

REPUBLIC OF MAURITIUS

DEPARTMENT OF CIVIL AVIATION

Sir Seewoosagur Ramgoolam International Airport, Plaine Magnien

MAURITIUS STATE ACTION PLAN FOR CO₂ EMISSIONS REDUCTION FOR THE AVIATION SECTOR

**ISSUE 2 REV 0
06 FEBRUARY 2023**

FOREWORD

The global aviation CO₂ emissions is approximately 2 percent which is contributing to the climate change. It is predicted that the amount of CO₂ emissions from aviation is expected to grow around 3 to 4 percent per year.

The Assembly of the International Civil Aviation Organisation (ICAO) had during its 37th session adopted Resolution A37-19: *Consolidated Statement on continuing ICAO policies and practices related to environmental protection* and resolved that Contracting States of ICAO and relevant organisations will work towards achieving a global annual improvement of 2 percent per annum.

The aviation sector often plays a central role in the national economy of any State, affecting numerous economic sectors and contributing to its further development. As such, any measure to limit or reduce the impact of international aviation on the environment, pursuant to the global aspirational goals agreed by the ICAO Assembly, should be an integral part of the broader sustainable development priorities and objectives of a State.

In this context, Contracting States of ICAO are encouraged to prepare action plans outlining their respective policies and actions including annual reporting on international aviation CO₂ emissions to ICAO. The Department of Civil Aviation (DCA) of the Republic of Mauritius has set up a working group comprising of:

- The DCA, which regulates all the aviation activities and is the service provider of air navigation services;
- The national carrier, Air Mauritius Ltd, which is the only airline operator in Mauritius; and
- The Airports of Mauritius Co Ltd (AML), which is the licenced aerodrome operator for the Sir Seewoosagur Ramgoolam International Airport.

The steering committee has met on a regular basis to prepare this action plan which will be a living document and will be reviewed as and when required. A number of key initiatives have been earmarked and put in place to increase the fuel efficiency of our national carrier such as modernising the national airline fleet, restructuring of the Mauritius Flight Information Region (FIR), improved efficiency of the Air Traffic Management amongst others.

The Assembly Resolutions A38-18, A39-2 and A40-18 represents a milestone in the continuing efforts of ICAO to address greenhouse gas (GHG) emissions from international aviation and further encourages States to submit their voluntary action plans outlining goal to reduce GHG emissions from aviation operations, and should contribute to the global effort to minimise aviation's carbon footprint, safeguarding our ominous environment from global climate change.

Mauritius had submitted the initial State Action Plan to ICAO in May 2014. This State Action Plan is an updated version as per the guidelines given in ICAO Doc 9988.

A number of key initiatives had been earmarked and put in place to increase the fuel

efficiency of our national carrier such as modernising airport facilities, improved efficiency of Air Traffic Management amongst others since 2014. These measures are part and parcel of our daily operation.

This plan has once again set an ambitious goal to reduce GHG emissions from aviation operations, and should contribute to the global effort to minimise aviation's carbon footprint, safeguarding our ominous environment from global climate change.

This is the second update of the Mauritius State Action Plan. This action plan was finalised on 06 February 2023, and shall be considered as subject to update after that date.



I POKHUN

Director of Civil Aviation

AMENDMENT RECORD

Amendment No.	Date of issue	Date entered	Entered by
Issue 1	28 May 2014	28 May 2014	Ag DCA
Issue 2	06 February 2023	06 February 2023	DCA

