for consumption/RTK ratios.

RTK and Fuel Consumption growth forecast

For the RTK growth forecast, the PAN (National Civil Aviation Plan) growth forecasts were used for domestic traffic and the ICAO post-COVID-19 Forecast Scenarios for international traffic. Aviation kerosene consumption was estimated based on ICAO DOC 9988, which establishes a methodology for calculating the consumption projection based on the historical evolution of fuel efficiency (a concept established by the DOC that represents the ratio of fuel consumption per RTK).

RTK forecast

The PAN estimates the number of passengers and the mass of transported cargo distributed according to established routes according to the potential demand from 2022 to 2050. The growth of the product of the number of passengers, or cargo mass, by the distance of the route was considered to be the RTK growth for passengers and freight, respectively.

$$(RTK_{pax})_{growth} \approx \left(\sum Qty_{pax} \times distance_{route}\right)_{growth}$$

$$(RTK_{cargo})_{growth} \approx \left(\sum kg_{cargo} \times distance_{route}\right)_{growth}$$

Therefore, the projection of the domestic RTK, both for passengers and for cargo, was determined from 2022 according to the PAN growth perspective for the reference scenario.

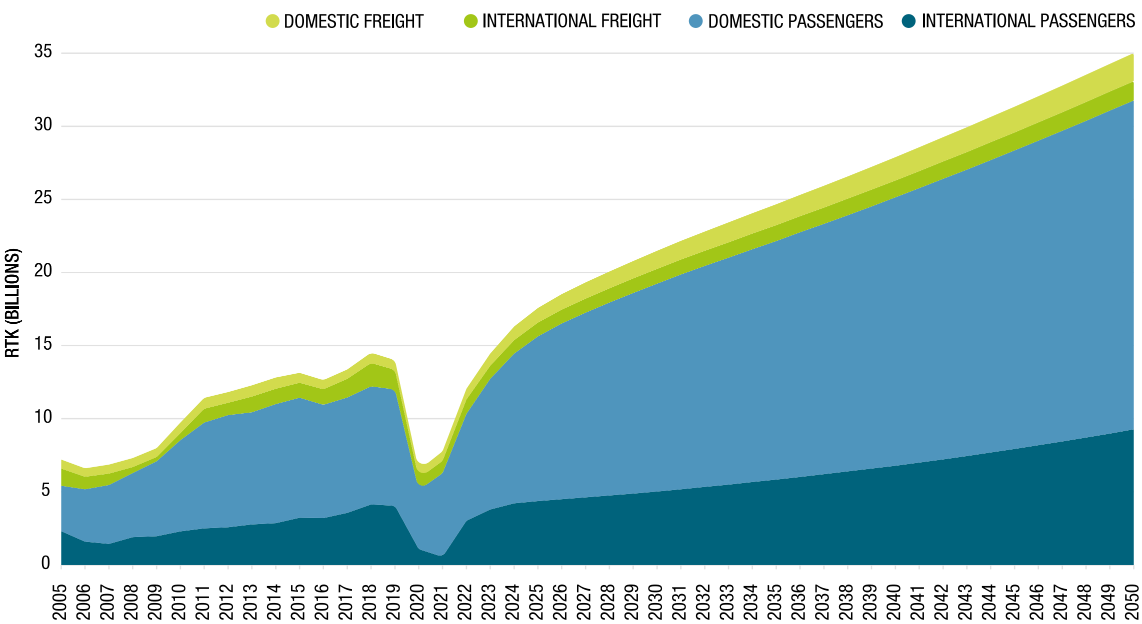
In the case of international RTK, the RTK growth values by route group present in the ICAO post-COVID-19 Forecast Scenarios were directly used. As in the domestic context, the forecasts were divided into RTK related to passengers and RTK related to cargo. Although three recovery scenarios were available, the analyzes presented in this document only consider the mid average scenario[6].

Graph 02 shows the evolution of RTKs, according to the forecasts detailed above, from the beginning of the historical series of statistical data in 2005 until 2050.

Based on the year 2019, the projection adopted resulted in a total RTK average annual growth of 3.0% or an accumulated growth of 150% until 2050. It is important to note that the growth forecast was drastically changed due to the impacts caused by the pandemic of COVID-19 in the years 2020 and 2021.

6 More information regarding the considerations for each scenario can be found at: https://www.icao.int/sustainability/Pages/Post-Covid-Forecasts-Scenarios.aspx

GRAPH 02. DOMESTIC AND INTERNATIONAL RTK FOR PASSENGER AND CARGO.



Fuel Efficiency Forecast

ICAO DOC 9988 establishes a methodology for calculating the projection of fuel consumption based on the historical evolution of fuel efficiency. The method consists of identifying a trend line with the best fit (between linear, exponential, polynomial and logarithmic) of the fuel consumption per RTK unit based on the historical evolution of this indicator. This trend line is then extrapolated to the year in which the projection is to be carried out and subsequently multiplied by the RTK corresponding to the same year, constituting the fuel consumption estimate for the entire period.

The best fit for the fuel efficiency curve was the logarithmic one, which captures the fact that efficiency improvements are attenuated with time, still representing improvement values consistent with the expected. For the adjustment, data from the last ten years were used, divided between domestic and international movements.

Graph 03 shows the adjustment and the efficiency projection for the two cases. Between 2019 and 2050, a cumulative efficiency gain of 16.6% is projected for international aviation and 14.1% for domestic aviation.

Regarding the evolution of fuel efficiency, this edition of the action plan differs significantly from the 3rd edition. The main reasons are, in addition to the inclusion of the last three years in the history, the exclusion of the first years of the historical series as contributors to the efficiency curve, the sudden drop in demand due to the pandemic and the disregard of suspicious data involving flights da Latam between 2016 and 2018. In view of the expected behavior and ICAO's emission reduction forecasts, it is understood that the current methodology better reflects the trend of evolution.

Consumption forecast

Combining the two projections (RTK and Fuel Efficiency), we finally have the projection of fuel consumption, shown in Graph 03, divided between domestic and international consumption.

According to the projection, the cumulative growth in fuel consumption between 2019 and 2050 will be 120%, being the domestic growth 145% and the international growth 65%.

Additional Mitigation Measures

The reduction in fuel consumption per unit of RTK displayed up to this point represents the mitigation measures that would take place if the historical evolution trend were maintained, that is, in the absence of additional measures. However, several initiatives to reduce fuel consumption and greenhouse gas emissions have been adopted by the various stakeholders involved in the civil aviation sector.

These measures will be described in more detail in the next sections of this plan, nevertheless, some of them can be compared with the projection of aviation kerosene consumption in terms of the reduction of GHG emissions achieved are listed below.

Fleet renewal

Among the technological solutions to reduce fuel consumption, the replacement of aircraft with more recent and therefore more efficient models stands out. In Brazil, the main fleet changes projected by airlines are the introduction of the Airbus A320neo, A321neo and A330-900 models; Embraer E195-E2; and Boeing 737 MAX 8 and 737 MAX 10.

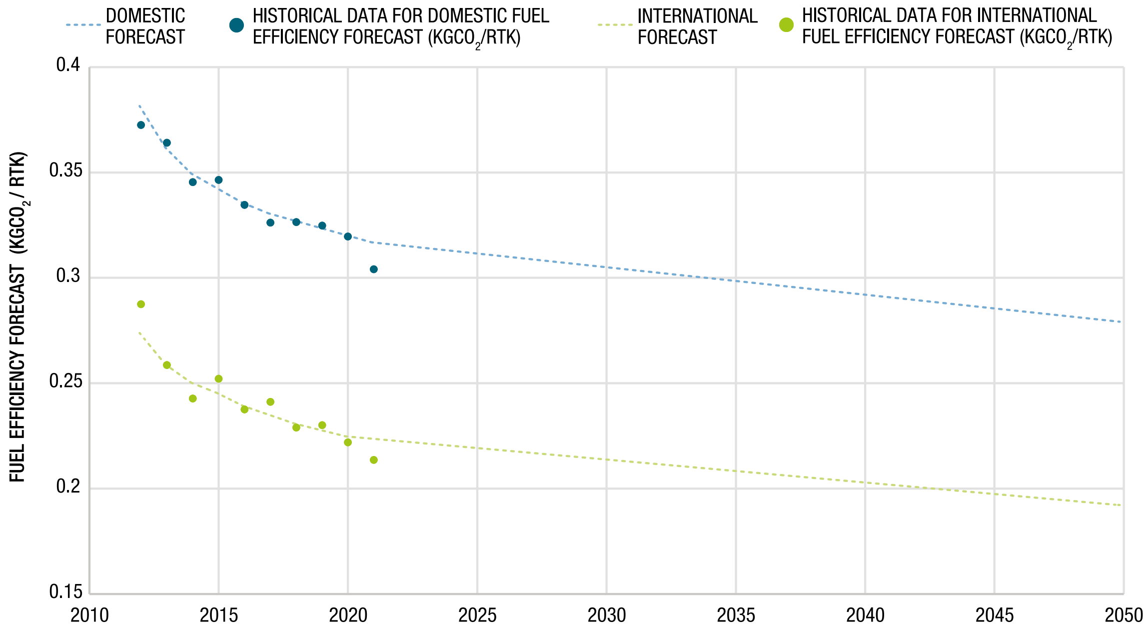
Considering the fleet renewal plans provided by the air operators, and the difference in consumption between new aircraft and their respective replaced models, the fuel economy per year until 2025 will be according to table 01.

TABLE 01. TONQAV ECONOMY PROJECTION BY YEAR DUE TO PROJECTED FLEET RENEWAL - 2022 TO 2025

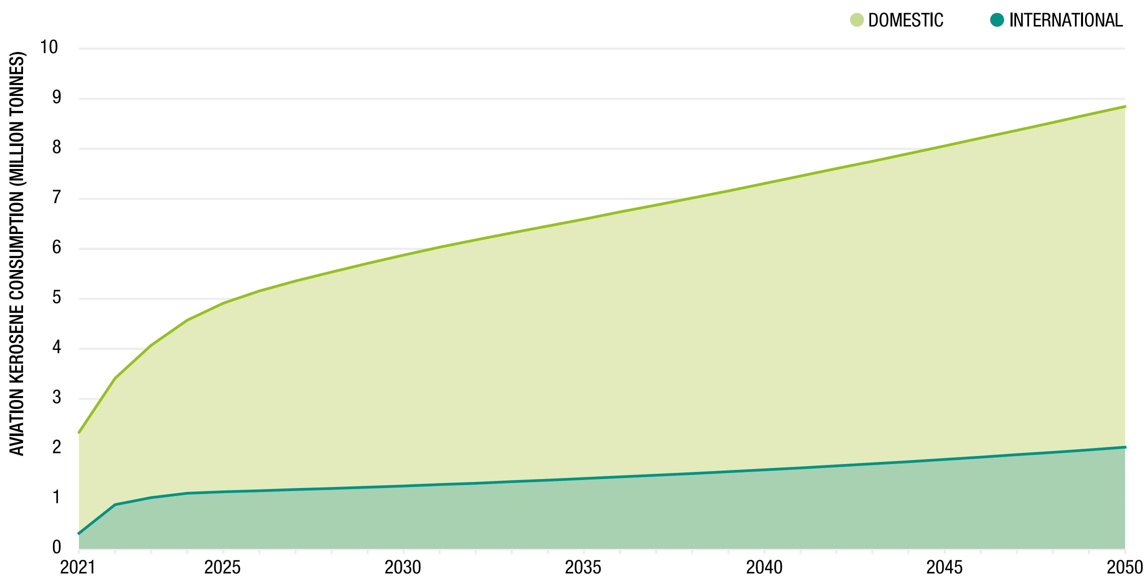
Year	Economy (tonQAv)
2022	52.296
2023	10.662
2024	6.363
2025	6.363

SOURCE: DATA PROVIDED BY AIRLINES THROUGH THE ANAC'S SUSTENTAR PROGRAM.

