ACTION PLAN FOR CARBON DIOXIDE EMISSIONS REDUCTION FROM INTERNATIONAL CIVIL AVIATION IN RWANDA

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About the second phase of the ICAO Capacity Building Project

With the goal of assisting States in their efforts to mitigate CO_2 emissions from international aviation, and to ensure that all States have the capacity required to develop their Action Plans and implement mitigation measures, ICAO launched in 2013 the first phase of the Assistance Project Capacity building for CO_2 mitigation from international aviation, in partnership with the European Union (EU). The project successfully supported 14 States in Africa and the Caribbean, and met all its expected results, exceeding the initial targets by its completion in 2019.

Building on this successful partnership, ICAO initiated the second Phase of its Assistance Project with the European Union funding. The Project seeks to contribute to the mitigation of CO_2 emissions from international civil aviation in the selected States by implementing capacity building activities to support the development of low carbon air transport and environmental sustainability. The EU's overall Action under this second phase involves three Areas of Activities, with ICAO responsible for Area of Activity 1, funded at 1.5 million, and focusing on the Preparation and/or update and implementation of ICAO's State Actions Plans.

Since 2020, ICAO has officially kicked off the implementation of the Second Phase entitled "Capacity Building for CO_2 Mitigation from International Aviation-Development of ICAO States' Action Plans for 10 States", planned to be carried out until October 2023, and providing support to five States from the Eastern and Southern African Region (Botswana, Madagascar, Rwanda, Seychelles and Zimbabwe), and five from the Western and Central African Region (Benin, Cabo Verde, Côte d'Ivoire, Mali, and Senegal).

For more information, visit https://www.icao.int/environmental-protection/Pages/ICAO_EU_II.aspx

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ACRONYMS

ANSP: Air Navigation Service Provider

APU: Auxiliary Power Unit

ATM: Air Traffic Management

CCO: Continuous Climb Operations

CO_2: Carbon dioxide

CDO: Continuous Descent Operations.

EAC: East African Community

EASA: European Aviation Safety Agency

EBT: Environmental Benefits Tool

EDPRS: Economic Development and Poverty Reduction Strategy

GDP: Gross Domestic Product

GSE: Ground Support Equipment

IATA: International Air Transport Association

IFC: International Finance Corporation

IOSA: IATA Operational Safety Audit Programme

ISAGO: IATA Safety Audit for Ground Operations.

ICAO: International Civil Aviation Organization

LED: Light-Emitting Diode

MININFRA: Ministry of Infrastructure

NAPT: National Action Plan Team

PBN: Performance Based Navigation

RCAA: Rwanda Civil Aviation Authority

RAC: Rwanda Airport Company

REMA: Rwanda Environment Management Authority

SAF: Sustainable Aviation Fuels

SAP: State Action Plan

SARPs: Standards and Recommended Practices

SDG: Sustainable Development Goals

SPA : Société Pétrolière Aviation

1. INTRODUCTION

Rwanda is a landlocked country situated in central Africa. Also known as 'The Land of a Thousand Hills', Rwanda has five volcanoes, 23 lakes and numerous rivers, some forming the source of the river Nile. The country lies 75 miles south of the equator in the Tropic of Capricorn, 880 miles 'as the crow flies' west of the Indian Ocean and 1,250 miles east of the Atlantic Ocean - literally in the heart of Africa. The Altitude ranges from 1,000m to 4,500m above the sea level.

Rwanda is bordered by Uganda to the north, Tanzania to the east, Burundi to the south and the Democratic Republic of Congo to the west.

Figure 1 RWANDA ON MAP OF AFRICA

The Main water bodies are Lakes Kivu, Muhazi, Ihema, Bulera, Ruhondo and Mugesera.Rwanda's Vegetation ranges from dense equatorial forest in the north-west of the country to tropical savannah in the east.

The main National Parks/Animal Reserves are Akagera, Volcanoes and Gishwati-Mukura National Parks.

In Rwanda the great animals of the wild are protected from poachers and roam free in the vast national parks. The Volcanoes National Park in the Virunga volcanic mountains with its high-altitude forests is world famous for mountain gorillas - timid and passive family-oriented giants. The Park teems with wildlife both large and small, while Lake Kivu to the west offers beautiful beaches, jutting peninsulas and an archipelago of islands.

1.1 Population of Rwanda

With an estimated total population of 12.3 million people, Rwanda is a relatively young nation. 50 percent of the Rwandan population is under 20 years old, with the median age standing at 22.7 years old.
Rwandans share cultural values notably unity, patriotism, social cohesion, resilience, hard work among others, with Kinyarwanda being the common language, spoken in all parts the country. Other official languages are English, French and Kiswahili.

1.2 Economy of Rwanda

Rwanda's developing economy suffered heavily in the wake of the 1994 genocide but has since strengthened over the past decade. Rwanda has experienced strong economic growth across a wide range of sectors, including agriculture, energy, mining, industry to mention but a few.

By adhering to green economy principles during this growth, the country has positioned itself to become a world leader in green growth. The economy is based mostly on subsistence agriculture. Coffee and tea are the major cash crops for export.

Rwanda now aspires to achieve Middle Income status by 2035 and High-Income status by 2050 through a series of seven- year National Strategies for Transformation (NST1) underpinned by sectoral strategies focused on achieving the Sustainable Development Goals. The NST1 is expected to lay the foundation for decades of sustained growth and transformation that will accelerate the move towards achieving high standards of living for all Rwandans. The NST1 came after two five-year Economic Development and Poverty Reduction Strategies EDPRS (2008-12) and EDPRS-2 (2013-18), under which Rwanda experienced robust economic and social performance. Growth averaged 7.2% over the decade to 2019, while per capital gross domestic product (GDP) grew at 5% annually.

Due to the COVID-19 pandemic, economic activities were sharply curtailed in 2020. GDP fell by 3.4% in 2020, the first recession since 1994. Before the COVID-19 pandemic, Rwanda enjoyed strong economic growth, averaging over seven percent GDP growth annually over the last two decades. The Rwandan economy grew more than nine percent in 2019 thanks to strong growth in industry, construction, services, and agriculture.
External financing through grants, concessional and non-concessional borrowing played a key role in financing public investments. Going forward, the private sector will play a bigger role in helping to ensure economic growth. Low domestic savings, skills, and the high cost of energy are some of the major constraints to private investment. Stronger dynamism in the private sector will help to sustain a high investment rate and accelerate growth. Promoting domestic savings is viewed as critical, along with inclusive growth. GDP in Rwanda is expected to reach 10.50 USD Billion by the end of 2021, according to Trading Economics global macro models and analysts' expectations. In the long-term, the Rwanda GDP is projected to trend around 11.00 USD Billion in 2022 and 11.50 USD Billion in 2023, according to our econometric models.

1.3 Agriculture Sector

For the past twenty years, agriculture in Rwanda has been the main driver of growth and poverty reduction by puling 1.7 million people above the poverty line in only five years. The commercialization has increased and the agriculture sector has been the driving force for about 45% of poverty reduction in the last decade. Close to 90% of the Rwanda population get their livelihoods from Agriculture, therefore a strong pillar to the economy. But also needs transformation to ensure that the sector produces increased output to support the economy. Agriculture export income increased from $70 million before 1994 to $421.1 million to date. Only coffee, tea & Pyrethrum were considered as cash crops, but staple crops, animal products, new commodities like Macadamia, flowers, fruits, vegetables, cereals & grains became cash commodities.

