

FIRST EDITION
2018



**ACTION PLAN FOR CO₂
EMISSIONS REDUCTION FROM INTERNATIONAL
CIVIL AVIATION OF THE REPUBLIC OF PANAMA**



Presidential Plane, Marcos A. Gelabert International Airport



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First Edition 2018.

**Action Plan for CO₂ Emissions Reduction from
International Civil Aviation of the Republic of Panama.**

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Abbreviations

ANSP's: Air Navigation Service Providers

APU: Auxiliary Power Unit

ATM: Air Traffic Management

CAA: Civil Aviation Authority of Panama

CCO: Continuous Climb Operation

CDM: Clean Development Mechanisms

CDO: Continuous Descent Operation

CO₂: Carbon Dioxide

CORSIA: Carbon Offsetting Reduction Scheme for International Aviation

DGA: Airport Management Directorate, Civil Aviation Authority

DNA: Air Navigation Bureau, Civil Aviation Authority

EBT: Environmental Benefits Tool

FIR: Flight Information Region

GSI: Ground Speed Indicator

GTPA: Panama's Action Plan Working Group

ICAO: International Civil Aviation Organization

MiAmbiente: Ministry of Environment

MRV: Monitoring, Reporting and Verification

PBN: Performance-Based Navigation

RACP: Civil Aviation Regulation of Panama

RNAV: Area Navigation

RTK: Revenue Tonne Kilometer

SAF: Sustainable Aviation Fuel

SNE: National Energy Secretariat

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1. Presentation

Today's climate challenges urge society as a whole to commit to building a sustainable development models. All the parties involved must base this approach on a shared solution.

In this regard, the aviation sector is actively involved, dedicating continuous efforts to build an air transport system that is increasingly safe, efficient and committed to protecting the environment, including initiatives for resources and energy consumption in a more optimized and responsible manner.

Aviation represents approximately 2%¹ of global CO₂ emissions produced by human activity. While international aviation represents 1.3%² of this total, as ICAO Member States and jointly with the aviation industry, we continue taking concrete measures to reduce the emissions produced by international aviation.

ICAO's global aspirational goals aim at maintaining a 2% annual fuel efficiency improvement and a carbon neutral growth from 2020³ onwards. These ambitious goals will require worldwide efforts through initiatives that provide a service that can strike a balance between quality and responsibility with the environment.

The Civil Aviation Authority of Panama presents the first edition of the "Action Plan for CO₂ Emissions Reduction from the International Civil Aviation Authority of the Republic of Panama", in an effort to compile and communicate information on its activities to address



CO₂ emissions from international civil aviation, and to achieve the objectives established by ICAO's Assembly Resolution A37-19, and reaffirmed by Assembly Resolutions A38-18 and A39-2.

These efforts are being carried out in an integrated manner with the key actors of the aviation sector, who have jointly addressed the commitment to continue working on concrete actions that contribute to the achievement of collective goals and global strategies to face climate change.



Engineer Alfredo Fonseca Mora

Director General

Civil Aviation Authority of Panama

^{1,2} Fifth Evaluation Report (AR5), Intergovernmental Panel on Climate Change (IPCC), 2014.

³ Resolution A37-19: Consolidated Declaration of ICAO's Permanent Policies and Practices Relating to the Protection of the Environment-Climate Change, 2010.

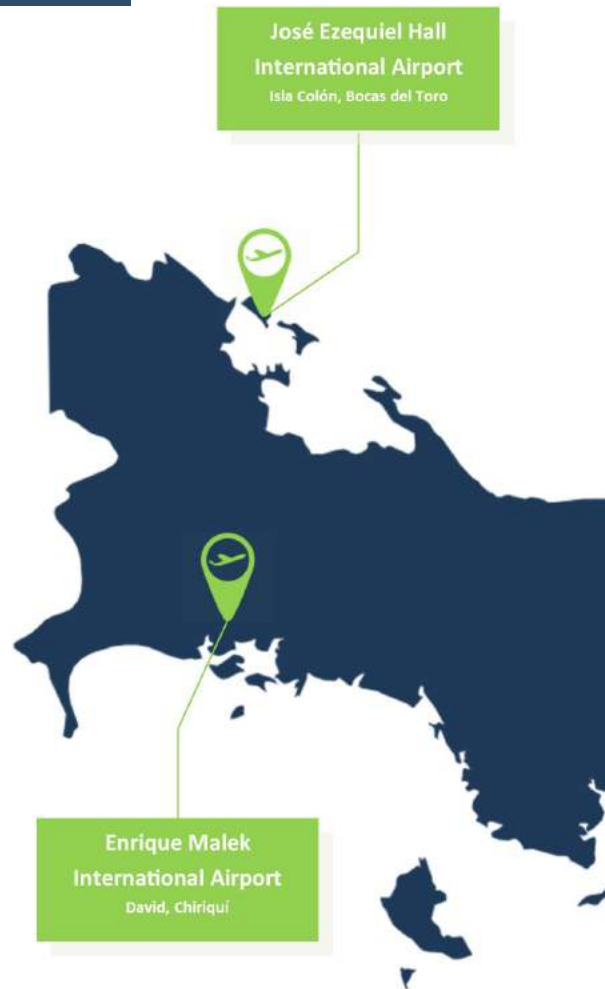
2. Context and scope

2.1 Geographic location

The Republic of Panama is a sovereign state located in the southeast of Central America. It borders the Caribbean Sea to the north, the Pacific Ocean to the south, and Colombia to the east, and Costa Rica to the west. It has a territorial surface of 75, 845,072⁴ square kilometers and an estimated population of 4 million inhabitants⁵.

