ACTION PLAN FOR CO_2 EMISSIONS REDUCTION IN THE AVIATION SECTOR 2022-2028

KENYA CIVIL AVIATION AUTHORITY

SEPTEMBER 2022

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Figure 1: Kenya airways Aircraft taking off

ACRONYMS

The following is a list of acronyms used in this document:

ADS-B	Automatic Dependent Surveillance – Broadcast
ADS-C	Automatic Dependent Surveillance – Contract
AIC	Aeronautical Information Circular
AIM	Aeronautical Information Management
AMAN	Arrival Manager
APU	Auxiliary Power Units
ANS	Air Navigation Service
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Service
ATK	Available Tonne Kilometres
ASK	Available Seat-Kilometres
A-SMGCS	Advanced Surface Movement Guidance & Control System
AEWG	Aviation Environmental Working Group
BAU	Business As Usual
CAEP	Committee on Aviation Environmental Protection
CNS/ATM	Communication Navigation Surveillance/Air Traffic Management
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CPDLC	Controller Pilot Data Link Communications
DMAN	Departure Manager
CTA	Controlled Airspace
DME	Distance Measuring Equipment
ETS	Emissions Trading Scheme
EU	European Union
FRA	Free Route Airspace
GHG	Greenhouse Gas
GPU	Ground Power Unit
GNSS	Global Navigation Satellite System
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
ILS	Instrument Landing System
KAA	Kenya Airports Authority
KCAA	Kenya Civil Aviation Authority
KAAO	Kenya Association of Air Operators
KMD	Kenya Meteorological Department
KQ	Kenya Airways
MET	Meteorological Services for Air Navigation
MOTIH & UD	Ministry of Transport, Infrastructure, Housing & Urban Development and Public Works

MSSR	Mono-pulse Secondary Surveillance Radar
NDC	Nationally Determined Contribution
NEMA	National Environmental Management Authority
PBN	Performance Based Navigation
PCA	Pre-Conditioned Air
PSR	Primary Surveillance Radar
RNAV	Area Navigation
RNP	Required Navigation Performance
RNP AR	Required Navigation Performance Authorisation Required
RTK	Revenue Tonne Kilometre
RPK	Revenue Passenger Kilometres
SAF	Sustainable Aviation Fuels
SDOT	State Department for Transport
SID	Standard Instrument Departure
SSR	Secondary Surveillance Radar
STAR	Standard Instrument Arrival
WAM	Wide Area Multilateration

Figure 2:Aviation House

PREAMBLE

Aviation is a critical catalyst for global and national development. Air transport in Kenya has continued to grow and contribute to job creation and increased trade with other countries. The air transport industry was expanding steadily over the past years up to 2019 as a result of increased demand for air transport services. Indeed, air transport itself has acted as a key cause and facilitator of economic growth in Kenya by facilitating the country's integration into the global economy, providing direct benefits for users and wider economic benefits through its positive impact on productivity and economic performance.

The aviation sector in Kenya experienced traffic decline in the year 2020 due to the outbreak of Coronavirus (COVID-19) pandemic which resulted to the suspension of all international passenger flights in and out of Kenya on 25th March 2020 after the first case was confirmed on 13th March 2020. Domestic passenger traffic resumed on 15th July 2020 and international passenger traffic resumed on 1st August 2020. Despite these challenges, recent data for 2021 shows that economies are recovering at a faster rate than earlier anticipated after re-opening from the great lock down.

Since Air transport contributes to greenhouse gas emissions, Kenya Civil Aviation Authority and other aviation stakeholders submitted to ICAO the 2nd edition of Kenya's Aviation Action Plan for CO_2 Emissions Reduction on 24th December 2015, as a tool that was used to showcase and communicate both at the national and international level, Kenya's efforts to address Carbon dioxide (CO_2) emissions from aircraft operating national and international air service. The Action plan 2015-2021 has achieved an implementation level of 91.7 per cent with 33 out of 36 mitigation measures mentioned in the action plan having been completed within the timeframe upto December 2021. The completed measures have been able to reduce 1,252,503.78 Tonnes Carbon Dioxide (tCO_{2e}) for the past six years.

This 3rd edition of the Action Plan for CO_2 emission reduction expresses how Kenya aviation sector intend to reduce greenhouse gas emissions from aviation activities. In order to achieve the objectives of this Plan, specific activities have been developed in the short, medium and long term. This Plan has incorporated all the relevant stakeholders' views and comments for adoption and implementation. The implementation of this plan will be implemented from 2022 to 2028. For the plan to be effectively implemented Kenya will build capacity on environmental issues, data collection and conduct research on the impact of environmental issues on the aviation industry. This plan will be reviewed after every three years.

Signed: _____ 22/09/2022

Emile N. Arao

Director General-KCAA **Date**

EXECUTIVE SUMMARY

Globally, aviation has grown faster than other modes of transportation and is expected to outpace them in the future. As a result, there has been a rapid growth in aircraft fleets, expansion rates, and other developments to meet today's demand and capacity needs for the future. This growth has directly translated into an increase in emissions from aviation and airport-related activities. These emissions include but are not limited to: Carbon Dioxide (CO_2), Nitrogen Oxides (NOx), Sulphur Dioxides (SOx), Particulate Matter (PM10), Carbon (Soot), Hydrocarbons (HCs), and Volatile Compounds (VOCs).

The Kenya Civil Aviation Authority (KCAA) and its aviation stakeholders have worked together to develop this Action Plans for CO2 Emissions Reduction from both domestic and International Aviation. Recognizing the importance of the global warming issue, Kenya has progressively made efforts to address Greenhouse Gas (GHG) Emissions from Aviation. Kenya has taken a wide range of possible measures in various fields in aviation, that include; Technology and Standards improvements, Sustainable aviation fuels (SAF), Operational improvements, Market-based measures and Airport Improvements.

Kenya has been upgrading its air navigation systems, airports facilities, operations and procedures to meet the dynamic changing aviation industry and global challenges. The upgrades have significantly resulted in a more efficient Flight Information Region. These upgrades include the installation of new and modern air navigation systems, implementation of performance-based navigation, air traffic control services and upgrade of Airports infrastructures. In addition, Kenya has made effort in human capital development in aviation industry**.**

Building on the successful implementation of the Second Action Plan for the Reduction of CO2 Emissions in Aviation Sector 2015-2021 and the voluntary agreement to address greenhouse gas (GHG) emissions from aviation, KCAA and the Kenyan aviation industry has developed Kenya's Third Action Plan for CO2 emission reduction from Aviation from 2022-2028.

Taking into account achievements to date, Kenya has developed a National Climate Change Response Strategy, National Climate Change Action Plan, Climate Change Act 2016 and is committed to continue with the implementation of concrete actions towards a greener aviation. The aviation industry Action Plan sets an ambitious goal to reduce GHG emissions from both domestic and international operations, which is expected to contribute to both global efforts to minimize aviation's carbon footprint and Kenya's Nationally Determined Contribution (NDC) target.

In line with the ICAO Resolution A40-18, the Action Plan sets an aspirational goal to improve fuel efficiency from a 2020 baseline by an average annual rate of 2 percent from 2021 to 2050. To help ensure that this goal is achieved, the Action Plan has

adopted the four categories of measures and supplemental benefits for domestic sector that are expected to have the greatest environmental benefits namely:

a) Technology and standards;
b) Sustainable aviation fuels;
c) Operational improvements;
d) Market-based measures; and
e) Supplemental benefits for domestic sectors on Airport improvements

The Action Plan also highlights other measures with beneficial environmental results but cannot be expressed in quantitative terms. These include:

- Regulatory measures;
- International/National Coordination;
- Afforestation programs.

Further Kenya will introduce the following initiatives:

- Encouraging investment in aircraft efficiency improvements and the development of sustainable biofuels policy that includes the Sustainable Aviation Fuels (SAF);
- Monitoring and reporting of aviation carbon footprint;
- Working towards a multilateral approach through ICAO for managing the climate change impacts for international aviation; and
- Establishment of annual fora involving relevant Government agencies and industry to facilitate review and exchange of information on progress and challenges on mitigating measures and implementation.

The Action Plan is a living document that will evolve through:

- Annual meetings of the Aviation Environmental Working Group (AEWG);
- Annual reporting on the progress towards achievement of the Action Plan's fuel efficiency targets; and
- The review of the Action Plan, that will occur after three years or on need basis.

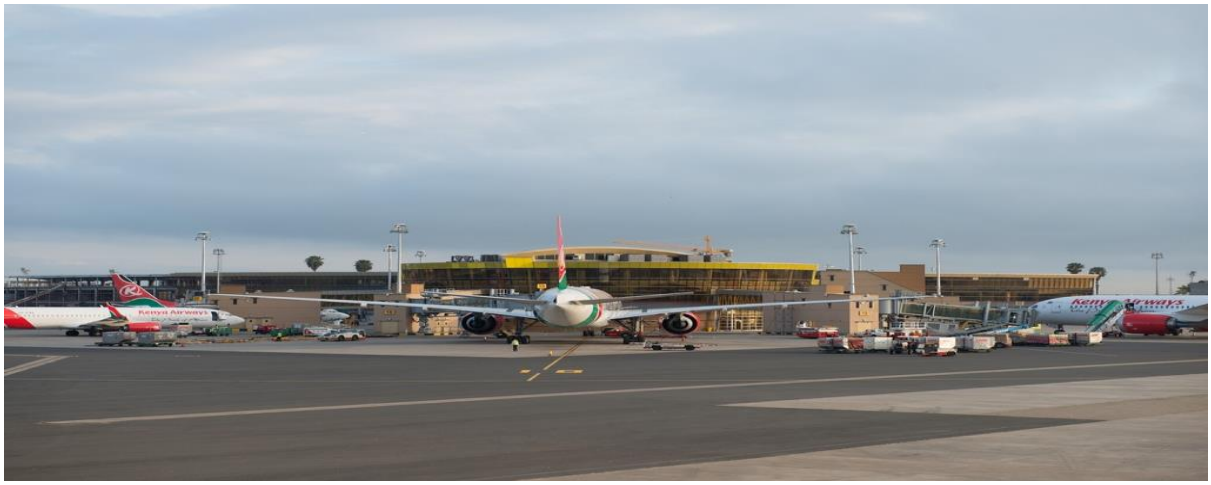


Figure 3: Kenya Airways Aircraft Parked at JKIA

1.0. INTRODUCTION

1.1. Background

The aviation sector often plays a central role in the national economy of Kenya, supporting numerous economic sectors and contributing to the Country development. As such, any measures to limit or reduce the impact of aviation on the environment, pursuant to the global aspirational goals agreed by the 37th Session of the ICAO Assembly and reaffirmed by the 38th and 39th Sessions of the Assembly, should be an integral part of the broader sustainable development priorities and objectives of Kenya. This would promote sustainable growth of aviation while ensuring consistency with any overarching greenhouse gas (GHG) emissions limitation or reduction efforts.

The ICAO Assembly at its 40th Session in 2019 adopted Resolution A40-18: Consolidated statement of continuing ICAO policies and practices related to Environmental Protection and Climate Change. It reiterated the aspirational goal to improve fuel efficiency improvement from a 2020 baseline by an average annual rate of 2% per annum from 2021 to 2050.

To achieve the global aspirational goals and to promote sustainable growth of international aviation, ICAO is pursuing a basket of measures including technology and standards, sustainable aviation fuels, operational improvements and market-based measures.

ICAO resolution A40-18 further encouraged States to submit voluntary action plans outlining respective policies and actions and annual reporting on international aviation CO_2 emissions to ICAO. The action plans should include information on the basket of measures considered by States, reflecting respective national capacities and circumstances, quantified information on the expected environmental benefits from the implementation of the measures chosen from the basket, and information on any specific assistance needs.

More precisely, ICAO resolution A40-18 required States to:

1. Consider policies to encourage the introduction of more fuel efficient aircraft into the market, and work together through ICAO to exchange information and develop guidance for best practices on aircraft end-of-life such as through aircraft recycling;
2. Accelerate investments on research and development to bring to the market more efficient technology;
3. Accelerate the development and implementation of fuel efficient routings and air navigation procedures to reduce aviation emissions, and work with ICAO to

bring the environmental benefits to all regions and States, taking into account the Aviation System Block Upgrades (ASBUs) strategy;

4. Reduce legal, security, economic and other institutional barriers to enable implementation of the new air traffic management operating concepts for the environmentally efficient use of airspace;
5. Work together through ICAO to exchange information and best practices on Green Airports;
6. Set a coordinated approach in national administrations for policy actions and investment to accelerate the appropriate development, deployment and use of clean and renewable energy sources for aviation, including the use of sustainable aviation fuels, in accordance with their national circumstances;
7. Consider the use of incentives to encourage the deployment of clean and renewable energies sources for aviation, including sustainable aviation fuels;
8. Consider measures to support research and development as well as processing technology and feedstock production in order to decrease costs and support scale-up of sustainable production pathways up to commercial scale, taking into account the sustainable development of States;
9. Recognize existing approaches to assess the sustainability of all fuels in general, including those for use in aviation which should achieve net GHG emissions reduction on a life cycle basis, contribute to local social and economic development; competition with food and water should be avoided; and
10. Adopt measures to ensure the sustainability of aviation fuels, building on existing approaches or combination of approaches, and monitor their production at a national level.

At national level, section 15 (5) of the Kenya Climate Change Act No. 11 of 2016 requires State Departments and National Government public entities to report on sectoral greenhouse gas emissions for the national inventory and designate a unit with adequate staff and financial resources and appoint a senior officer as head of the unit to coordinate the mainstreaming of the climate change action plan and other climate change statutory functions and mandates into sectoral strategies for implementation.

From the foregoing, Kenya has prepared this Action Plan as a tool that will be used to showcase and communicate both at the national and international levels, Kenya's efforts to address the GHG emissions from aircraft operating national and international air navigation. Through the Action Plan, Kenya has identified, quantified and is implementing the environmental mitigation measures that will contribute to Kenya's Nationally Determined Contribution (NDC) target and the ICAO global aspirational goals for international aviation.

This Action Plan has identified appropriate future mitigation measures, activities, barriers and constraints in the implementation of future actions and how to overcome them. These include access to financial resources, building national capacities and technology transfer and developing options to track the implementation of actions. The elaboration of this action plan has followed an inclusive process that has brought together all stakeholders.

1.2. Kenya's Aspirational Goals for Aviation

Kenya's *Action Plan to Reduce CO_2 Emissions from Aviation* describes ongoing and planned activities to reduce CO_2 emissions from national and international aviation activities.

This plan, seeks to undertake an ambitious mitigation contribution towards the 2015 Paris Agreement. Kenya's first NDC target was to reduce emission by 30%. This has been updated in the second NDC which commits to abate GHG emissions by 32% by 2030 relative to the business as usual (BAU) scenario of 143 $MtCO_2e$; and in line with its sustainable development agenda and national circumstances.

Through the implementation of these measures, the aviation sector, has set a target to achieve an annual average fuel efficiency improvement of 2% per annum from 2021 to 2050 which will contribute to Kenya's updated NDC and ICAO's aspirational goal of fuel efficiency improvement, calculated on the basis of volume of fuel consumed per revenue tonne kilometre (RTK).

1.2.1 The short term

Kenya will:

a) Report on international aviation CO_2 emissions to ICAO;
b) Report on domestic aviation CO_2 Emissions to Climate Change Directorate (CCD) in Ministry of Environment;
c) Review and update baseline emission data to reflect the current status of CO_2 emissions;
d) Maintain a national inventory of CO_2 emissions for the aviation sector
e) Develop respective policies and implement actions; and
f) Provide information on the basket of measures considered, reflecting our national capacities, circumstances and information on any specific assistance needs.

1.2.2 The long term

Kenya will:

a) Identify barriers and constraints in the implementation of future actions and how to overcome them, including access to financial resources, building national capacity and technology transfer;
b) Identify appropriate future mitigation measures and activities; and
c) Track the implementation of actions with an aim of continuous improvement.

1.3. Strategic Approach and Guiding Principles

Multiple factors informed the development of this Action Plan:

a) Review of the implementation status of the second action plan by identifying:
   - Benefits
   - Challenges and limitations
   - Opportunities
   - Lessons learnt
   - Gaps
b) Need for automated reporting system on aviation emissions;
c) The need to create national awareness to the stakeholders;
d) Public participation to enhance ownership; and
e) Need to meet both national and international requirements as guided by the principles established by Kenya Climate Change Act, ICAO Assembly Resolutions and other guidelines from the relevant UN and other specialized organizations.

In developing this State Action Plan for the reduction of CO_2 emissions, the following principles were relied on as a guide to selecting the actions:

a) On-going mitigation measures;
b) How the selected actions will contribute to the ICAO global aspirational goals;
c) How the actions may also contribute to Kenya's NDC;
d) Identified risks, barriers and constraints in the implementation of actions;
e) Options to track the implementation of actions; and
f) Stakeholders' involvement in the design and implementation of actions.

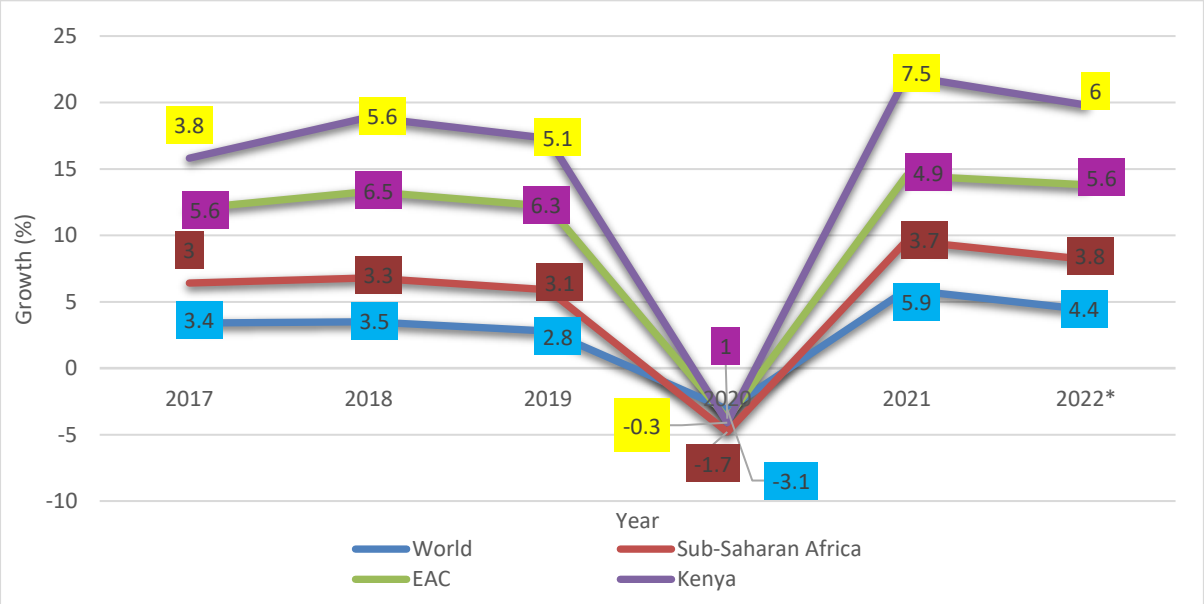
2.0 THE BUSINESS ENVIRONMENT

Aviation is a key driver of global economic development, where over a third of all trade by value is sent by air which makes aviation a key component of business worldwide. The industry supports employment, adds value to the economy by contributing to the GDP and facilitates global trade. During the year 2020 global trade was affected by the COVID-19 pandemic that had a negative impact on the civil aviation activities.. The recovery is projected to be more gradual and full recovery is estimated to occur in 2024 as the vaccine continue to be administered globally.