1.4 Tourism Sector

Rwanda is regarded as one of the safest countries to visit in Africa according to use bounce, a renown review site (Year). Thanks to the iconic Visit Rwanda brand and the vibrant meetings, incentives, conferences, and events (MICE) sector, Rwanda's tourism industry has totaled the US $1.5 billion in investments since the year 2000. Rwanda's tourism sector has increased jobs and significantly contributes to the overall growth of the country's economy. Tourism is the largest source of foreign exchange earnings in Rwanda and it is projected to grow at a rate of 25% every year. The sector is the biggest contributor to the national export strategy. The sector has also attracted foreign direct investments with major international hotel brands setting shop in the country. Rwanda is carving out its niche as a regional and international conference hub, with its new world class conventional center, owning to ever improving conference facilities and diverse entertainment options. Tourists enjoy of some of the unique and fascinating features of Rwanda, including the rare mountain gorillas of the Volcanoes National Park Rwanda is one of only two countries in which mountain gorillas can be visited safely, and the large numbers of animal species in Nyungwe and Akagera National Park.

Source: https://www.gov.rw/about
Source: https://www.worldbank.org/en/country/rwanda/overview#1
Source : https://www.gov.rw/highlights/economy-and-business)

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2. RWANDA CIVIL AVIATION SECTOR

2.1 Organization and stakeholders of Aviation Sector

Various national entities have overall responsibility for controlling the air transport system in Rwanda and share the mission of ensuring the safety and delivery of air services to the public.

Ministry of Infrastructure (MININFRA)

MININFRA is responsible for infrastructure policy and development throughout the country. Its mission is to ensure sustainable infrastructure development in the areas of transportation, energy, water, and sanitation, housing, and human settlement, to promote economic growth in Rwanda and improve the quality of life of its citizens. The civil aviation sector is under the control of the Ministry of Infrastructure which ensures that the interests and requirements of the State are respected by all the stakeholders in the air transport sector and the upgrading of the country's aviation infrastructures.

Rwanda Civil Aviation Authority (RCAA)

RCAA is mandated to regulate and ensure oversight of Aviation Safety, Security, Economic regulation of Air Services and development of civil aviation as guided by the provisions of the Convention on ICAO Standards and Recommended Practices (SARPs).

RwandAir

At the forefront of air transportation in Rwanda is the national Carrier, RwandAir, which operates domestic and international services to East Africa, Central Africa, West and Southern Africa as well as to Europe, the middle East and Asia.

Rwanda Airports Company Ltd (RAC Ltd)

Rwanda Airports Company Ltd (RAC Ltd) has within its scope the daily management, operation and provision of air navigation services for all airports in Rwanda such as; - Kigali International Airport (KIA), Kamembe International Airport (KME) and Gisenyi Airport. RAC Ltd also manages the Ruhengeri Airstrip, Butare Airstrip and Nemba Airstrips.

Akagera Aviation

Akagera Aviation is a Rwandan based aviation company specializing in helicopter solutions, pilot training among other services. They offer aerial excursions within Rwanda and the neighboring countries in the East African Community (EAC).

SP Aviation

Societe Petroliere Aviation Ltd (SPA) is a limited company established in the Republic of Rwanda for the import and distribution of petroleum products. SP Aviation has over 13 years of experience in aviation fuel storage and aircraft services.

2.2 Airport infrastructures

Rwanda has six Civil Aviation Airports in operation and one greenfield airport under construction. Two of the airports operate commercial air operations whereas the other 4 operate general aviation air operations.
Kigali international Airport served 1.2 million passengers in 2019. As of December 2021, the post recovery of passengers is 43% of the 2019 levels. The aircrafts movements amounted to 12,957.

Figure 2 Kigali International Airport

Kamembe airport is served by one airline RwandAir. The airport receives one commercial flight per day. It served almost 13000 passengers 2019. As of December 2021, the recovery of passenger numbers is around 52% of the 2019 levels.
The remaining four aerodromes namely; - Musanze airstrip, Rubavu Airport, Nemba Airstrip, and Huye Airstrip receive only general aviation mostly helicopters which serve mostly the tourists moving around the country.
Bugesera Airport once completed will contribute immensely to the goal of Rwanda being an aviation hub in Africa. The airport is scheduled to serve 7 million passengers in the first phase.

2.3 Airlines

a. National Operators

RwandAir is the flag carrier airline of Rwanda. It was founded on 1st December 2002 and started operations on 27th April 2003. It provides services domestically and internationally with base at Kigali International Airport. The Airline operates in and out of 29 different destinations in East Africa, Central Africa, West and Southern Africa as well as in Europe, Middle East and Asia. The Airline is a member of the International Air Transportation Association (IATA), and an EASA, IOSA and ISAGO certified operator. RwandAir fleet is as shown in the table below.

Airbus A333 x 1
Passengers : 274
Cargo: 132.20m³

Airbus A332 x 1
Passengers : 244
Cargo: 109.10m³

Boeing 737-800NG x 4
Passengers: 154
Cargo: 21.4 – 52.0m³

Boeing 737-700NG x 2
Passengers: 120
Cargo: 27.3m³

Bombardier CRJ-900 x 2
Passengers : 75
Cargo: 16.8m³

Bombardier Q-400 x 2
Passengers : 67
Cargo:14.2m³

Furthermore, Rwanda also has an aviation company, Akagera Aviation specializing in helicopter solutions, pilot training and aerial excursions in Rwanda and East African neighboring States. Some of the services the company provides include photography, emergency medical services and aerial surveys, and so on. The company is based at Kigali International Airport. Its fleet includes types: - Augusta A109S, Augusta AW119MKII and a Robinson 44 (R44).

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b. Foreign Airlines

There are 7 Foreign Airlines operating in Rwanda as shown in the table below namely:

Table 2: Foreign airlines operating in Rwanda

Airline	Frequency (Weekly Flights)	Operating Equipment
Kenya Airways	3x	E190, B787-8, B737-3/8
KLM	5x	A332, A333, B777-200
Brussels Airlines	4x	A333
Turkish Airlines	5x	A333, B737-8/9
Egypt Air	2x	B737-8
Airworks	5x	Cessna 208-B
Ethiopian Airlines	7x	Q-400,B737-7/8, B787-6

c. Evolution of air traffic

The following tables present the evolution of air traffic for international and domestic movement from 2018 to 2021.