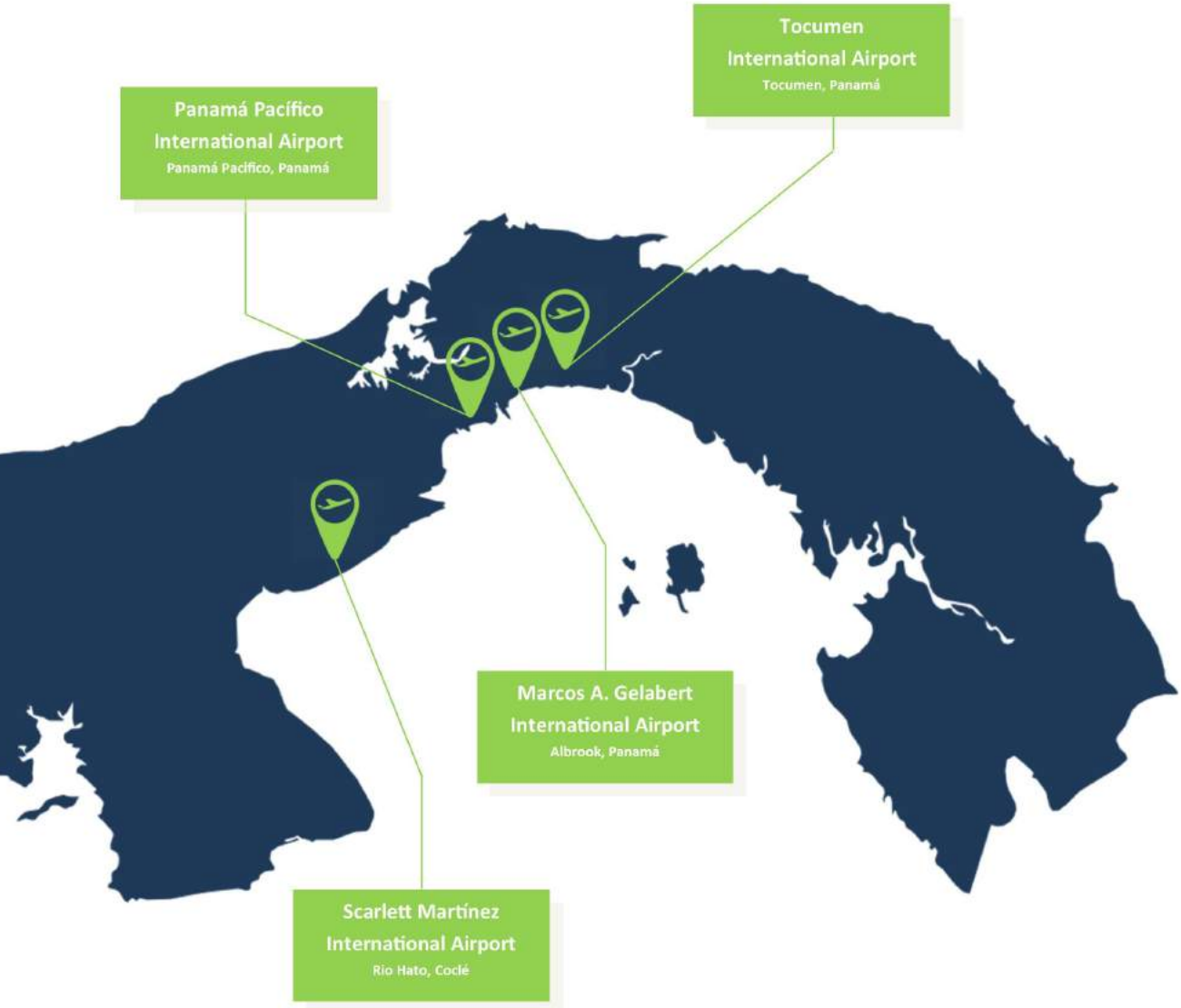
Its privileged geographic position forms a link between Central America and South America, which has allowed it to be, from its origins, one of the most important logistics hub in the Western Hemisphere.

Its government system is democratic, and economic development is based mainly on financial, logistic and tourism services.



⁴ National Geographic Institute "Tommy Guardia", Panama.

⁵ The National Institute of Statistics and Census, Office of the Comptroller General of the Republic of Panama, 2010.



Panama has six international airports, distributed along the national territory.

2.2 Aviation in the Republic of Panama

In 1903, our founding fathers this nation, excited by this new mode of transportation, offered a USD 3,000 reward to those who flew the first aircraft in Panama. The first propelled flight in the Republic of Panama happened on April 12, 1912 by Clarence A. de Giers, in a Bleriot XI monoplane, in front of more than 4,000 spectators.

Captain Enrique Malek, considered the father of commercial aviation, founded the first airline in 1932 under the name *Aerovías Nacionales S.A.* In 1933, Marcos A. Gelabert founded Gelabert Air Transport, which flew until December 1941, when all domestic flights were canceled for the safety of the Panama Canal due to the II World War.

Panamanian aviation had a resurgence at the end of 1944 where almost the entire country is connected by air. During this period, new airlines are born including the Panamanian Aviation Company, COPA. On August 8, 1963, Decree Law 19 was enacted, after which National Aviation is regulated. On January 22, 1969, the Directorate of Civil Aeronautics of Panama, now the Civil Aeronautical Authority of Panama, was constituted as an autonomous institution of the State, in order to expedite the management of commercial aviation.

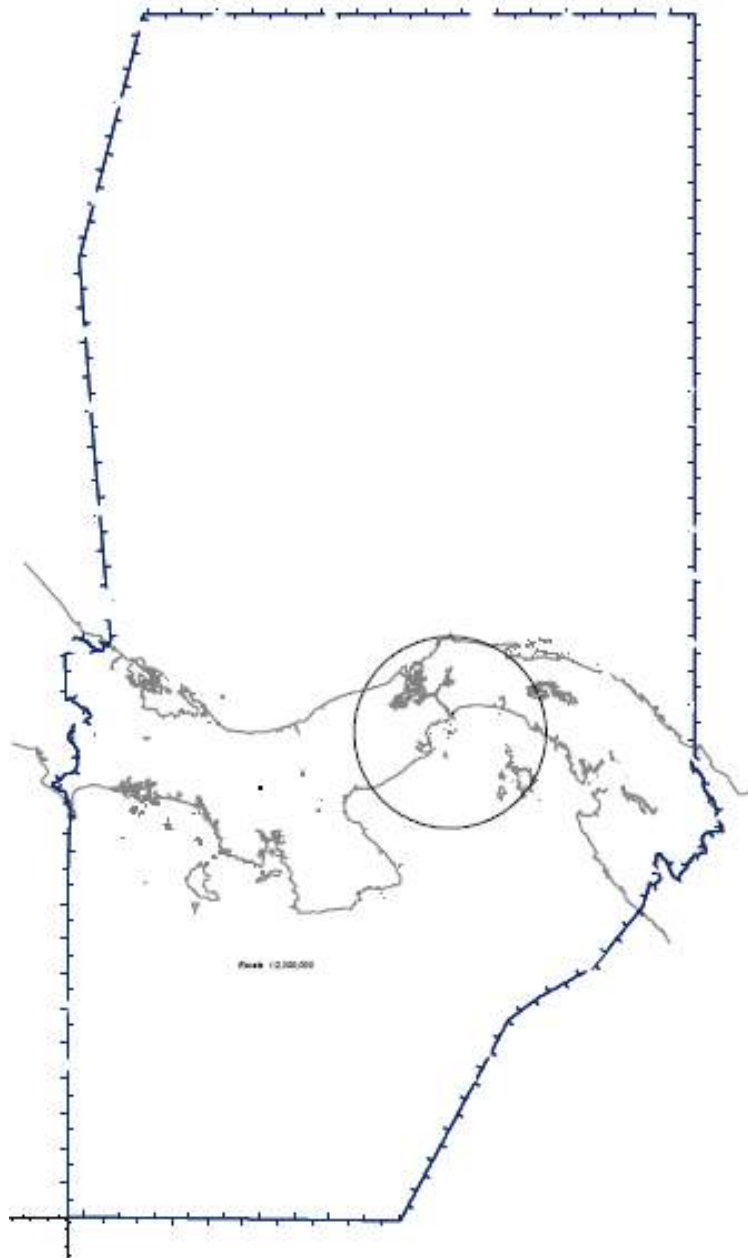
Technical Cooperation with the International Civil Aviation Organization (ICAO) began in Panama in 1971, and since then has been an asset for developing national aviation.