2.1. Global Economic Context

The World Economy is estimated to have grown by 5.9 percent in 2021 from a negative growth of 3.1 percent in 2020. The Sub-Saharan African region grew by 3.7% in 2021 from a negative 1.7 percent in 2020 due to the impact of the Covid-19 pandemic. The EAC region is estimated to have grown by 4.9 percent in 2021 from a growth of one percent in 2020. The economic growth in Kenya recorded a 7.5 percent in 2021 compared to a negative growth rate of 0.3 percent in 2020 mainly due to the continued recovery from COVID -19 pandemic. This positive growth has impacted positively to the growth of the civil aviation industry's performance during the year thereby affecting the Authority's financial performance. Passenger, freight, and aircraft traffic increased this financial year compared with the previous year. The trend of GDP growth rate comparison is shown below in figure 2.1

Figure 2.1: Global Economic Growth, Percent



Source of Data: Kenya National Bureau of Statistics

According to the ICAO's forecasts, global passenger traffic was expected to grow at 4.2 per cent annually from 2018 to 2038. The current forecast for revenue passenger kilometres (RPK) for 20-year (2018-2038) period Post-COVID is estimated to grow at

an average rate of 3.3%. In Africa, the current forecasted average growth rate for RPK is 4.5% for the period 2018-2050.

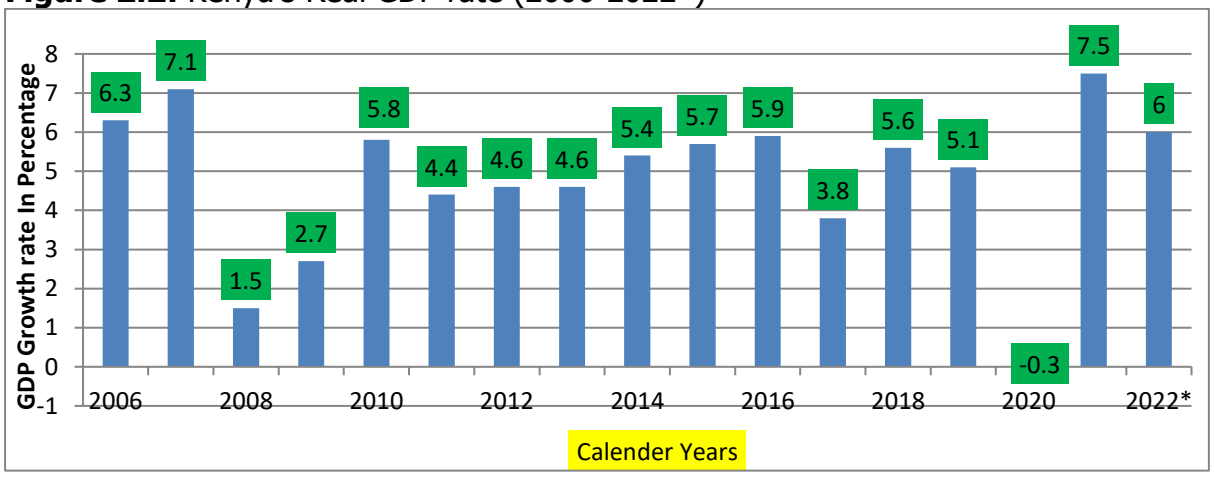
Macroeconomic data on recent estimates of demand shocks shows that traffic forecast will return to 2019 levels in 2023/2024 at low growth rate of 3.6% compared to 4.2% before COVID-19 based on ICAO Global forecast. The global freight traffic is expected to remain at a growth rate of 3.5% similar to the pre Covid-19 level. With the implementation of the Covid-19 containment measures, the aviation industry is on a recovery path and is expected to remain on an upward trend. During 2021, global scheduled passengers increased to 2.3 billion from the lowest levels of 1.8 billion achieved in 2020. Passenger traffic in Kenya recorded a growth rate of 98.8 percent in 2021/2022 compared to last year, Cargo traffic recorded a growth rate of 6.43 percent compared to the last year, while Aircraft movements recorded 44.4 percent growth this year compared to the previous financial year.

Aviation impacts on the environment include noise, impact on the climate and local air quality. Due to increasing pressure and a strong call for an environmentally sustainable aviation, it has become necessary for the global aviation sector to incorporate environmental considerations in its growth. An environmentally responsible air transport is an essential component of the sustainable growth of the sector.

2.2. Kenya's Economic Context

On the domestic scene, Gross Domestic Product (GDP) grew by 7.5 % from a contraction of 0.3 per cent in 2020. The Economy is projected to grow at 6.0% in 2022. In 2020 Kenya's economy was adversely affected by the Coronavirus Disease (COVID-19) and due to the containment measures put in place for both domestic and International passenger service, that significantly slowed down the economic activities in 2020.The Kenyan growth rate from 2006 to 2022 is shown the figure below.

Figure 2.2: Kenya's Real GDP rate (2006-2022*)



*Forecasts

Source of Data: Kenya National Bureau of Statistics

2.3. Kenya's Aviation Sector

Kenya has a vibrant aviation sector in the East and Central African region, with the sector directly accounting for 0.5 per cent of the country's GDP in 2021. The Jomo Kenyatta International Airport is East Africa's largest aviation hub and handles over 78 airlines from different parts of the world.

The Government has undertaken several major capital upgrades and infrastructure modernization initiatives at Kenya's airports to improve passenger handling capacity and airline access, thus increasing the country's ability to handle more traffic every year. These expansions together with the maintenance of FAA IASA Category 1 status that allows direct flights between Kenya and USA has contributed to increase in passengers handled at Kenya's airports. The non-stop flights to the USA by Kenya Airways have contributed to expansion of trade and business between the two countries.

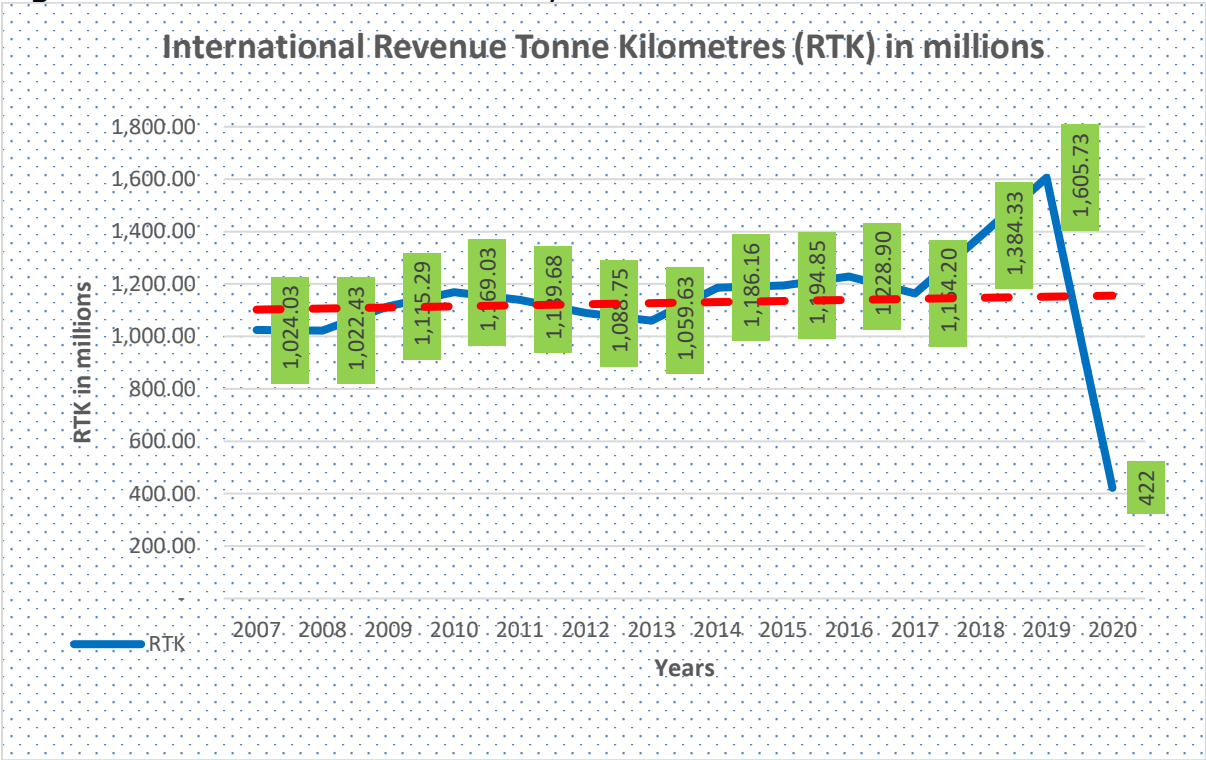
Kenya was negatively impacted by the Covid 19 pandemic with passenger numbers declining by 63% in 2020 compared to 2019 and by 45% in 2021 compared to 2019. The number of passengers declined from 12.0 million achieved in 2019 to 4.5 million in 2020 and recovered to reach 6.7 million in 2021 which translated to an increase of 48.6% from 2020. The overall aircraft movements within the Kenyan airspace increased by 28.15% from the 2020 movements of 197,428 to reach 253,009 in 2021 mainly due to the gradual resumption of aviation activities and passenger flights that was greatly disrupted by the Covid-19 pandemic in the year 2020. Major investments in airports, air navigation and aviation training infrastructure, equipment and systems continue to be undertaken to improve the air transport industry in Kenya.

As a result of the Covid-19 pandemic the contribution of civil aviation industry to Kenya's Gross Domestic Product dropped from 0.9% in 2019 to 0.4% in 2020 but increased to 0.5% in 2021. Despite the decline, the aviation industry continues to play a critical role in global connectivity, integrating Kenya into the global economy and providing wider economic benefits through its positive impact on productivity and performance in business, trade, conferences and events. Indeed, the ongoing recovery is expected to continue and traffic is expected to increase in the next five years. Passenger traffic is expected to grow from 6.7 million in 2021 to 12.0 million in 2024 and 14.6 million by 2028 with a constant growth of 5% which is above the Africa average growth rate of 4.4%. Freight traffic will grow from 377,504 tonnes in 2021 to 476,526 tonnes in 2024 and 650,202 tonnes in 2028 with an average growth rate of 8% above the global average of 3.5% annum.

2.3.1. Capacity trends

The figures shows that International Revenue Tonnes Kilometer (RTK) for Kenya from 2007 to 2020> The year 2019 recorded the highest RTK.

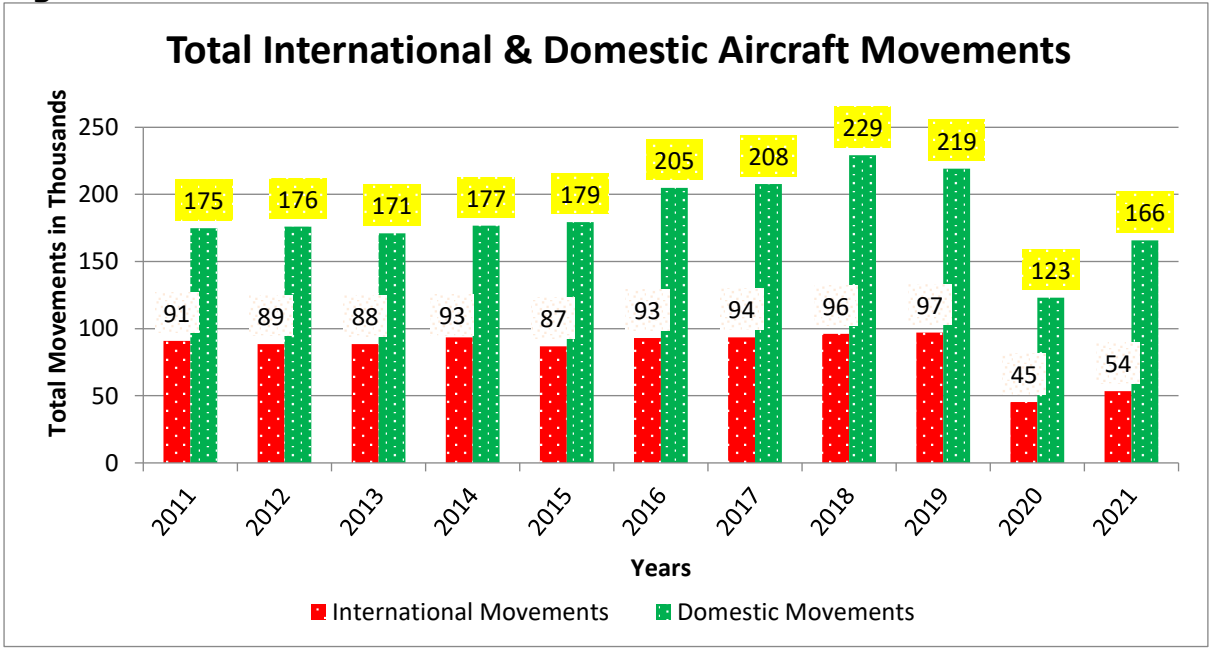
Figure 2.3: International RTK for Kenya



2.3.2. Traffic trends

Figure below shows the aircraft movements' trend from 2011 to 2021 for both international and domestic flights. Aircraft movements within the Kenyan airspace was lowest in 2020 mainly due to the disruption in aviation activities and passenger flights due to the COVID-19 pandemic.

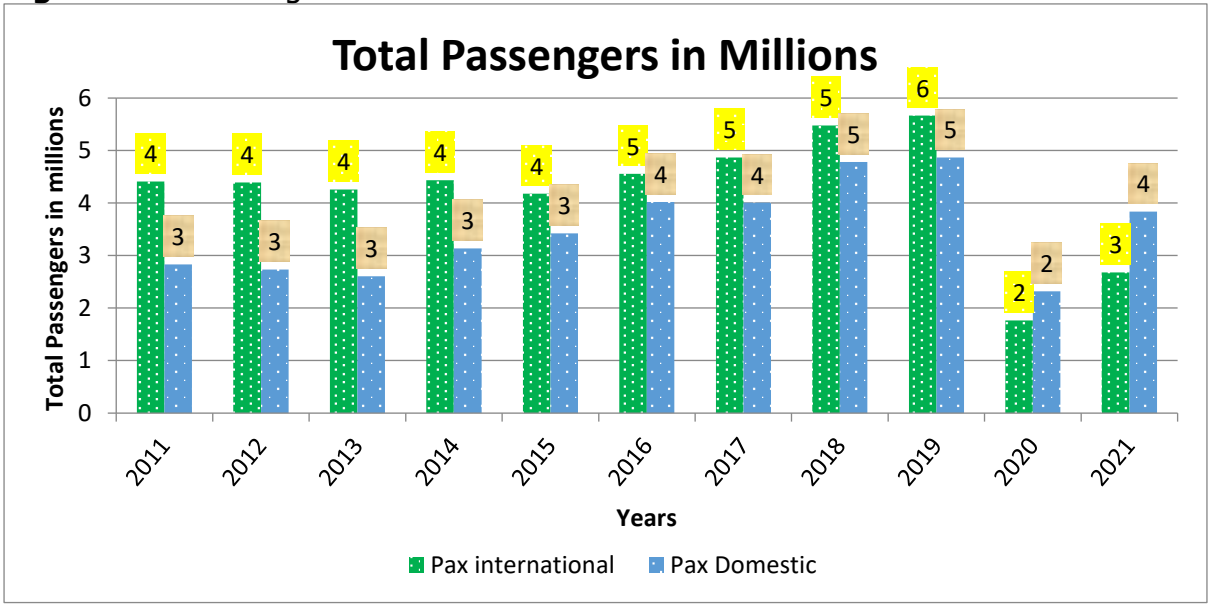
Figure 2.4: Total international and Domestic Aircraft Movements



Source: KCAA

Figure 2.5 indicates that in 2021, the passenger traffic increased in comparison to 2020 mainly due to the gradual resumption of economic and aviation activities that was greatly hampered in 2020 due to COVID-19 pandemic.

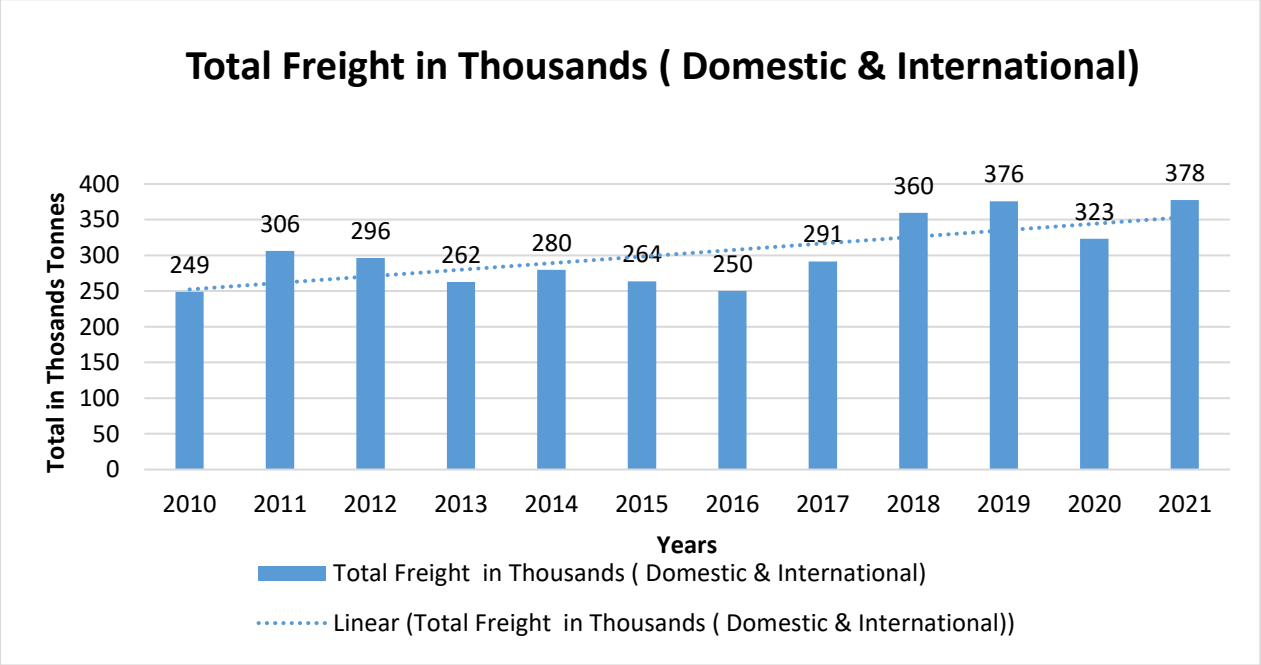
Figure 2.5: Passengers Traffic



Source: KCAA

The figure below shows that total freight traffic for 2021 increased in comparison with 2020 due to increased demand for cargo products amidst the covid-19 Pandemic.

Figure 2.6: Freight Traffic



Source: KCAA

2.3.3. State Department for Transport

The State Department for Transport (SDOT) under the Ministry of Transport, Infrastructure, Housing, Urban Development and Public Works is responsible for policy development in road, rail, air, maritime and non-motorized transport. The mandate of the State Department for Transport include:

- Transport Policy Management for Rail, Marine and Air Transport,
- Civil Aviation Management and Training,
- National Roads Development Policy Management,
- Mechanical and Transport Services,
- Development and Maintenance of Aerodromes,
- Axle Load Control and Advise the Government on National Policy with regard to Road Transport Sector.

Air Transport sub-sector is an enabler to the realization of the Kenya's economic agenda and is critical in the promotion of socio-economic activities and development. In addition, it plays key role in national, regional and international integration, trade facilitation and more importantly in job creation in the country. SDOT coordinates the transport sector climate change units in implementation and reporting of climate change activities. SDOT commits to ensure conducive environment for low carbon transport sector through development of relevant policies.