Table 3: International passenger movement from 2018 to 2021

International Pax movement				
	2018	2019	2020	2021
Arrival	333,759	394,305	123,185	194,690
Departure	370,978	438,630	133,583	177,291
Total (Arr+Dept)	704,737	832,935	256,768	371,981
Transfer	278,402	291,974	87,661	111,958
Total Pax	**983,139**	**1,124,909**	**344,429**	**483,939**

Table 4: Cargo imports and exports from 2018 to 2021

CARGO (Tonnes)				
	2018	**2019**	**2020**	**2021**
Imports	6,783.73	7,766.47	6,726.46	6,866.62
Exports	3,948.68	4,328.33	4,511.78	5,908.69
Total	**10,732.41**	**12,094.80**	**11,238.24**	**12,775.32**

Table 5: Domestic passenger movement from 2018 to 2021

Domestic Pax movement (KME)				
	2018	2019	2020	2021
Arrival	9,895	10,950	3,025	5,731
Departure	9,386	10,009	2,897	5,285
Total Domestic	19,281	20,959	5,922	11,016
Total Pax (Int + Dom)	**724,018**	**853,894**	**262,690**	**382,997**

Table 6: Mail imports and exports from 2018 to 2021

MAILS (Tonnes)				
	2018	**2019**	**2020**	**2021**
Imports	238.68	158.88	98.44	164.35
Exports	101.02	96.10	78.44	236.71
Total Pax	**339.70**	**254.98**	**176.88**	**401.06**

3. ACTION PLAN DEVELOPMENT PROCESS

State Action Plans (SAPs) are a voluntary planning and reporting tool for States to communicate information on their activities to address CO_2 emissions from international civil aviation to ICAO.

This initiative enables all ICAO Member States to establish a long-term strategy on climate change for the international aviation sector, involving all interested parties at the national level. These parties are encouraged to work together to define a quantified baseline scenario, select appropriate emissions mitigation measures from ICAO's basket of measures, and calculate the expected results of implementing those measures.

The important phases in the development process include:

- establishing the team that will contribute to the development of the action plan
- estimating the baseline (without action) international aviation fuel consumption and traffic
- selecting the measures to mitigate CO_2 emissions and improve fuel efficiency
- estimating the expected results from the actions (mitigation measures) selected
- identifying any assistance needed to develop and/or implement the plan.

3.1 National Action Plan Team

Rwanda's National Action Plan Team (NAPT) was set up as a committee of 8 institutions and was in charge of developing and will implement the measures in this State action plan. The Committee is composed of the following eight (8) representatives:

- the Ministry in charge of infrastructure, the Chairperson
- the Ministry in charge of environment, the Vice Chairperson
- the State organ in charge of civil aviation, the Rapporteur
- the State organ in charge of environmental conservation-member
- the aviation fuel supplier company-member.
- Rwanda Airports Company-member
- RwandAir-member

3.2 Activities of the National Action Plan Team

Establishing the team was the first step in developing the SAP. All relevant stakeholders (from the public and private sectors) were involved taking into consideration their specific expertise. The team convened on a monthly basis and discussed the progress of the SAP development. The team has managed to collect data and generate a baseline scenario.

This baseline scenario is envisioned to serve as a reference scenario for CO_2 emissions of Rwandan aviation in the absence of any of the mitigation actions described in Part V of this Plan. The team collected and used sets of data (2018, 2019) and forecasts action up to 2050 was calculated and presented in the second NAPT meeting.

Subsequently, the NAPT developed the process of identifying and selecting mitigation measures from the ICAO basket of measures to limit or reduce CO_2 emissions from international aviation.

When considering the feasibility of measures, NAPT considered the practical implications of implementation, such as understanding the steps required, the resources needed, the timing of measures and the entity responsible for carrying out appropriate tasks in order to implement those measures.

Expected results represent the projected fuel consumption and CO_2 emissions after the implementation of the measures selected. The quantification of expected results from the implementation of an action plan is a crucial element, as it is the means by which ICAO can understand the expected global advancement to be achieved toward the environmental aspirational goals established by the ICAO Assembly.

Finally, the NAPT identified assistance needed in the implementation of the measures selected which included financing, technical and training/capacity building. This will allow ICAO to address the States' specific needs in terms of facilitating access to the required assistance.

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4. BASELINE SCENARIO FOR CO_2 EMISSIONS IN INTERNATIONAL AVIATION

4.1 Calculation Methodology

Rwanda's baseline scenario was estimated based on the ICAO methodology provided in ICAO Doc 9988 in which each State reports the CO_2 emissions from the international flights operated by aircraft registered in the State (State of Registry). The baseline scenario was calculated on the assumption of the continuation of the evolution of emissions in the future in the absence of the actions.

The forecasts for air transport activity and for related emissions in the baseline scenario are presented in tables below:

Table 7: Key parameters for the baseline scenario

Data Provider	RwandAir
Historical Data Year	2019
Horizon Time	2050
Density of fuel	0.8 kg/liter
Mass of CO_2	3.16 kg of CO_2/kg of fuel

Table 8: Estimations of the 2019 activity and CO_2 emissions

Year	2019
International RTK	215,932,000
International fuel burn	115,491 t
International CO2 emissions	364,051.56 t
Fuel efficiency	0.53 kg/tkm

The Environmental Benefit Tool (EBT) was used to calculate the baseline value for Rwanda. Due to the large size of the fleet, with more than ten aircraft and data for a single year only, the baseline was generated using Method C with RTK growth rate of 4% per year as suggested in EBT. As this method is based on a single year value only, the fuel efficiency is assumed to be constant.

4.2 Results

The results of the baseline for CO_2 emissions up to 2050 are presented in the following figure and table. CO_2 emissions from international aviation are expected to grow from 364,051.56 tonnes in 2019 to 1,231,030 tonnes of CO_2 in 2050 in the absence of mitigating measures that corresponds to a 70% growth in CO_2 emissions from 2019 to 2050. The Figure 5 represents the growth of CO_2 emissions and fuel efficiency through 2050.