GRAPH 03. FUEL EFFICIENCY HISTORICAL AND PROJECTIONS FOR DOMESTIC AND INTERNATIONAL OPERATIONS



GRAPH 04. ESTIMATED FUEL CONSUMPTION BY YEAR - 2021 TO 2050



Operational improvements

The reduction in GEE emissions from aviation is a desire of the entire aeronautical community. Therefore, DECEA, through the SIRIUS Program, has been implementing several operational measures that contribute to improving the efficiency of operations. This improvement is reflected in the reduction of fuel consumption and, consequently, in the reduction of CO_2 emissions.

Among the operational measures implemented under the SIRIUS Program and included in DOC 9988 "Guidance on the Development of States' Action Plans on CO_2 Emissions Reduction Activities" are: the application of the concepts of Continuous Descend Operations (CDO), Continuous Climb Operations (CCO), Standard Terminal Arrival Routes (STAR), Performance Based Navigation - Standard Instrument Departures (PBN-SID), Automatic Dependent Surveillance – Broadcast (ADS-B), Airport Collaborative Decision Making (A-CDM), Radius to Fix PBN Procedures , Required Navigation Performance Procedures (RNP-AR), and the Advanced Surface Movement Guidance and Control System (A-SMGCS).

The fuel consumption/CO_2 emissions reduction values for the years 2019, 2020, 2021, as well as the total value, for each operational measure implemented, are given at table 02 below.

TABLE 02. CO_2 REDUCTION VALUES OF THE MEASURES IMPLEMENTED BY DECEA

Year	2019		2020		2021	
Measure	low end	high end	low end	high end	low end	high end
CDO	570,445	570,445	382,156	382,156	469,054	469,054
PBN STAR	101,216	168,641	63,018	105,030	84,887	141,321
CCO	855,682	1,426,137	382,156	955,389	469,042	703,563
PBN SID	0	84,887	0	88,973	0	109,806
A-CDM	3,587	10,735	1,916	5,747	2,307	6,922
ADS-B Surveillance	6,527,067	26,108,266	6,978,715	27,914,859	22,585	7,704,286
radius to fix PBN procedures	4,896,126	9,719,055	2,841,230	5,639,982	3,732,059	7,408,283
RNP AR APCH	154,936	191,128	89,909	191,128	118,099	191,128
A-SMGCS peak	6,289	12,577	3,166	6,332	3,628	6,332
A-SMGCS low	719	1437	362	724	415	829
A-SMGCS night	180	360	91	181	104	208

FONTE: DECEA

CORSIA

The International Aviation Offsetting and Reduction Scheme (CORSIA) is the market mechanism adopted by ICAO to meet the aspirational objective of limiting emissions to 2020 levels[7] in the scope of international civil aviation.

From 2027, Brazilian airlines will be required to offset part of their CO_2 emissions on international flights through the purchase of carbon credits or the use of SAF (Sustainable Aviation Fuels). The scheme is expected to run until 2035.

ANAC[8] estimated the amount of CO_2 that must be offset by Brazilian airlines during the scheme. The values are shown in table 03, considering an intermediate scenario of recovery from the impacts of the COVID-19 pandemic and the current baseline of the scheme (average of 2019 and 2020 emissions).

7 At the time when the goal of carbon neutral growth from 2020 was agreed, the effects of the COVID-19 pandemic on aviation were not considered. The ICAO is currently under discussion to change the CORSIA baseline to 2019 only, rather than the current average for 2019 and 2020.

8 The Air Services Superintendence (SAS) carried out a study on the impact of CORSIA and its main elements on different types of air operators (SEI process n° 00058.022788/2020-00).

TABLE 03. CORSIA CO_2 OFFSETTING FORECAST FOR BRAZILIAN OPERATORS

Year	Offsets (tonCO_2)
2027	1,124,185
2028	1,208,860
2029	1,298,981
2030	1,480,509
2031	1,577,333
2032	1,666,153
2033	2,071,944
2034	2,203,211
2035	2,402,186

Alternative fuels

Sustainable Aviation Fuels (SAF) are the main tool for the decarbonization of aviation when considering the technologies available in the short and medium term[9]. A joint effort between the Government and Industry is underway in Brazil to create a public policy to encourage the use of SAF. This will be the main mechanism for meeting the 2050 carbon neutrality target of Brazil's Nationally Determined Contribution, which encompasses domestic aviation.

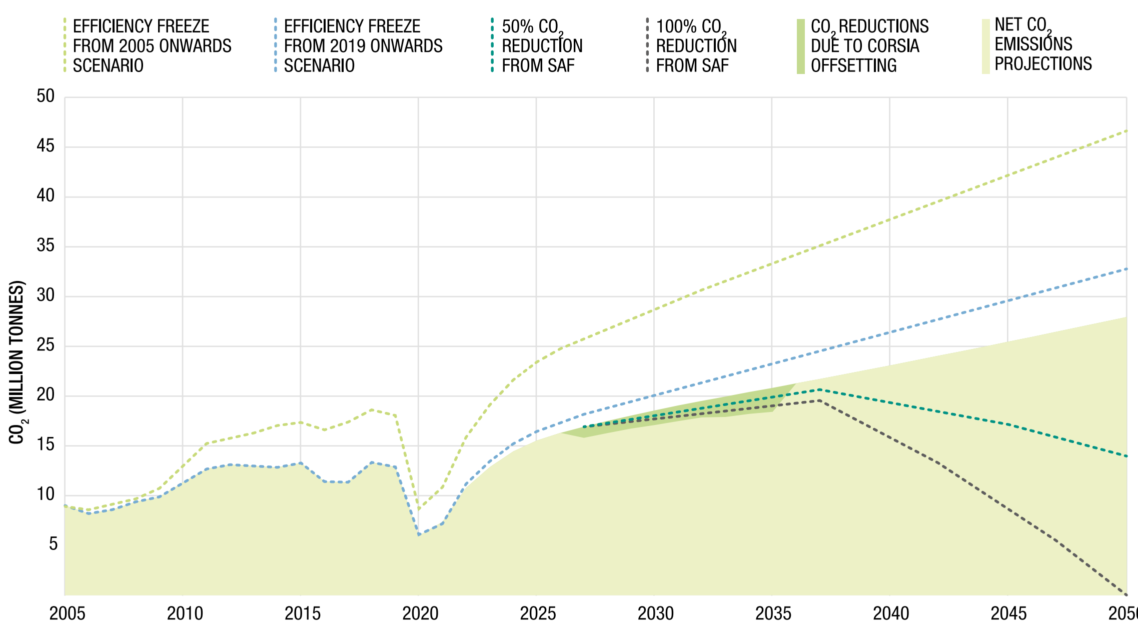
9 According to the Report on the Feasibility of a Long-Term Aspirational Goal (LTAG) for CO_2 Emission Reductions from International Civil Aviation, produced by CAEP/ICAO. Available in: https://www.icao.int/environmental-protection/LTAG/Pages/LTAGreport.aspx

Emissions

Once the fuel consumption projections have been calculated, the projection of carbon dioxide emissions is obtained through the relation 1 kg QAv (aviation kerosene) = 3.16 kg CO_2. Graph 05 shows the estimates of CO_2 emission reductions for the period 2020 to 2050 considering the evolution of fuel efficiency from 2019 levels and the offsets from CORSIA. Also shown for contextualization are the consumption line considering the 2005 efficiency and the projection of emissions due to the use of SAF, which is divided into two scenarios: 50% reduction in emissions in 2050 and 100% reduction. Although the emissions avoided using SAF are not quantified in these two scenarios, it is possible to verify the effect of the introduction of fuels with the respective life cycle reductions on the sector's total emissions in graph 05.

An accumulated reduction in CO_2 emissions of 90Mt is projected in the period from 2020 to 2050, considering the efficiency gain since 2019. If we compare the scenario with the efficiency as of 2005, between 2006 and 2050, the avoided emissions are 428Mt. Specifically in 2050, the reductions would be 17.2% compared to the 2019 efficiency scenario, which represents an absolute reduction of 4.8Mt.

GRAPH 05. PROJECTIONS OF EFFICIENCY SCENARIOS



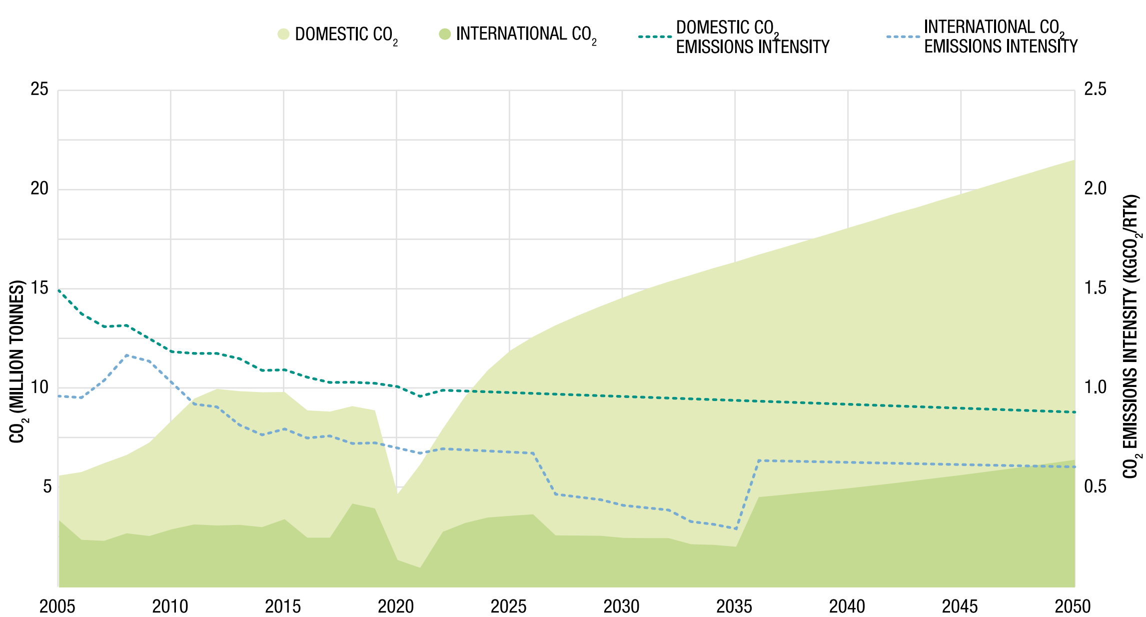
Emissions Intensity

Another relevant concept is the Emissions Intensity (IE), which represents the net emissions of carbon dioxide per RTK. The comparison between the evolution of CO_2 emissions and the Emission Intensity is made in Graph 06, for domestic and international flights.

The graph shows an intense drop in magnitudes between 2027 and 2035 for international flights, because of the offset emissions in CORSIA. Again, the reductions expected to occur by the use of SAF in these projections are not considered, as they were not quantified.

Graph 06 shows the trend of reduction in Emissions Intensity over time, even though total emissions increase.

GRAPH 06. EMISSIONS INTENSITY PER YEAR



Responsive Regulation

As an alternative to the regulatory model based essentially on punishment, known as command and control, the National Civil Aviation Agency (ANAC) launched the Responsive Regulation Project.

The Agency began, therefore, to seek action focused on prevention and regulatory compliance, based on incentives, using command and control tools only when strictly necessary.

Thus, it is expected that the regulation of civil aviation will become more effective, with positive results for the regulated environment and for society. For this, it is equally essential to strengthen relations with the regulated, based, above all, on dialogue and transparency.

With the initiative, the Agency also encourages the adoption of less prescriptive interventions for minor risks, for example, the use of seals, awards and consensual solutions.

That is the case of such programs as Sustainable Airports ("Aeroportos Sustentáveis") and SustentAr, described below.

Sustainable Airports

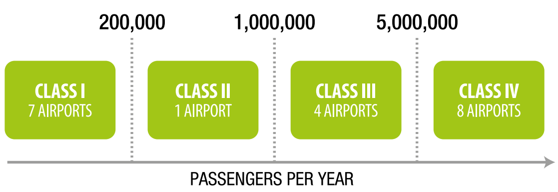
Created in 2019, the Sustainable Airports program ("Programa Aeroportos Sustentáveis") aims to analyze and monitor the environmental performance of airports, in order to reflect and encourage good practices adopted to reduce the impact of Brazilian airport operations on the environment.