2.3.4. Ministry of Energy

The role of the ministry of energy is to develop and implement policies, and create an enabling environment for the country to transit to 100% renewable energy. Kenya ratified the Paris Agreement, and the energy sector is expected to contribute towards GHG emission reduction by 46MtCO2e. Currently about 90% of electricity used in Kenya is from renewable energy sources. The ministry plans to achieve 100% by 2030.

The Ministry has done baseline studies on the potential of biofuels production in the country to promote the use of Sustainable Fuels in the transport sector. The Ministry of Energy will implement the following initiatives:

- Start pilot projects for utilization of green hydrogen for ground and aviation services
- Undertake full feasibility study(s) for take-off of green hydrogen.
- Start pilot projects for production of Sustainable Aviation Fuels (SAFs)
- Review of the Ministry of Energy Bioenergy Strategy
- Review the SAF standards to ensure consistent product quality.
- Conduct training and capacity building

2.3.5. Kenya Civil Aviation Authority

Kenya Civil Aviation Authority (KCAA) is a State Corporation established on 24th October 2002 by the Civil Aviation (Amendment) Act 2002. The Authority is responsible for performance of three broad functions namely; Regulation of the civil aviation

industry in Kenya, provision of air navigation services and provision of aviation training, done through the East African School of Aviation. The Authority is required to carry out its functions in a manner consistent with the Chicago Convention on International Civil Aviation and any other international conventions and protocols relating to civil aviation, to which Kenya is a party.

The aviation activities have varying impacts on environment and social settings both at the international level and on the local situation through noise, air quality, safety aspects and ecological conflicts among others. KCAA recognizes that these environmental and social issues must be considered in order to promote a vibrant, safe, secure and sustainable civil aviation system.

KCAA has undertaken to implement the following initiatives:

a) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) by developing regulations and manuals to assists in the implementation of CORSIA.
b) Has developed and published Kenya Airspace Master Plan for the period 2015-2030 to facilitate planning and mobilization of resources towards the evolution of Air Navigation Systems (ANS) in reference to ICAO Global Air Navigation Plan (GANP) requirements. The Airspace Master Plan offers an opportunity to integrate KCAA's environment and social considerations into the airspace operations in accordance with the global trend through technologies and operational improvements focusing on efficiency and better air traffic management.
c) Has invested in modern equipments for ATM, AIM, CNS and Search and Rescue (SAR) facilities. These facilities have enhanced safety and operational efficiency in Kenya's airspace management leading to reductions in fuel burn, aircraft noise and carbon dioxide emissions.
d) Established Performance Based Navigation (PBN) implementation framework and concept of operations for Kenya.
e) Collaboration in regional initiatives that are geared towards reducing impact of aviation CO_2 emission on the environment.

2.3.6. Kenya Airports Authority (KAA)

The Kenya Airports Authority (KAA) was established in 1991 under KAA Act, Chapter 395 of the Laws of Kenya, that provides facilitative infrastructure for aviation services between Kenya and the outside world. Its main functions are to:

a) Administer, control and manage aerodromes;
b) Provide and maintain facilities necessary for efficient operations of aircrafts;
c) Provide rescue and fire-fighting equipment and services;
d) Construct, operate and maintain aerodromes and other related activities;
e) Ensure good environmental, health and safety status at all airports and aerodromes.

Airports are responsible for direct and indirect carbon emissions from the use of fossil fuels that supply power to airport infrastructure, ground transport, other equipment and facilities. Kenya has three international airports (Jomo Kenyatta, Moi and Eldoret), 23 domestic (regional) airports, 510 airstrips and 20 helipads around the country.

KAA aims at reducing its carbon emissions through provision of modern airport infrastructure. KAA plans to reach level 3+ carbon neutrality for four airports which include; Jomo Kenyatta International Airport, Moi International Airport, Eldoret International Airport and Kisumu International Airport by 2030 through the Airport Council International (ACI) Airports Carbon Accreditation (ACA) programme. This is towards achieving Net Zero by 2050. Two of the main airports are described below:

a) Jomo Kenyatta International Airport (JKIA)

JKIA is Kenya's largest airport facility and one of the busiest airports in East and Central Africa. JKIA, is Africa's premier hub and ideal gateway into and out of East and Central Africa. It also serves as a major cargo centre for both inbound and outbound goods. The following figures illustrate the traffic and movements data on aircraft, passenger and freight for JKIA from the year 2010 and projections till 2030.

Figure 2.7: JKIA Traffic Movements from 2010 to 2030

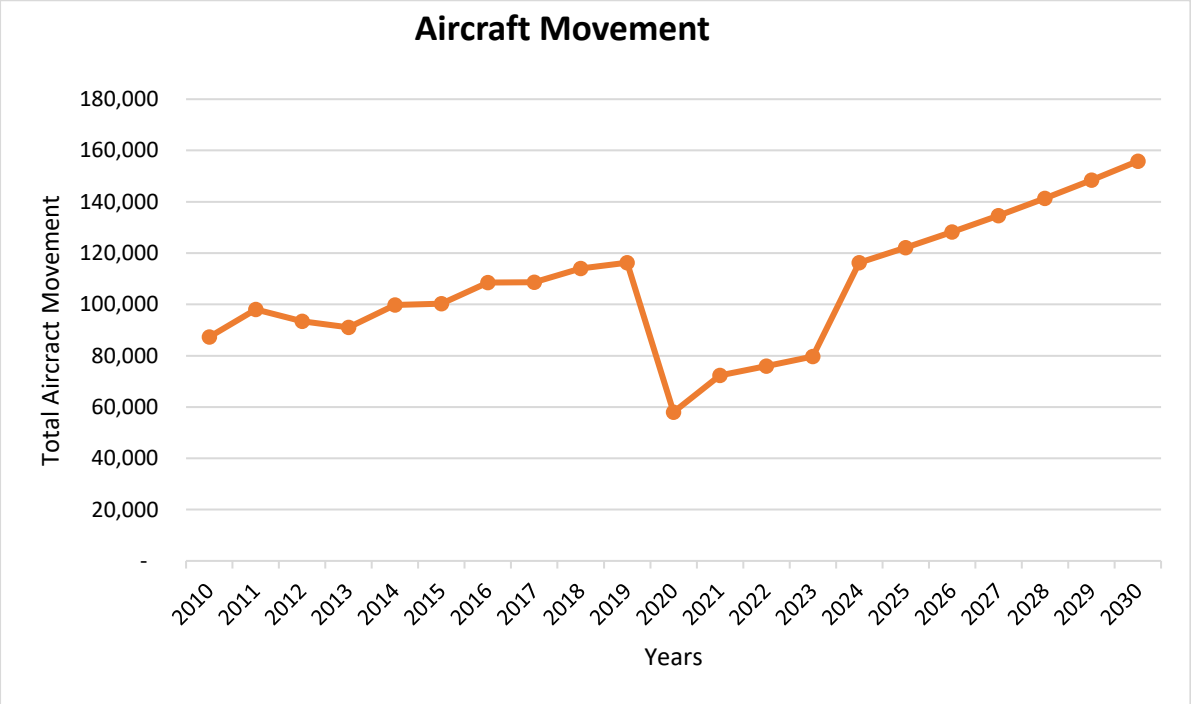


Figure 2.8: JKIA Passenger traffic from 2010 to 2030

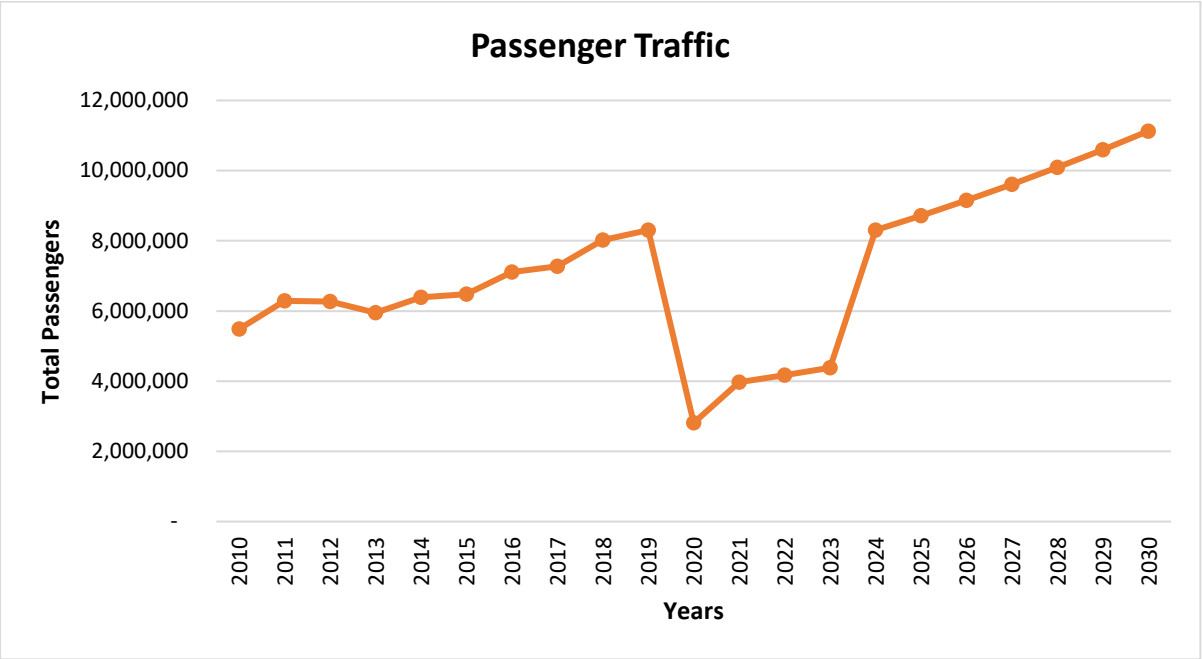


Figure 2.9: JKIA Freight Traffic 2010 to 2030

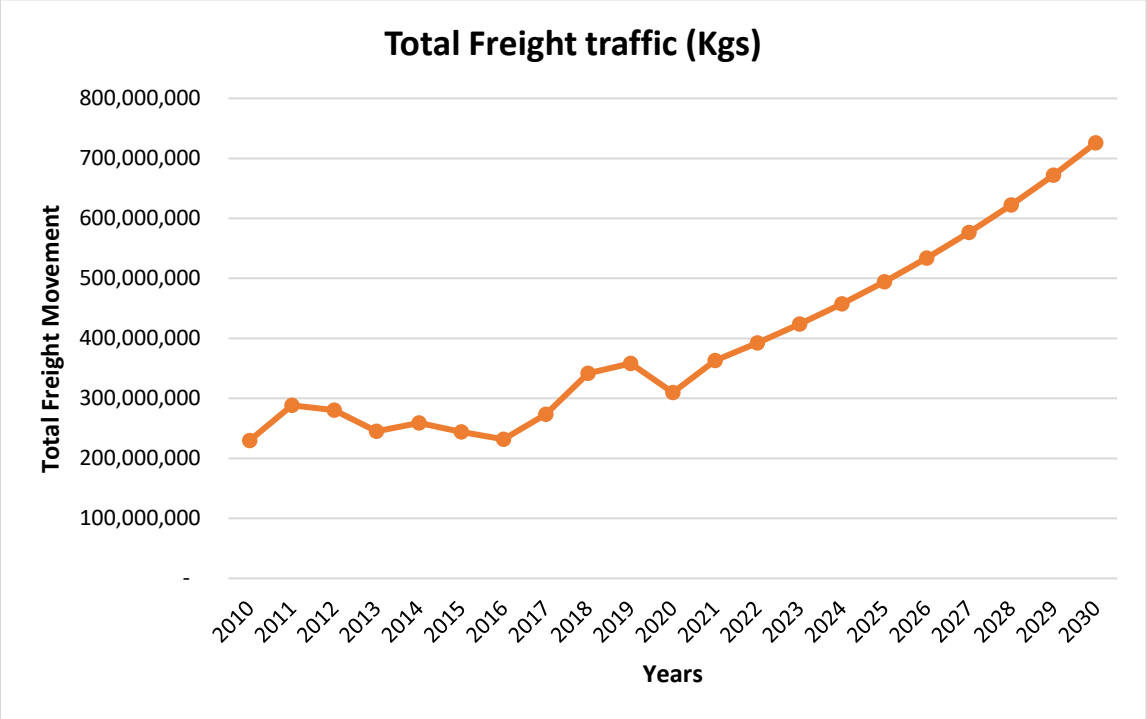


Photo of Jomo Kenyatta International Airport Terminal A1

b) Moi International airport (MIA)

Moi International airport (MIA) is Kenya's second largest airport and handles passenger and cargo. The airport offers connections to over 20 cities in the region. Mombasa region has remained attractive to tourists and the airport has therefore been developed to handle long haul international flights. Moi International Airport benefited from the ICAO EU project that installed 0.507 MW solar plant, which has been in operation since May 2019.

The following figures illustrate the traffic and movements data on aircraft, passenger and freight for JKIA from the year 2010 and projections till 2030.

Figure 2.10: MIA Traffic Movements from 2010 to 2030

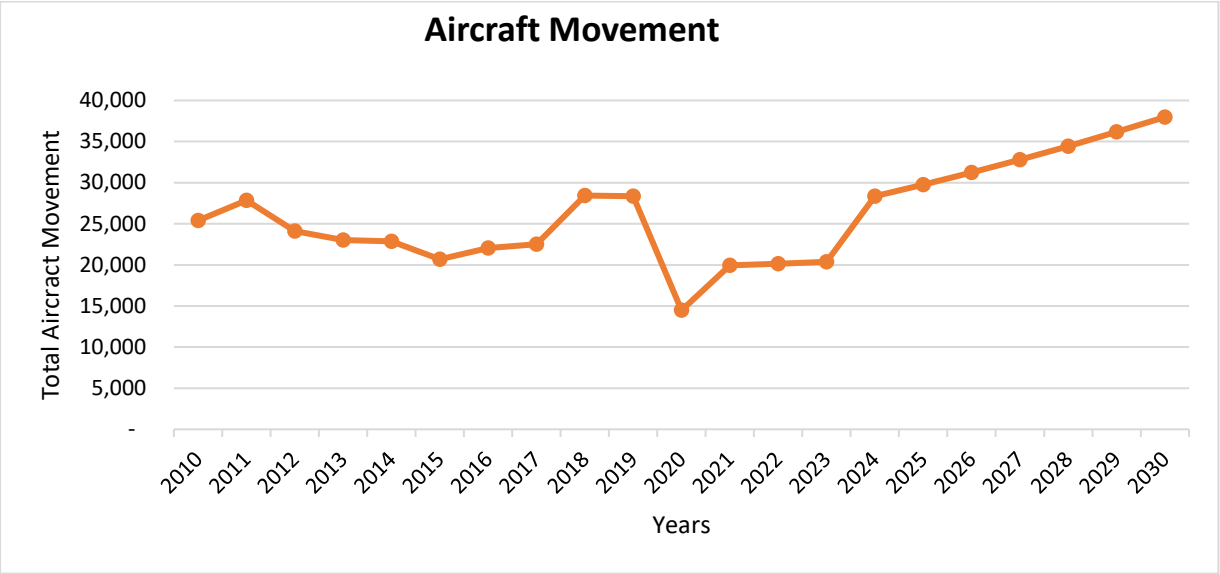


Figure 2.11: MIA Passenger Traffic from 2010 to 2030

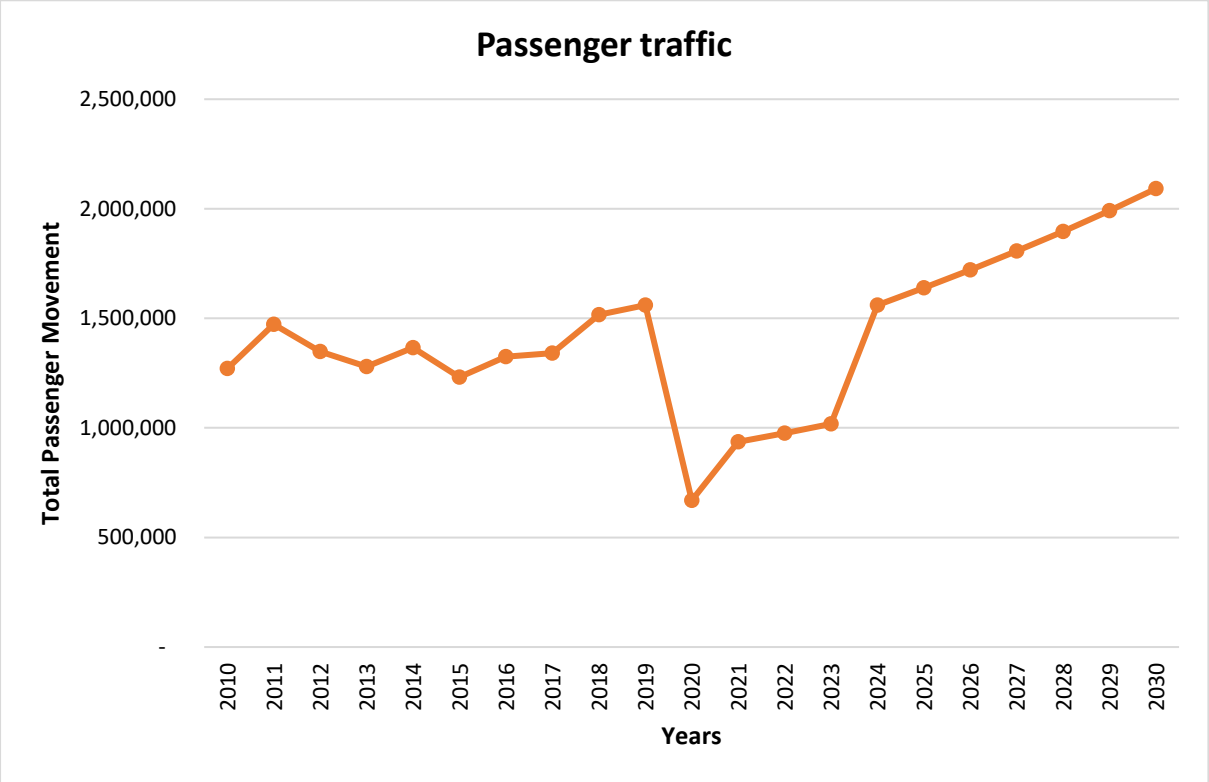
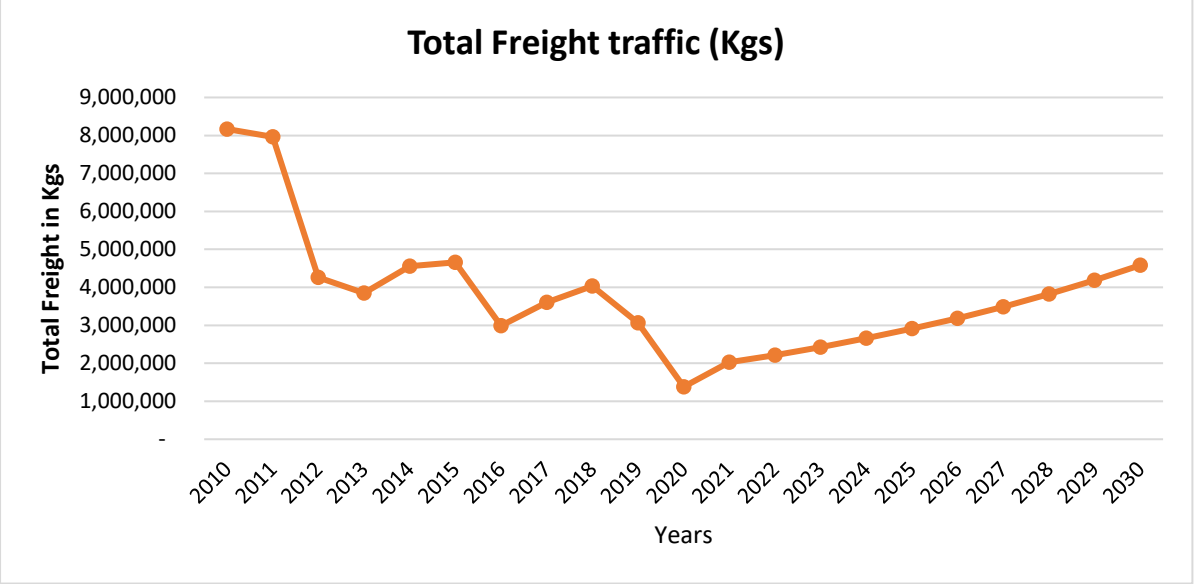
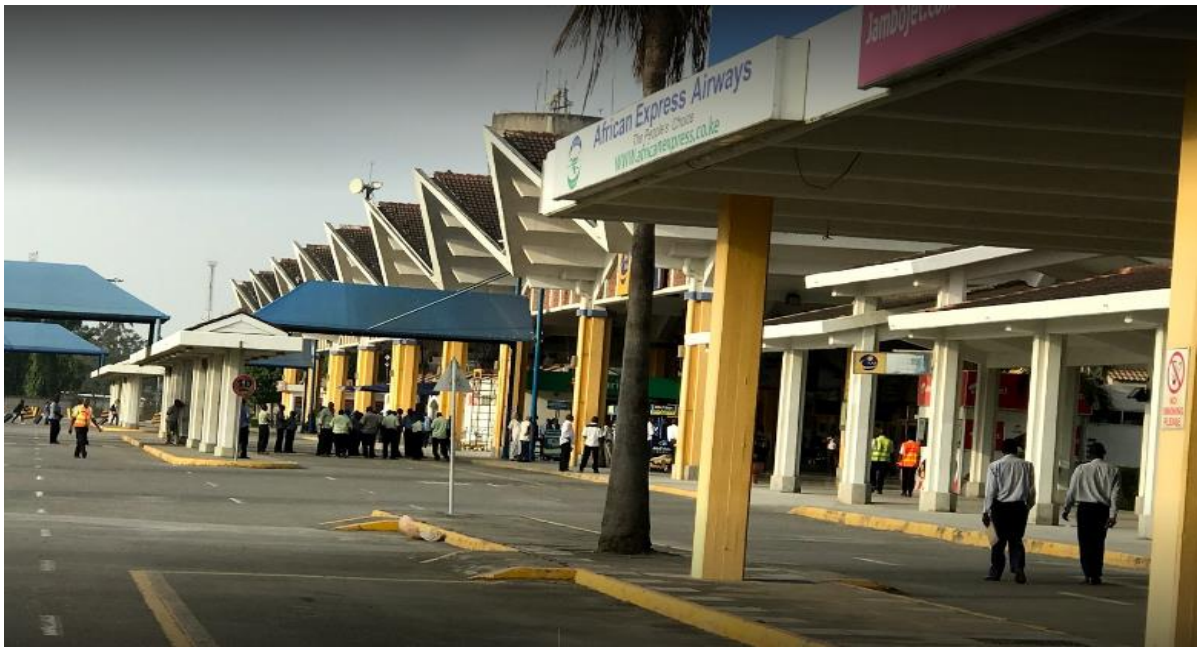