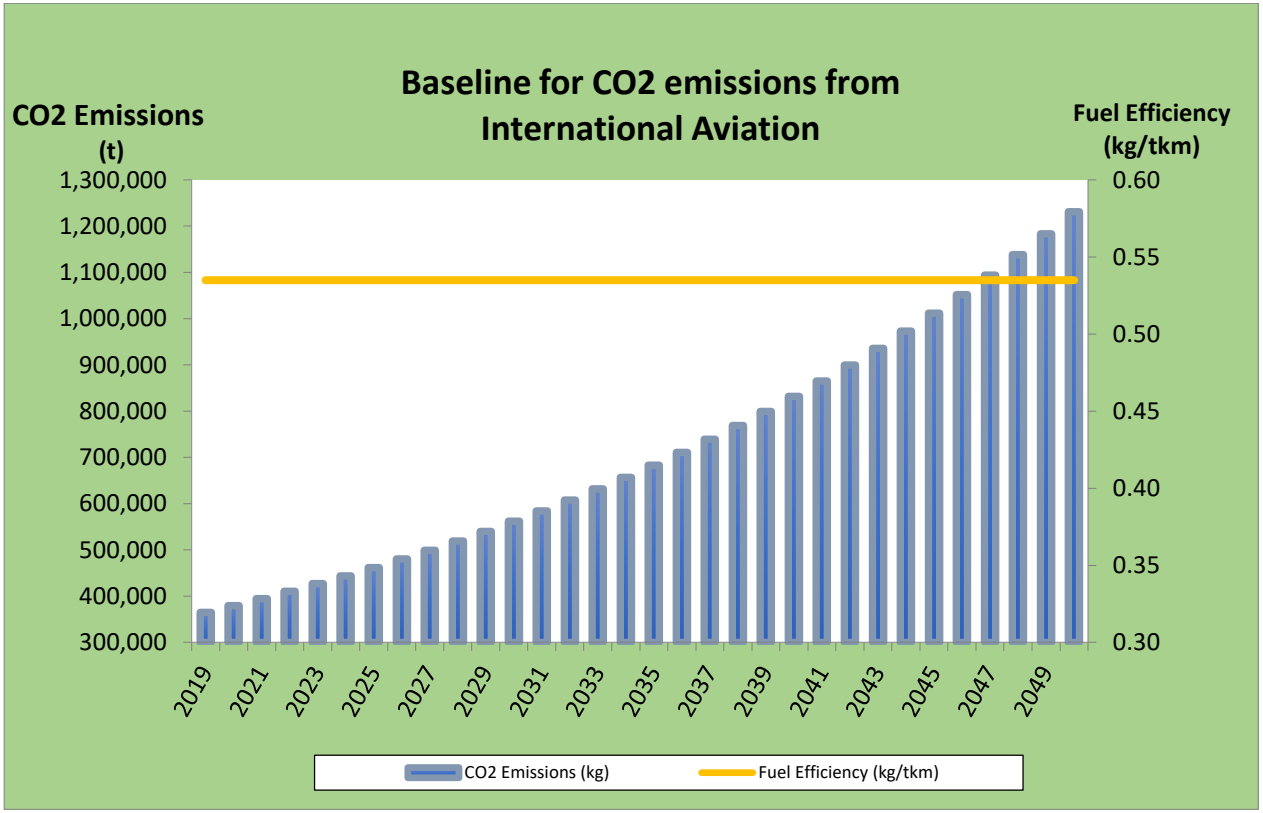

Figure 5: Baseline CO_2 emissions from international aviation from 2019 to 2050

Table 9: Annual international RTK, fuel burn and CO_2 emissions under the baseline scenario

BASELINE				
Year	International RTK ('000)	International Fuel burn (t)	International CO_2 Emissions (t)	Fuel efficiency (kg/tkm)
2019	215,932.00	115,491.00	364,952	0.53
2020	224,569.28	120,110.64	379,550	0.53
2021	233,552.05	124,915.07	394,732	0.53
2022	242,894.13	129,911.67	410,521	0.53
2023	252,609.90	135,108.13	426,942	0.53
2024	262,714.29	140,512.46	444,019	0.53
2025	273,222.87	146,132.96	461,780	0.53
2026	284,151.78	151,978.28	480,251	0.53
2027	295,517.85	158,057.41	499,461	0.53
2028	307,338.57	164,379.70	519,440	0.53
2029	319,632.11	170,954.89	540,217	0.53
2030	332,417.39	177,793.09	561,826	0.53
2031	345,714.09	184,904.81	584,299	0.53
2032	359,542.65	192,301.00	607,671	0.53
2033	373,924.36	199,993.04	631,978	0.53
2034	388,881.33	207,992.77	657,257	0.53
2035	404,436.59	216,312.48	683,547	0.53
2036	420,614.05	224,964.98	710,889	0.53
2037	437,438.61	233,963.58	739,325	0.53
2038	454,936.16	243,322.12	768,898	0.53
2039	473,133.60	253,055.00	799,654	0.53
2040	492,058.95	263,177.20	831,640	0.53
2041	511,741.30	273,704.29	864,906	0.53
2042	532,210.96	284,652.46	899,502	0.53
2043	553,499.39	296,038.56	935,482	0.53
2044	575,639.37	307,880.10	972,901	0.53
2045	598,664.95	320,195.31	1,011,817	0.53
2046	622,611.54	333,003.12	1,052,290	0.53
2047	647,516.01	346,323.25	1,094,381	0.53
2048	673,416.65	360,176.17	1,138,157	0.53
2049	700,353.31	374,583.22	1,183,683	0.53
2050	728,367.44	389,566.55	1,231,030	0.53

5. BASKET OF MEASURES FOR RWANDA

This section explores the mitigation measures identified in Rwanda to reduce CO_2 emissions from international aviation. It first provides an overview of the national clean energy ambitions and landscape in the State that could be leveraged to support the transition to a sustainable aviation. It further presents the measures quantified in this Action Plan. The selected mitigation measures are described in more detail in Annex 2.

5.1 Overview of the energy and climate objectives in Rwanda

Ensuring access to sustainable and affordable energy is an integral part of Rwanda's development agenda. Although part of the electricity generated to date comes from thermal power plants, production from renewable sources is growing rapidly. The State has set its energy efficiency and renewable energy targets, including the generation of at least 60% of its electricity through renewable energy sources by 2030. Rwanda aims to reach a target of 100% electricity access by 2030 through the development of on-grid and mini-grid access. The State similarly promotes access to clean cooking through improved cook stoves. The electrification of the transport sector, and the production of energy using its abundant natural energy sources including hydropower, solar and lake methane gas have been of paramount importance to reaching Rwanda's clean energy objectives. The State ambitions to champion the electrification of road transport in the region, and has recorded a rapid growth in the operations of electric motorcycles and vehicles,

As for bioenergy, the potential has not been effectively utilized in the provision of energy. The State aims at exploring opportunities for sustainably transforming wastes from agricultural production and processing, residues of livestock and crops, including cassava, rice, tea, coffee, etc. into modern energy. The current State Action Plan for CO_2 emissions reduction from international aviation developed by the National Action Plan Team aligns with Rwanda's national energy objectives. Given that worldwide, significant progress has been made in the production and use of Sustainable Aviation Fuels, Rwanda ambitions to further explore the possibility of producing feedstock or refining aviation fuels, and to examine how the country can leverage the electrification of road transport for the benefit of the aviation sector. To achieve these projects, additional support will be needed from Rwanda's technical and financial partners.

5.2 Technology and Standards

Rwanda is keen on advancing its technology to better suit the necessity for environmental sustainability with regards to international aviation and other modes of transportation. The Government of Rwanda's position on creating a green sustainable environment is evidenced in its fiscal incentives and administrative measures being established to encourage new technologies such as electric vehicles.

Rwanda currently has 264,524 registered electric vehicles countrywide, excluding state registered/government vehicles. The state currently has a number of practical initiatives on electrical mobility.

There are currently five such companies in Rwanda namely; Ampersand, Safi Universal Links Ltd, Rwanda Electric Motorcycle Company, Volkswagen and Victoria Motors. Additionally, the International Finance Corporation (IFC)/World Bank expressed interest to partner with Rwanda to introduce e-buses in the City of Kigali (CoK). In this context, IFC has dispatched a team of consultants to conduct the feasibility study of e-buses in the City of Kigali.

In regard to aviation, the same principles are to be applied to implement the use of cleaner sustainable electric energy for airport operations. The state through its Aeroplane / Airport Operators and Aviation Fuel supplier intends to implement the use of electric and hybrid Ground Support Equipment (GSE) to reduce the impact of the use of fossil fuels on the environment. The benefits of these Electric GSE are not only the reduction on the carbon footprint but also a significant decrease in maintenance costs borne by the Operators.