Airports participate voluntarily and are evaluated as to whether their practices adhere to criteria established by the program. The criteria are based on other similar programs carried out in Brazil and around the world and aim to reflect the best initiatives for airport sustainability.

The program aligns with the Sustainability Guidelines of MInfra, implemented by Ordinance Nº 05 of January 31, 2020, and is also included in its Sustainability Agenda, approved by Ordinance Nº 04 of January 31, 2020.

The results of the program are still included in the Environmental Performance Index – IDA of the Ministry of Infrastructure – MINFRA. This index aims to verify the qualitative evolution and the socio-environmental commitment of the infrastructure of the transport sector in Brazil. It should be noted that Sustainable Airports program was, to a certain extent, inspired by INFRAERO's Environmental Performance Indicator (IDMAI), which aims to continuously improve the company's environmental aspects, as well as by ANTAQ's IDA.

In March 2022, ANAC released the results of the third edition of the initiative. The base year 2021 edition ranked 20 Brazilian airports, from 8 different operators, divided into 4 classes based on the annual number of passengers processed, according to the Brazilian Regulation for Civil Aviation - RBAC 153 (figure below).



A total of 32 criteria were evaluated, each with different weights according to their importance in relation to the other criteria. The determination of these weights was performed according to the AHP (Analytic Hierarchy Process) and in consultation with experts from ANAC and the National Civil Aviation Secretariat – SAC/MINFRA.

The weights of the specific criteria met by each airport are then added up and the participants are classified into two levels regarding the sustainability actions implemented, considering their result in relation to their group and excluding airports with a final score below 25%, as:

- First Class - Airports that obtained a final score equals to or higher than the simple average of their group;
- Business Class - Airports that obtained a final score lower than the simple average of their group.

The airports that scored the best in each class were:

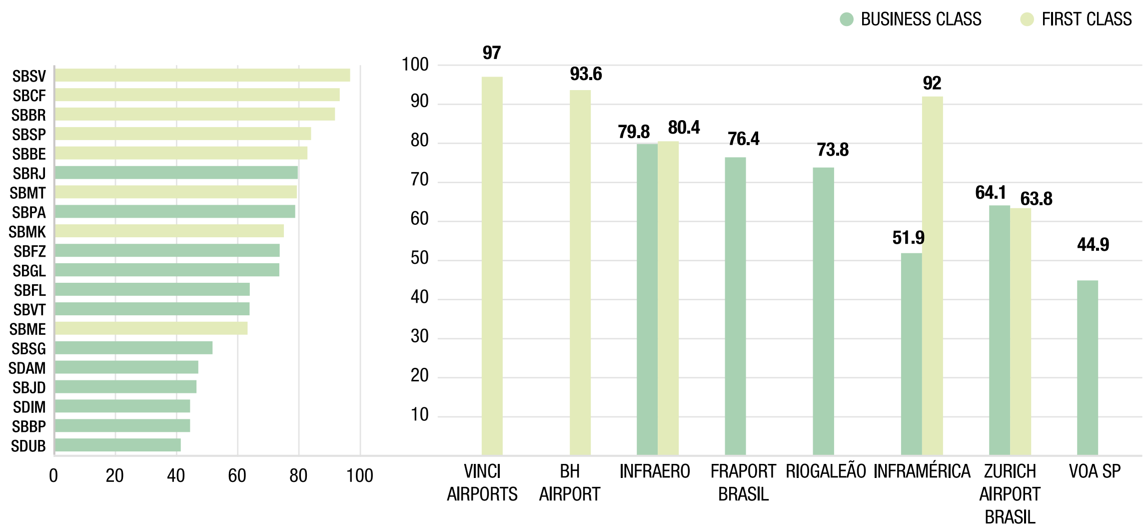
- **Class I:** Campo de Marte Airport (SBMT)
- **Class II:** Montes Claros Airport (SBMK)
- **Class III:** Belém International Airport (SBBE)
- **Class IV:** Salvador International Airport (SBSV)

Graph 07, on the next page, shows the score achieved for each airport, as well as the average score per airport operator. More information on the criteria met by each airport or on the initiatives adopted by them are available on the page dedicated to the environment on the ANAC website[10].

In general, the participating airports demonstrate robustness and pioneering spirit in the management of natural resources, closely monitoring their use and employing innovative initiatives to reduce and reuse inputs. In terms of electricity, airports, in addition to regularly replacing their equipment with more efficient and safer models, are progressively turning to cleaner and renewable sources of energy, either through their own generation or purchase on the Free Electricity Market.

10 Address: https://www.gov.br/anac/pt-br/assuntos/meio-ambiente

GRAPH 07. SCORE BY AIRPORT AND AIRPORT OPERATOR



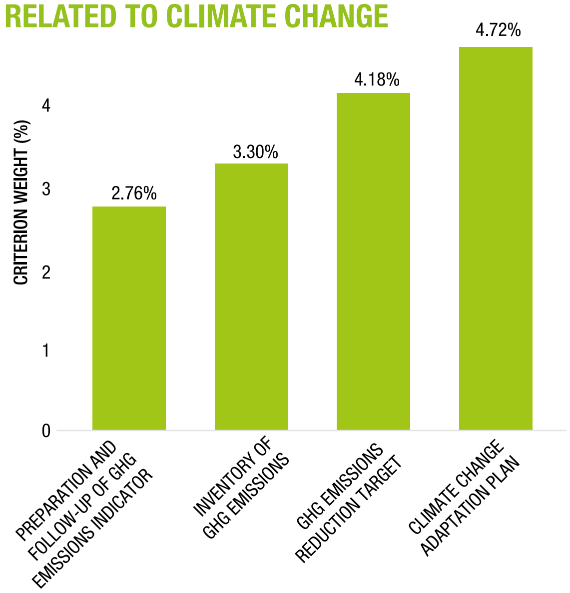
When it comes to water, the growing number of airports that have their own stations for the treatment of their effluents, as well as the increase obtained by them in the use of treated water is remarkable.

Airport operators have also been gradually reducing the generation of waste, acting both to limit the acquisition of products and raw materials through conscientious consumption campaigns and reducing the use of disposable materials, as well as increasing the recycling and reuse of the waste produced. Thus, participants advance not only in the environmental sustainability of their operations but also in the financial sustainability of the business, since sustainable management is largely focused on the efficient allocation of resources, avoiding waste in the short term and acting to mitigate costs resulting from long-term environmental degradation.

Climate Change Criteria – 2021 Edition

One of the program's main criteria concerns practices related to climate change, totaling 15% of the total score in the 2021 edition. In this regard, airports are demanded for inventorying greenhouse gases, monitoring indicators, setting targets for emission reduction and climate change adaptation planning. Each of these criteria has weight according to the chart 08.

GRAPH 08. WEIGHTS OF EACH CRITERIA RELATED TO CLIMATE CHANGE



Evolution

Considering all airports, 65% of the participants comply with the requirements for the preparation and monitoring of indicators and an emission inventory, while 55% of them comply with the criteria for an emission reduction target and adaptation plan. This percentage is significantly higher when considering larger airports, as can be seen in graph 09.

All eight Class IV airports comply with the emission inventory and Adaptation Plan criteria, while 88% comply with the elaboration and monitoring of indicators and 75% with the emission reduction target.

It should be noted that the only airport registered in Class II, Montes Claros – MG, complied with all the climate change criteria.

It is also interesting to observe the evolution of the airports throughout of the implementation of the program. The criterion that draws the most attention, without a doubt, is the climate change adaptation plan, which went from 4% of participants complying with the criteria in 2019 to 55% in 2021. There was also an evolution in the emission reduction target item, in which 26% of the participating airports were compliant in 2019 and 65% started to comply in 2021. The other two criteria remained in the same compliance range, with little variation in 2020, as shown in graph 10 in the next page.

When analyzing the chart of the evolution of the criteria, it is necessary to keep in mind that the number of participants changes from one year to the next, in addition to

GRAPH 09. PERCENTAGE OF PARTICIPANTS THAT MEET EACH CLIMATE CHANGE CRITERIA BY CATEGORY

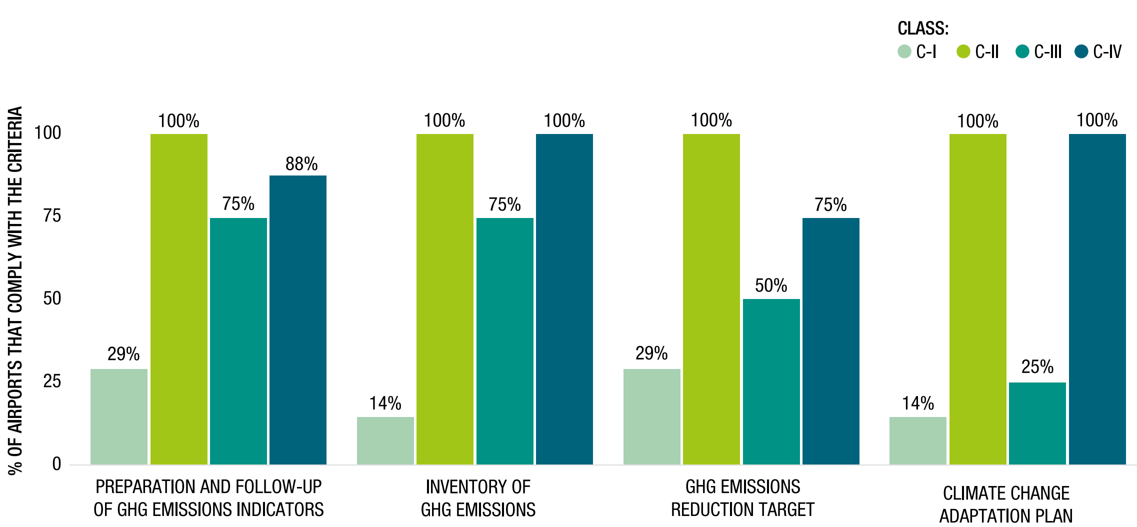
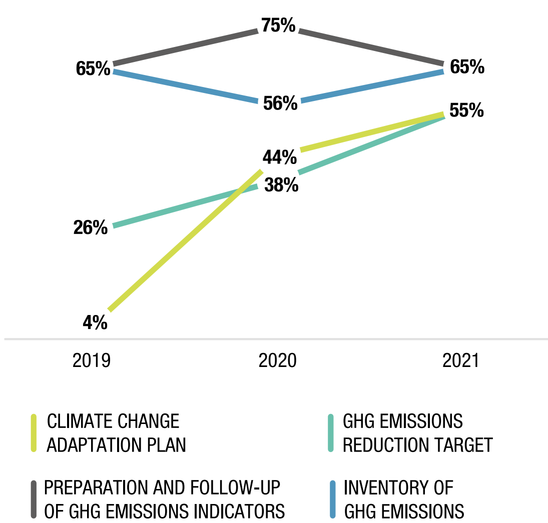


CHART 10. EVOLUTION OF CRITERIA RELATING TO CLIMATE CHANGE



the fact that the minimum requirements to fulfill each criterion may also change.

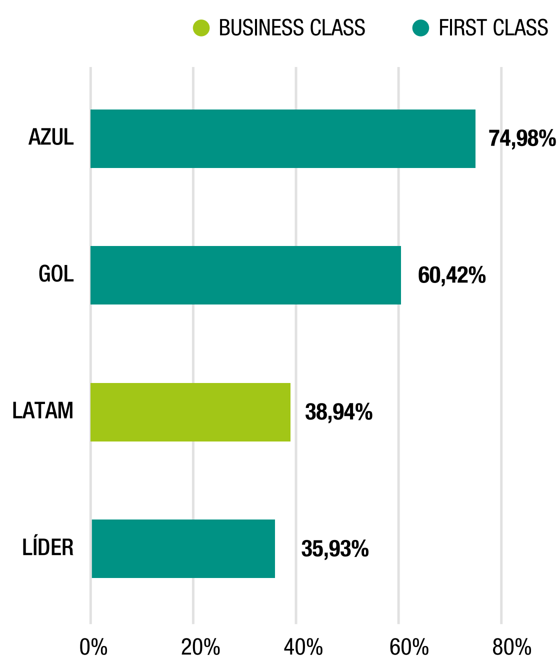
However, it can still be said that in a short space of time, there was a significant evolution of the actions taken by airports in the face of climate change, as can be seen in graph 10.