The construction of the Tocumen International Airport, in 1947, with an initial capacity of 1.5 million users, has increased its movement of passengers to more than 12 million passengers per year.

Currently, the Tocumen International Airport is the largest airport in Central America, connecting with 80 destinations in 34 countries in America and Europe.

The expansion of Terminal 2 (T2) represents an investment of more than 770 million dollars. Once Terminal 2 concludes, Tocumen International Airport, as a whole, will have 148 thousand square meters, 8 remote positions and 54 gates for the embarkation and disembarkation of passengers, completing 62 bridges. The South Terminal will have 20 contact positions and the current passenger terminal has 34⁶.

⁶ Tocumen, S.A., 2018.



Source: Department of Aeronautical Information, Civil Aeronautics Authority, 2018.

Panamanian air space has a surface of 623,835 km².

2.3 Scope of Panama's Action Plan



Terminal 1
Tocumen International Airport

The Action Plan is a tool designed by ICAO that States can use to display and communicate voluntarily, both nationally and internationally, their efforts to address the CO₂ emissions produced by their international aviation. The structure of the Action Plan maintains a simple format, to facilitate a direct communication of the actions that a State is implementing, the future measures in which it intends to undertake and the expected results of the same.

For the purposes of the implementation of this Action Plan, Panama chooses to use ICAO's definition for international flight, which is specified as the operation of an aircraft from the takeoff in an aerodrome of a contracting State or its territories, up to landing on an aerodrome of another Contracting State or its territories.

In order to delimit international flights whose CO₂ emissions are attributed to the Panamanian State, we rely on the airlines that maintain the Republic of Panama as a notifying State, who hold national operating certificates. The airlines within this scope are: Air Panama, Copa Airlines and DHL Aero Expreso.



States have the flexibility to choose between a "basket of measures" that encompass four elements of action, according to their particular circumstances. These four action elements are: technological, operational, sustainable aviation fuels, and market-based measures.

Within the scope of its Action Plan, Panama includes establishing a baseline for CO₂ emissions starting in 2013, which has been made with real data based on the number of passengers, cargo weight, fuel consumption and distance traveled.

The calculated baseline contains reductions attributed to the implementation of measures to reduce the use of aircraft fuel that are already being implemented. The new or additional measures will be quantified in Section 6.2.

Another important aspect is the identification of barriers or limitations in the implementation of future actions and how they could be overcome, as well as the integral evaluation of the assistance opportunities that would be essential in promoting greater benefits within this line of work.

3. Panama's Action Plan Working Group (GTPA)

3.1 Objective

The Working Group for Panama's Action Plan includes all the parties involved in the process of designing and promoting the mitigation measures in which Panama is working to reduce carbon emissions from International Civil Aviation. Its dynamic encourages close cooperation between all the components, which will help facilitate the selection and implementation of the most appropriate measures for carbon emission reductions.

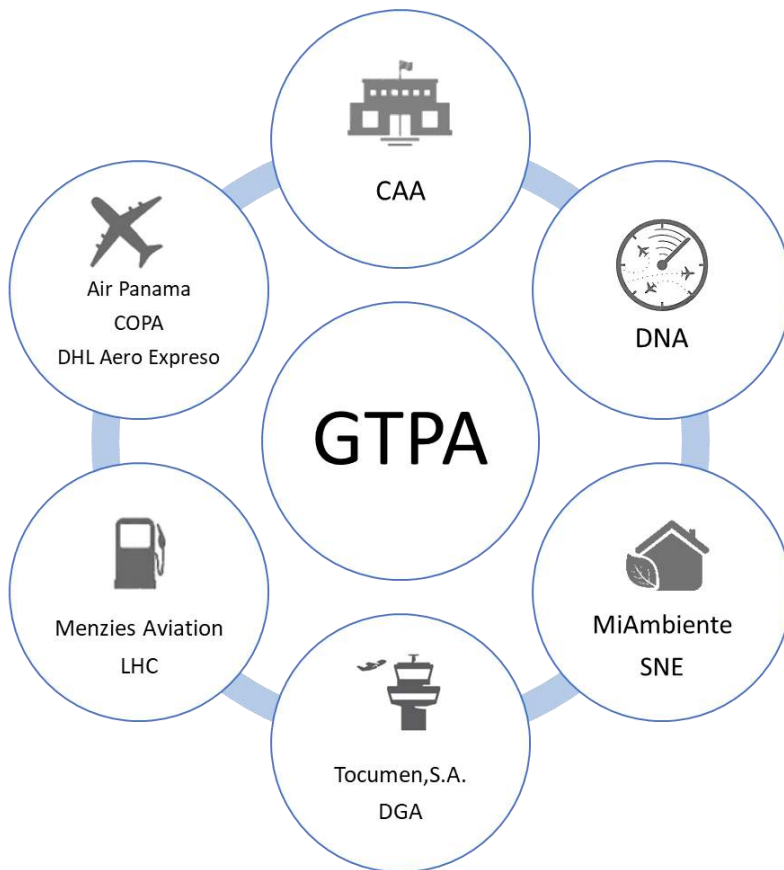


Diagram 1. GTPA representative



3.2 Members

The GTPA is composed of representatives from various aviation sectors present in Panama, and government institutions are directly related to environmental, commercial and hydrocarbon regulation matters.

Table 1 shows the different entities represented in the GTPA.

Table 1. Detail of entities represented in the GTPA	
	<p>Aviation Institutions Civil Aviation Authority, Air Transport Directorate</p>
	<p>Air Navigation Service Providers Civil Aviation Authority, Air Navigation Directorate</p>
	<p>Environmental Institutions Ministry of Environment, Climate Change Directorate National Energy Secretariat, Electricity and Hydrocarbons Directorate</p>
	<p>Airports Tocumen, S.A. Civil Aviation Authority, Airport Management Directorate</p>
	<p>Fuel Providers Menzies Aviation, 2010-2018 LHC, 2018-ss</p>
	<p>Airlines Air Panama COPA DHL Aero Expreso</p>

4. CO₂ emissions baseline

The CAA uses the ICAO calculation method as a reference to establish its baseline CO₂ emissions for international flights as of 2013. The tool used to calculate the CO₂ emissions has been the "EBT-Environmental Benefits Tool" version 2.1, developed by ICAO, which uses fuel usage and revenues per ton-kilometer per year as a base.