5.3 Sustainable Aviation Fuels

Rwanda through its main Aviation Fuel Provider- SP is keen on Sustainable Aviation Fuels (SAFs) as one of its basket of measures considered in the State Action Plan. The Government of Rwanda believes that they soon have policies and a legal framework to facilitate the use of SAFs.

During the meeting on SAF hosted by ICAO's Office of Environment on 28th January 2022, RCAA emphasized how Rwanda is keen on ensuring a green environment and welcomed the implementation of innovative measures such as SAF to mitigate CO_2 emissions. This is to be achieved in collaboration with ICAO and EU. So, it would be beneficial to conduct a feasibility study to assess the potential of SAF in Rwanda.

5.4 Operational Improvements

The State through its main Aeroplane operator RwandAir and the main Airport Operator Rwanda Airports Company intend to embark on a number of operational improvements to reduce carbon dioxide emissions during their operations; -

- The use of newly purchased aircraft for their operations whose implication is good-condition engines & airframe hence relatively low fuel consumption;
- Enhanced GSE management i.e., Parking GSEs to the nearest place possible to reduce distance travelled to aircraft;
- Selecting Aircraft best suited to the route and with fleet selected based on fuel consumption and CO_2 savings;
- Airplane Performance Monitoring done to establish performance factor every 3 months, the actual aircraft fuel consumption compared to data from the manufacture's handbook. This is currently done on the A330 fleet;

- Improve flight procedures (such as Final reserve fuel policy as recommended by manufactures) to reduce the amount of fossil fuels used hence reduction in CO_2 emissions, Use of Electronic Flight Bags (EFBs) hence reduction in Basic Empty Weight (BEW) and in future RwandAir intends to implement Single Engine taxing and achieve Contingency Fuel Reduction from 5% to 3%; and
- The use of Electrically operated ground vehicles (GSEs) is to be implemented in future to replace diesel powered ground vehicles to reduce CO_2 emissions around the airport Improve flight procedures to reduce the amount of fossil fuels used hence reduction in carbon emissions such as Final reserve fuel policy as recommended by manufactures, Use of Electronic Flight Bags (EFBs) hence reduction in Basic Empty Weight (BEW) and in future RwandAir intends to implement Single Engine taxing and Contingency Fuel Reduction from 5% to 3% and
- The use of electrically operated ground vehicles (GSEs) is to be implemented in future to replace diesel powered ground vehicles to reduce CO_2 emissions around the airport.

5.5 Airport Improvements

Besides the fact that Rwanda is in the process of building a new state of the Art International Airport in Bugesera district, the State has continued to upgrade its airport infrastructure and plans to implement the following measures to facilitate environmental sustainability;

- Improve airport ground operations, such as apron management and parking to reduce unnecessary movements and idling of GSE
- Design and construct buildings that reduce energy consumption.
- Installation of Light Emitting Diode (LED) lighting to replace old lighting systems at the airside and landside.
- Installation of renewable energy, such as solar power at airports.
- Adapting better Air Navigation operations such as Continuous Descent (CDO) and Performance Based Navigation Operations (PBN).
- Improve airport infrastructure by installing fixed electric ground power at airport gates, to enable aircraft to use electric power instead of its own APU which uses fossil fuels.
- Improve airport collaboration decision making with aviation stakeholders for more efficient use of resources, punctuality and predictability, this will reduce wastage of energy usage.

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6. EXPECTED RESULTS

The table below gathers annual fuel burn data before and after when considering the reduction in fuel consumption to be achieved as a result of mitigation measures implemented by stakeholders from 2020 to 2025, as well as the future effect of the continuous adoption of these measures.

By the end of the projected period, ongoing implementation of mitigation measures will prevent the emissions of more than 7 million tonnes of CO_2, which is more than the emissions estimated for the baseline scenario. The projected reduction in CO_2 emissions will be 254,593 tonnes in 2024 to 258,474 tonnes in 2050.

Table 5.1: Evolution of fuel consumption for the scenario without measures and with the adoption of mitigation measures

Year	Annual Fuel burn before implementation of mitigation actions (t)	Annual Fuel burn after implementation of mitigation actions (t)	Annual CO_2 savings (t)	CO_2 Saving (%)
2019	115, 491,00	115 491,00	0	0,00
2020	120,110,64	120,110,64	0	0,00
2021	124,915,07	124,915,07	0	0,00
2022	129,911,67	95,333,36	109,267	-26,62
2023	135,108,13	57,180,12	246,253	-57,68
2024	140,512,46	59,945,02	254,593	-57,34
2025	146,132,96	64,337,29	258,474	-55,97
2026	151,978,28	70,182,61	258,474	-53,82
2027	158,057,41	76,261,74	258,474	-51,75
2028	164,379,70	82,584,03	258,474	-49,76
2029	170,954,89	89,159,22	258,474	-47,85
2030	177,793,09	95,997,42	258,474	-46,01
2031	184,904,81	103,109,14	258,474	-44,24
2032	192,301,00	110,505,33	258,474	-42,54
2033	199,993,04	118,197,37	258,474	-40,90
2034	207,992,77	126,197,09	258,474	-39,33
2035	216,312,48	134,516,81	258,474	-37,81
2036	224,964,98	143,169,30	258,474	-36,36
2037	233,963,58	152,167,90	258,474	-34,96
2038	243,322,12	161,526,45	258,474	-33,62
2039	253,055,00	171,259,33	258,474	-32,32
2040	263,177,20	181,381,53	258,474	-31,08
2041	273,704,29	191,908,62	258,474	-29,88
2042	284,652,46	202,856,79	258,474	-28,74
2043	296,038,56	214,242,89	258,474	-27,63
2044	307,880,10	226,084,43	258,474	-26,57
2045	320,195,31	238,399,64	258,474	-25,55
2046	333,003,12	251,207,45	258,474	-24,56

Year	Annual Fuel burn before implementation of mitigation actions (t)	Annual Fuel burn after implementation of mitigation actions (t)	Annual CO_2 savings (t)	CO_2 Saving (%)
2047	346,323,25	264,527,57	258,474	-23,62
2048	360,176,17	278,380,50	258,474	-22,71
2049	374,583,22	292,787,55	258,474	-21,84
2050	389,566,55	307,770,88	258,474	-21,00

Table 1 Expected Results

The graph below shows the comparison of fuel consumption for the scenario without the adoption of mitigation measures (baseline) and fuel economy when considering measures implemented by national stakeholders of aviation sector. The red and violet curves present the evolution of fuel efficiency up to 2050.