Figure 2.12: MIA Freight Traffic (Kgs) from 2010 to 2030





Moi International Airport Terminal

KAA has undertaken to implement the following initiatives:

a) Airport Carbon Accreditation that has 4 levels (Mapping, Reduction, Optimization and Neutrality). KAA is at level 1 (the mapping stage) that gives a clear picture of the total emissions from which a carbon management plan shall be developed.
b) Upgrade the international and domestic air transport facilities.
c) Install cleaner alternative sources of power generation (photovoltaic panels, wind generators)
d) Install cleaner heater/cooler equipment

e) Reduce electrical demand
f) Enhance ground support equipment (GSE) management
g) Conversion of GSE to cleaner fuels
h) Improve transportation to and from airport

2.3.7. National Airlines

The following table shows the national airlines and air operators registered in Kenya and operating international flights:

Table 1: National Airlines

N0	ICAO	IATA	Airline name
1.	XAK	P2	Air Kenya
2.	-	K4	Aircraft Leasing Services
3.	ACP	8V	Astral Aviation
4.	BBZ	-	Blue Bird Aviation
5.	EC	EC	East African Airways
6.	KQA	KQ	Kenya Airways
7.	XLK	F2	Safari Link
8.	IHO	FE	748 ASL
9.	FFV	5H	EASAX
10.	JBW	3J	Jubba Airways Limited
11.	SEW	OW	Skyward Express Limited
12.	JMA	JM	Jambojet
13.	FFV	5H	FLY 540

2.3.7.1 Kenya Airways

Kenya Airways is the National carrier for Kenya and among the leading African airlines. It was established in January 1977 following the breakup of the East African Community and subsequent disbanding of the jointly owned East African Airways. The head office is located in Embakasi, Nairobi, with its hub at Jomo Kenyatta International Airport. It flies to 42 destinations worldwide, 35 of which are in Africa. Kenya airways carries over 4 million passengers annually.

Kenya airways has fleet of 34 modern aircraft that comprise of nine B787, eight 737-800, two B737-300 and fifteen Embraer 190.

Kenya airways Aircraft preparing to land

Kenya Airways is committed to the reduction of carbon emissions and has employed various fuel efficiency initiatives. Currently KQ has planted approximately 1,000,000 indigenous trees. Guided by IATA principles, the initiatives are implemented during the day to day operations of the airline. They are categorized into 4 major areas of savings:

i) Flight Dispatch - 43%
ii) Flight Operations - 33%
iii) Maintenance and Engineering -14%
iv) Ground Operations and Commercial -10%

a) Flight Dispatch

Fuel efficiency requires a coordinated effort between flight operations, flight dispatch and operations control. Fuel savings and reduced emissions start from the planning process until the end of the flight. The flight planning system used by the flight dispatchers helps in ensuring fuel efficiency through:

- Optimizing cost index
- Flight level optimization
- Commercial and technical alternate selection
- Reduction of Pilot/Dispatcher additional fuel
- Zero fuel weight accuracy
- Reduction of contingency fuel from 5% to 3%
- Redispatch planning
- Training of staff on flight planning system for flight routes optimization and visibility of planning options

b) Flight Operations

The flight operations initiatives aimed at fuel savings include:

- Single engine taxi in
- Reduced flap landing
- Continuous descent approaches
- Idle reverse on landing
- Pilot technique and flight management
- Automation of Fuel Efficiency Solution system

c) Maintenance and Engineering

The maintenance and engineering fuel saving initiatives include:

- Removal of fly-away kit on particular route
- Purchasing fuel efficient aircraft thus reducing the carbon emissions.
- On-board weight: dirt, dust, over-paint
- Drag reduction through rigging of aircraft panels, doors and seals
- Paint and cleanliness
- Engine performance monitoring and Improvement
- Engine core wash and body wash

d) Ground Operations and Commercial

The ground operations and commercial fuel saving initiatives include:

- Use of electrical Air bridge ground service units
- Operation of electric tow trucks to tow dollies, trolleys, GPUs and non-motorized steps
- Aircraft servicing
- Aircraft commercial (discretionary) weight
- Potable water management
- On-board weight reduction
- Optimal aircraft loading
- Use of alternate forward centre of gravity for take off
- Installation of solar panels on the hangar 1 and 2 and Kenya Airways Headquarters
- Planting 500,000 trees as a Corporate Social Responsibility (CSR) project.

e) Carbon Offset Program

To ensure environmental sustainability and in an effort to attain carbon neutral growth, Kenya Airways is currently offsetting the carbon emissions produced from its flights by:

a) Implementing a voluntary carbon offsetting platform allowing guests to offset the carbon emitted from their booked flight; the monies collected from this program are used in the rehabilitation of the Kasigau Corridor REDD+ project in Voi, Kenya;
b) Participating in Carbon Offsetting Reduction for International Aviation (CORSIA)
c) Participating in EU and UK emission trading schemes.

2.3.7.2. 748 Air Service Limited

748 Air Services (K) Ltd is an Air Charter Company that holds an Air Operator Certificate and an imbedded Aircraft Maintenance Organization that is authorized by the Kenya Civil Aviation Authority. Since its inception in 1994, 748 Air Services (K) Ltd has grown into one of the most reliable air charter companies in the region, catering to the humanitarian sector, natural resource sector and government institutions. 748 ASL fleet is made up of six Q400, six Q100 and four C208.In May 2021, 748 ASL started domestic operations in five destinations in Kenya namely: Kisumu, Mombasa, Malindi, Ukunda and Mara.

748 ASL is committed to the reduction of carbon emissions through the following initiatives:

a) Modernization of Aircraft fleet by purchasing 10 Q400 and retiring three HS748 as a measure to get more fuel efficient and reliable aircraft.
b) Use of Fore Flight weather systems that allows for planning optimum flight level hence lower fuel burn.
c) Optimized use of performance charts in all phases of flight for efficient fuel burn.
d) Minimizing weights by reducing fly away kit onboard, carrying less catering and oil thus, leading to reduction of fuel burn.

2.3.7.3 Astral Aviation Ltd

Astral Aviation Ltd is an all-Cargo Airline based at Jomo Kenyatta International Airport, Nairobi, Kenya. The fleet includes 2 B747-400F, one B767-200F, 2 B727-200F, 1 B757- 200F, and 1 DC9-34F.

Astral Aviation Ltd operates scheduled Cargo Flights from Nairobi to Johannesburg, Dubai, London, Hong Kong, Dar Es Salaam, Mogadishu, Entebbe, Kigali, Mwanza, Juba and any other Ad-Hoc charters.

Astral Aviation Ltd is planning to add 1 more B757-200 and 1 more B767-300 on the existing fleet in the next on year as the expansion in the Cargo transportation industry.

2.3.8. Kenya Meteorology Department

Kenya Meteorological Department (KMD) provides meteorological and climatological services to various sectors of the economy. As stated in the World Meteorological Organization (WMO) Convention, the purpose of a National Meteorological and Hydrological Services (NMHS), like KMD, is in observing and understanding weather and climate and in providing meteorological, hydrological and related services in support of relevant national needs, which include the following areas:

a) Safety of life and protection of property;
b) Safeguarding the environment;
c) Contributing to sustainable development;
d) Promoting long-term observation and collection of meteorological, hydrological and climatological data, including related environmental data;
e) Meeting international commitments;
f) Contributing to international cooperation; and

KMD provides Aeronautical Meteorological Services to both domestic and international airports. The type of service depends on the size of the airports and their operational needs.

KMD has undertaken to implement the following initiatives:

a) Modernizing the weather forecasting systems and observing system for all the Kenyan Airports to enable provision of more accurate weather information.
b) Conduct training and capacity building

2.4. Aviation Environmental Working Group

The Aviation Environmental Working Group was officially created in 2012 incorporating relevant stakeholders in the aviation industry in order to;

a) Advise KCAA on matters related to Climate Change;
b) Adopt and implement the ICAO Assembly resolution related to Climate Change in Kenya;
c) Develop the environmental action plan for CO_2 reduction in the aviation industry;
d) Collection, analysis and submission to KCAA the fuel emission data; and
e) Support in the implementation of Climate Change Act of 2016.

The following table shows the participating stakeholders;

Table 2: AEWG Participating stakeholders

No	Organization	Category	Representation
1	Kenya Civil Aviation Authority (KCAA)	Government	1.National Focal Point 2.Alternate National Focal Point 3.Air Navigation Services Provider 4.Aviation Safety, Security and regulation 5.Corporation Secretary 6.Corporate Directorate
2	Kenya Airports Authority (KAA)	Government	Environment Department
3	National Environmental Management Authority (NEMA)	Government	Compliance and Enforcement Department.
4	Kenya Meteorological Department	Government	Aeronautical MET Section

5	Ministry of Transport, Infrastructure, Housing,Urban Development & public Works	Government	Climate Change Desk
6	Ministry of Environment and Natural Resources	Government	National Climate Change Directorate
7	Ministry of Energy	Government	Climate Change Desk
8	Energy Petroleum Regulatory Authority (EPRA)	Government	Petroleum and Gas
9	Ministry of Defence	Government	Environment Coordinator
10	Kenya Power	Government	Environment Department
11	Kenya Pipeline	Government	Environment Department
12	Kenya Airways	National Airlines	1.Safety & Environment Department 2. Fuel Analysis Department
13	Kenya Association of Air Operators (KAAO)	National Airlines	Executive Secretary
14	748 Air Services Limited (ASL)	National Airlines	Operations
15	African Express Airways	National Airlines	Safety/Operations
16	Fly 540	National Airline	Safety/Operations
17	Aircraft Leasing Service	National Airlines	Safety/Operations
18	East African Safari Express EASAX	National Airline	Safety/Operations
19	Astral Aviation Limited	National Airline	Safety/Operations
20	JamboJet	National Airline	Safety/Operations
21	Air Kenya	National Airline	Safety/Operations
22	Kenya Aerotech	Ground Handling	Safety/Operations
23	Swissport	Ground Handling	Safety/Operations
24	Total Kenya	Fuel supplies	Environmental Department

3.0. BASELINE FOR CO_2 EMISSIONS IN INTERNATIONAL AVIATION

3.1. Data collection

Kenya forecasts that the air traffic will grow at an average annual rate of 7.5 percent from 2024 until 2035 for both domestic and international air traffic (Annex 1). Kenya's forecast is largely in line with the air traffic forecasts based on the Covid-19 recovery of the aviation industry

KCAA requires airlines operating in Kenya to submit traffic statistics with fuel consumption data and Revenue Tonne Kilometer (RTK). From this data, calculation of emissions from domestic aviation is being undertaken based on estimation of fuel consumed by all civil aviation domestic flights for operators of passenger and freight traffic inside the country.

Historical data on fuel burnt and RTK for the years 2010 to 2021 were obtained from the main national airline and data published from ICAO Website on Kenya traffic data. Future updates of the Action Plan will take as far as possible account of the all other domestic national airlines as well.

The historical data that was used to calculate the baseline is detailed in the following table 3.

Table 3: Baseline data for International RTK

BASELINE				
Year	**International RTK (tkm)**	**International Fuel burn (L)**	**International CO2 emissions (kg)**	**Fuel efficiency**
2010	867,615,649	351,365,119	888,251,021	0.405
2011	857,415,984	429,432,615	1,085,605,651	0.501
2012	915,134,999	446,195,617	1,127,982,520	0.488
2013	921,665,778	452,681,102	1,144,377,826	0.491
2014	1,118,515,206	505,303,689	1,277,407,725	0.452
2015	1,194,851,696	546,995,630	1,382,804,953	0.458
2016	1,228,900,000	570,092,954	1,441,194,987	0.464
2017	1,164,200,000	547,288,094	1,383,544,302	0.470
2018	1,384,327,883	659,457,252	1,667,107,934	0.476
2019	1,605,731,680	738,636,573	1,867,273,256	0.460
2020	601,279,169	276,588,418	699,215,520	0.460
2021	733,793,633	337,545,071	853,313,940	0.460

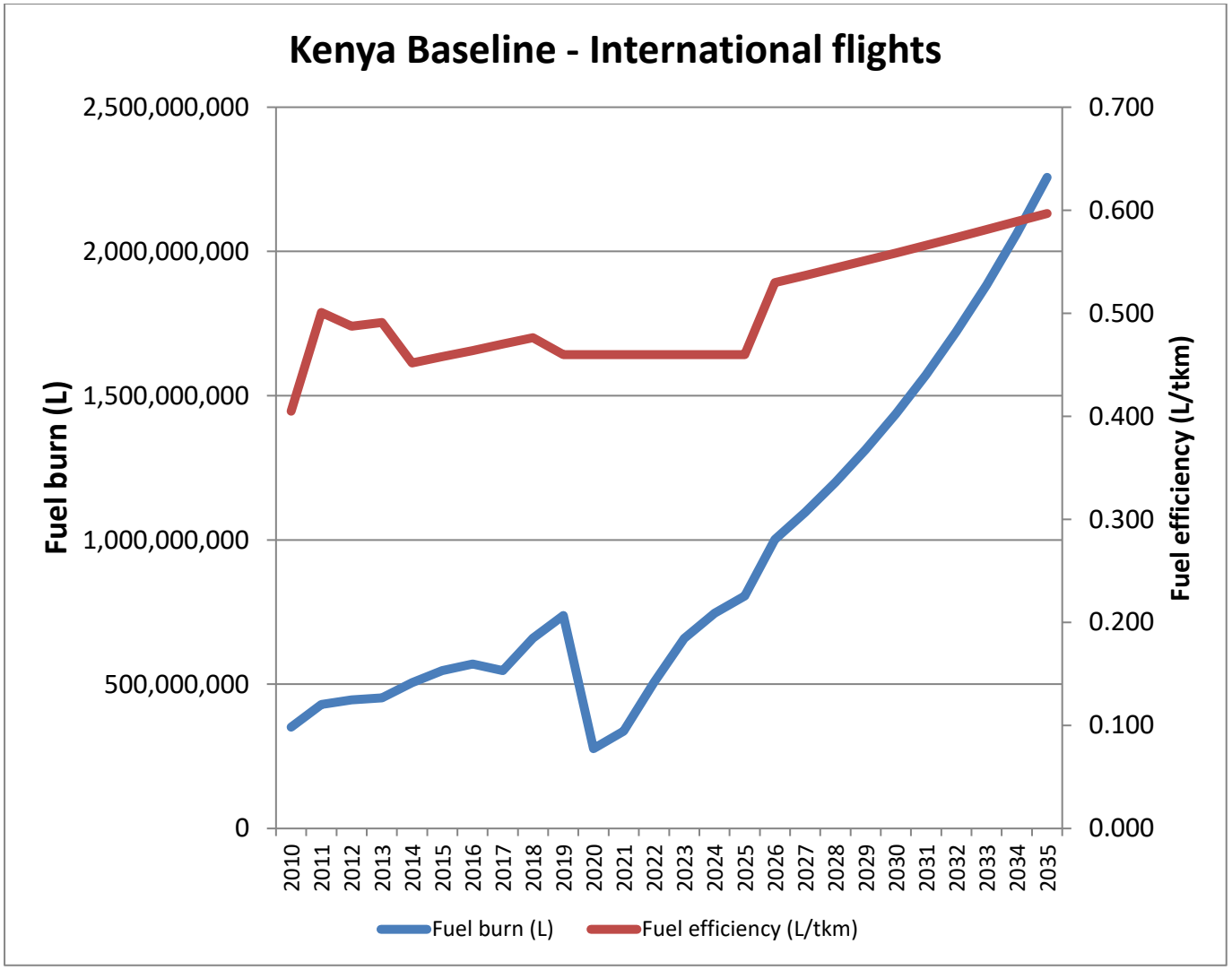
3.2. Baseline calculation

The following table 4 and figure 3.1 illustrate the results of the baseline and projection up to the horizon of 2035.