The total revenue tone-kilometer is calculated using the formula:

$$\text{RTK} = A + B + C$$

Where:

A = Kilometer passenger ton = (passengers carried * flight distance * 100kg) / 1000 (t / km)

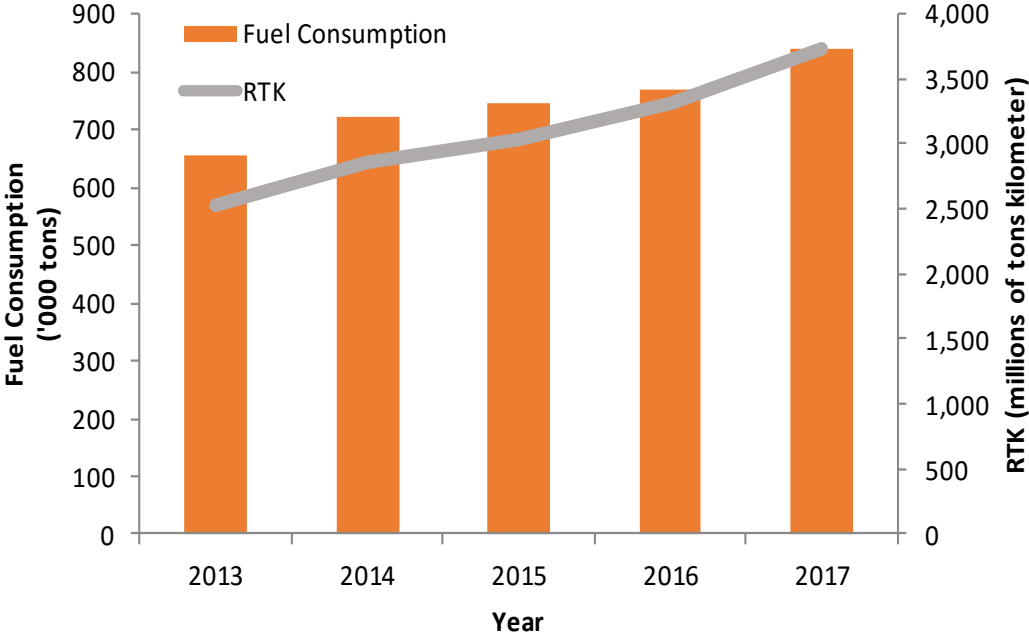
B = Tons of freight transported * flight distance (t / km)

C = Mail carried tons * flight distance (t / km)

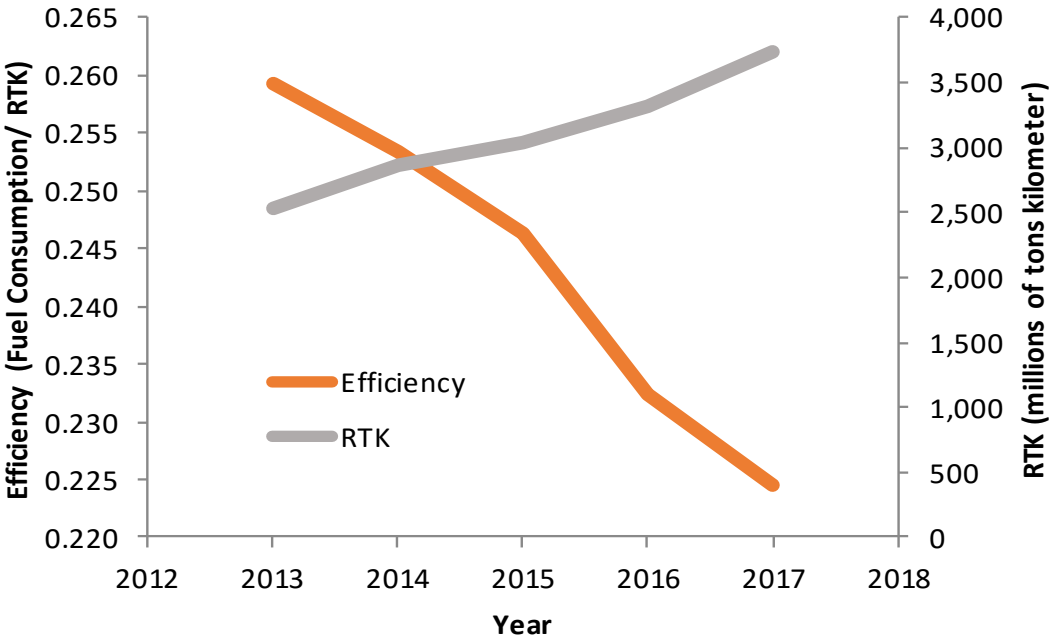
Table 2 presents the RTK statistics corresponding to Panama, for a period of 5 years.

Year	RTK (millions of tons kilometer)	Fuel Consumption ('000 tons)	Efficiency (Fuel Consumption/RTK)
2013	2,527.09	655.17	0.26
2014	2,854.78	723.44	0.25
2015	3,034.31	747.44	0.25
2016	3,311.37	769.61	0.23
2017	3,735.53	838.59	0.22

Graph 1. Fuel consumption vs RTK



Graph 2. Efficiency vs RTK



4.1 Historic behavior of CO₂ emissions

The CO₂ emissions baseline represents the past behavior of air traffic and fuel burned and serves to project the future trend under a scenario with no actions undertaken. The purpose of establishing a future behavior without additional measures helps to have a clearer vision of the impact of the measures taken to limit or reduce fuel consumption and therefore CO₂ emission. It is important to note that in this Action Plan the emissions baseline already includes mitigation measures for the years concerned, as established in section 5. Therefore, additional measures will be those that have an impact on emissions reduction to 2050.