SustentAr

As an unfolding of the Sustainable Airports program, in 2021 the SustentAr program was created. The same principles of voluntary participation, non-regulatory incentives and the promotion and recognition of good environmental practices were also applied to Brazilian air operators.

The first edition of SustentAr, still in the pilot phase, had the participation of four Brazilian airlines. The companies were divided into two different categories: operators that have an operative specification in accordance with RBAC n.121 and operators that have an operative specification in accordance with RBAC n.135, but do not have a specification to operate in accordance with RBAC n. 121.

GRAPH 11. CLASSIFICATION OF PARTICIPANTS



The score achieved by each operator is shown in the chart 11. In the class of RBAC n. 121 operators, Azul obtained the best result, reaching 74.98% of compliance with the criteria. In the class of RBAC n. 135 operators, Líder air taxi was the only participant and reached 35.93% of the total score.

Climate changes

Given the relevance of the topic, the SustentAr program has several criteria related to climate change. Within the Global Criteria for Operational Efficiency, there are measures adopted to reduce fuel consumption, and consequently greenhouse gas emissions:

- Aircraft performance improvement
- Fuselage conservation
- Average fleet age
- APU usage reduction
- Aircraft performance improvement plan
- Fleet renewal plan
- Optimized operating procedures
- Aircraft weight reduction

Under the Atmospheric Emissions criteria, we have the following criteria related to greenhouse gas emissions (those that contribute to climate change):

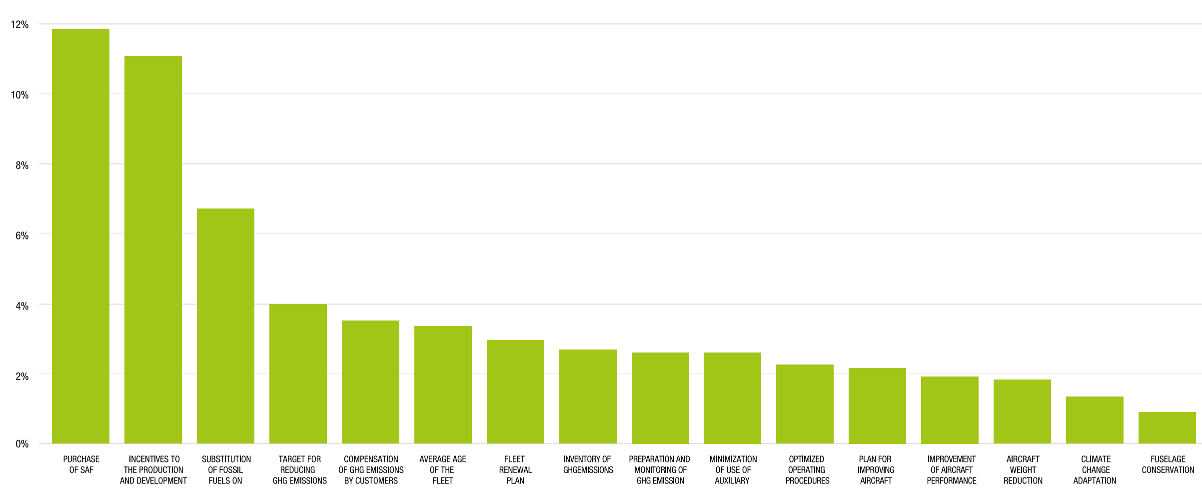
- Compensation of greenhouse gas emissions by customers
- Preparation and monitoring of greenhouse gas emission indicators
- Inventory of greenhouse gas emissions
- GHG emissions reduction goal
- Climate change adaptation plan

Finally, there is also the Energy Transition criteria:

- Purchase of sustainable aviation fuels
- Sustainable aviation fuels development and production support
- Replacement of fossil fuels in the land vehicles

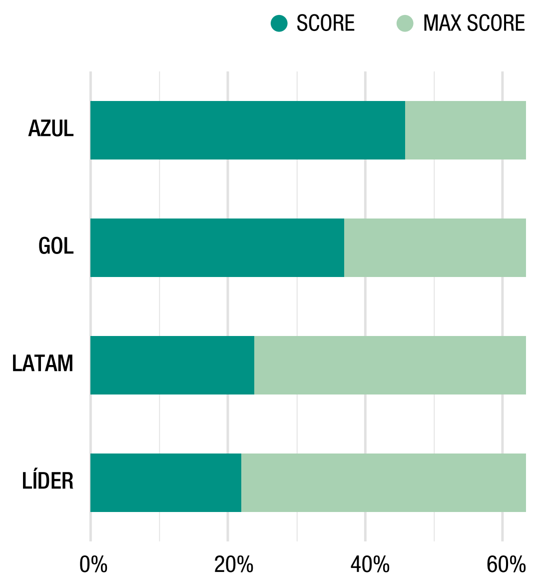
The weight of each criteria can be seen in graph 12. As seen, the highest weights are related to the Energetic Transition. This is largely due to the great current concern with the viability of the sustainable aviation fuels (SAF) market.

GRAPH 12. WEIGHT OF THE CLIMATE CHANGE RELATED CRITERIA



Considering only the criteria related to climate change, the score achieved by each operator can be seen in graph 13. The result, when restricted to these criteria, is quite similar to the global result, evidencing the great weight attributed to climate change in the program.

GRAPH 13. OPERATORS SCORE IN THE CLIMATE CHANGE RELATED CRITERIA



It is worth noting that all companies in the category certified to operate in accordance with RBAC n.121 have an ambitious long-term goal to reduce net CO_2 emissions to zero. All related targets are publicly available11 on the companies' websites.

TABLE 03. EMISSIONS REDUCTION GOAL BY AIR OPERATOR

OPERATOR	GOAL
AZUL	ZERO NET CARBON EMISSIONS BY 2045
GOL	ZERO NET CARBON EMISSIONS BY 2050
LATAM	OFFSET 50% OF DOMESTIC FLIGHT EMISSIONS BY 2030, SETTING A PATH TO BE CARBON NEUTRAL BY 2050

11 Azul:https://www.voeazul.com.br/documentos-sustentabilidade.
Gol: https://www.voegol.com.br/sobre-a-gol/sustainability .
Latam: https://www.latamairlines.com/br/pt/sustainability/mutanca-climatica

Alternative Fuels

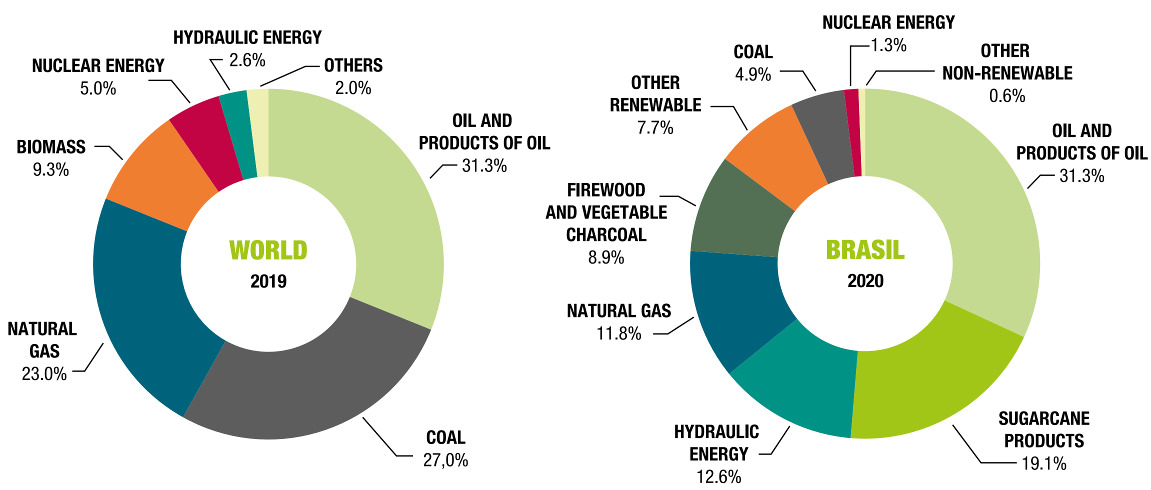
Biofuels in Brazil

The Brazilian energy matrix is renowned worldwide for its high degree of renewability. In 2020, 48.3% of the energy supply was generated from renewable sources such as biomass, hydraulic resources and wind and solar energy, a percentage much higher than that observed in the world energy matrix in 2019, of approximately 14% 12.

The performance indicators of the national energy matrix place Brazil among the countries that emit the least GHGs in energy production and consumption. In 2018, emissions associated with domestic energy supply totaled 1.42 tCO_2-eq/ toe, equivalent to 72% of that emitted by the European Union, 64% by the United States and 47% by China in the same period.

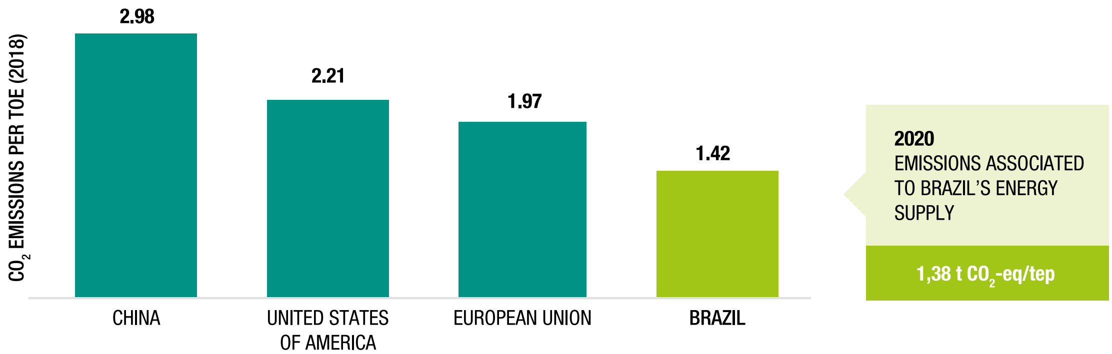
12 EPE (2021), Energy and Electric Matrix, https://www.epe.gov.br/pt/abcdenergia/matriz-energetica-e-eletrica

GRAPH 14: BRAZILIAN ENERGY MATRIX 2020 AND WORLD ENERGY MATRIX 2019



SOURCE: IEA, 2021; EPE, 2021, HTTPS://WWW.EPE.GOV.BR/PT/ABCDENERGIA/MATRIZ-ENERGETICA-E-ELETRICA

GRAPH 15: EMISSIONS PER UNIT OF INTERNAL ENERGY SUPPLY



BRAZIL'S EMISSIONS EQUAL 72% OF EUROPEAN UNION'S; 64% OF UNITES STATES OF AMERICA'S; AND 47% OF CHINA'S FOR EACH TONNE OF OIL EQUIVALENT (TOE).

SOURCE: EPE (2021), BEN 2021 SYNTHESIS REPORT

Biofuels play a prominent role in Brazilian energy policy, contributing significantly to the achievement of national strategic objectives of security of fuel supply and mitigation of greenhouse gas (GHG) emissions.

In 2020, the transport sector was responsible for 32.7% of the country's energy consumption. During this period, anthropogenic CO_2 emissions associated with the Brazilian transport energy matrix reached 179.8 Mt CO_2-eq, equivalent to 45% of the total recorded for the period[13].

Brazil is currently the second largest producer of biofuels in the world[14]. The share of ethanol and biodiesel in the national transport matrix increased from 16.7% in 2011 to 24.5% in 2020, the year in which biofuels accounted for around 19.5 Mto[15] of consumption in the sector.