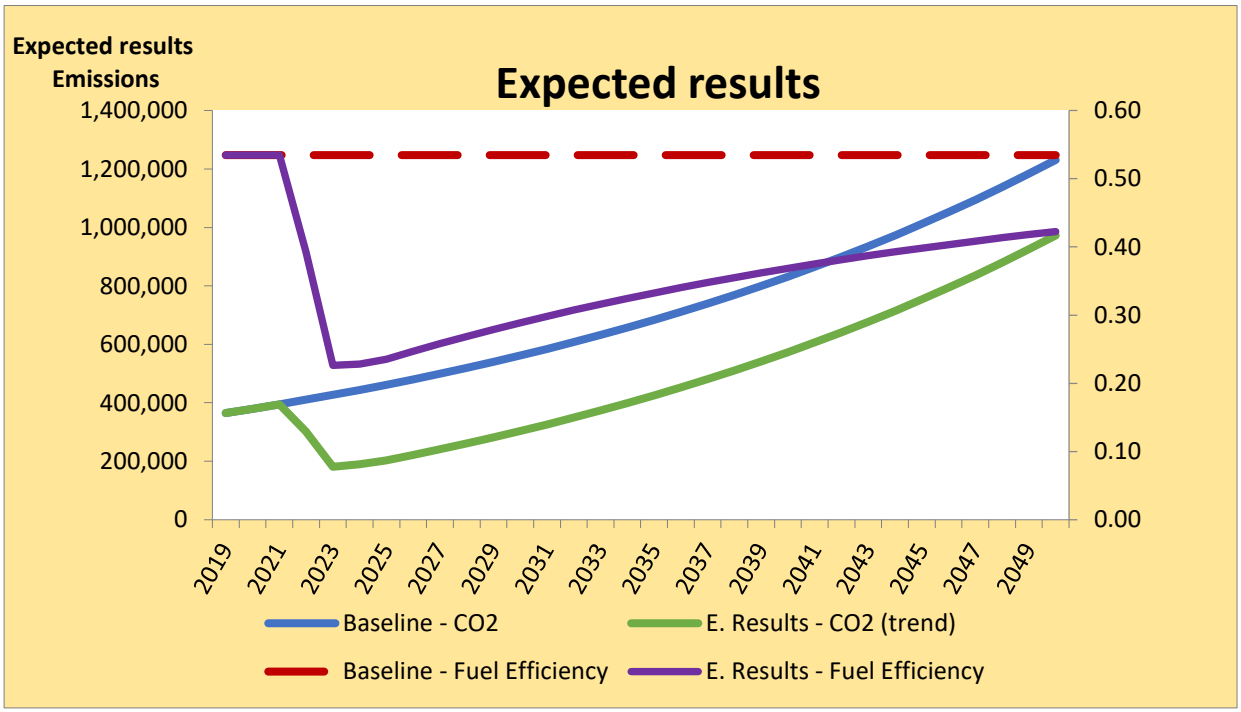

Figure 5.1: Expected results

The roadmap for the implementation of mitigation measures is provided below.

7. ROADMAP FOR THE IMPLEMENTATION OF MITIGATION MEASURES

No	Description	2020	2021	2022	2023	2024	2025
1	Conduct a feasibility study to assess the potential of promoting SAF their use in aviation sector						
2	Develop standards for SAF use and equivalence and similarity to current equipment technology						
3	Review aircraft fuel efficiency						
4	Improve Apron Management (Reduced movements and distance by GSE)						
5	Reduce turnaround times (all stakeholders collectively working together)						
6	Efficient use of flight levels, which reduces unnecessary descents and climbs.						
7	Plan and use a flexible way on a day-to-day basis by all categories of airspace users						
8	Implement Continuous Climb Operations (CCO) in international airport of Kigali						
9	Implement Continuous Descent Operations (CDO) in international airport of Kigali						
10	Improving existing SIDs & STARs PBN						
11	Implementing PBN procedures and requiring aircraft to be retrofitted with conforming systems						
12	Establish a civil-military coordination framework to cater for the flexible use of airspace						
13	Improve taxing procedures						
14	Recommend to the apron management to park all aircraft nose-in						
15	Replace facilities at the terminal that use fuel with those that use solar, electrical, or other green energy						
16	Increase parking capacity at the apron						
17	Provision of enhanced weather information						
18	Enhance and improve the current tankering policy, pantry uplifts, potable water uplift						

No	Description	2020	2021	2022	2023	2024	2025
19	Control of thrust reversers use during landing						
20	Introduce Single engine taxi procedures across the network						
21	Improve load factors by ensuring RwandAir achieves the highest load factor possible on every flight						
22	Ensure pilots training on fuel efficiency measures and consistent monitoring						
23	Replace some classic lighting with LED Lighting						
24	Install solar lighting and LED systems in terminal buildings and runway						
25	Install solar water heating systems in terminal buildings						
26	Park aircraft close to boarding Gates to reduce use of GSE or use bridges where applicable						
27	Avoid unnecessary idling of GSE during operations						
28	Conversion of GSE to Hybrid Electrical Vehicles or to Battery Electrical Vehicles						
29	Develop enforcement tool promoting use of Electrical vehicles at the airports						
30	Develop enforcement tools for promotion of mass transport at the airports						

Table 2 Roadmap for the implementation of Mitigation measures

8. ASSISTANCE NEEDS

The State will require assistance from the relevant partnerships to implement some of the listed mitigation measures in this State Action Plan. The assistance required includes but is not limited to: -

- Implementation of new high capital-based projects through Funding into research and development such as SAF, electric vehicle innovations etc.
- Training in areas identified and prioritised by the State in regard to Environmental sustainability.
- Development of training programs in line with Environmental Sustainability to ensure that the state has the technical capacity to locally sustain its programs meant to ensure reduction in Carbon-dioxide emissions.

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9. LIST OF MITIGATION MEASURES SELECTED

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
1. Technology and standards								
Fuel efficiency	Establish fuel efficiency program that will contain recommended practices for flight crew to follow and minimize fuel burn. Purchase of fuel efficiency monitoring systems called fuel Dashboard; it includes all recommended practices for flight crew laid in the Fuel Efficiency Program. Purchase Systems' integration: It involves the integration of the Fuel Dashboard into operations. The fuel dashboard should be able to get the actual fuel burnt from the aircraft and transmit it to Flight Crew and Flight Operations Engineers for possible analysis	2022	2022	**109,267.46 t CO_2**	RwandAir	50,000	No	1. Review and amend documentation on fuel efficiency 2. Purchase of fuel Monitoring dashboard 3. Training Personnel
Detail on quantification: EBT used								

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
- Aircraft category: WB: 2 – NB: 8 – TP: 2 - Age of aircraft when replaced: 15 years - Annual flight time per aircraft: WB: 4,782 hr – NB: 3,772 hr – TP: 1,938 hr - Annual fuel savings: (475.4+33,905.90+197.27) = 34,578.31t - Annual CO_2 savings: 34,578.31 * 3.16 = 109,267.46t CO_2								
2. Sustainable aviation fuels								
Development of SAF	The development and use of sustainable aviation fuel would reduce the amount of CO_2 emitted with minimal investment in fuel handling infrastructure changes and aircraft fleet but it still has challenges as the production cost is high and most of the technologies are under R&D. As on our case, in Rwanda, there also is a challenge on limited arable area to grow feedstock for fuel conversion and assure food security.	2022	2025	NA	MININFRA, MINAGRI, Private R&D companies, air carriers	TBD	YES	1)MININFRA, MINAGRI to incentivize feedstock producers, conversion companies, Air carriers using SAF. 2) R&D companies to further develop a lower life cycle feedstock for fuel conversion.