Table 4: Baseline data for International RTK

BASELINE					EXPECTED RESULTS				
Year	International RTK (tkm)	International Fuel burn (L)	International CO2 emissions (kg)	Fuel efficiency	Year	International RTK (tkm)	International Fuel burn (L)	International CO2 emissions (kg)	Fuel efficiency
2010	867,615,649	351,365,119	888,251,021	0.405	2010	867,615,649	351,365,119	888,251,021	0.405
2011	857,415,984	429,432,615	1,085,605,651	0.501	2011	857,415,984	429,432,615	1,085,605,651	0.501
2012	915,134,999	446,195,617	1,127,982,520	0.488	2012	915,134,999	446,195,617	1,127,982,520	0.488
2013	921,665,778	452,681,102	1,144,377,826	0.491	2013	921,665,778	452,681,102	1,144,377,826	0.491
2014	1,118,515,206	505,303,689	1,277,407,725	0.452	2014	1,118,515,206	505,303,689	1,277,407,725	0.452
2015	1,194,851,696	546,995,630	1,382,804,953	0.458	2015	1,178,915,027	462,130,915	1,168,266,953	0.387
2016	1,228,900,000	570,092,954	1,441,194,987	0.464	2016	1,242,576,439	462,221,352	1,168,495,578	0.376
2017	1,164,200,000	547,288,094	1,383,544,302	0.470	2017	1,309,675,566	436,228,489	1,102,785,619	0.375
2018	1,384,327,883	659,457,252	1,667,107,934	0.476	2018	1,380,398,047	544,135,219	1,375,573,832	0.393
2019	1,605,731,680	738,636,573	1,867,273,256	0.460	2019	1,454,939,541	620,305,725	1,568,132,873	0.386
2020	601,279,169	276,588,418	699,215,520	0.460	2020	1,533,506,277	165,377,108	418,073,330	0.275
2021	733,793,633	337,545,071	853,313,940	0.460	2021	1,616,315,616	224,017,409	566,316,010	0.305
2022	1,100,690,450	506,317,607	1,279,970,910	0.460	2022	1,703,596,659	386,376,588	976,760,015	0.351
2023	1,430,897,584	658,212,889	1,663,962,183	0.460	2023	1,795,590,878	532,499,850	1,346,159,620	0.372
2024	1,621,788,997	746,022,939	1,885,945,989	0.460	2024	1,892,552,786	616,973,118	1,559,708,041	0.380
2025	1,751,532,117	805,704,774	2,036,821,668	0.460	2025	1,994,750,636	674,387,043	1,704,850,445	0.385
2026	1,891,654,686	1,001,990,849	2,533,032,867	0.530	2026	2,102,467,171	863,214,248	2,182,205,618	0.456
2027	2,042,987,061	1,096,596,328	2,772,195,517	0.537	2027	2,216,000,398	954,224,718	2,412,280,088	0.467
2028	2,206,426,026	1,200,134,221	3,033,939,310	0.544	2028	2,335,664,419	1,053,828,171	2,664,077,616	0.478
2029	2,382,940,108	1,313,447,903	3,320,396,298	0.551	2029	2,461,790,298	1,162,835,933	2,939,649,239	0.488
2030	2,573,575,317	1,437,460,381	3,633,899,842	0.559	2030	2,594,726,974	1,282,135,937	3,241,239,648	0.498
2031	2,779,461,342	1,573,181,807	3,977,003,609	0.566	2031	2,734,842,231	1,412,699,949	3,571,305,472	0.508
2032	3,001,818,249	1,721,717,713	4,352,502,379	0.574	2032	2,882,523,711	1,555,591,491	3,932,535,288	0.518
2033	3,241,963,709	1,884,278,009	4,763,454,807	0.581	2033	3,038,179,991	1,711,974,495	4,327,871,524	0.528
2034	3,501,320,806	2,062,186,843	5,213,208,338	0.589	2034	3,202,241,711	1,883,122,793	4,760,534,422	0.538
2035	3,781,426,471	2,256,893,385	5,705,426,478	0.597	2035	3,375,162,763	2,070,430,487	5,234,048,272	0.548

Figure 3.1: Kenya Baseline and Forecast for International flights fuel burn


Kenya Baseline - International flights
Fuel burn (L)
Fuel efficiency (L/tkm)
2,500,000,000
2,000,000,000
1,500,000,000
1,000,000,000
500,000,000
0
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
Fuel burn (L)
Fuel efficiency (L/tkm)

4.0. MITIGATION MEASURES FOR CO_2 EMISSIONS REDUCTION IN AVIATION

4.1. Past and ongoing initiatives

Aircraft movements within the Kenyan airspace were at lowest in 2020 due to the due to the COVID-19 pandemic that caused disruption in aviation activities and passenger flights. However, Kenya recorded growth in freight traffic during the period. There was a decline in the growth of carbon dioxide (CO_2) emissions during the year 2020 due to reduced movements.

Kenya published the second action plan for the Reduction of CO_2 Gas Emissions to manage the Carbon Footprint in Kenya Aviation industry in 2015 and implemented most of the measures, which were contained in the action plan during the period 2015-2021.

The measures included air traffic management improvements and infrastructure use, airport improvements initiatives, improvements in aircraft technology development and more efficient air operations. The implementation of these measures is continuous and the aviation stakeholders in Kenya have also included them in their operational procedures for application by their operations and technical personnel in their day-to-day activities.

Kenya played and continues to play a key role in development of a global market-based measures (GMBM) of Carbon Offsetting and Reduction Scheme (CORSIA) to address any annual increase in the CO_2 emissions from international civil aviation above the 2020 levels. In this regard Kenya decided to voluntarily participate in the CORSIA scheme from 2021.To build on the aviation sector's fuel efficiency advances, Kenya has conducted studies aimed at the development of sustainable alternative fuels for aviation.

During the implementation of the previous action plan a number of challenges were encountered and will be addressed in this action plan. The aviation stakeholders in Kenya have proposed several measures to be implemented during the period 2022-2028, details of which are contained in this Action Plan (Annex 3).

4.2. Selected mitigation measures for the Action Plan

The Action Plan takes a sustainable development approach by taking into account the environmental, social and economic impacts of each measure. Details of the mitigation measures selected for the Action Plan are based on ICAO Doc 9988. The plan has adopted the five categories of the basket of measures that include:

i) Technology and standards;
ii) Sustainable aviation fuels;
iii) Operational improvements;
iv) Market-based measures; and
v) Supplemental benefits for domestic sectors on airport improvements.

4.2.1. Technology and standards

Background

This category includes medium-term and long-term measures. Medium-term measures include retrofits and upgrade improvements on existing aircraft, optimizing improvements in aircraft produced in the near- to mid-term. Long-term measures include purchase of new aircraft or the adoption of revolutionary new designs in aircraft/engines and the setting of more ambitious standards.

The fleet renewal efficiency gains are based on acquisition of modern aircraft which are more technologically advanced thus more fuel efficient than the fleets being replaced. Kenya Airways replaced its fleet with more efficient aircraft during the 2nd action plan implementation, whereby six B767 aircraft were replaced with new fleet of six B787 (Dreamliners).

The Kenyan airline industry has continued to modernize their fleets, infrastructure, and technology. The aviation industry plans to invest over USD 1 billion between 2022 and 2030.

Mitigation measures selected for the Action Plan

i) Jambo jet Fleet Upgrade
ii) Astral Aviation Fleet Upgrade
iii) 748 ASL fleet upgrade
iv) ALS fleet upgrade

Overall, national airlines of Kenya expect to achieve an average annual fuel efficiency improvement of **0.7 percent** for both domestic and international flights between 2022 and 2030 through further fleet changes.

4.2.2. Sustainable Aviation Fuels

Background

The use of SAF is a promising means to reduce aviation emissions. A motivating factor for the deployment of SAF is that the environmental benefits achieved through the implementation of technological and operational mitigation measures will not be

sufficient for the international aviation sector to reach its aspirational goal.

Under the ICAO-EU project, Kenya conducted a feasibility study on the potential of a sustainable aviation fuel supply chain in Kenya. A technical analysis of the potential pathways to produce sustainable aviation fuel was undertaken and various options, issues, risks and opportunities that exist in reaching this objective documented.

The Kenyan Government is developing a comprehensive renewable fuels strategy primarily focused on on-road transportation including aviation with five key elements:

i) A regulation to establish minimum bio fuels content for ethanol and diesel;
ii) Programs to support farmer participation in the industry;
iii) A production incentive to stimulate domestic production;
iv) Encourage the use of ethanol from the sugar industries; and
v) Initiatives to support next generation technologies.

Kenya will continue to assess the effectiveness of the renewable fuels strategy and analyze areas for future policy development. Kenya will also implement the report of the feasibility study conducted for sustainable aviation fuel production, supply and use of bio-fuel for the aircraft and ground support equipment in this action plan.

Mitigation measures selected for the Action Plan

Kenya will implement the following measures:

i). Set up a taskforce to develop a policy framework to support and promote the production, storage and distribution of sustainably Aviation fuel;
ii). Review of the Ministry of Energy Bioenergy Strategy;
iii). Start pilot projects for utilization of green hydrogen for ground and aviation services;
iv). Undertake full feasibility study(s) for take-off of green hydrogen;
v). Start pilot projects for the production of Sustainable Aviation Fuels (SAFs);
vi). Promotion of SAF technologies;
vii). Domestication of SAF toolkit;
viii). Develop partnerships with development partners and States for production of SAF in Kenya;
ix). Review the SAF standards to ensure consistent product quality;
x). Training and capacity building.

4.2.3. Operational improvements

Background

This category reflects changes to air traffic management (ATM) procedures and improvements to infrastructure and operations. This helps States and stakeholders to achieve sustained growth, increased efficiency and responsible environmental stewardship while also improving safety.

The ICAO Global Air Navigation Plan presents all States with a comprehensive planning tool supporting a harmonized global air navigation system. It identifies all potential performance improvements available, details the next generation of ground and avionics technologies that will be deployed worldwide and provides the investment certainty needed for States to make strategic decisions for their individual planning purposes.

4.2.3.1. Air Traffic Management (ATM)

Kenya has adopted the ICAO Global Air Navigation Plan (GANP) as an integrated planning tool for both regional and national levels which addresses required solutions by introducing the Aviation System Block Upgrades (ASBUs) initiative. Implementation of the ASBUs initiatives has been incorporated into the Kenya Airspace Master Plan 2015 – 2030 and subsequently the Strategic Environmental Assessment (SEA) Study Report that enhances harmonization, increased capacity, environmental efficiency, as well as airspace planning and sustainable utilization. This aspect forms the basis for selection of mitigation measures and initiatives related to ATM improvement and infrastructure use.

Kenya will implement the following initiatives:

i). Pre-departure planning (DMAN) and arrival planning (AMAN);
ii). Ground operations improvement;
iii). Improvement of Collaborative decision making (A-CDM);
iv). Improved use of optimum flight levels;
v). Improved use of optimum routings;
vi). Improved flexible tracks;
vii). Improved fuel-efficient departure and approach procedures;
viii). Full utilization of RNAV/RNP capabilities;
ix). Improved flexible use of civil-military airspace;
x). Enhancing weather forecasting services; and
xi). Collaborative research endeavours.

4.2.3.2. Pre-departure planning (DMAN) and arrival planning (AMAN)

The installation of this system is planned in the FY 2022/2023. Once the system is fully implemented the aviation industry will have the following benefits:

i) Improved efficiency by balancing arrivals and departures;
ii) Optimized planning for inbound and outbound flights;
iii) Reduced costs and environmental impacts caused by capacity imbalances;
iv) Support future air traffic flow management (ATFM)

4.2.3.3. Improve ground operations

This measure will be implemented through the upgrade of existing system to an Advanced Surface Movement Guidance and Control System (A-SMGCS) at JKIA and Mombasa Moi Airport.

A-SMGCS provides guidance and surveillance for the control of aircraft and vehicles in order to maintain the declared surface movement rate under all weather conditions while maintaining the required level of safety including delivering of improved situational awareness to controllers. A-SMGCS will provide benefits in terms of safety, increased Runway throughput and efficiency.

4.2.3.4. Airport Collaborative Decision Making (A-CDM)

A-CDM has been implemented in all manned Kenya airports and aims to improve the efficiency of airport operations by optimising the use of resources and improving the predictability of air traffic. It achieves this by encouraging the airport stakeholders to collaborate and exchange accurate and timely information.

When integrated with AMAN/DMAN the system will improve en-route and sectoral planning which will in turn, reduce the fuel burn, as it will focus on aircraft turn-round, pre-departure and pre-arrival process.

4.2.3.5. Fuel efficient departure and approach procedures

i) Continuous Descent Operations (CDO)

CDO is an aircraft operating techniques that is enabled by airspace design, procedure design and facilitated by Air Traffic Control (ATC). The concept allows aircraft to follow a flexible and optimum flight profile. The aircraft are flown with optimal fuel flow and in low drag configuration, they minimize fuel burn and fuel usage, while simultaneously reducing greenhouse gases emission and aircraft noise. CDO has been implemented in Nairobi JKIA, Moi International, Eldoret International Airport and other domestic airports.

ii) Continuous Climb Operations (CCO)

CCO has been implemented in Nairobi JKIA, Moi International, Eldoret International Airport and other domestic airports. This process has resulted to minimizing noise, reduced fuel consumption and emissions during the climb phase.

4.2.3.6. Full utilization RNAV/RNP capabilities

i) Free Route Airspace (FRA) Concept

Free Route operations enable airspace users to fly as closely as possible to their preferred trajectory without being constrained by fixed airspace structures or fixed route networks. FRA permits freely flight planning the route from a defined entry point to a defined exit point subject to airspace availability.

Kenya is participating in the implementation of AFI region FRA concept. The users of the FRA route will benefit through:

a) Reduced flight distances;
b) Reduced flight duration;
c) Reduce fuel burn and CO_2 emission;
d) Improved capacity; and
e) Flight flexibility and efficiency.

ii) Flight Plannable Direct Routes

Kenya has implemented flight plannable direct routes within Nairobi FIR to increase flight efficiency and minimize carbon dioxide emission. The promulgated flight plannable entry and exits gates are:

a) RUDOL-PATAR;
b) ANTAX – ETORU -KISAK;
c) ALEMU- WAJIR- DESRA-KISAK; and
d) LOSIN-WAJIR.

iii) Performance-Based Navigation (PBN)

Kenya has developed the PBN Implementation Plan that provides the framework for proper guidance and direction to the air navigation service, airspace operators and users, regulating agency, as well as foreign operators who operate or plan to operate in the airspace.

The primary driver for this plan is to maintain and increase safety, accommodate the increasing air traffic demand and capacity. Further PBN will facilitate implementation of new technology in consultation with relevant stakeholders and hence reducing fuel burned and CO_2 gas emissions.

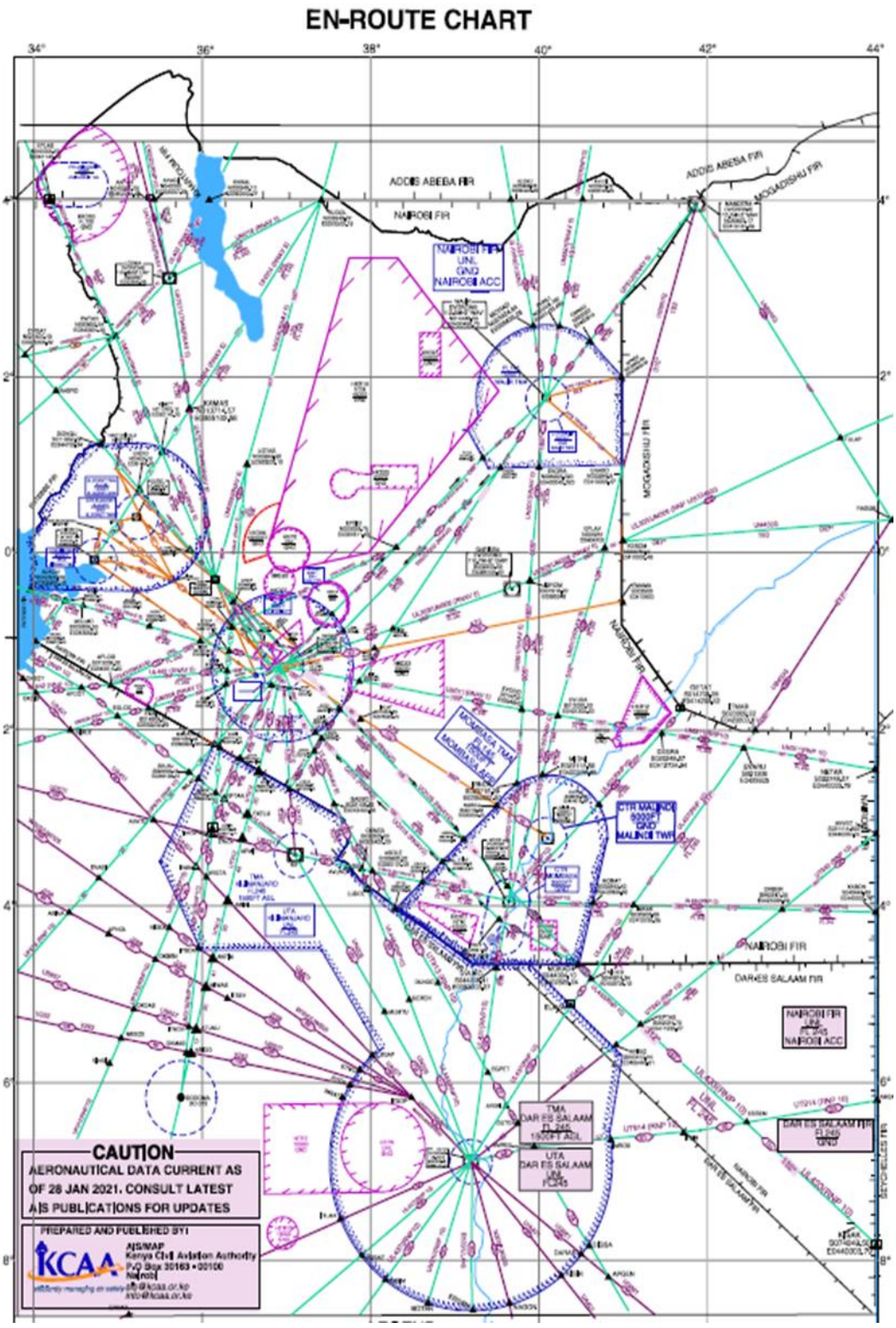


Figure 4.1 Nairobi FIR Enroute Chart Showing PBN routes

4.2.3.7. Improved flexible use of civil-military airspace

Kenya has enhanced civil/military coordination through engaging the military on ways to manage available airspace in a flexible manner. This is in line with ICAO recommendations on the implementation of the Flexible Use of Airspace (FUA) concept that has benefits for both civil and military aviation.

4.2.3.8. Collaborative research endeavours

i) Indian Ocean Strategic Partnership to Reduce Emission (INSPIRE)

ANS undertook the initiative to develop and implement operational procedures to reduce the environmental footprint for aircraft operating in the oceanic airspace. This objective was aimed at allowing air operator's access to User Preferred Routes (UPR) across the Indian Ocean and adjoining airspaces. Kenya has facilitated INSPIRE initiative by facilitating UPR Airspace for long-haul flights operating Nairobi FIR. The participating Airlines have reported considerable saving in distance and time and fuel burn.