Emissions avoided[16] using ethanol (anhydrous and hydrated) and biodiesel in 2020, when compared to fossil equivalents (gasoline and diesel), totaled 67.2 $MtCO_2$. In addition to liquid biofuels, sugarcane bioelectricity also contributed to the reduction of CO_2 emissions. Considering the energy exported and the self-consumption by the

13 EPE (2021), BEN 2021 Synthesis Report, https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-601/topico-588/BEN_S%C3%ADntese_2021_PT. pdf

14 EPE (2021), Conjuncture Analysis of Biofuels - Year 2020, https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-615/NT-EPE-DPG-SDB-2021-03_Analise_de_Conjuntura_dos_Biocombustiveis_ano_2020.pdf

15 EPE (2021), – National Energy Balance – BEN 2021, base year 2020, https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-601/topico-596 / BEN2021.pdf

16 To estimate avoided emissions, the emission rate of tCO_2 per MWh generated was used, calculated by the Ministry of Science, Technology and Innovation (MCTI, 2021)

sugar-energy units, the emissions avoided by bioelectricity add up to 2.4 $MtCO_2$[17].

The high renewability of the Brazilian energy matrix can be attributed not only to the very favorable soil and climate conditions and the extensive land availability in the country, but also to important governmental stimuli[18].

Among the most relevant public policies for the transport sector are the establishment of mandatory blends of anhydrous ethanol with gasoline and biodiesel with diesel oil, the insertion of vehicles with flex -fuel technology fuel and, more recently, the implementation of RenovaBio and the Combustível do Futuro Program. The country also has tax differentiation policies and specific financing lines administered by the Brazilian Development Bank (BNDES)[19].

In view of the Brazilian potential electricity production and fuels from renewable sources, the significant share of renewable resources in the energy matrix tends to remain the sector's main strategy for mitigating GHG emissions. For the transportation segment, the medium and long-term national energy planning foresees the introduction of new biofuels and an increase in the sector's systemic efficiency.

Sustainable Fuels for Aviation

Global concern about climate change, as well as high prices and uncertainties about oil supply, has led to a growing demand for the development of new renewable energy technologies and for the adoption of more efficient energy conversion processes.

Despite the significant efficiency gains achieved through operational, technological and infrastructure improvements, trend analysis shows that CO_2 emissions are expected to increase in the coming decades, as a result of the continuous growth in air traffic.In March 2022, the Long Term Aspirational Goal (LTAG) Feasibility Report was published, being produced by the CAEP as a follow-up to the 2019 ICAO A40 Assembly[20]. The report describes three emission reduction scenarios considering different levels of ambition and maturity and technological accessibility in three major reduction fronts: technologies to be applied in new aircraft, operational improvement measures and fuels. The result is represented in graph 16, which shows the impor-

17 EPE (2021), Conjuncture Analysis of Biofuels - Year 2020 JULY 2021, https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-615/NT-EPE -DPG--SDB-2021-03_Analise_de_Conjuntura_dos_Biocombustiveis_ano_2020.pdf

18 EPE (2020), Renewable fuels for use in Diesel cycle engines, https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-467/NT_Combustiveis_renovaveis_em_%20motores_ciclo_Diesel.pdf

19 EPE (2022), The Ten Year Energy Expansion Plan - 2031, https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-607/topico-609/Relatorio_PDE2031_ConsultaPublica.pdf

20 The complete report, as well as its annexes, can be accessed via the following link: https://www.icao.int/environmental-protection/LTAG/Pages/LTAGreport.aspx

tance of using sustainable fuels as a tool to achieve emission reductions in all scenarios. In the IS3 scenario, for example, it is estimated that 55% of emissions in 2050 could be reduced by the use of alternative fuels, eliminating the use of fossil kerosene by 2040.

In this context, the use of sustainable fuel with a reduced carbon footprint when compared to fossil-based QAv has been pointed out as an important alternative for achieving the goal of reducing carbon emissions assumed by the aviation industry.

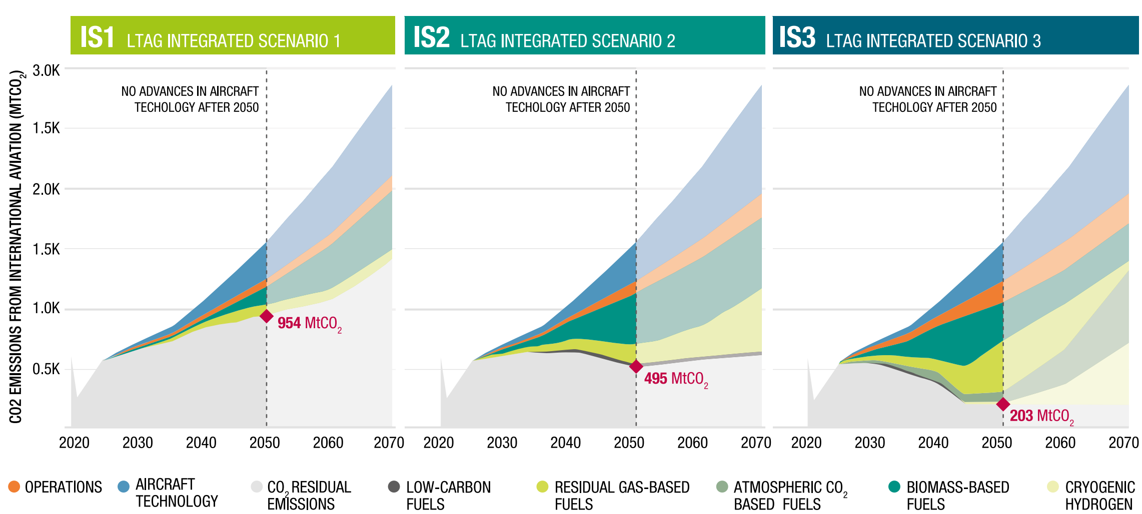
Nevertheless, fuel expenditure represents the most relevant factor for an airline's operating cost. Thus, there are industrial and economic challenges to be overcome so that biofuels can be competitive in relation to fossil fuels.

In Brazil, the first test with biokerosene was carried out in 2010, on a TAM flight, today Latam. The airlines Azul and Gol also conducted experiments with sustainable fuels. During the 2014 World Cup, Gol performed more than 300 flights with a blend of 4% biofuel, which avoided the emission of 239,136.32 kg of CO_2.

There are prospects that the national production of sustainable aviation fuel will begin in 2027, reaching, in 2031, a volume of 130 thousand cubic meters21, equivalent to about 1.4% of the total demand for aviation fuel in the period. Brazil has a wide range of raw materials to produce jet fuel, such as babassu, sugar cane, macaúba,

21 The premise adopted was the introduction of a production unit of this biofuel, associated with the production of HVO, bionaphtha and LPG, of about 400 thousand m3 per year, world average, at a production rate of 35% for BioQAV.

GRAPH 16: EMISSION REDUCTION SCENARIOS - LTAG REPORT



SOURCE: ICAO, LONG TERM ASPIRATIONAL GOAL (LTAG) FEASIBILITY REPORT, 2022.

palm, soy and forest resources (eucalyptus)[22].

Considering the characteristics of the national aviation fuel market, as well as the continental dimension of the country and its favorable climatic and territorial conditions, the use of biofuels can represent an important alternative to the importation of fossil energy sources to supply the growing demand projected for the sector.

Public Policy Development Process for SAF in Brazil

Contextualization

The Brazilian National Council for Energy Policy (CNPE) instituted, on April 20, 2021, the "Programa Combustível do Futuro" (Fuel for the Future), creating the Technical Committee Fuel for the Future (CT-CF) in order to manage the Program. The Program aims to propose measures to increase the use of sustainable and low-carbon fuels, as well as national vehicle technology, to decarbonize the national transport energy matrix, including the Brazilian aviation sector.

Due to the relevance of the "Programa Combustível do Futuro", it was incorporated into the national strategy for climate neutrality, launched by Brazil at the 26th United Nations Conference on Climate Change (COP-26), as an important step in reducing emissions of the transport sector.

The "Programa Combustível do Futuro" operates using its strategic guidelines 23, ruling by the following principles:

- Protection of consumer interests in terms of price, quality and offer of products;
- Guarantee of fuel supply throughout the national territory;
- Protection of the environment and promotion of energy conservation;
- Use of alternative energy sources, through the economic use of available inputs and applicable technologies;
- Strengthening of national technological development;
- Pursuing economic efficiency and promoting competition; and
- Brazil's leadership on the "Energy Transition" theme at the United Nations High-Level Dialogue on Energy.

Regarding Sustainable Aviation Fuels (SAF), the "Programa Combustível do Futuro" has two objectives: introducing the fuel into the Brazilian energy matrix and

22 EPE (2022), The Ten Year Energy Expansion Plan - 2031, https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-607/topico-609/Relatorio_PDE2031_ConsultaPublica.pdf

23 Article 2 of the CNPE Resolution Resolution No. 7/2021 establishes the strategic guidelines of the "Programa Combustível do Futuro" in light of national sustainable development:
I - Integration of public policies related to the Program;
II - Promoting the reduction of the average carbon intensity of the fuel matrix, the reduction of emissions in all modes of transport and the increase in energy efficiency;
III - assessment of energy-environmental efficiency through complete life cycle analysis (from well to wheel) in the various modes of transport; and
IV - Encouraging technological development and innovation.

creating incentives for resources to be applied to projects focusing on the topics covered in the "Programa Combustível do Futuro". To achieve these objectives, the ProBioQAv Subcommittee was created, which will be detailed as following.

ProBioQAv Subcommittee

The process of structuring and conducting the ProBioQAv Subcommittee began in July 2021. After the creation of the subcommittee, the phase of identifying and prioritizing public policy problems began.

Among the 12 problems listed, the following were prioritized: (1) Absence of a legal framework and public policy guideline and (2) Low integration and thematic gap in the availability of studies on the economic and technological feasibility to the production of SAF in the country. Therefore, each problem had its action plan drawn up.

The general work strategy of the ProBioQAv subcommittee, consisted of delivering as final products a Bill and the due infra-legal referrals for the regulation of the legal framework.

The strategy was based on the construction of public policy with broad social participation[24], mobilizing a group of stakeholders in a series of working meetings with

24 Available at : https://www.gov.br/mme/pt-br/assuntos/secretarias/petroleo-gas-natural-e-biocombustiveis/combustivel-do-futuro/subcomites-1/probioqav/atas-das-reunioes .

FIGURE 02: MEETINGS WITH STAKEHOLDERS

16/09	23/09	30/09	07/10	15/10
2	1	3	3	4
• MINISTRY OF MINES AND ENERGY • GIZ • PROQR	• GOL • ALTA • JUCARB • IATA • ABEAR	• AZUL • RBQAV • UFRN • UFG • ABAG	• BOEING • LATAM • UFMG	• APROBIO • PETROBRAS • EMBRAER • BIOKEROSENE AND RENEWABLES PLATFORM OF ZONA DA MATA

21/10	28/10	25/10	01/12	23/12
3	5	3	5	1
• RAÍZEN • ULTRABIO • SAE BRASIL	• BNDES • ECB • BSBIOS • RSB • ICAO • ANP	• CLEAN SKIES FOR TOMORROW • WOLRD ECONOMIC FORUM • ANEAA • MINISTRY OF AGRICULTURE, LIVESTOCK AND SUPPLY	• GIZ • PROQR • S&P GLOBAL PLATTS • IBP • UNIGEL • MINISTRY OF MINES AND ENERGY	• AIRBUS

1 **10 WORK MEETINGS** WITH *STAKEHOLDERS*

2 **OVER 60 PARTICIPANTING** STAKEHOLDERS

3 **OVER 20 PRESENTATIONS BY** STAKEHOLDERS (115 CONTRIBUTIONS)

FIGURE 03: ASSUMPTIONS FOR THE POTENTIAL PUBLIC POLICY OF THE SAF IN BRAZIL.