The CO₂ emission factor, for a specific mass of fuel consumed is:

Where:

$$\text{CO}_2 = (\text{CC}) (0.8) (3.16)$$

Where:

CC = Fuel consumption (L)

0.8 = fuel density (kg / L)

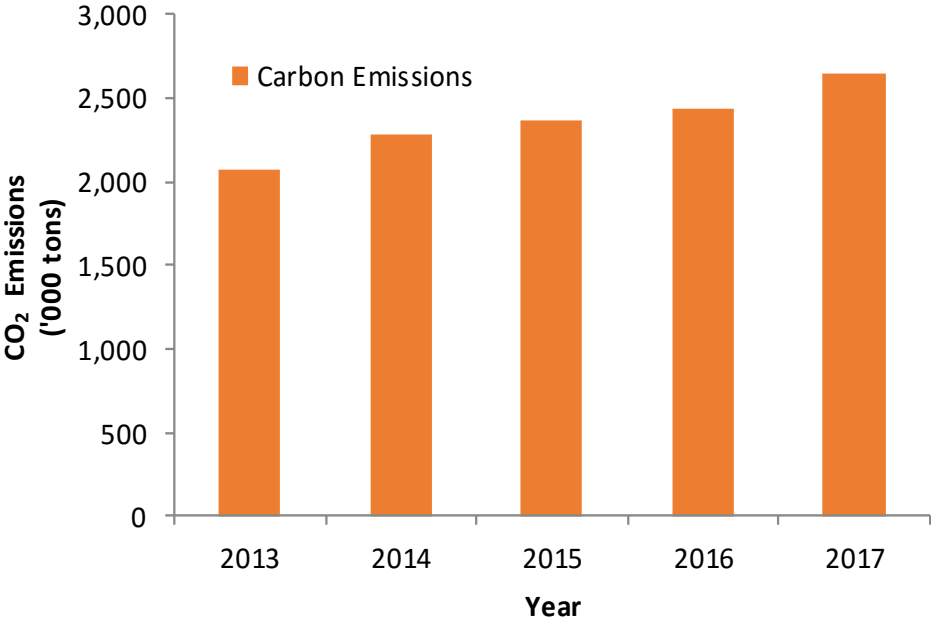
3.16 = conversion factor (kg CO₂ / kg of fuel)

Historic behavior of CO₂ emissions for Panamá corresponding to the years 2013-2017 is presented in Table 3.

Year	Carbon Emission (‘000 tons)
2013	2,070.35
2014	2,286.06
2015	2,361.91
2016	2,431.95
2017	2,649.93



Graph 3. Carbon Emissions vs Year



4.2 Future projections of CO₂ emissions behavior

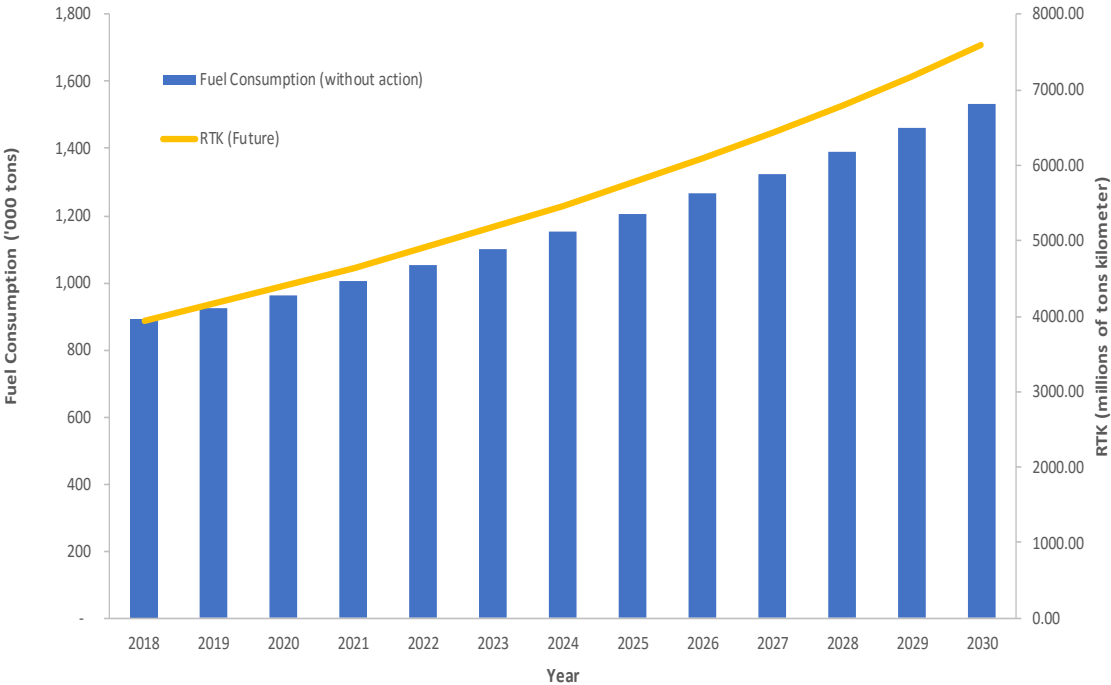
Panama's air traffic is estimated to maintain a growth of 5.6%, according to the ICAO growth rate projected for the Region. Table 4 represents the growth of air traffic in Panama and expected CO₂ emission under a scenario with no action.

Table 4. RTK, fuel consumption and CO₂ future projections

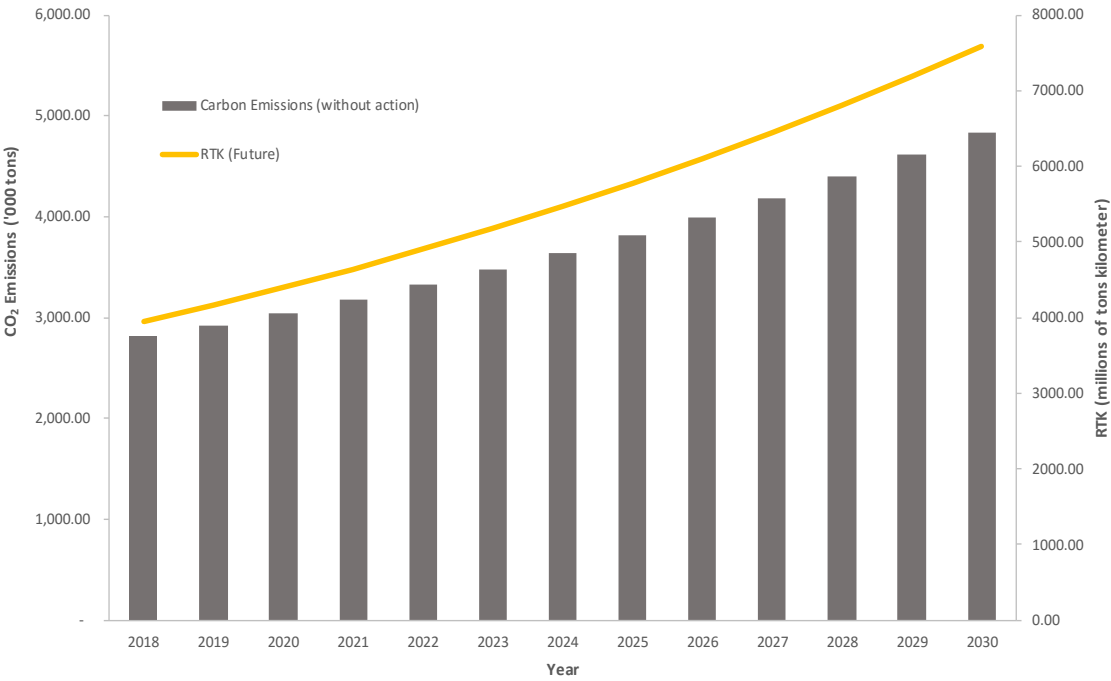
Year	RTK (Future) (Millions of tons kilometer)	Fuel Consumption (without action) (^{'000} tons)	CO₂ Emissions (without action) (^{'000} tons)
2018	3,944.72	889.08	2,809.50
2019	4,165.63	925.17	2,923.55
2020	4,398.90	964.45	3,047.68
2021	4,645.24	1,006.79	3,181.47
2022	4,905.37	1,052.15	3,324.79
2023	5,180.08	1,100.54	3,477.70
2024	5,470.16	1,152.02	3,640.37
2025	5,776.49	1,206.67	3,813.07
2026	6,099.97	1,264.60	3,996.13
2027	6,441.57	1,325.93	4,189.95
2028	6,802.30	1,390.82	4,395.00
2029	7,183.23	1,459.42	4,611.77
2030	7,585.49	1,531.90	4,840.80