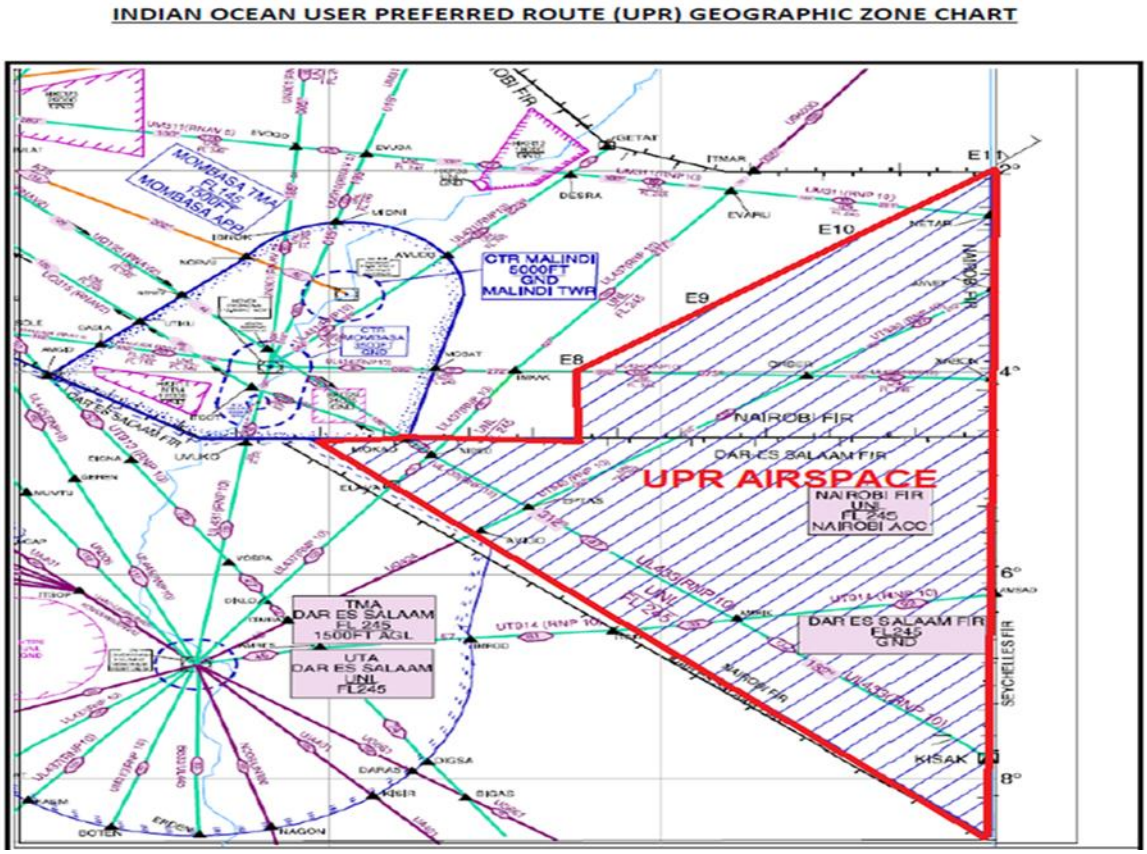


Figure 4.2: Nairobi FIR UPR Airspace

ii) Research on utilization of alternative energy sources for equipment and systems and implementation of the application

The recommendation of the research will help in the implementation of the different green energy to support the air navigation equipment.

4.2.3.9. Operations

Reducing GHG Emissions at the Gate and on the Ground — Airlines and airports are working together to reduce emissions from APUs and ground support equipment (such as baggage tugs and tractors). Airlines and Airport Authority will also collaborate to develop an effective way to track how these efforts reduce emissions from these sources.

GHG Emission Inventories— KCAA will be receiving and arching data from Kenyan airlines to refine and improve data quality and explore opportunities to adopt emission reductions strategies.

4.2.4. More efficient operations

Background

Technological improvements are not the only means to reduce emissions, better planning of operations is also a key factor when trying to find a way towards cleaner aviation. This is a priority for the Kenya aviation industry as portrayed in the previous action plan. Kenya aviation industry is expected to achieve tremendous fuel efficiency improvement for both domestic and international flights for the period between 2021 and 2025 through improved operations from implemented measures.

Based on the 2nd action plan the industry had implemented measures aimed in achievement of fuel saving activities within the areas of their flight operations. These activities are;

i. Modification of existing aircraft and upgrades of engines;
ii. Stakeholder collaboration with airports and air navigations service;
iii. Use of cruise speed and optimum flight level;
iv. Flight planning of shortest possible route;
v. Minimizing flaps (take-off and landing);
vi. Single engine taxi;
vii. Improving load factors;
viii. Improved ground operations: limit usage of APU;
ix. Training pilots in practicing flight operation measures to save fuel and reduce emissions;
x. Optimized aircraft maintenance integrated with the airline' specific conditions;
xi. Selecting aircraft best suited to the mission; and
xii. Downgrading/Upgrading aircraft is applied to achieve optimal load/seat factor.

Mitigation measures selected for the Action Plan will mainly aim at enforcing further best practices in operations, such as minimizing weight.

The national airline Kenya Airways is also considering the opportunity to acquire a Fuel Management System that would contribute to a reduction of the fuel consumed. According to their initial analysis, an improvement of 5% of the fuel efficiency could be obtained with this system. Selecting aircrafts best suited for the mission and optimizing aircrafts maintenance (engine or aircraft wash) are additional measures considered in this category.

4.2.4.1 Airport improvements

Kenya Airports Authority (KAA) has been undertaking significant initiatives for the improvement of the environment around the Kenya airports. Among the initiatives, KAA has taken to reduce emissions include;

(i) Installation of a 0.5 MW solar plant at Moi International Airport under the ICAO/EU assistance programme
(ii) Use of solar powered APU/GPU at Moi International Airport under the ICAO/EU assistance programme
(iii) Installation of 9 APUs that are electrically powered at JKIA
(iv) Development of sustainable concessionaire policies that encourage ground handlers to improve their ground handling equipment's, promote use of low/zero emission vehicles and other equipment.

KAA proposes to implement the following measures in the coming period to reduce emissions;

(i) The current demand for energy at JKIA is 6MW, KAA intends to Install a 3MW solar power at JKIA to reduce energy demand by 50%.
(ii) Utilization of the 0.5MW solar power plant installed in 2018 at Moi International Airport is expected to reduce energy demand by 50% at MIA and hence CO2 reduction
(iii) Utilization of electric powered GPU and PCA instead of diesel powered at JIKIA and MOI will help in reduction of CO2 emission.
(iv) Use renewable energy for general lighting and other airport operations
(v) Redesign the taxiways (Rapid taxiways)
(vi) Engage the stakeholders on continuous basis on the use of low emission vehicles and equipment
(vii) Refurbishing the terminals 1 (B, C, D) building that will increase energy efficiency
(viii) Proposing installation of electric charging points to encourage the use of electric vehicles within the airport.
(ix) The Airport carbon Accreditation has 4 levels (Mapping, Reduction, Optimisation and Neutrality). KAA has targeted 4 airports for the program and is currently at level 1 in the implementation. The timelines for achieving carbon Neutrality is as shown below.

Table 5: Airport carbon Accreditation

No.	Airports	ACA LEVEL 1	ACA LEVEL 2	ACA LEVEL 3	ACA LEVEL 3+
1.	JKIA	December 2019	July 2020	December 2020	December 2022
2.	MIA	December 2019	July 2020	December 2020	December 2022
3.	KIA	December 2019	July 2020	December 2020	December 2022
4.	EIA	December 2019	July 2020	December 2020	December 2022

- Undertaking environmental impact assessments for construction of KAA large projects and implementation of subsequent environmental management planstogether with engineering contractors.
- Undertaking environmental audits which involves evaluation of airport activities and processes of ongoing projects to determine how far they conform to soundenvironmental requirements.
- Development of waste Audits and prepared waste management plans inaccordance with national regulations.
- KAA has also embarked on preparation of Noise Maps and Noise mitigation action plans for JKIA, MIA, EIA, KIA and soon Wilson Airport. KAA is the first institution to achieve this in the country.
- KAA has successfully planted and maintained trees in various airports to promote ecological restoration. The number of trees planted per airport include;
  - ✓ 600,000 trees in Eldoret Airport,
  - ✓ 150,000 trees in JKIA,
  - ✓ 6000 trees in Kitale airstrip,
  - ✓ 3000 trees in Isiolo Airport,
  - ✓ 3000 trees in Nyaribo Airstrip,

  All these trees were planted as a carbon sink.

Other projects include;

- Replacement of indoor lighting for JKIA terminal building lighting to LED
- Replacement of current street lights with LED in JKIA
- Replacement of Air conditioning systems with CFC free ones in all Airports

KAA is undertaking a set of activities for improved environmental management and monitoring at JKIA and other major airports. The project aims at achieving the following:

- Capacity building for Environmental officers in the following areas (environment and aviation, noise and air monitoring, Strategic Environment assessment, benchmarking with good airport practices)
- Installation of solid waste management infrastructure

- Purchase and installation of Noise and Air Monitoring equipment
- Environmental management Systems (ISO 14001)
- Climate Change Mitigation

Other major "green" projects are planned in the coming years, as described in the following paragraphs.

4.2.4.2 The Green Terminal Project

The passenger traffic at the Jomo Kenyatta International Airport is expected to grow to 28.8 million passengers per annum by the year 2030. The Government of Kenya, through KAA, is planning to expand JKIA by building a new Green Fields Terminal (GFT, also referred to as Terminal 3) and associated aircraft pavements (aprons and access roads) to handle the expected increased traffic flow.

The GFT is designed to meet world class standards and best practices in environment, social and economic terms. On the environmental front, the project is geared towards energy use reduction, water saving, natural lighting, natural aeration, waste reduction and safety focus. The Environmental and Social Management Plan (ESMP) has been developed to provide a tool for ensuring integration of environmental and social recommendations into the project implementation and operations thereafter.

A set of additional developments and reconfigurations at JKIA are under consideration to increase operations efficiency, and will be closely related to the progress of the GFT. This includes:

- A second runway parallel to the existing one;
- New taxiways for rapid exit;
- Remote stands comprising the construction of passenger apron and remote aircraft parking spaces.

4.2.4.3 Improved energy use at international airports

Following an energy audit initiated by KAA, a set of initiatives have been planned to improve the energy use in 4 major international airports: Jomo Kenyatta, Moi in Mombasa, Eldoret and Wajir. Through an integrated approach, this project aims at reducing the energy demand, improving energy efficiency and increasing the use of renewable energy in the selected facilities.

4.2.4.4 Carbon offset project

Under the World Bank funded projects, KAA is undertaking carbon footprint assessment for JKIA. This forms part of KAA commitment to Environment sustainability effort towards climate change mitigation.
Phase 1 of this assessment involves acquisition of data on the sources and establishment of the amount of CO2 emitted from JKIA operations. The output of this exercise will be a map of CO2 emissions for the airport.

Phase 2 of this assignment will be development of reduction measures for JKIA. This will eventually help JKIA apply for Airport Carbon accreditation status, for both Phase 1 and 2.

This assignment will also provide a Carbon Neutralization strategy for JKIA. One of the proposed neutralization strategy, KAA will plant one million trees by 2028.

4.2.4.5 Mitigation measures selected for the Action Plan

The mitigation measures related to Airports improvement and selected for the Action Plan are focused on;

(a) The use of electrically power APUs and GPUs in the airports. This measure, when implemented shall contribute directly to reducing CO_2 emissions from aviation.
(b) Switch to use of renewable energy to power Ground Support Equipment (GSE).
(c) Reduction of energy demand by use of solar power at various airports
(d) Use of renewable energy for general lighting and other airport operations
(e) Redesign the taxiways (Rapid taxiways)

More details on these initiatives are provided in the list of measures (Annex 3) as well as in the Annex 4.

4.3. Additional Measures

This Action Plan contains other measures whose expected results are not expressed in quantitative terms due to the nature of the activity or their current stage of implementation. These measures will be essential at achieving the long-term aspirational goals of the aviation industry and Kenya's NDC.

4.3.1. Air Navigation Services Power Systems

Kenya Air Navigation Services has installed solar power as to supply CNS systems in various ANS stations. The installations include;-

i) Malindi Airport- DVOR/DME station;
ii) Wajir Airport –DVOR/DME station;
iii) Athi River- DVOR station;
iv) Lodwar –DVOR/DME station;
v) Lokichoggio Airport;
vi) Mandera- DVOR/DME station; and
vii) Mwakirunge DVOR/DME station.

In Ngong station, solar and wind power has been installed to supply the VHF and theDVOR systems.The total capacity of the solar systems is about 0.07

MW. The ANS plans to install more solar systems in other stations like Kisumu and upgrade the existing systems.

4.3.2. Operations

Reducing GHG Emissions at the Gate and on the Ground — Airlines and airports are working together to reduce emissions from APUs and ground support equipment (such as baggage tugs and tractors). Airlines and Airport Authority will also collaborate to develop an effective way to track how these efforts reduce emissions from these sources.

GHG Emission Inventories— KCAA will be receiving and archiving data from Kenyan airlines to refine and improve data quality and explore opportunities to adopt emission reduction strategies.

4.3.3. Regulatory Measures

Development of Civil Aviation (CORSIA) Regulations and other Emissions Standard.
As a member of ICAO's Committee on Aviation Environmental Protection (CAEP), Kenya will continue to support ICAO in formulating new policies and adopting new Standards and Recommended Practices (SARPs) related to aircraft noise and emissions, and more generally to aviation environmental impact. KCAA will continue to adopt ICAO standards and recommended practices into specific operating regulations. Kenya is in the process of adopting ICAO Annex 16 Volumes 4 Into civil aviation (CORSIA) Regulations which are in the final stage of approval. Kenya will also adopt other ICAO annex 16 volumes into Kenyan regulations. KCAA will comply with Climate Change Act compiling and reporting of domestic aviation emissions to Climate Change Directorate.

4.3.4. Enhancing weather observation/forecasting services

The government of Kenya will enhance the weather observation/forecasting services by implementing the following items;

- Weather Radar and a wind profiler for Jomo Kenyatta International Airport
- Wind profiler for Kisumu International Airport
- Upgrading of forecasters systems at Moi International Airport, Eldoret International Airport and Kisumu Airport
- Enhanced capacity for aero-met staff

4.3.5. International Coordination

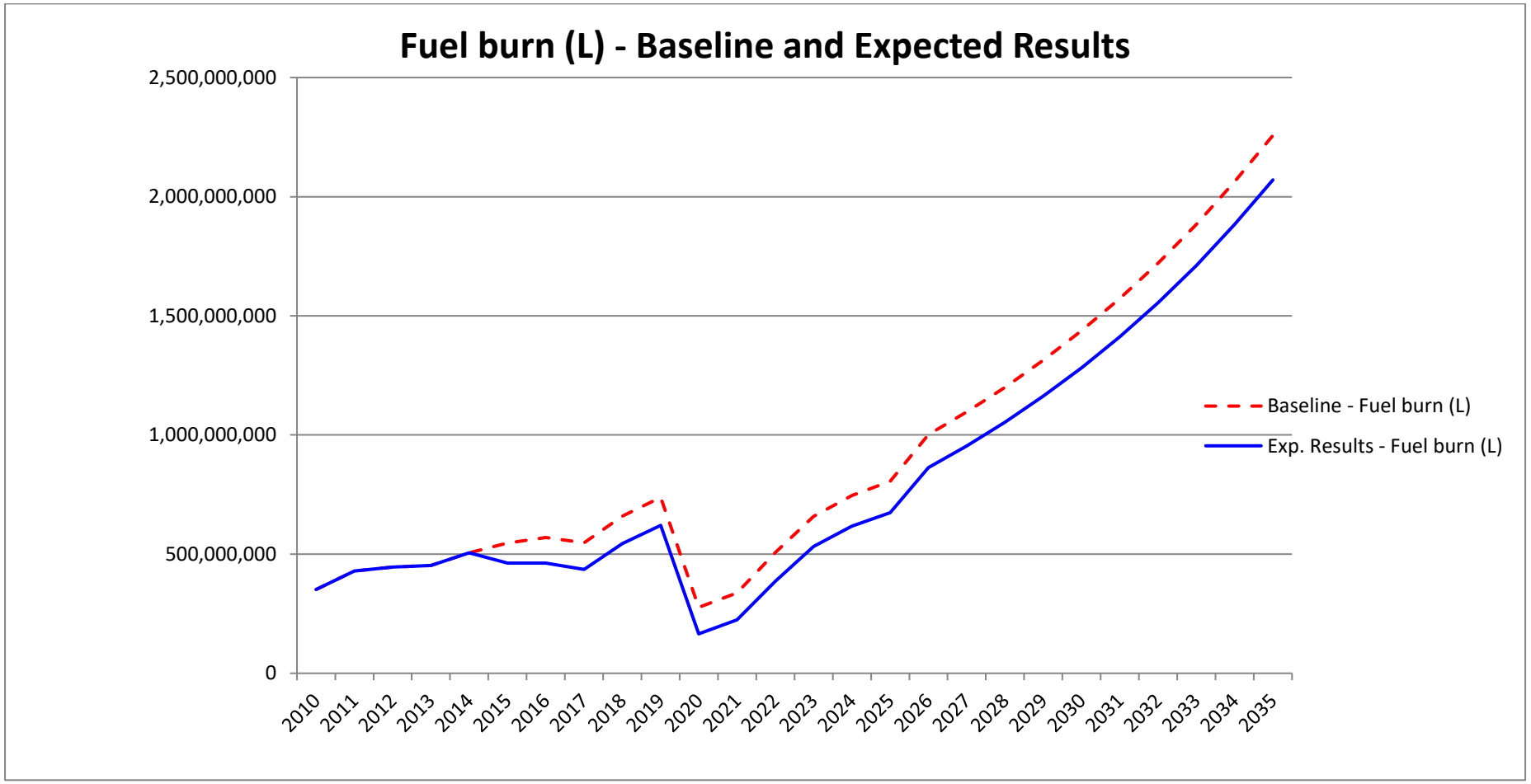
Recognizing that efforts to address climate change require international action and coordination, KCAA and Aviation stakeholders will continue to actively participate, through ICAO, on the implementation of global approaches and standards to address climate change. This will include participation in international meetings and conferences. Kenya will continue to engage the aviation industry and other

stakeholders as part of the international dialogue on market-based measures and participation of CAEP meeting and WorkshopsKenyan aviation sector will continue to actively participate in other international forums e.g. United Nation Framework Convention on Climate Change (UNFCCC).