1 MANDATE

- ESTABLISH A MANDATE TO REDUCE EMISSIONS FROM THE AIRLINE INDUSTRY
- ALLOW ALL TECHNOLOGICAL ROUTES APPROVED BY ASTM AND ANP
- ALLOW DIFFERENT SAF LEVELS IN ANY PART OF THE NATIONAL TERRITORY
- EXEMPT INTERNATIONAL SEGMENTS OF INTERNATIONAL FLIGHTS, RESPECTING THE RECIPROCITY OF INTERNATIONAL AIR TRANSPORT AGREEMENTS
- PROVIDE FLEXIBILITY TO CNPE
- ENABLE AIRPORTS FOR THE USE OF SAF, CONSIDERING AS CRITERIA THE DEVELOPMENT OF SAF PRODUCTION AND LOGISTICS CHAINS, AIRPORT DEMAND AND THE AVAILABILITY OF RAW MATERIAL
- ENABLE THE APPLICATION OF “BOOK & CLAIM” FOR SPECIFIC CASES

2 GOALS OF DECARBONIZATION AND CORSIA

- ASSIGN CBIO PURCHASE TARGETS TO JETFUEL DISTRIBUTORS
- EVALUATE THE POSSIBILITY OF ALIGNING RENOVABIO’S AND CORSIAS’ METHODOLOGIES REGARDING SAF
- ACCOUNT FOR SAF-ONLY EMISSION REDUCTIONS, WHETHER DOMESTIC OR IMPORTED

3 PROJECT FINANCING AND RD&I

- REGULATE ARTICLE 3, I OF LAW N. 14,248/2021 (FEDERAL INCENTIVE)
- STRUCTURE SAF FINANCING LINES THROUGH BNDES
- EXTEND SAF INCENTIVES TO GREEN DIESEL IN ORDER TO DEVELOP BIOREFINERIES
- ESTABLISH GOVERNMENT GUIDELINES FOR PROJECT AND RD&I FUNDING
- ASSESS THE STRUCTURING OF A GUARANTEE FUND WITH THE PARTICIPATION OF THE NATIONAL TREASURY FOR INVESTMENT PROJECTS IN SAF

4 TAXATION

- CREATE TAX CLASSIFICATION FOR SAF (PURE AND BLENDED)
- DEFINE RULES FOR “ICMS” REGARDING SAF (PURE AND *BLENDED*)
- REGULATE ARTICLE 3, II OF LAW N. 14,248/2021 (PIS/COFINS)
- EVALUATE THE FEASIBILITY OF ENCOURAGING THE USE OF RAW MATERIAL FROM FAMILY FARMING

5 QUALITY AND CERTIFICATION

- EVERY SAF MUST COMPLY WITH ASTM AND ANP SPECIFICATIONS
- CREATE SAF QUALITY MONITORING PROGRAM
- CREATE INCENTIVES FOR THE FORMATION OF A NETWORK OF ACCREDITED LABORATORIES
- ESTABLISH A PROCESS OF QUALITY AUDITS AND CERTIFICATIONS

6 GOVERNANCE AND OTHER TOPICS

- INSERT DEFINITION OF SAF IN LAW NO. 9,478/1997
- CREATE SAF EXPORT INCENTIVES
- DEBUREAUCRATIZE AND OPTIMIZE ENVIRONMENTAL LICENSING REQUESTS FOR SAF
- DEFINE CNPE, ANP AND SAC’S RESPONSIBILITIES REGARDING PUBLIC POLICIES ON SAF

expressive support from the institutions, leading to a robust set of contributions to the formulation of public policy[25].

The contributions made by the stakeholders were gathered into themes. The strategy adopted consisted of systematizing these contributions into thematic pillars, for which premises were stated that the future public policy of the SAF in Brazil should meet.

Thus, the 115 contributions became 27 premises, distributed in 6 pillars (as shown in Figure 02): (1) Mandate, (2) Decarbonization and CORSIA Goals, (3) Project Financing and RD&I, (4) Taxation, (5)Quality and Certification and (6)Governance and Other Issues. These assumptions were used to elaborate a draft law text to address the assumptions that need treatment in law.

Brazilian Network of Biokerosene and Sustainable Hydrocarbons for Aviation (RBQAv - aviation kerosene)

The Brazilian Network of Biokerosene and Sustainable Hydrocarbons for Aviation (RBQAv - aviation kerosene) is an initiative coordinated by the Entrepreneurship and Innovation Secretariat of the Ministry of Science, Technology and Innovation (Sempi /MCTI) and the Federal University of Rio Grande Norte, with the objective of providing support to research, technological development and innovation, creating conditions, through public policies, to increase the interaction between different stakeholders, as well as their engagement in actions to support the sector.

Since 2017, when the project started, RBQAv has been promoting the dissemination of the proposal for the use of sustainable aviation fuels and promoting knowledge in the area through congresses, courses and scientific dissemination.

Another contribution of RBQAv is to contribute to the formation of public policies through the participation of ProBioQAv and other actions. The project's goal is to consolidate a management system for articulating the various stakeholders involved in research, development and innovation in biokerosene and renewable hydrocarbons; neutralize growth or offset GHG emissions and reduce the cost of producing sustainable aviation fuels.

It is important to emphasize that research, development and innovation (RD&I) are essential to overcome technological bottlenecks in the search for new sustainable energy sources, thus seeking to reduce dependence on oil derivatives and, consequently, reduce GHG emissions.

25 The set of all contributions brought by stakeholders, whether through presentations - per institution, or for the availability of studies technical that already exist is available at : https://www.gov.br/mme/pt-br/assuntos/secretarias/petroleo-gas-natural-e-biocombustiveis/combustivel-do-futuro/subcomites-1/probioqav/participacao-social .

Public Investments

Cooperation with the Federal University of Juiz de Fora (UFJF)

In May 2022, the National Civil Aviation Secretariat of the Ministry of Infrastructure (SAC/MInfra) signed a cooperation agreement with the Federal University of Juiz de Fora (UFJF) to carry out studies on alternatives for the air sector in the face of national and international commitments to reduce of greenhouse gas (GHG) emissions related to the use of sustainable aviation fuels (SAF) and their implications in order to support the Secretariat in the proposition and evaluation of policies and guidelines for economic regulation of air services, airport infrastructure and civil aeronautics, to stimulate development, competition, environmental sustainability and the adequate provision of services.

The partnership lasts 24 months, with a total investment of BRL 1,244,414.00.

In addition to mapping the current scenario related to SAF, in Brazil and abroad, and the study of technical, economic, commercial and environmental and social impacts (EVTECIAS) of the development of this industry, the project set a case study to identify the airport infrastructure adjustments needed to deliver SAF in a commercial scale and demonstrate the implications for airports.

Another point worth mentioning is the survey of obstacles and identification of the needs for legal adjustments to the implementation of the "book & claim" mechanism in Brazil. It is understood that this possibility can contribute to the viability of the first sustainable fuel production plants in the country.

Investment in the laboratory of the Brazilian National Agency of Petroleum, Natural Gas and Biofuels(ANP)

In Brazil, the Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (ANP) is responsible for setting technical specifications for aviation fuels as well as for the supervision of the segment's activities, which includes the control of the quality of the fuel along the supply chain.

Located in Brasília/DF, the Center for Research and Technological Analysis - CPT is the ANP's laboratory and its main duties are: i) to carry out physical-chemical tests on samples of fuels and lubricants, to meet the demands of the ANP, including inspection and ii) to develop studies and research in oil quality, derivatives and biofuels.

The Center has modern analytical infrastructure for complete certification of gasoline, ethanol, diesel oil, biodiesel (B-100), lubricating oils and petroleum, and is accredited according to ISO 17025.

In relation to aviation fuels (QAv and GAv), the laboratory has infrastructure, estimated at around BRL 5 million, for certification of around 60% of the tests required in the alternative aviation kerosene specifications26. The CPT has expertise in the

26 ASTM D7566 and RANP 856/2021, and aviation gasoline, ASTM D910 and RANP 5/2009

subject, since it is frequently requested by institutions such as the Aeronautical Accidents Investigation and Prevention Center (CENIPA) and the Federal Police not only to carry out physical-chemical tests, but also to issue technical opinions and recommendations on operational procedures sampling and best practices to ensure the quality of aviation fuels.

The National Secretariat of Civil Aviation of the Ministry of Infrastructure (SAC/MInfra) intends to invest in the CPT, around BRL 11 million, so that the laboratory can carry out all the tests necessary for the certification of aviation fuel quality. SAC believes that the measure is extremely relevant not only for aviation safety, but also for the development of sustainable fuels.

Currently, the CPT/ANP has been working on innovation and, in addition, has expanded its capacity and competence for certification and quality control of sustainable aviation kerosene, including the acquisition of analytical equipment and specific training for human resources. Therefore, these additions to the laboratory's infrastructure will make possible to fully meet the demands of government institutions in the aviation segment.

Regarding innovative initiatives, the CPT will play an active role in the Brazil-Germany cooperation project "Alternative Fuels without Climate Impacts - ProQR", which aims to contribute with a technical solution for the gradual decarbonization of aviation. The decentralized production of aviation fuels was identified as the most promising niche, and the Fischer-Tropsch route was chosen as the most appropriate route to ensure the reliability and quality of products, using renewable hydrogen and some renewable source of carbon dioxide.

In the project, the CPT will be responsible for certifying the fuels to be produced and for suggesting adjustments to the production process to achieve the highest level of quality, possibly beyond the quality of fossil fuel. Such participation was formalized by the signature, on August 24, 2018, of a memorandum of understanding between the ANP and GIZ, creator of the project.

The Subsecretariat of Sustainability - SUST/MInfra and the National Civil Aviation Secretariat - SAC/MInfra have been discussing and promoting the issue with other stakeholders through the Via Viva Socioenvironmental Seminar.

Aeronautical Industry

Embraer

Emission reduction commitments

As part of its commitment to building a sustainable future, Embraer announced ambitious new ESG goals and a path to achieving carbon neutral operations by 2040. Efforts have been intensified towards low carbon aviation while remaining dedicated to innovative solutions.

The objective is to decarbonize direct and indirect operations, focusing primarily on carbon reduction and efficiency.

Commitments:

- Carbon neutrality in operations until 2040 (Scope 1+2)
  - Reduce net carbon emissions by 50% by 2040, considering the base year of 2018;
  - Acquire 100% of electricity from renewable sources by 2030 and an intermediate target of at least 50% renewable energy by 2025;
  - Start using sustainable aviation fuel (SAF) in operations from 2021 and reach at least 25% by 2040;
  - Compensate for any residual emissions that are not reduced through efficiency projects, available alternative energy or new technologies.
- Carbon neutral growth from 2022
  - Commitment to limit carbon emissions to 2021 levels, given the growth of operations.
- Support zero carbon aviation by 2050 (Scope 3)
  - Develop disruptive sustainable products, services and technologies, including electrification, hybrids, biofuels such as SAF, and other innovative alternative energies;
  - Work together with suppliers to make current aircraft compatible with the use of 100% SAF;
  - Actively work with the supply chain to expand the global scale of SAF production;
  - Continuously improve the efficiency of current aircraft until the certification of new technologies.
- Launch zero-emission eVTOL aircraft by 2026

Net-zero 2050 Aviation Commitment

In 2021, jointly with other players in the global air transport industry, Embraer make an agreement to drive aviation towards achieving the long-term climate goal of net zero carbon emissions by 2050, confirming its previously announced commitment. The agreement was signed during the annual meeting of the International Air Transport Association (IATA), held in October 2021 in Boston (USA).

Air Transport Action Group's (ATAG) Waypoint 2050 report shows that, although the goal is challenging, there are possible paths for civil aviation to achieve net zero carbon emissions by 2050 in the world. Embraer supports the industry's initiative and believes that net zero carbon emissions by 2050 can be achieved through the development of disruptive sustainable products, services and technologies, such as electrification, hybrids, biofuels and other innovative alternatives.

Future aircraft concepts

Embraer is developing a new generation of turboprop aircraft designed to fly in the short-haul segment up to 150 seats. The new turboprop, designed to be the most cost-effective solution for short-haul operators, will be 100% compatible with sustainable aviation fuels and will facilitate integration with future hydrogen propulsion technologies. Focused on sustainability, the new turboprop, compared to the current turboprop in operation, has a 15% reduction in CO_2 emissions.

Embraer also announced a family of concept aircraft, the “Energia Family”, comprising four concept aircraft of varying sizes that incorporate different aircraft layouts, energy sources and propulsion technologies – electricity, hydrogen fuel cell, gas turbine dual fuel and hybrid-electric.

This project explores a range of sustainable concepts to transport up to 50 passengers and seeks to reduce carbon emissions by 50% as of 2030 – a key step towards the goal of being carbon neutral by 2050.