Graph 4. Fuel Consumption vs RTK



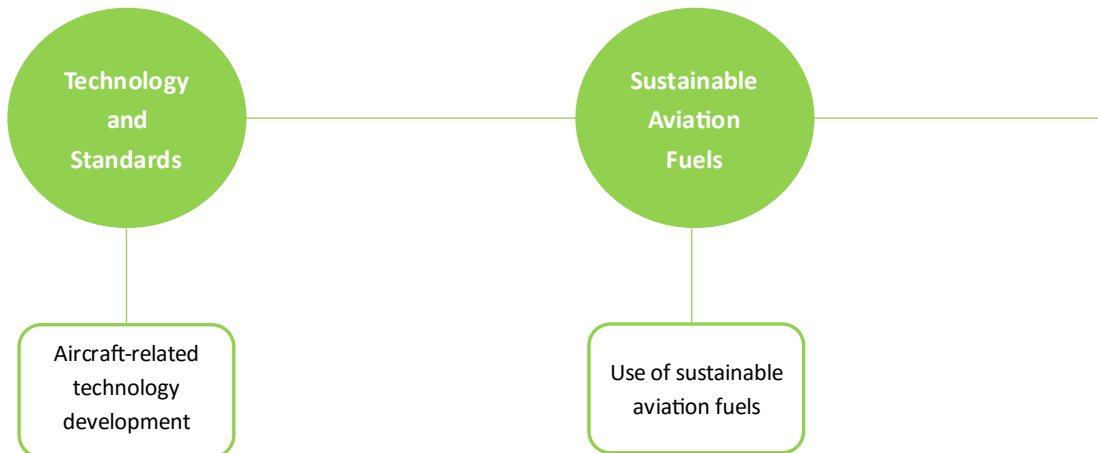
Graph 5. Carbon Emissions vs RTK

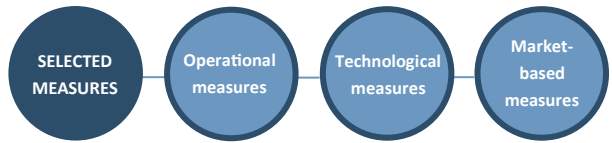


5. Selected measures that contribute to CO₂ emissions reduction

Initiatives have been identified from the basket of measures that can represent significant impacts in the reduction of carbon emissions produced by international civil aviation. It is important to consider their feasibility and the implications at the time of implementation, from sizing the necessary resources to the correct selection of each task manager.

Within this process, Panama has identified a "basket of measures": the operational, technological and market-based measures as the first lines of action to address the reduction





of CO₂ emissions resulting from its international flights. It is important to note that of these four elements of action, a series of categories are subdivided as shown in Diagram 2. In the Republic of Panama, some measures are being implemented, while others are being planned

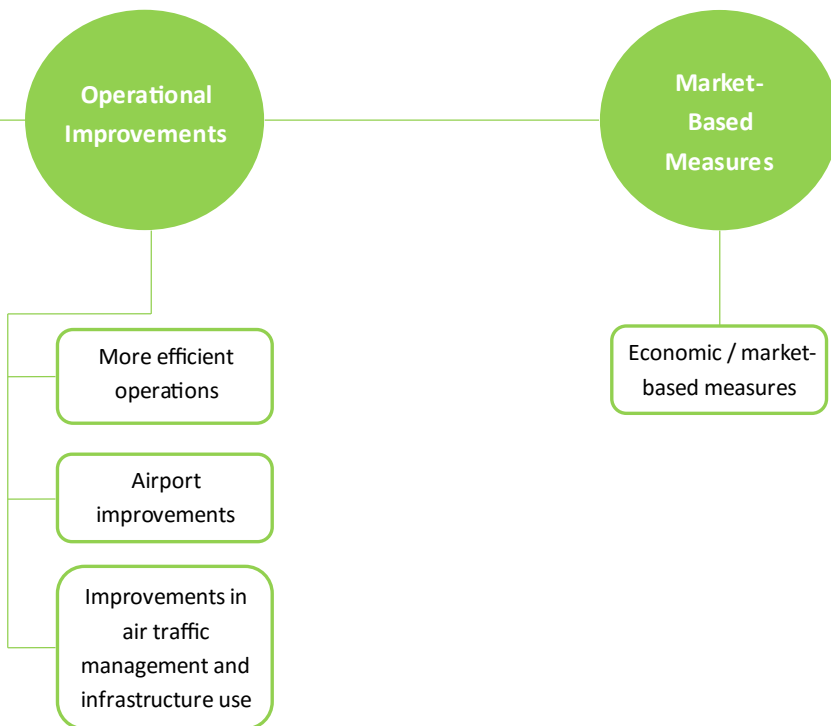


Diagram 2. Basket of measures for CO₂ emissions reduction

5.1 Operational measures



Control Tower
Tocumen International Airport



Terminal 2
Tocumen International Airport

Operational measures, in general, can be achieved through lower cost adjustments and their benefits are achieved in the short term. These measures reflect changes in how aircraft are loaded and operated. There are initiatives that can be implemented in pre-flight operations such as: flight planning, take-off mass, center of gravity, as well as flight procedures. Likewise, it is possible to make improvements in management and infrastructure of transit from airports, and enhancements in air traffic management patterns from the aeronautical service providers.