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
Detail on quantification: NA								
Standards requirements for SAF use	Development of standards for SAF use and equivalence and similarity to current equipment technology (Filter, pumps,)	2022	2025	NA	Fuel production companies, Standards development entities	TBD	YES	Fuel production companies and standards development entities to work on standards roll-out and feasibility. States to incentivize SAF for market accessibility and cost reduction.
Detail on quantification: NA								
3. Operational improvements								
Ground operations	Improvement in Apron Management (Reduced movements and distance by GSE)	2022	2023	**587.15 tCO_2**	Airlines, Ground Control staff	TBD	No	Redesigning of the parking bays on the apron.
Detail on quantification: EBT used - Aircraft category: WB: 2 – NB: 8 – TP: 2								

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
-Time savings per movement: 3 min - % of implementation: 30 - Annual fuel savings: (4.30+122.21+59.30) = 185.81t - Annual CO_2 savings: 185.81 * 3.16 = **587.15t**CO_2								
Airport Collaborative Decision Making	Establishing and operationalizing an effective A-CDM Platform. All stakeholders collectively working together. Reduced turnaround times	2022	2023	**149.82 tCO_2**	Airlines Airport ATM Handling Services Security AIM	TBD	No	1) Appointing members from all stakeholders to the A-CDM 2) Developing A-CDM procedures and guidelines 3) Familiarization of the A-CDM to stakeholders 4) Operationalization of the A-CDM
Detail on quantification: EBT used - Aircraft category: WB: 2 – NB: 8 – TP: 2 - Time savings per movement: 3 min - % of implementation: 30								

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
- Annual flight time per aircraft: WB: 4,782 hr – NB: 3,772 hr – TP: 1,938 hr - Annual fuel savings: (8.61+977.70+10.47) = 996.78t - Annual CO_2 savings: 996.78 * 3.16 = **3,149.82t**CO_2								
Optimum flight levels	The use of Surveillance systems and procedures to improve the optimization of flight levels. Efficient use of flight levels, which reduces unnecessary descents and climbs.	2022	2022	TBD	RCAA Airlines ANS ATM CNS	400,000 $	No	1) Redesigning of the airspace 2) Working with neighboring ANSP to establish and implement procedures / equipment for seamless operations of ATM Systems
Detail on quantification: No methodology available to quantify								
Flexible use of airspace	Airspace to be considered as a single spectrum, planned and used in a flexible way on a day-to-day basis by all categories of airspace users.	2021	2023	TBD	RCAA RAC Rwanda Defense Forces	TBD	No	Establishment of the Civil-Military Committee

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
	To access designated military airspace by civilian aviation, when not in use through coordination.							Operationalization of the committee
Detail on quantification: No methodology available to quantify								
Keyword	**Measure**	**Start date**	**End date**	CO_2 **savings**	**Stakeholders**	**Cost**	**Assistance needs**	**Required action**
Efficient departure procedures	Implementation of the Continuous Climb Operations (CCO)	2023	2024	**498.64 tCO_2**	RAC Neighboring FIRs	TBD	No	Implement Continuous Climb Operations in collaboration with neighboring FIRs
Detail on quantification: EBT used Number of movements 2019: 5,260 - % of implementation: 30 - Fuel savings/operation: 100kg Annual fuel savings: 157.80 t - Annual CO_2 savings: 157.80 * 3.16 = **498.64t**CO_2								
Efficient approach procedures	Implementation of the Continuous Descent Operations (CDO)	2023	2024	**299.41 tCO_2**	RAC Neighboring FIRs	TBD	No	Implement Continuous Descent Operations in

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
								collaboration with neighboring FIRs
Detail on quantification: EBT used Number of movements 2019: 5,264 - % of implementation: 30 - Fuel savings/operation: 60kg Annual fuel savings: 94.75 t - Annual CO_2 savings: 94.75 * 3.16 = **299.41t**CO_2								
Efficient departure and approach procedures	Improving existing SIDs & STARs Establishing Standard pathways from the airport to joining the airways and from airways to landing at an airport. Reduction in unnecessary maneuvers before joining the airways or landing at an airport.	2022	2024	**623.65 tCO_2**	ATM Airlines Navigation	TBD	No	Redesign Air Traffic Service and flight procedures, in order to efficiently manage both Standard Instrument Departures and Standard Arrival Routes, through establishing de-conflicting route
Detail on quantification: EBT used PBN SID: Number of movements 2019: 5,260 - % of implementations: 75 - Fuel savings/operation: 15kg								

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
PBN STAR: Number of movements 2019: 5,264 - % of implementations: 75 - Fuel savings/operation: 35kg Fuel Save: 59.18 + 138.18 = 197.36 t - CO_2 Save: 197.36 * 3.16 = **623.65t**CO_2								
RNAV/RNP Capabilities	Implementing PBN procedures and requiring aircraft to be retrofitted with conforming systems. Performance based navigation that allows aircraft to fly between two specific points without using conventional airways. Efficient use of airspace	2022	2024	TBD	ATM Airlines Navigation	TBD	No	Implementation of PBN concept
Detail on quantification: EBT used - Aircraft category: WB: 2 – NB: 8 – TP: 2 - Time savings per movement: 10 min - Number of climbs to optimal level: 3 - % of implementations: XX								
Civil-Military airspace	Establishing a civil-military coordination framework to cater for the flexible use of airspace. Optimum utilization of the airspace.	2021	2023	TBD	RCAA RDF RAC	TBD	No	Creation of a civil-military committee to implement the civil-military airspace concept.

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
Taxiing	Improved taxing procedures Reduced unnecessary maneuverability	2022	2023	TBD	Airport operations Airlines	TBD	No	Develop new Taxi procedures which will enhance capacity while reducing carbon emissions
Detail on quantification: Data not available								
Parking	Recommending to the apron management to park all aircraft nose-in, this will reduce maneuvers on the apron, that increase fuel burn hence carbon emissions.	2022	2025	TBD	Airport operations ATM GHS	TBD	No	Develop and Adopt new procedures for parking
Detail on quantification: Data not available								
Terminal support facilities	Replacing facilities at the terminal that use fuel with those that use solar, electrical or any other green energy. Relying less on fossil fuels for energy used in the terminal	2022	2023	TBD	RAC Airport Operations	100 000	No	Plan to acquire alternative energy using facilities (Lifts, Conveyer belts), like those that use solar, etc.
Detail on quantification: Data not available								

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
Environmental issues	Congestion caused by capacity issues Increased parking capacity at the apron.	2022	2023	TBD	RAC	TBD	No	Start utilizing the new the southern aprons by assigning parking slots to selected aircraft.
Detail on quantification: Data not available								
Forecasting Services	Providing up-to-date weather information Provision of enhanced weather information	2021	2023	TBD	Aeronautical meteorology, ANS, Finance	TBD	No	1) State of the art weather equipment was acquired 2) Installation and testing 3) Commissioning and handover of the equipment.
Detail on quantification: Data not available								
Minimizing weight	Enhancing and improving the current Tankering policy, pantry uplifts, potable water uplifts: Fuel tankering should be done	2022	2022	TBD	RwandAir	None	No	To review and amend procedures to be