Electrification and hydrogen tests

The Electric Demonstrator Aircraft is yet another initiative by Embraer on the journey towards a zero-carbon future. In 2021, the project launched a new phase starting the flight test campaign of the aircraft. Developed specifically to evaluate new technologies and solutions that enable 100% electric and more sustainable aeronautical propulsion, the demonstrator carries out tests at the Embraer unit, in Gavião Peixoto, state of São Paulo.

This technological cooperation project used a WEG electric powertrain system and a set of batteries financed by EDP, which were integrated into the EMB-203 Ipanema, an aircraft that is part of Embraer's history and became, in 2004, the first aircraft in the world certified and scale-produced to fly using a fuel from a renewable source (ethanol).

The results of the Electric Demonstrator Aircraft allow Embraer to use the knowledge acquired to apply innovative electrification technologies in the development of new products in line with the continuous search for a sustainable future. The Electric Demonstrator Aircraft flight took place in 2021, while the hydrogen fuel cell demonstrator is planned for 2025.

eVTOL

EVE Air Mobility, EmbraerX's first spin-off, was officially launched as a new, independent company that is developing a safe, affordable and sustainable ecosystem for air mobility. In the portfolio of solutions to face challenges related to mobility in large urban centers, the development and certification of the company's electric vertical take-off and landing vehicle, the eVTOL, stands out.

The company is designing a unique and affordable urban air mobility experience with a low-noise, zero-emissions vehicle. With eVTOL, commuting within cities will take just a few minutes. EVE ended 2021 with Letters of Intent (LOI) for up to 1,735 eVTOLS and over 30 partners worldwide.

Jets E2 aircraft

In recent years, Embraer has introduced new models of its generation of single-aisle commercial aircraft, the EJets E2, to the market. Considered the most efficient in their class, the E175-E2, E190-E2 and E195E2 models have shaped the regional market by featuring sustainable technology, superior cabin comfort, excellent economy and optimal range. With more advanced technologies, surprising levels of reduction in fuel consumption and greenhouse gas emissions have been achieved, including:

- 25.4% better fuel efficiency per seat*;
- Reduction of up to 10% in fuel consumption compared to competitors;
- Offers 16% lower fuel consumption*;

* COMPARED TO FIRST GENERATION E-JETS.

The E2's outstanding fuel efficiency and superior performance is the result of innovations and high technology that are found throughout the aircraft. Furthermore, Embraer also took on the challenge of reducing aircraft noise and made this a focus in the development of the E-Jets E2. As result, the E190-E2 is considered the quietest aircraft in its class.

Market-based Measures

Carbon Offsetting and Reduction Scheme for International Aviation - CORSIA

In 2016, ICAO member states agreed to create the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), a global market measure to meet the aspirational goal of keeping net carbon emissions from international civil aviation at 2020 levels. It was approved on Resolution A39-3: Consolidated statement of continuing ICAO policies and practices related to environmental protection – Global Market-based Measure (MBM) scheme.

The mechanism determined that, as of 2021, airlines should compensate for CO_2 emissions that exceed a baseline formed by the average of emissions in the years 2019 and 2020. To this end, companies must monitor, report and verify its emissions, sending a report annually to ANAC. Flights with aircraft weighing 5,700kg or less, humanitarian, medical or firefighting flights and operators emitting less than 10,000 tonnes of CO_2 per year have no obligations under CORSIA. Countries with international activity whose volume in the year 2018 is above 0.5% of the total international RTK, or in the accumulated up to 90% in descending order of RTK, have mandatory entry into the scheme from 2027. Before that, participation is voluntary, and, in the event of non-participation by a given State, the routes that involve it are exempt from compensation.

Brazil opted not to enter the scheme voluntarily and will start offsetting from 2027 on. Nevertheless, CORSIA's obligations related to monitoring, reporting and verification (MRV) of emissions are already in place. Brazil has internalized these rules into the domestic regulatory framework through ANAC Resolution No. 496/2018 and Ordinance No. 4005/ASINT/2018. Furthermore, the regulation of CORSIA's offsetting obligations is included in[27] ANAC's Regulatory Agenda 2021-2022, scheduled for completion in December 2022. In the section referring to FORECAST OF GROWTH AND REDUCTION OF EMISSIONS, an estimate of the amount of CO_2 to be compensated by Brazilian companies under CORSIA.

27 More information at: https://www.gov.br/anac/pt-br/acesso-a-informacao/participacao-social/agenda-regulatoria/agenda-regulatoria-2021-2022

RenovaBio

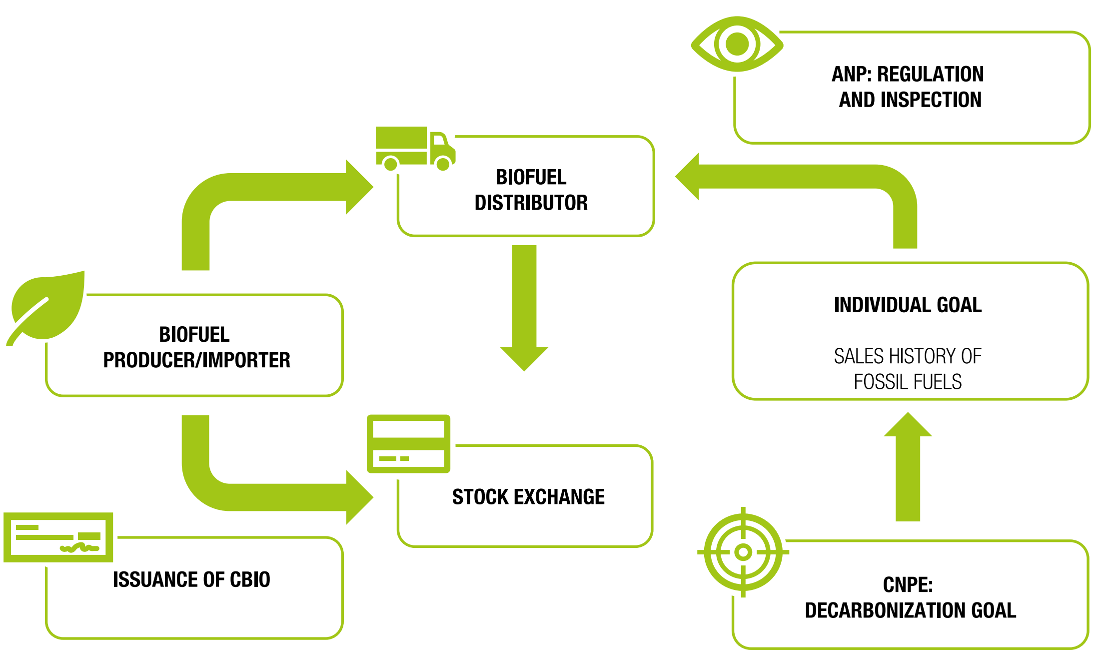
The National Biofuels Policy (RenovaBio Program) was established by Law No.13, 576, of December 26, 2017. Its main objective is to recognize the strategic role of biofuels in the Brazilian energy matrix in relation to energy security and the mitigation of greenhouse gas emissions - GHGs in the fuel sector. The policy seeks to value the positive environmental externalities of biofuels and, thereby, promote the process of decarbonization of the fuel market.

Thus, the Program intends to provide an important contribution to the fulfillment of Brazil's Nationally Determined Commitments under the Paris Agreement; promote the adequate expansion of biofuels in the energy matrix, with emphasis on the regularity of fuel supply; and ensure predictability for the fuel market, inducing energy efficiency gains and reducing GHG emissions in the production, commercialization and use of biofuels.

Unlike traditional measures, RenovaBio does not propose the creation of subsidies, carbon tax, presumed credit or volumetric mandates for adding biofuels to fossil fuels. The program seeks to stimulate the production and use of biofuels through two instruments:

- **Establishment of national emission reduction targets for the fuel matrix**, defined for a period of ten years. National targets will be broken down annually into individual targets for fuel distributors, according to their share of the fossil fuel market. The law establishes fines in cases of non-compliance with targets; and

FIGURE 04: RENOVABIO AND CBIO MARKET DEVELOPMENT PROCESS



PARAMETERS: FUNCTION AND VOLUME, LIFE-CYCLE ASSESSMENT AND REGIONAL FACTOR.

- **Individual certification of biofuel producing units**, assigning grades in a value inversely proportional to the carbon intensity of the biofuel produced. The score accurately reflects the individual contribution of each producing agent to the mitigation of a specific amount of greenhouse gases in relation to its fossil substitute (in terms of tonnes of CO_2 equivalent).

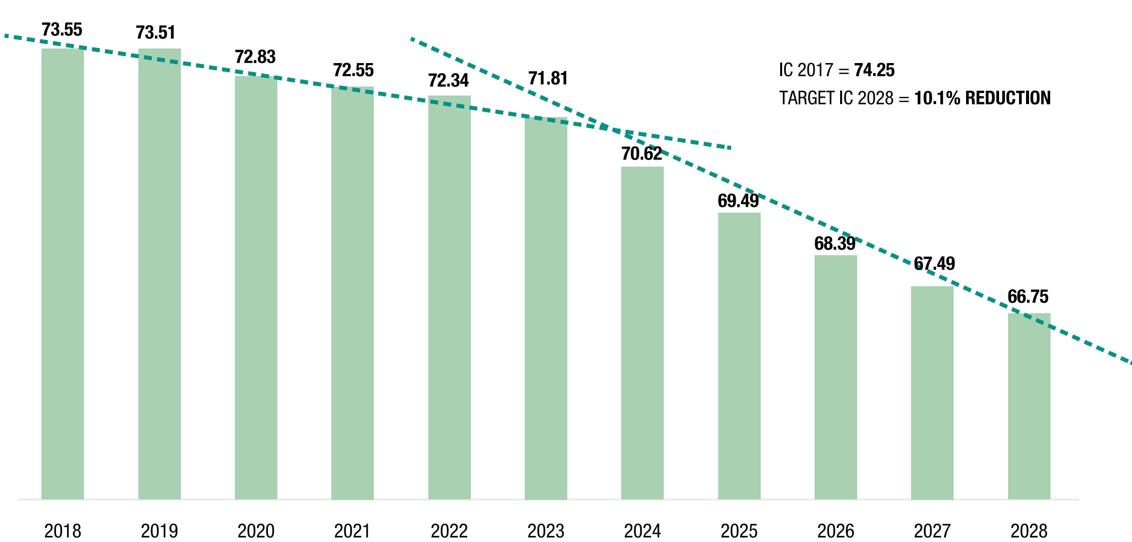
The three eligibility criteria defined are: I. The certified raw material cannot be originated from an area deforested after December 26, 2017, the date of signature of the RenovaBio law; II. Sugarcane producers must have a Rural Environmental Registry (CAR) with an updated or pending status; and III. Cultivation areas must respect palm oil agroecological zoning.

These two instruments will be connected by the creation of the Biofuels Decarbonization Credit (CBIO): a financial asset traded on the stock exchange and issued by the biofuel producer after commercialization (invoice).

The number of CBIOs issued will vary according to the volume of biofuels sold and the Energy-Environmental Efficiency Score of each primary issuer. Thus, the lower the carbon intensity in the biofuels life cycle, the greater the amount of CBIOs emitted for a given volume traded. Fuel distributors will meet the target by demonstrating ownership of the CBIOs in their portfolio. The Figure below illustrates the process of implementing RenovaBio and issuing CBIOs.

RenovaBio establishes a market mechanism that seeks to diversify the supply of fuels in the country, inducing energy and environmental efficiency, given that the certification process values and recogni-

GRAPH 17: AVERAGE CARBON INTENSITY OF THE FUEL MIXTURE (GCO_2E/MJ)



zes the best biofuels in terms of greater amounts of energy. generated with lower levels of GHG emissions. This mechanism should guarantee the necessary security for investments in new plants, since the CBIOs will offer greater revenue for producers.

Therefore, “by creating a market for a fuel decarbonization certificate (CBIO), RenovaBio allows the internalization of the positive environmental externalities of biofuels and, therefore, the remuneration of the sector for this service provided to reduce GHG emissions. It is this additional remuneration that, by expanding the revenue pool and contributing to the apportionment of costs, allows the expansion of the biofuel supply to the social optimum”.