4.4. Expected results

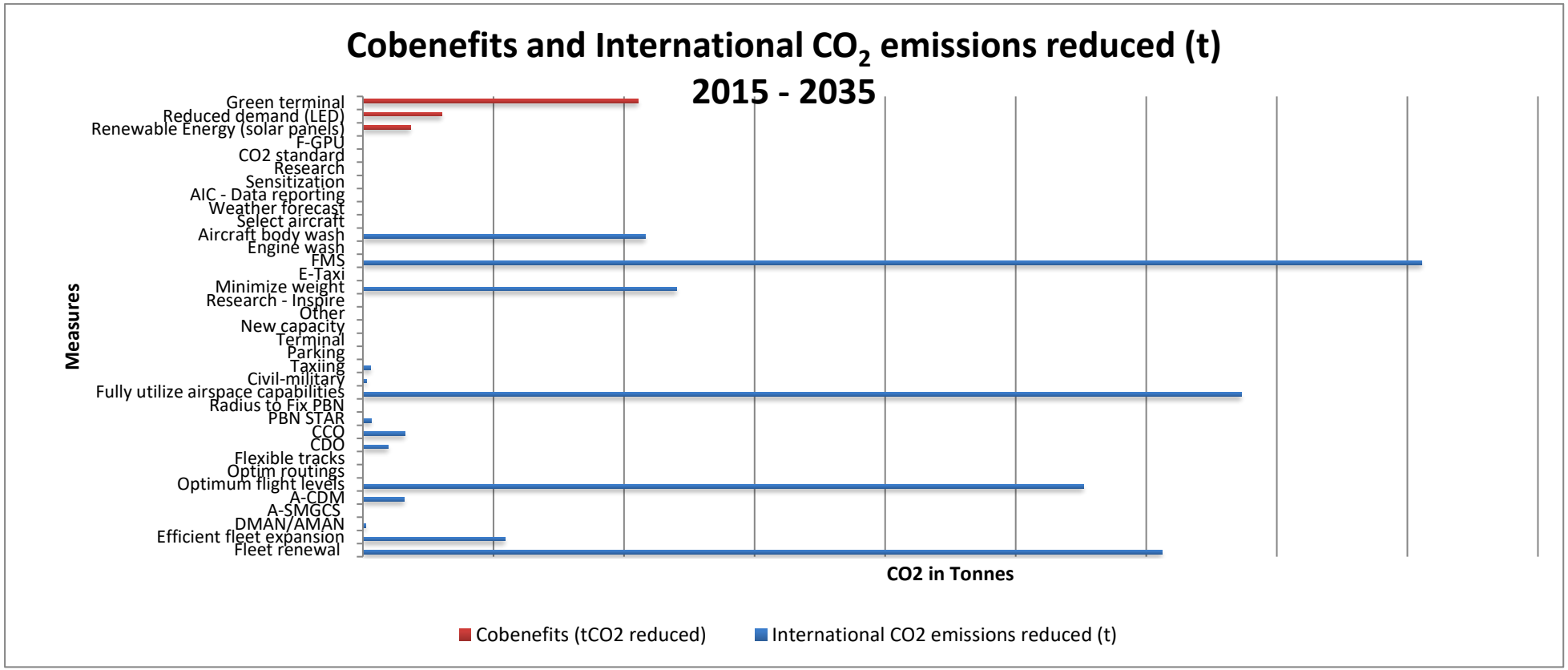
The graph below shows the baseline and the expected results as a result of Implementation of the measures in the action plan

Figure 4.1: Baseline Vs Expected results



The graph below shows the Contribution of each selected measures in CO2 Emission reduction from internation aviation and the other Cobenefits.

Figure 4.2: Contribution of selected measures



5.0. ASSISTANCE REQUIRED

The assistance needed to implement the Action Plan is multi-fold and includes mostly technical as well as financial support from external stakeholders.

Kenya is particularly looking for assistance in the following areas:

1) Support in updating the present Action Plan;
2) Support in the development of technical capacity;
3) Support in financial capacity in the implementation of mitigation measures;
4) Assistance to set up systems for the monitoring of emissions in the Nairobi FIR, the national airlines and the airports;
5) Support in supply and installation of CO_2 gas monitoring system
6) Support in collaborate research endeavor's
7) Support in installation of fuel management systems for airlines
8) Support in modernization of weather observing equipment and capacity building
9) Support in supply and installation of complete solar unit
10) Support in construction of greenfield terminal and second runways at JKIA (note the Design are ready and complete)
11) Support in the development of a pilot project for sustainable aviation fuels for aircraft and ground based vehicles in Kenya.

The details on each measure is described in Annex 3 and 4.

6.0. GOVERNANCE OF THE ACTION PLAN AND REPORTING

6.1. Governance

The Working Group on Aviation Emissions will oversee Kenya's Action Plan.

The Working Group will meet quarterly, to monitor individual and collective progress made in the implementation of the selected mitigations towards achieving Kenya's fuel efficiency target. The group will also discuss the barriers and how to overcome them in order to successfully in implement the action plan

6.2. Quarterly meeting and Annual Reporting

The working group will also meet, track and reporting the achievement annually. Annual Report will be prepared to summarize the progress that has been made in meeting CO_2 gas emission reduction goals and other Action Plan activities.

KCAA will introduce an annual forum involving relevant Government agencies and industry to facilitate the exchange of information and ideas on mitigating actions and to discuss any obstacles to implementation.

The Annual Reports will include:

- A quantitative description of achievements (including relevant indicators such as kilogramms fuel consumed per Revenue Tonne Kilometre);
- KCAA will collect all of the information necessary to report on the fuel efficiency improvements achieved;
- A list of stakeholders /organizations reporting; and
- A quantitative and/or qualitative description of the actions taken by all Working Group members to achieve progress on the measures identified in the Action Plan.
- The aviation activity and emission data reported in the Annual Reports will be segregated for domestic and international aviation

6.3. Review

The Working Group will conduct a review of the Action Plan within three years from the date of approval to assess progress towards the environmental goals and commitments .

The Working Group will also:

(a) Review the Barriers and how to overcome them; and
(b) Review the Action Plan either adjusting on the targets.

6.4. Auditing and Monitoring

To ensure continued confidence in the reliability of the reports, a qualified auditor together with Working Group, will be given access at least once over the next five years of the Action Plan, to audit the reports, processes, and supporting documentation that pertain to the Action Plan.

7.0. ANNEXES

7.1 Annex 1: Traffic trends for the years 2010 to 2035

The statistics below capture the flights from national and foreign airlines serving Kenya. Flights from 2010 to 2021 reflect historical data. Data from 2022 to 2035 are based on projections.

Item	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Flights International	79,967	90,837	88,618	88,463	93,495	86,750	93,029	93,531	96,101	97,084	45,279	53,510
Flights Domestic	153,276	174,882	176,046	170,941	176,690	179,483	204,803	207,644	229,238	219,266	123,048	165,662
Passengers International	3,924,771	4,409,638	4,392,273	4,258,770	4,437,916	4,176,663	4,554,429	4,869,744	5,476,669	5,663,645	1,763,267	2,676,653
Passengers Domestic	2,330,009	2,832,753	2,734,163	2,604,414	3,139,031	3,420,767	4,019,648	4,006,486	4,781,044	4,865,238	2,318,190	3,837,790
Freight International	246,507,663	303,697,967	294,606,752	260,356,610	276,158,286	259,020,882	248,404,251	290,024,377	357,829,991	374,552,764	322,069,279	376,839,203
Freight Domestic	2,276,562	2,288,567	1,788,823	2,123,936	3,747,483	4,627,302	1,628,388	1,363,538	1,757,257	1,197,681	949,019	664,858
Total Freight (Domestic and International)	248,784,225	305,986,534	296,395,575	262,480,546	279,905,769	263,648,184	250,032,639	291,387,915	359,587,248	375,750,445	323,018,298	377,504,061

Item	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Flights International	69,563.00	83,475.60	91,823.16	98,709.90	106,113.14	114,071.62	122,627.00	131,824.02	141,710.82	152,339.13
Flights Domestic	215,360.60	258,432.72	284,275.99	305,596.69	328,516.44	353,155.18	379,641.81	408,114.95	438,723.57	471,627.84
Passengers International	3,479,648.90	4,523,543.57	5,428,252.28	5,835,371.21	6,273,024.05	6,743,500.85	7,249,263.41	7,792,958.17	8,377,430.03	9,005,737.28
Passengers Domestic	4,605,348.00	5,065,882.80	5,572,471.08	5,990,406.41	6,439,686.89	6,922,663.41	7,441,863.16	8,000,002.90	8,600,003.12	9,245,003.35
Freight International	395,681,163.15	415,465,221.31	436,238,482.37	458,050,406.49	480,952,926.82	505,000,573.16	530,250,601.81	556,763,131.91	584,601,288.50	613,831,352.93
Freight Domestic	698,100.90	733,005.95	769,656.24	808,139.05	848,546.01	890,973.31	935,521.97	982,298.07	1,031,412.98	1,082,983.62
Total Freight (Domestic and International)	396,379,264.05	416,198,227.25	437,008,138.62	458,858,545.55	481,801,472.82	505,891,546.46	531,186,123.79	557,745,429.98	585,632,701.48	614,914,336.55

Item	2032	2033	2034	2035
Flights International	163,764.57	176,046.91	189,250.43	203,444.21
Flights Domestic	506,999.93	545,024.92	585,901.79	629,844.43
Passengers International	9,681,167.58	10,407,255.15	11,187,799.28	12,026,884.23
Passengers Domestic	9,938,378.60	10,683,757.00	11,485,038.78	12,346,416.68
Freight International	644,522,920.57	676,749,066.60	710,586,519.93	746,115,845.93
Freight Domestic	1,137,132.80	1,193,989.45	1,253,688.92	1,316,373.36
Total Freight (Domestic and International)	645,660,053.38	677,943,056.05	711,840,208.85	747,432,219.29

7.2 Annex 2: The National Strategy

Constitution of Kenya

The constitution of Kenya recognizes the need to protect the environment. Chapter Five Part 2 Section 69 and 70 says;

69. (1) The State shall—

(d) encourage public participation in the management, protection and conservation of the environment;
(f) establish systems of environmental impact assessment, environmental audit and monitoring of the environment;
(g) eliminate processes and activities that are likely to endanger the environment; and
(*h*) utilise the environment and natural resources for the benefit of the people of Kenya.

(2) Every person has a duty to cooperate with State organs and other persons to protect and conserve the environment and ensure ecologically sustainable development and use of natural resources.

70. (1) If a person alleges that a right to a clean and healthy environment recognized and protected under Article 42 has been, is being or is likely to be, denied, violated, infringed or threatened, the person may apply to a court for redress in addition to any other legal remedies that are available in respect to the same matter.

(2) On application under clause (1), the court may make any order, or give any directions, it considers appropriate—

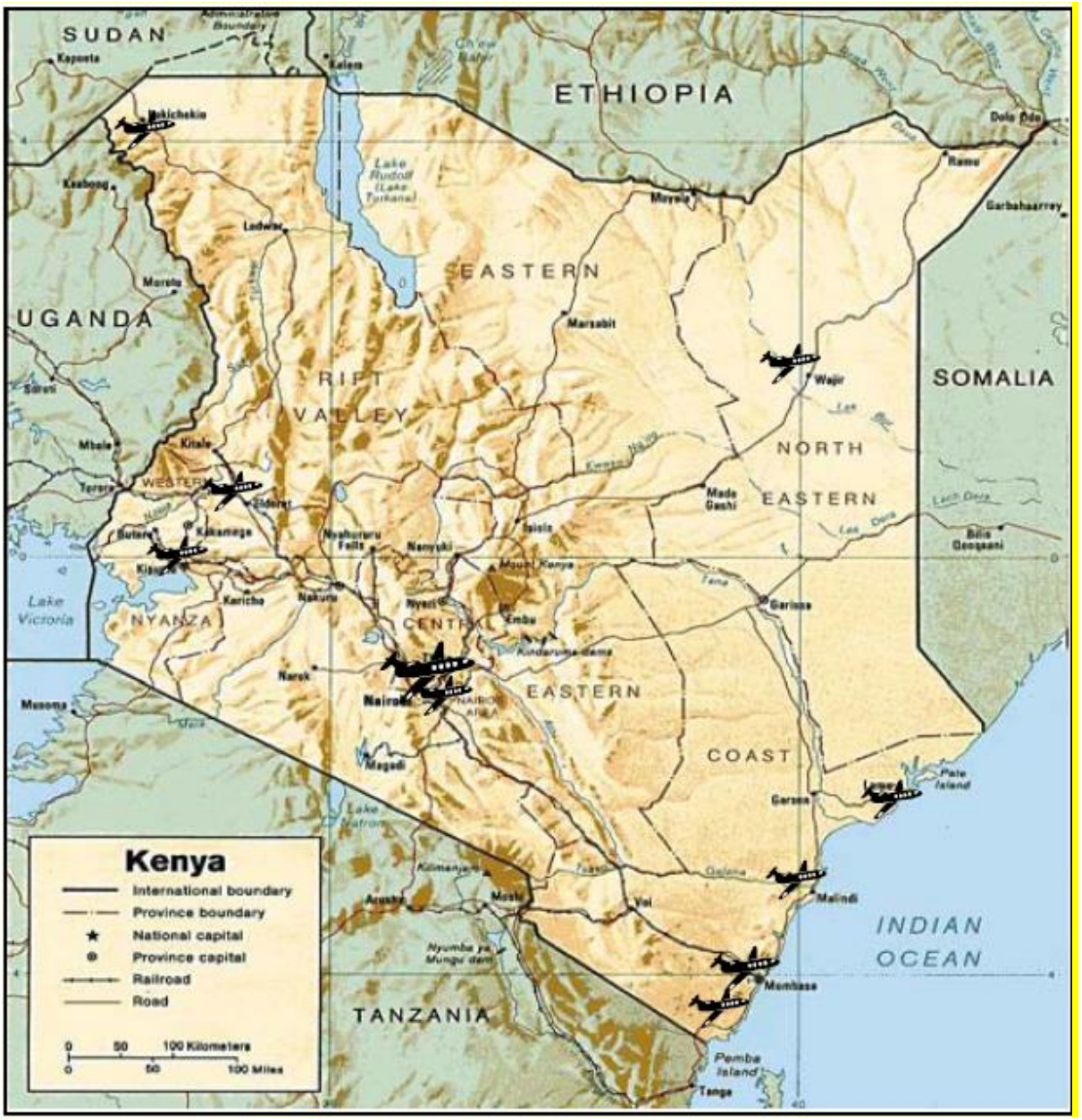
(a) to prevent, stop or discontinue any act or omission that is harmful to the environment;
(b) to compel any public officer to take measures to prevent or discontinue any act or omission that is harmful to the environment; or

Legislation

All the emissions are covered by the Environmental Management and Co-Ordination Act, 1999.
Part VII Section 78 Subsection (d) state that;
78. (1) the standards and enforcement review committee shall, in consultation with the relevant lead agencies:

(d) recommend to the authority guidelines to minimize emissions of green houses gases and identify suitable technologies to minimize air pollution;
(e) advise the authority on emissions concentration and nature of pollutants emitted;
(f) recommend to the authority the best practicable technology

available in controlling pollutants during the emission process.



7.3 Annex 3: List of Selected Measures

Measure nb	Category	Measure	Action	Description	Start date	End date	Objectives	Current status	GHG/Fuel Efficiency Impact (EBT)/ Expected Results	Economic Cost (USD)	Stakeholders
	1. Technology and Standards										
		a) Aircraft fuel efficiency standards									
M1			i) Purchase of 10 modern Q400 to the fleet.	Purchased 7 Q400 series and to eliminate 4 Hawker Sidley as measures to reduce CO2 emission To replace 6 Q100 with 3 Q400 which are efficient.	2016	2027	i. To purchase modern aircraft with bigger capacity. ii. To Replace 4 HS748 with 4 Q400 which are more efficient. iii. Reduce Co2 Emission significantly through data monitoring program. iv. To save $64,884.00 on fuel each month and fuel load of 6.7tonnes(2354tonne P.a).	Purchased 7 Q400 by 2021.	7438.64t Co2 e.	USD 110M	748 ASL KAA KCAA ANSP
		b) Purchase of new aircraft									
M2				8 Embrear 135 Jet aircrafts 8 Embrear 145 Jet Aircrafts	2015	Continuous	1) Acquire Reliable Aircrafts with more fuel-efficient Engines. ERJ145 and ERJ135 aircrafts to replace the ageing 18 Dash-8	8 ERJ 135 Purchase at $132,000,000 by 2021 3 ERJ 145 Purchased at $58,500,000 By 2021	To be calculated	5 ERJ 145@ ($19,500,000) $97,500,000	ALS/KAA/KCAA
		c) retrofitting and upgrade improvements on existing aircraft									
M3			i. Use of LED lights for interior and exterior of the aircraft.		2023	Continuous	To replace lighting system for 10 Q400 with LED lights.	Conventional lighting	To be Quantified	USD 0.07M	748 ASL KAA KCAA ANSP

Measure nb	Category	Measure	Action	Description	Start date	End date	Objectives	Current status	GHG/Fuel Efficiency Impact (EBT)/ Expected Results	Economic Cost (USD)	Stakeholders
M4			ii. Painting of aircraft to reduce drag.		2022	Continuous	i. Flying better profile and reduction in fuel burn. ii. 6.8tonnes of fuel to be saved annually across the fleet as a results of painting	Painted	21.49tCo2 e.	USD 0.04M	748 ASL KAA KCAA ANSP
M5			iii. Installing OF Flight Data Monitoring systems(FDM) in 10 Q400.		2021	2027	i. To install FDM in 10 Q400 to avoid errors and enhance compliance with SOPs. ii. To save 1.2tonnes of fuel annually.	Installed in 2 Q400 with FDM.	3.792tCo2 e	USD0.84M	748 ASL KCAA AIRCRAFT MANUFACTURE
	2. Sustainable aviation fuels (SAF)										
		a) development of aviation fuels with lower life cycle CO2 emissions									
M6			1) Start pilot projects for utilization of green hydrogen for ground and aviation services in collaboration with stakeholders to gather enough user data to kick start the policy development		2022	2027	Production, distribution and utilization of green hydrogen Reduction of aviation carbon emission	Baseline study conducted	Not quantifiable	USD 1M	MoEnergy MoPetroleum MoTransport Treasury KAA KCAA KPC EPRA OMC(s) Air carriers
M7			2) Undertake full feasibility study(s) for take-off of green hydrogen.		2023	2030	To conduct full feasibility study for G.H To develop policy for G.H To develop strategies and work-plan for G.H	-	Not quantifiable at the moment	USD 0.5M	MoEnergy MoPetroleum MoTransport KAA KCAA KPC EPRA OMC(s) Air carriers

Measure nb	Category	Measure	Action	Description	Start date	End date	Objectives	Current status	GHG/Fuel Efficiency Impact (EBT)/ Expected Results	Economic Cost (USD)	Stakeholders
M8			3) Start pilot projects for production of Sustainable Aviation Fuels (SAFs)		2015	2030	• Conduct feasibility studies for SAF • Establish a SAF supply chain based on used cooking and other non-petroleum oil based feed-stocks • Promotion of SAF technologies • Develop blending infrastructure for SAF (biofuels and aviation fuels) • Develop partnership with development partners and States for production of SAF in Kenya	Feasibility study conducted	Not quantifiable at the moment	USD 1M	MoEnergy MoPetroleum MoTransport KAA KCAA KPC EPRA OMC(s) Air carriers Academia
M9			4) Review of the Ministry of Energy Bioenergy Strategy		2023	2027	To capture the aviation industry Domestication of SAF toolkit	Bioenergy strategy 2020-27 in place	Not quantifiable	USD 200,000	MoE MoTransport KAA KCAA EPRA Air carriers
		b) standards/requirements for SAF use									
M10			1) Review the SAF standards to ensure consistent product quality. 2) Training and capacity building		2022	2027	Ensure a consistent quality of SAF production in the country consistent with other countries.	Technical committee established	Not quantifiable	USD 0.2M	MoEnergy MoPetroleum MoTransport KEBS EPRA KAA KCAA Air carriers
	3. Operational improvements										
	3.1 Air Traffic Management (ATM)										

Measure nb	Category	Measure	Action	Description	Start date	End date	Objectives	Current status	GHG/Fuel Efficiency Impact (EBT)/ Expected Results	Economic Cost (USD)	Stakeholders
		a) more efficient ATM planning, ground operations, terminal operations (departure, approach and arrivals), en-route operations, airspace design and usage, aircraft capabilities									
M11			i. measures to improve pre-departure planning and arrival planning (departure management (DMAN) and arrival management (AMAN))		2022	2027	To optimize use of runway and departure process from push back to take off Improves efficiency by balancing arrivals and departures Optimizes planning for inbound and outbound flights	Planning being done manually - To start 2023	* Rule of thumbs: 240 tCO2 per year	USD 0.3 Million	ANSP & KCAA KAA, Air operators
			ii) measures to improve ground operations								
M12				A-SMGCS (SURF) during peak periods	2010	continuous	To optimize use of runway by generating additional movements during peak times	Implemented and to be upgraded	Included in the quantification for A-CDM.	USD 1 Million	ANSP and KCAA
M13				A-SMGCS (SURF) during periods of Low visibility	2010	continuous	To optimize use of runway during adverse weather conditions e.g Low Visibility and Wind change	Implemented and to be upgraded	Included in the quantification for A-CDM.		ANSP and KCAA
M14				A-SMGCS (SURF) during night operations	2010	continuous	To reduce ATC workload and improve safety and efficiency	Implemented and to be upgraded	Included in the quantification for A-CDM.		ANSP and KCAA
			iii) measures to improve airport collaborative decision-making (A-CDM)								