Table 5. Operational measures for emissions reductions

Operational Area	Measure	Implementation
Air Navigation	Through an investment of 8 million dollars ⁷ , the Panamanian State seeks to evaluate the current situation of its ATM capacity and define in a comprehensive manner a process that will modernize its infrastructure and capacity that reflects the best standards of safety, efficiency and best practices, according to current regulations and environmental responsibility. The reordering of Panamanian airspace, aiming at correcting deficiencies and at bringing the infrastructure and procedures to a level of best practices such as its capacity to accommodate arrivals and departures, the use of pavements and infrastructure. The project aims at redesigning all the segments within the FIR of Panama, in an integrated manner, including flight paths for seven (7) international airports, in order to allow the use of PBN procedures. The update will be made, considering the capabilities of each installation and the current and future expansion needs for the next 10 years.	As of 2019
	Implementation of CCO and CDO procedures.	In implementation



Airport	Improvements at the Tocumen International Airport with the construction of T2, which will provide 20 new boarding gates and a total projection of 20 million passengers per year.	As of January 2019
	Improved ground support equipment for fuel supply that included the conversion of 17 ground support equipment to renewable energy sources. The use of 17 solar trucks for fuel supply at the Tocumen International Airport covers 40% of total supply and represented 37 million gallons as of May 2018.	In implementation
	Improved transportation to and from the Tocumen International Airport, with the construction of Line 2 of the Panama Metro in the eastern area of the province of Panama. This improvement in transportation infrastructure will have the potential to impact the passengers embarking and disembarking from this airport, which for 2017 were 4,545,914 pax ⁸ ; and that for June 2018 have been 2,177,120 pax ⁹ .	First quarter of 2019
	Efforts to maintain an efficient track, minimize taxi times and congestion in arrivals and departures.	In implementation
Aircraft	Aircraft weight reduction from replacing carpeting, coffee machines, ovens, emergency equipment, and entertainment equipment.	In implementation
	Single engine taxi.	In implementation
	Use of the Flight Management System, with the characteristic cost index, which allows identifying the most cost-effective speeds and altitudes for the use of fuel on the flight.	In implementation
	Use of APU to reduce engine start-up time prior to take-off.	In implementation
	GSI implementation to reduce the time interval between brake removal and pushback when leaving the boarding gate.	In implementation

⁷ Public Tender 2017-1-38-0-08-LV-009002: "Study, Redesign, Implementation and Training for the Adaptation and Optimization of Panama's Airspace", 2017.

^{8,9} Department of Air Transport Analysis, CAA, 2018.



5.2 Technological measures

On the other hand, there are technological measures focused on aircraft development, which require substantial investments with benefits obtained from the medium to long term; however, their corresponding reductions are generally significant. Some of these investments can be applied through innovative designs in aircraft that include improvements in their structure, propulsion and aerodynamics, either by updating the existing fleet, or by purchasing new aircraft.

At this point, ICAO is implementing, through standards and recommended methods, a global CO₂ certification for aircraft engines. These certifications will apply to new aircraft designs starting in 2020 and to designs in production starting in 2023.

Technological Area	Measure	Implementation
Aircraft	Fleet renewal with innovative propulsion and aerodynamic designs.	As of August 2018
	Aerodynamic updates on existing aircraft with Winglets (5% fuel efficiency) and Split Scimitar Winglets (1.3% fuel efficiency).	In implementation



5.3 Market-based measures

Market-based measures (MBM) are policy tools designed to achieve environmental objectives with alternative methods to traditional measures. Some methods include trade or exchange of emissions, charges related to emissions (charges and taxes) and compensation of emissions.

The compensation of emissions implies the compensation of the impact of emissions resulting from an operation, with an equivalent amount of reductions of specific emissions to projects outside of this operation.

The ICAO Council adopts on June 27, 2018, the norms and methods recommended in Annex 16 of Protection of the Environment, Volume IV: CORSIA (Compensation and Carbon Reduction Plan for International Civil Aviation), the purpose of This global scheme is to complement the broader basket of measures to achieve the desired global goal of carbon neutral growth after 2020.

Table 7. Market-based measures for emissions reductions

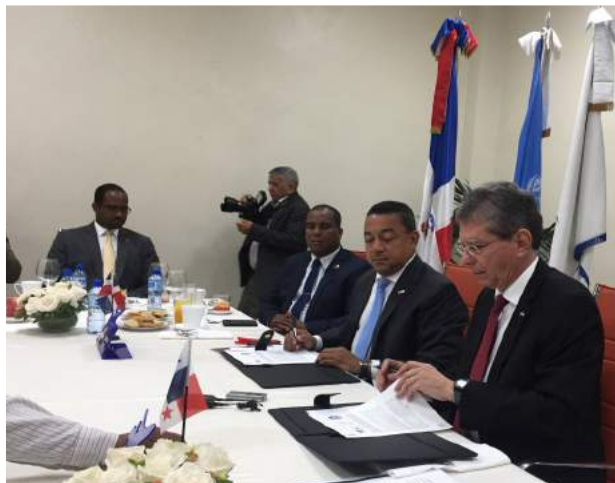
Market Area	Measure	Implementation
Emissions Compensation	Adoption of the standard and recommended practices SARP's for CORSIA in the Civil Aviation Regulations of Panama-RACP.	From January 2019
	Implementation of CORSIA and its corresponding MRV system.	From January 2019

6. Results

6.1 Achieved milestones

Worth mentioning are some significant milestones in the work of reducing the environmental impact through this process. Efforts on this area will certainly continue.

Signing of the Buddy Programme Agreement between Panama and the Dominican Republic



On May 28, 2018, Panama and the Dominican Republic signed the Agreement of Friendly States of ICAO, which aims to facilitate, through international cooperation, the development and presentation of the Plan of Action of their States.

The scope of this agreement includes the creation of capacity based on training, site visits, technology transfer, exchange of relevant information, technical meetings and collaboration workshops. Another important aspect of the partnership will be the exchange based on the development experience and the rationalization of the policies related to the preparation of Action Plans, the collection of information and the emission reduction strategies

Participation in the National Climate Change Committee of Panama-CONACCP



The CAA actively participates in periodic meetings of the CONACCP, which chairs the Climate Change Directorate of the Ministry of Environment, and of which all the sectorial public institutions with environmental competence are part. Its objective is to create coordination mechanisms for intervention strategies through which the Public Sector and Civil Society contribute to compliance with the agreements assumed by the Panamanian State in relation to climate change.