Thus, the program strives for the promotion of free competition in the biofuels market, for adding value to Brazilian biomass and for economic and social development and inclusion.

In line with the nationally determined Brazilian contribution, CNPE Resolution No. 17/2021 established the global target for 2022, as well as the center of the target with tolerance intervals for the period 2023-2031. Thus, the policy predicts that by 2030, the reduction of the average carbon intensity of the fuel matrix by 10% will be promoted. Besides, the emission of more than 620 million tons of GHG will be avoided.

It is noteworthy that in its third full year, the RenovaBio Program has been consolidating itself as the world´s largest decarbonization program for the fuel matrix, having avoided, in 2021 alone, the emission of 24.4 million tons of greenhouse gases. due to the retirement of 24.4 million Decarbonization Credits (CBIOs) by distributors, which met about 98% of the 2021 target.

According to analyzes and simulations, it is estimated that the basket of fuels (total) to the consumer will present an estimated price drop of 0.84%.

Initially, considering the lack of national supply of aviation biofuels on a commercial scale, the market share of aviation kerosene will not be part of the calculation of distributors’ targets. Nevertheless, there are no impediments for producers and importers of aviation biofuels to benefit from the issuance of CBIOs.

It should be noted that the Ministry of Mines and Energy (MME) highlighted the interest that CBIOs can be used within the scope of CORSIA to fulfill the compensation obligations of airlines. To do so, they must meet the criteria established by the ICAO for enabled carbon credit markets.

Finally, it recognizes the importance of RenovaBio also encouraging the development of new technologies for producing sustainable fuels, including for aviation.

CHAPTER 7

Final Considerations

This Action Plan reflects the collaborative action of the members of the Working Group - WG, amended by Ordinance No. 123/2021. In December of the same year, the WG met for a workshop that guided part of the information presented here.

Since 2018, important progress has been made in terms of public action to promote the sector's sustainability, such as the responsive regulation programs launched by ANAC, investments in projects and studies related to environmental issues, the adoption of policies to promote sustainable fuels of aviation, as well as the Brazilian participation in the Aviation Environmental Protection Committee (CAEP) of the ICAO and support for multilateral solutions related to the basket of measures to reduce greenhouse gas emissions from international aviation, including CORSIA.

According to data presented in the inventory, it is clear that air operations continue to evolve in terms of energy efficiency, a direct reflection of the actions implemented by both the airlines and the Department of Airspace Control (DECEA).

In this context, it is observed that the average annual growth of RTK, from 2005 to 2019, was 6.17% in the domestic market and 3.17% in the international market, while the growth in fuel consumption during the same period was of only 3.34% and 1.15%, respectively.

Regarding the projections until 2050, base year 2019, an accumulated growth of the total RTK of 150% is expected and an accumulated energy efficiency gain of 16.6% for international aviation and 13.6% for domestic aviation.

It is important to note that the forecasts regarding the efficiency levels consider the maintenance of the measures currently adopted. However, there are several planned initiatives that tend to promote additional gains.

Airports also contribute in this regard by providing adequate infrastructure capable of meeting air demand. In addition, as described in Chapter 3, many comply with requirements for the preparation and monitoring of indicators and emission inventories, with definition of reduction targets and adaptation plans. Also, at the domestic level, several measures adopted by airport operators promote environmental gains, such as those related to water, waste and electricity management.

The protection of the environment is a growing demand of the whole society and Brazilian civil aviation is attentive to this issue. The commitments made require a combination of actions on different fronts and a joint effort by the entire industry, together with governments, investors and researchers. It is understood that the success in reaching the goals relies mainly on the increase in the production of SAF and the development of innovative technologies such as hydrogen and electric propulsion.

Brazilian civil aviation has a broad potential growth and this Action Plan reflects Brazil's commitment to national efforts to achieve the sector's strategic objectives of sustainable development, with increased accessibility, connectivity and efficiency, while conserving the environment. In this context, Brazil reinforces its voluntary commitments to energy efficiency, carbon neutral growth and to continually improve its Action Plans. Furthermore, the country will make efforts that contribute to the achievement of the ICAO's Vision 2050 for Sustainable Aviation Fuels.

Inventory Data

RTK PER YEAR FOR DOMESTIC AND INTERNATIONAL OPERATIONS

YEAR	INTERNATIONAL	DOMESTIC
2005	3,481,128,785	3,726,829,396
2006	2,448,908,228	4,159,374,316
2007	2,222,965,495	4,638,843,302
2008	2,311,830,384	4,991,664,903
2009	2,247,738,483	5,734,092,720
2010	2,766,575,833	6,969,634,738
2011	3,433,820,988	7,990,608,442
2012	3,421,483,642	8,393,683,290
2013	3,832,240,126	8,443,455,506
2014	3,914,224,364	8,895,516,471
2015	4,251,159,318	8,879,176,440
2016	4,273,185,125	8,368,434,942
2017	4,842,072,014	8,528,653,175
2018	5,742,126,367	8,768,133,887
2019	5,390,301,351	8,614,182,852
2020	1,886,289,630	4,591,790,763
2021	1,392,402,916	6,371,984,891
2022	4,002,177,231	8,045,165,285
2023	4,692,090,278	9,763,159,985
2024	5,130,272,595	11,175,135,591
2025	5,298,872,983	12,277,264,887
2026	5,441,904,962	13,073,593,657
2027	5,581,129,125	13,737,256,047
2028	5,726,006,465	14,337,896,367
2029	5,874,782,578	14,904,744,595
2030	6,031,290,283	15,451,685,999
2031	6,198,414,789	15,962,559,446
2032	6,369,279,473	16,434,070,007
2033	6,548,513,758	16,874,777,441
2034	6,732,778,436	17,318,611,248
2035	6,924,372,330	17,736,888,936
2036	7,118,923,867	18,187,996,357
2037	7,317,742,436	18,619,280,122
2038	7,521,334,567	19,055,138,984
2039	7,730,898,333	19,493,427,939
2040	7,947,649,610	19,941,998,735
2041	8,176,649,530	20,387,691,491
2042	8,413,832,579	20,845,193,822
2043	8,659,095,856	21,270,620,055
2044	8,912,432,370	21,722,966,941
2045	9,173,642,802	22,170,550,309
2046	9,440,908,090	22,619,735,310
2047	9,715,414,124	23,071,552,680
2048	9,997,667,604	23,525,611,959
2049	10,289,099,773	23,976,721,511
2050	10,590,402,485	24,418,401,277

KG OF CO_2 PER YEAR FOR DOMESTIC AND INTERNATIONAL OPERATIONS

YEAR	INTERNATIONAL	DOMESTIC
2005	3,378,103,620	5,619,080,041
2006	2,391,931,626	5,802,341,867
2007	2,336,417,090	6,246,208,309
2008	2,715,993,431	6,663,377,403
2009	2,583,897,541	7,284,381,162
2010	2,916,946,183	8,396,719,702
2011	3,169,399,385	9,498,956,779
2012	3,110,256,450	9,988,391,863
2013	3,146,009,130	9,864,398,981
2014	3,025,449,063	9,812,376,842
2015	3,432,485,448	9,831,694,240
2016	2,493,842,781	8,909,616,208
2017	2,494,378,154	8,841,477,565
2018	4,212,955,317	9,115,369,392
2019	3,964,515,255	8,905,104,904
2020	1,374,099,074	4,692,532,993
2021	982,577,617	6,182,821,316
2022	2,790,671,791	7,981,972,506
2023	3,242,389,093	9,612,188,051
2024	3,515,665,661	10,924,111,494
2025	3,602,972,648	11,921,923,054
2026	3,673,235,248	12,616,329,898
2027	2,617,129,865	13,179,253,097

YEAR	INTERNATIONAL	DOMESTIC
2028	2,604,617,092	13,679,486,146
2029	2,589,438,959	14,145,807,313
2030	2,488,057,101	14,591,845,073
2031	2,478,343,206	15,002,692,680
2032	2,478,980,364	15,375,735,252
2033	2,167,934,205	15,719,416,311
2034	2,134,454,417	16,065,543,646
2035	2,037,729,339	16,387,547,571
2036	4,543,769,520	16,739,411,767
2037	4,650,035,163	17,072,488,460
2038	4,758,999,970	17,409,252,908
2039	4,871,385,167	17,747,692,567
2040	4,987,913,987	18,094,898,606
2041	5,111,704,861	18,438,870,200
2042	5,240,147,755	18,792,871,444
2043	5,373,133,864	19,117,359,534
2044	5,510,617,547	19,465,462,076
2045	5,652,437,317	19,808,655,661
2046	5,797,441,028	20,152,651,045
2047	5,946,332,480	20,498,355,425
2048	6,099,392,988	20,845,408,092
2049	6,257,463,738	21,189,210,465
2050	6,420,928,434	21,524,076,594

CO_2 PER YEAR FOR: EFFICIENCY FROZEN IN 2005; FROZEN EFFICIENCY IN 2019; AND RESULTING AFTER CORSIA OFFSETS

YEAR	lb_2005	lb_2019	co2_corsia
2005	8,910,592,506	8,997,183,661	8,997,183,661
2006	8,563,820,213	8,194,273,493	8,194,273,493
2007	9,062,335,448	8,582,625,399	8,582,625,399
2008	9,674,477,651	9,379,370,834	9,379,370,834
2009	10,721,162,543	9,868,278,703	9,868,278,703
2010	13,064,465,232	11,313,665,886	11,313,665,886
2011	15,230,151,060	12,668,356,164	12,668,356,164
2012	15,820,005,963	13,098,648,313	13,072,706,580
2013	16,289,250,354	13,010,408,112	12,782,636,673
2014	17,042,923,077	12,837,825,905	12,910,132,398
2015	17,342,494,317	13,264,179,688	12,893,133,257
2016	16,601,228,209	11,403,458,989	12,094,867,396
2017	17,387,391,216	11,335,855,719	12,499,775,389
2018	18,610,297,131	13,328,324,710	13,237,054,454
2019	18,042,195,524	12,869,620,159	12,677,343,606
2020	8,668,379,768	6,066,632,067	5,974,236,799
2021	10,851,011,703	7,165,398,933	7,355,488,199
2022	15,858,070,648	11,166,765,141	10,772,644,298
2023	19,086,077,051	13,431,575,108	12,854,577,144
2024	21,615,212,890	15,199,277,153	14,439,777,156
2025	23,422,600,848	16,452,962,820	15,524,895,702
2026	24,748,900,248	17,374,221,163	16,289,565,146
2027	25,873,491,693	18,156,558,617	15,796,382,962

YEAR	lb_2005	lb_2019	co2_corsia
2028	26,909,438,215	18,878,328,953	16,284,103,238
2029	27,898,687,985	19,568,254,393	16,735,246,272
2030	28,865,654,443	20,243,372,094	17,079,902,174
2031	29,788,986,098	20,889,194,323	17,481,035,886
2032	30,657,152,329	21,497,339,172	17,854,715,616
2033	31,487,382,500	22,079,957,629	17,887,350,517
2034	32,327,116,514	22,669,442,503	18,199,998,063
2035	33,135,746,960	23,238,029,323	18,425,276,910
2036	33,996,229,998	23,842,459,111	21,283,181,287
2037	34,831,222,694	24,429,647,222	21,722,523,623
2038	35,677,634,970	25,025,001,779	22,168,252,878
2039	36,533,416,675	25,627,192,613	22,619,077,733
2040	37,411,458,109	26,245,161,902	23,082,812,592
2041	38,296,980,258	26,869,084,262	23,550,575,060
2042	39,208,000,054	27,511,076,926	24,033,019,200
2043	40,078,905,242	28,126,026,359	24,490,493,397
2044	40,997,760,500	28,774,474,285	24,976,079,622
2045	41,917,075,490	29,423,759,141	25,461,092,978
2046	42,844,603,185	30,079,090,560	25,950,092,073
2047	43,783,022,528	30,742,388,696	26,444,687,904
2048	44,732,237,823	31,413,621,278	26,944,801,079
2049	45,685,875,048	32,088,501,013	27,446,674,204
2050	46,634,925,878	32,760,880,677	27,945,005,028

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