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
	based on approved formulae for efficient fuel burn. The uplifts and portable water uplifts will have to be optimized and carry only the necessary operating weight on each flight. The more weight carried means more fuel to be burnt to carry that weight.							incorporated in the fuel policy program)
Detail on quantification: Data not available								
Minimizing weight – TP NB WB	1. Removal of all manuals onboard of all RwandAir TP and NB aircrafts and Installation of EFB 2. Pantry Optimization for all RwandAir aircrafts 3. Potable Water Optimization for all RwandAir aircrafts	2022	2022	TBD	RwandAir	TBD	No	1. Secure approval from RCAA to use EFB on RwandAir TP & NB aircrafts 2. Optimize pantry required for each route for all RwandAir aircrafts 3. Optimize potable required for each

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
								route for all RwandAir aircrafts
Detail on quantification: EBT used - Aircraft category: WB: 2 – NB: 8 – TP: 2 - Annual flight time per aircraft: WB: 4,782 hr – NB: 3,772 hr – TP: 1,938 hr - Weight reduction per aircraft: WB: 227,800 kg – NB: 160,400 kg – TP: 113,800 kg - Annual fuel savings: (8,496.85+32,429.54+1,720.25) = 34,578.31t - Annual CO_2 savings: 34,578.31 * 3.16 = **42,646.64t**CO_2								
Minimizing Flaps	1. Minimizing flaps (takeoff) – TP - NB 2. Minimizing flaps (landing) – TP - NB	2022	2022	**3,881.17 t**CO_2	RwandAir	TBD	No	Advise Pilots to use Optimum Flaps settings where possible during takeoff
Detail on quantification: EBT used - Aircraft category: NB: 8 – TP: 2 - % of implementations: 90 - Total number of movements per aircraft per year: NB: 2,276 – TP: 1,604 - Annual fuel savings take-off in low configuration: (32.77+727.57) = 760.34t - Annual fuel savings landing in optimum configuration: (98.32+369.56) = 467.88t								

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
- Annual CO_2 savings: (760.34+467.88) * 3.16 = **3,881.17 t**CO_2								
Minimizing reversers use	Control of thrust reversers use during landing: The use of Thrust Reversers induces extra fuel burnt. Flight Crew are advised to use thrust reversers only when it is needed	2022	2022	**1,598 t**CO_2	RwandAir	None	No	Document procedures on use of thrust reversers in accordance with aircraft performance recommended practices
Detail on quantification: EBT used - Aircraft category: NB: 8 – WB: 2 - % of implementations: 90 - Total number of movements per aircraft per year: NB: 2,276 – WB: 1,139 - Annual savings per landing: NB: 26.01 kg – WB: 100.15 kg - Annual fuel savings: (205.33+300.38) = 505,71t - Annual C02 savings: 505.71* 3.16 = **1,598 t**CO_2								
Single engine taxi	Introducing Single engine taxi procedures across the network: During Taxi-in and	2022	2022	**3,805.49 t**CO_2	RwandAir	None	No	To document procedures on single

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
	Taxi-out the use of two engines is not necessary since the aircraft does not need more power. The use of a single engine during taxi would save close to 50% of the fuel needed for taxiing							engine tax in the fuel efficiency program
Detail on quantification: EBT used - Aircraft category: WB: 2 – NB: 8 – TP: 2 - Total number of movements per aircraft per year: NB: 2276 – TP: 1,604 - Time with one engine off per movement: WB: 15 min - % of implementation: 60 - Annual fuel savings: (5.74+1,164.12+34.41.25) = 1,204.271t - Annual CO_2 savings: 1,204.27 * 3.16 = **3,805.49 t**CO_2								
Training Pilots	Ensuring that pilots are trained on fuel efficiency measures and consistent monitoring is in place: All pilots will have to be trained and sensitized on company fuel efficiency program and on how to use the fuel dashboard	2022	2022	TBD	RwandAir	45,000	No	Identifying required trainings for the pilots and other involved personnel

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
ADS-B	Measures to fully utilize ADS-B surveillance	2022	2022	TBD	RwandAir	TBD	No	Identifying required trainings for the pilots and other involved personnel
GPU Usage	Minimize GPU usage time	2022	2022	TBD	RwandAir	TBD	No	Set guidelines on GPU usage to minimize fuel consumption (eg: Use GPU strictly 10 min before boarding)
4. Airport improvements								
LED Lighting	Replacing some classic lighting with LED Lighting	2021	2023	**590,97 t**CO_2	RAC Airport Operations Engineering	80,000	No	Gradually replace classic lighting.
Detail on quantification: Rules of thumb used Total kwh/year for light: 4,924,816.28 CO_2 savings = 0.4 * kWh * Kg of CO_2/kWhj = 0.4 * 4,924,816.28 * 0.0003 = **590,97 t**CO_2								

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
Reduce distance travelled	Parking A/C close to boarding Gates to reduce use of GSE (Pax can Walk to/ from Gate to A/C) or use bridges where applicable	2022	2024	TBD	Airport Authorities GHS	No direct cost	Yes	To engage different stakeholders on applicability
Avoid unnecessary idling of equipment	Avoid unnecessary idling of GSE during operations	2022	2022	TBD	Ground Handling	None	No	Developing procedures on use of GSEs to avoid unnecessary idling during operation.
Electrically operated ground vehicles	Purchase of electrically powered GSEs where possible	2023	2024	TBD	Ground operations/ MININFRA/ REMA/ MINECOFIN	TBD	Yes	Develop a plan on phasing out hydro-carbon GSE and introduce electrical GSEs.
GSE	Purchase of electrically operated ground vehicles to replace Diesel operated ground vehicles	2022	2024	TBD	RwandAir	TBD	No	Make a phasing out plan of most of diesel-powered ground vehicles

Keyword	Measure	Start date	End date	CO_2 savings	Stakeholders	Cost (USD)	Assistance needs	Required action
Avoid unnecessary idling of equipment	Refueling Equipment manufacturers are working on a hybrid technology with which a refueling vehicle will have diesel powered engine and an electrically powered pump for fuel delivery to avoid unnecessary idling while refueling. Three (03) Trucks out of six (6) can be converted to HEV's (Hybrid Electrical Vehicles).	2022	2025	Reduce CO_2 emission by more than 50%.	Into plane Companies, MININFRA, refueling vehicles producing companies	1,500,000	Yes	1) MININFRA to implement incentives program (Fiscal and Non-Fiscal), 2) R&D companies to further develop BEV's or HEV's vehicles at competitive cost
Conversion of GSE to Hybrid Electrical Vehicles (HEV's) or to Battery Electrical Vehicles (BEV's)	The development and use of Electrical Vehicles would reduce the amount of CO_2 emitted with minimal investment in fuel handling infrastructure changes and GSE fleet, but it still has challenges as the production cost is high and most of the technologies are under R&D. All new trucks from 2035 can be fully BEV's (Battery Electrical Vehicles)	2022	2025	Reduce CO_2 emission by more than 90%.	MININFRA, MINAGRI, Private R&D companies, air carriers	6,280,000	Yes	1) MININFRA to implement incentives program (Fiscal and Non-Fiscal), 2) R&D companies to further develop BEV's or HEV's vehicles at competitive cost

Table 3 List of Mitigation Measure

End Document