Meeting between key carbon emissions mitigation actors in the country



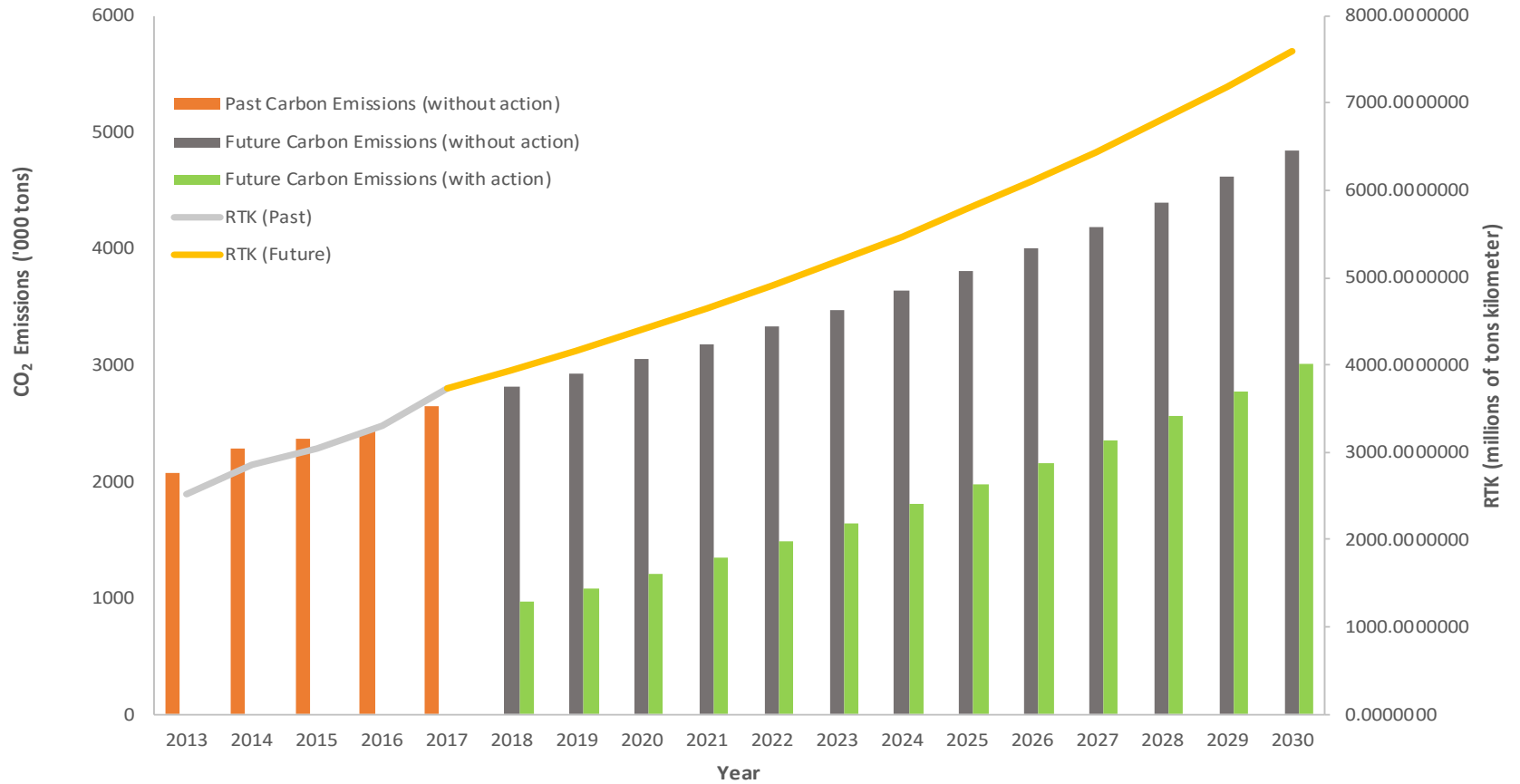
In order to associate actors with inheritance in areas of climate change mitigation, the CAA has served as a link to provide spaces for consultation to representatives of UN Environment, Ministry of Environment and representatives of the aviation industry as COPA Airlines and AeroRepública, to identify mitigation potentials present in the Panamanian State and evaluate work strategies.

6.2 Carbon emissions comparative for 2013-2030

Table 8. Carbon emissions behavior comparative

Year	RTK (Past) (Millions of tons kilometer)	RTK (Future) (Millions of tons kilometer)	Past Carbon Emissions (without action) (‘000 tons)	Future Carbon Emissions (without action) (‘000 tons)	Future Carbon Emissions (with action) (‘000 tons)
2013	2,527.09	-	2,070.35	-	-
2014	2,854.78	-	2,286.06	-	-
2015	3,034.31	-	2,361.91	-	-
2016	3,311.37	-	2,431.95	-	-
2017	3,735.53	-	2,649.93	-	-
2018	-	3,944.72	-	2,809.50	971.82
2019	-	4,165.63	-	2,923.55	1,085.87
2020	-	4,398.90	-	3,047.68	1,209.99
2021	-	4,645.24	-	3,181.47	1,343.78
2022	-	4,905.37	-	3,324.79	1,487.11
2023	-	5,180.08	-	3,477.70	1,640.02
2024	-	5,470.16	-	3,640.37	1,802.69
2025	-	5,776.49	-	3,813.07	1,975.38
2026	-	6,099.97	-	3,996.13	2,158.44
2027	-	6,441.57	-	4,189.95	2,352.27
2028	-	6,802.30	-	4,395.00	2,557.31
2029	-	7,183.23	-	4,611.77	2,774.08
2030	-	7,585.49	-	4,840.80	3,003.11

Graph 6. Carbon emissions behavior comparative



7. Assistance needs



Terminal 1 and 2,
Tocumen International Airport

Currently, several initiatives to reduce CO₂ emissions are being implemented in the field of aviation in the Republic of Panama. Some are led by airlines, such as weight reduction in aircraft, investment in fleet renewal and aerodynamics, strict maintenance programs, to name a few. Others are led by the State Institutions and private companies, such as the redesign of the airspace and the strengthening of the legislation in force, by the governing institutions on the subject, and in the case of private enterprise, observe the constant effort to promote the optimization of operations on land and the increasingly efficient use of resources to promote sustainability standards.

Among the opportunities identified, which could enhance current initiatives and generate significant benefits due to their subsequent complementary effects, we can identify:

- Technical and financial collaboration to develop initiatives for Clean Development Mechanisms: AMo 116 "Electrical taxi systems for aircraft" and AMS-I.M. "Solar energy for domestic operations at the boarding gate".



- Technical collaboration and training in best operational practices to reduce the use of fuel by air operators.
- Technical collaboration and advice for the development and implementation of clean technologies to boost energy efficiency in the country's international airports.
- Economic technical collaboration in Sustainable Aviation Fuels, to evaluate the introduction of this action element included in the basket of measures for the mitigation of CO₂ emissions.

We believe that the focus of the measures promoted by Clean Development Mechanisms, can strengthen feasibility and boost participation in the CORSIA scheme, since there is the possibility of generating carbon credits through projects of the industry, which would represent a double benefit for the country's aviation.



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