Measure nb	Category	Measure	Action	Description	Start date	End date	Objectives	Current status	GHG/Fuel Efficiency Impact (EBT)/ Expected Results	Economic Cost (USD)	Stakeholders
M15				A-CDM (non-US version)	2016	continuous	Optimize decisions making based on constraints and predicted situation	Implemented/ Continuous	Rule of thumbs: 3156 tCO2 per year	USD 0.2 Million	Airlines KAA, ANSP, Aviation MET and KCAA
M16			iv) measures to improve the use of optimum flight levels		2009	Continuous	To manage flight level allocation and to minimize time for climb to optimal flight levels	Implemented/ Continuous	Rule of thumbs: 52560 tCO2 per year	USD 1.5 Millions (cost for infrastructure , capacity building and documentation)	ANSP, Aviation MET Airlines Military Airports
M17			v) Measures to improve the use of optimum routings		2009	Continuous	To create shorter routes or direct routes	Implemented/ Continuous	Included in the quantification for optimum flight levels.		
M18			vi) Measures to improve flexible tracks		2009	Continuous	To have flexible tracts that allows aircraft to take advantage of weather forecast for delay reduction	Implemented/ Continuous	Included in the quantification for optimum flight levels.		
			vii) Measures to improve fuel efficient departure and approach procedures (PBN SIDs (CCO), STARs (CDO) etc.)								
M19				CDO	2010	Continuous	Improve Flexibility & Efficiency in Descent Profiles optimized to the performance of the aircraft	Implemented/ Continuous	3004 tCO2 per year	No cost as initiatives are as a result of change in procedures	ANSP, Air operators

Measure nb	Category	Measure	Action	Description	Start date	End date	Objectives	Current status	GHG/Fuel Efficiency Impact (EBT)/ Expected Results	Economic Cost (USD)	Stakeholders
M20				CCO	2010	Continuous	Improve Flexibility & Efficiency in Climb Profiles optimized to the performance of the aircraft	Implemented/ Continuous	3068 tCO2 per year	No cost as initiatives are as a result of change in procedures	ANSP, Air operators
M21				PBN Approach procedures	2010	Continuous	Enhanced stable approaches	Implemented/ Continuous	613 tCO2 per year	No cost as initiatives are as a result of change in procedures	ANSP, MET Air operators
M22			Training of five (5) Instrument Flight Procedure Designers		2023	2025	Improve capacity in Flight Procedure Design/Airspace Planning				ANSP
M23			viii) measures to fully utilize RNAV/RNP capabilities		2009	Continuous	To Achieve delay reduction as result of maximization of flight level and routes	Implemented/ Continuous	64097 tCO2 per year	No cost as initiatives are as a result of change in procedures	ANSP, Air operators
M24			ix) Measures to improve flexible use of civil-military airspace		2013	Continuous	To Achieve shorter routes by overflying military airspace	In Progress/ Continuous	252 tCO2 per year	No cost as initiatives are as a result of change in procedures	ANSP, Air operators, Military
		b) More efficient use and planning of airport capacities;									
M25			i) Measures to improve taxiing		2015	Continuous	• To have reduced taxi times by having rapid exit taxiways • Construction of a continuous taxiway linking end of RWY 06 and RWY 24 • Construction of 2nd Runway Project	In Progress	565 tCO2 per year	Kshs. 100B	KAA, KCAA, Airlines and Ground handler
M26			ii) Measures to improve parking		2012	Continuous	• Construction of 41 additional air bridges, • Construction of remote parking bays • Provision of parking for airport users	9 already done in 2017	Not quantifiable		KAA, KCAA, Airlines and Ground handler

Measure nb	Category	Measure	Action	Description	Start date	End date	Objectives	Current status	GHG/Fuel Efficiency Impact (EBT)/ Expected Results	Economic Cost (USD)	Stakeholders
M27			iii) Measures to enhance terminal support facilities		2012	Continuous	• Construction New Terminal building at JKIA including; • Construction of additional air bridges, • Installation of fixed electric ground power points for powering and pre-cooling aircraft cabins during servicing at JKIA • Provision of airport transport buses.	In Progress	Not quantifiable		KAA, KCAA, Airlines and Ground handler
M28			iv) Measures to plan new capacity when bottlenecks cause environmental problems		1978	Continuous	Acquisition of land to for airport expansions in Malindi Airport	In Progress	Not quantifiable		KAA, NLC, Local Communities
M29			v) enhancing weather forecasting services		1978	Continuous					
		c) collaborative research endeavours									
M30			ii) Inspire- Indian Ocean strategic Partnership to reduce emissions		2012	Continuous	Develop and Implement procedures to reduce emission for En-route phase of flight in the INSPIRE region. The perfect flight facilitate world-wide interoperability of environmentally friendly airspace	Implemented/ Continuous	benefits Quantified and reported by user airline	Funding required for documentation, sensitization and research at cost of USD 20,000 in operations	KCAA, ANSP, Air Operators and MET
	3.2 Operations										
		a) Best practices in operations – ICAO Doc 10013									
M31			i) Minimising weight		2021	Continuous	Reducing fly away kit onboard, carrying less catering, oil leads in reduction of 17.64tonnes of fuel	All Q400 weights for oil reduced from 12cans to 2cans per flight.	55.74tCo2 e	No cost	748 ASL KCAA
M32					2009	continuous	Removing unwanted weight from aircraft before commencing flight	Ongoing	22878 tCO2 per year	No cost as initiatives are as a result of	KQ

Measure nb	Category	Measure	Action	Description	Start date	End date	Objectives	Current status	GHG/Fuel Efficiency Impact (EBT)/ Expected Results	Economic Cost (USD)	Stakeholders
							to depart with less weight hence carry less fuel, resulting to reduced fuel burn			change in procedures	
M33					2020	continuous	3% contingency fuel with En-Route Alternate (ERA)	Ongoing	26,789 tCO2	No cost as initiatives are as a result of change in procedures	KQ KMD
M34					2020	continuous	Redispatch/ reclear flight planning	Ongoing	26,789 tCO2 reduction per year	No cost as initiatives are as a result of change in procedures	KQ KMD
M35			ii) minimizing flaps (take-off and landing)		2020	Continuous	Reduce CO2 emissions	Ongoing	123 tCO2 per year	No cost as initiatives are as a result of change in procedures	KQ
M36			iii) minimizing reversers use		2009	continuous	Reduce CO2 emissions	Ongoing	2195 tCO2 reduction per year	No cost as initiatives are as a result of change in procedures	KQ
M37			iv) single-engine taxi		2009	continuous	Reduce CO2 emissions	Ongoing	401,832 tCO2 reduction per year	No cost as initiatives are as a result of change in procedures	KQ KAA KCAA ANSP
M38			v) Reduce use of APU		2021	Continuous	Use APU Maximum 20mins before takeoff and planning to use Electrical GPU and PCA. The measure will lead to saving of 33.59tonnes fuel per year.	Using diesel powered GPU and APU.	106.144t Co2 e	No Cost	748 ASL KCAA

Measure nb	Category	Measure	Action	Description	Start date	End date	Objectives	Current status	GHG/Fuel Efficiency Impact (EBT)/ Expected Results	Economic Cost (USD)	Stakeholders
M39			viii) improved ground operations		2016	continuous	• WIFI enabled data transfer from aircraft to fuel management System Assist to Identify, Drive and Manage initiatives that will ensure a positive impact to the airline and environment. Increase data accuracy and consistency of data used in the airline and submitted to the authority for monitoring •Enable confident and effective decision making	Flight data transfer is done manually	Included in action number i, ii, iii and iv	300,000 USD wireless data installation on aircrafts and training cost	KQ
M40			ix) training pilots		2021	Continuous	Making sure each crew and operation staff are trained adequately to follow the guidelines.	26 Pilots to be trained but done with 10.	Included in the other measures	USD 3M	748 KCAA
					2015	Continuous	Train Flight Crew on weight minimization and aircraft cleanliness	All Flight Crew		$50,000	ALS KCAA
	4. Market-based measures										
		a) Voluntary inclusion of a State in the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)									
M41				Participation in CORSIA MRV	2019	2035	• To offset CO2 emitted above 2019 baseline data Capacity building for airline staff	Ongoing	N/A	USD 500,000	KQ KCAA
M42		b) Incorporation of emissions from international aviation into regional or national market-based measures, in accordance with relevant									
M43				Compliance with EU ETS	2010	Continuous	Ensure compliance with ETS	Ongoing	N/A	-	KQ

Measure nb	Category	Measure	Action	Description	Start date	End date	Objectives	Current status	GHG/Fuel Efficiency Impact (EBT)/ Expected Results	Economic Cost (USD)	Stakeholders
M44				Compliance with UK ETS	2022	Continuous	Ensure compliance with ETS	Ongoing	N/A	-	KQ
	Supplemental benefits for domestic sectors										
	Market-based measures										
	Airport Improvements										
		a) Airfield improvements									
			i) installation of LED lighting instead of classic lighting								
M45				Replacement of incandescent bulbs with LED at JKIA, MIA, KIA and EIA	2015	Continuous	10% Reduction of airport energy demand	Ongoing	6389 tCO2 per year (cobenefits)		KAA & other Stakeholders
M46				Remodel T 1 B,C,D	2020	2022	Provide modern terminal buildings with more natural light and smart lighting. Provide solar panels 10% reduction energy demand at the airport	Ongoing	To be quantified	Kshs. 950M	KAA
M47				Construction New Terminal building at JKIA including; Railway station, 32 air bridges, 18 remote parking bays	2026	2030	Provide modern terminal building with natural light, smart lighting, more parking spaces for aircrafts, Solar panels, rain water harvesting, Fixed electric ground power units	At Feasibility stage	26388Mt CO2	Kshs. 100B	AFDB, KAA
M48				Installation of 41 fixed electric ground power points for powering and pre-cooling aircraft cabins during servicing at JKIA;	2015	2030	To reduce fuel consumed by during the aircraft servicing	9 already installed	N/A		KAA, Airlines, GHAs
		b) Reduced energy demand and preferred cleaner energy sources									
			i) use cleaner alternative sources of power generation (photovoltaic panels, wind generators)								

Measure nb	Category	Measure	Action	Description	Start date	End date	Objectives	Current status	GHG/Fuel Efficiency Impact (EBT)/ Expected Results	Economic Cost (USD)	Stakeholders
M49				Use of alternative sources of power generation (Solar Power of 0.5 Megawatts) at Air Navigation aids stations	2018	Continuous	Cleaner source of energy and reduce emission (Upgrade of existing solar system and installation of new solar system in various ANS Stations.	0.1 Megawatts Installed in six (6) ANS Stations	N/A	1,000,000	ANSP
M50				JKIA – Installation of solar panels as part of the ongoing rehabilitation of T1B+C project	2020	2022	20% Reduction of airport energy demand	Ongoing	N/A		KAA
M51				Installation of Manda Airstrip 10KW Solar System – For all power needs;	2015		100% Reduction of airport energy demand – Zero CO2 emission	Continuous	N/A		KAA
M52				1Mw Solar Photovoltaic and Gate Electrification System at Moi International Airport and installation of 6 GPUs and APUs	2018	2027	To reduced energy demand by 50% and hence CO2	0.5Mw Installed together with 1 GPU and APU	CO2 saved as at 18th December 2020 was 1,186,386.28 MtCO2	Kshs. 300M	KAA, KCAA and SDOT
M53				Installation of Mandera Airstrip Solar system to providing all power needs	2020	Ongoing	100% Reduction of airstrip energy demand	Ongoing			KAA
M54				Installation of Isiolo Airport Solar System for Borehole water extraction	2015	Completed	5% Reduction of airport energy demand	Completed			KAA
M55				Installation of 3MW Solar plant at Jomo Kenyatta International Airport	2023	2027	50% Reduce energy demand and enhance carbon neutrality	At proposal stage	3861 tCO2 per year (cobenefits)	Kshs. 1B	KAA, KCAA and SDOT
			ii) use cleaner heater/cooler equipment and/or minimize heater/cooler utilization								

Measure nb	Category	Measure	Action	Description	Start date	End date	Objectives	Current status	GHG/Fuel Efficiency Impact (EBT)/ Expected Results	Economic Cost (USD)	Stakeholders
M56				Construction New Terminal building	2026	2030	Provide modern terminal building with natural light, smart lighting	At Feasibility stage	N/A		KAA
			iii) reduce electrical demand (switch off unnecessary lights, promote stairs instead of lifts, etc.)								
M57				Construction New Terminal building	2026	2030	Provide modern terminal building with natural light, smart lighting	At Feasibility stage	N/A		KAA
		c) enhanced ground support equipment (GSE) management									
			i) Reduce distance travelled								
M58				Rehabilitation of the existing RWY, to include construction of 2 Rapid exit taxiways and extension of Taxiway G at JKIA	2023	2027	To increase the runway 06/24 throughput. Reduce RWY occupancy time. To reduce fuel burnt for arriving and departing aircrafts.	At proposal stage	565 tCO2 per year	Kshs. 5.7B	KAA, KCAA / ANS and SDOT
M59				Construction of 2nd Runway Project	2023	2027	Reduce fuel burn, due to simultaneous take offs and landings.	At proposal stage	26,388 tCo2per year (Cobeneti ts)	Kshs. 22B	KAA , KCAA / ANS, airlines and SDOT
			ii) avoid unnecessary idling of equipment								
M60				Increase parking slots by 200 for airport users at JKIA	2022	2027	To reduce turnaround time and hence time taken looking for parking. This improves local air quality at the airport	At proposal stage	N/A	Kshs. 50M	KAA
M61				Construction of 35 parking slots at Nanyuki	2022	2027	To reduce turnaround time and hence time taken looking for parking. This improves local air quality at the airport	At proposal stage	N/A	Kshs. 20M	KAA
M62				Improvement of Terminal building and Construction of 150 parking slots at KIA	2022	2023	To reduce turnaround time and hence time taken looking for parking. This improves local air quality at the airport	On going	N/A	Kshs. 180M	KAA
		d) Conversion of GSE to cleaner fuels									
			i) Electrical operated ground vehicles								

Measure nb	Category	Measure	Action	Description	Start date	End date	Objectives	Current status	GHG/Fuel Efficiency Impact (EBT)/ Expected Results	Economic Cost (USD)	Stakeholders
M63				20 Installation of electric vehicle charging points at JKIA, MIA, EIA and KIA	2022	2027	To encourage airport users through sensitization to switch to electrical vehicles and equipment (Airside and Landside)	N/A		Kshs. 80M	KAA, KPLC, airlines, Ground Handlers and SDOT
			ii) Gas operated ground vehicles						N/A		
M64				Purchase 5 gas operated folk lifts at JKIA	2015	Continuous	Reduce use of fossil fuels at airside	N/A		Kshs. 5M	KAA
		e) improved transportation to and from airport								N/A	
			i) improved public transport access						N/A		
M66			Commuter rail line from Embakasi		2025	2030	Reduce No. of vehicles to the airport and hence emissions	At design	N/A		KRC, NAMATA, KAA
M67			Commuter rail line from SGR to Syokimou parking		2025	2030	Reduce No. of vehicles to the airport and hence emissions	stage	N/A		KRC, NAMATA, KAA
M68			21Km railway line from Nrb central station to JKIA MGR line		2023	2024	Reduce No. of vehicles to the airport and hence emissions	At design stage	N/A	Kshs. 1.2B	KRC, MoT, NAMATA, KAA
M69			Automating passenger security screening at JKIA		2021	2030	Reduces traffic congestion at the security check point	Continuous	N/A	Kshs. 30M	KAA, KCAA, SDOT
			ii) improved employee transportation						N/A		
M70			Provide electric buses for airport employees		2000	Ongoing	Reduce No. of vehicles to and from airport and hence emissions	Ongoing	N/A		KAA
M71			Sensitization airport users on use of mass transport to and from airports		2023		Encourage airport users to use mass transport to reduce emissions	Continuous	N/A	Kshs. 10M	KAA

7.4 Annex 4: Detailed Measure - Improved Energy Use at Airports

PHASE 1 INSTALLATION OF LED ON THE LAND SIDE STREET LIGHTING

- Total CO2 = power in MWh X grid emission factor for Kenya (0.5793) X 12hrs X 365days
- Assumption light are on 12 hours per day for 365 days per year
- Approximately 50% of power goes to lighting
- Average reduction of usage for LED vs incandescent lighting is 60% - very conservative estimates some manufacturers claim up to 80%
- Note for power in the building the figure is multiplied by 24 hours instead of 12 hours

International Airports	Power Consumption in kW/h per month	Power Consumption in kW/h per Year	kgCO2 from lighting	tCO2 from lighting
1. Jomo Kenyatta International Airport (JKIA)	2,600,000	2,600	6,597,068.40	6,597.07
2. Moi International Airport (MIA)	350,000	350	888,066.90	888.07
3. Wajir International Airport (WIA)	12,000	12	30,448.00	30.45
4. Eldoret International Airport (EIA)	60,000	60	152,240.04	152.24
Total			**7,667,823.34**	**7,667.83**

- JKIA, MIA, WIA and EIA produce approximately 7,667.83 mtCO2 or 7,667,823.34 kgCO2 from lighting
- Use of LED will cut down the emission by 60% = (100/60) (7,667.83/2) = 6,389.60 mtCO2
- Approximately = 6,389,600 kgCO2
- Cost of implementation USD 30M
- When we install LED at JKIA and MIA we will save 50% and 30% respectively in terms of revenue expenditure on electricity

PHASE 2 - INSTALLATION OF THE SOLAR PANEL MEANING 100% CONVERSION TO RENEWABLE ENERGY WITH ZERO EMISSIONS

Total CO2 = Amount of annual power generated from solar or replaced by solar X national grid factor

Assumptions - all emissions emitted in the process of the manufacture of the solar is not part of the emissions.

International Airports	**Power Consumption in kW/h per month**	**Power Consumption in kW/h per Year**	**Expected solar power generation (mw)**
1. Jomo Kenyatta International Airport (JKIA)	2,600,000	2,600	3.00
2. Moi International Airport (MIA)	350,000	350	2.00
3. Wajir International Airport (WIA)	12,000	12	0.50
4. Eldoret International Airport (EIA)	60,000	60	1.00
Total			**6.50**

- JKIA, MIA, WIA and EIA produce approximately 7,667.83 mtCO2 or 7,667,823.34 kgCO2 from lighting
- Total power generated = 6.50 MW
- Solar energy would be used mainly of lighting, hence 100% offset of 50% CO2 generated in total = (7,667.83/2) mtCO2 = 3,833.92 mtCO2
- In addition in EIA, the current electricity water pump will be replaced with a solar water pump hence saving an additional = offset of approx. 900kwh per month = 10,800 kWh per year = 27,403.21 kgCO2 per year
- Cost of implementation USD 170,000
- When we install solar power plant at JKIA we will save 25% in terms of revenue expenditure on electricity

KENYA ASSOCIATION OF AIRLINE OPERATORS (KAAO)