TABLE OF CONTENTS

FOREWORD.....	2
AMENDMENT RECORD.....	4
TABLE OF CONTENTS	5
LIST OF ABBREVIATIONS.....	7
1. Point of Contact.....	8
2. Current State of Aviation	9
3. Baseline/Fuel Statistics/CO ₂ Emissions	12
3.1 Historic Fuel Emissions of National Airline and the Mauritius Baseline	12
3.2 Data Sources and Methodology.....	13
4. Measures to Mitigate CO ₂ Emissions.....	15
INTERNATIONAL MEASURES TO MITIGATE CO ₂ EMISSIONS.....	16
4.1 Re-fleeting of Air Mauritius Aircraft	16
4.1.1 Incremental improvements/benefits of Measure 4.1.....	17
4.2 Restructure of the Mauritius Flight Information Region (FIR) (Operational Improvements).....	18
4.2.1 Incremental Improvements/Benefits of Measure 4.2	20
4.3 Dynamic Flight Plan.....	22
4.3.1 Incremental Improvements/Benefits of Measure 4.3	22
4.4 Optimised Aircraft Maintenance - Engine Wash	23
4.4.1 Incremental Improvements/Benefits of Measure 4.4	24
DOMESTIC MEASURES TO MITIGATE CO ₂ EMISSIONS	25
4.5 Painting of Aircraft Lead-in Line / Stop Line for Different Aircraft Type.....	25
4.6 Replacement of all Old Generation Induction Motors with New Generation Motors of Standards IE3 or 4, Permanent Magnet Type.....	26
4.7 Re-Development of an Optimised Building Management System (BMS) System.....	27
4.8 Installation of LED Lights instead of Classic Lights.....	28
4.9 Replacing Existing 132 kWh of Bollard Lights by Solar Lights.	29
4.10 Implementation of a Solar Farm at the Airport	29
4.11 Replacement or Conversion of all Fresh Air Handling Units into Demand Control type units (DCV – Demand Controlled Ventillation).....	30
4.12 Replacement of Existing Old Motors and Transformers by Newer Efficient Ones	31
4.13 Installation of Reflector Films on Glass Panels to Reduce Heating from Sun Rays	32

4.14 Installation of Motion Sensors in Baggage Claim Area	32
4.15 Splitting of Roof Light Switching in Two Parts – Check-In and Boarding	33
4.16 Installation of PIR Sensors	34
4.17 Replacement of Diesel Powered Ground Vehicles to Electric Vehicles	34
5. Mauritius Mitigation Measures – Expected Action Plan Results.....	36
6. Future Initiatives.....	38
7. Conclusion	38
8. Appendix	39

LIST OF ABBREVIATIONS

AML	Airports of Mauritius Co Ltd
ATM	Air Traffic Management
ATOL	Airport Terminal Operations Ltd
CCO	Continuous Climb Operations
CDO	Continuous Descent Operations
DCA	Department of Civil Aviation
DFP	Dynamic Flight Plan
EBT	Environmental Benefit Tool
FIR	Flight Information Region
GHG	Greenhouse Gas
GSE	Ground Support Equipment
ICAO	International Civil Aviation Organisation
MCAR	Mauritius Civil Aviation Requirements
PBN	Performance Based Navigation
PIR	Passive Infrared
RNP	Required Navigation Performance
RPK	Revenue Passenger Kilometre
RTK	Revenue Tonne Kilometre
SID	Standard Departure Route
STAR	Standard Arrival Route
TMA	Terminal Manoeuvring Area
UNFCCC	United Nations Framework Convention on Climate Change
ZFW	Zero Fuel Weight

1. Point of Contact

Name of the authority	Department of Civil Aviation (DCA)
Point of Contact	Mr. I Pokhun - Director of Civil Aviation (Focal Point)
Address	Sir Seewoosagur Ramgoolam International Airport
Country	Mauritius
Province/City	Plaine Magnien
Telephone Number	230-6032000
Fax Number	230-6373164
E-mail address	civil-aviation@govmu.org

Name of the authority	Department of Civil Aviation
Point of Contact	Mr. G Sewlall - Airworthiness Engineer
Address	Sir Seewoosagur Ramgoolam International Airport
Country	Mauritius
Province/City	Plaine Magnien
Telephone Number	230-6032000
Fax Number	230-6373164
E-mail address	gsewlall@govmu.org

Name of the authority	Air Mauritius Ltd
Point of Contact	Capt. Patrick Ter Hofsteede - Technical Manager
Address	Sir Seewoosagur Ramgoolam International Airport
Country	Mauritius
Province/City	Plaine Magnien
Telephone Number	230-6033580
Fax Number	230-6373190
E-mail address	phofsteede@airmauritius.com

Name of the authority	Airports of Mauritius Co Ltd (AML)
Point of Contact	Mr Rajeev Lollbearree – Chief Executive Officer
Address	Sir Seewoosagur Ramgoolam International Airport
Country	Mauritius
Province/City	Plaine Magnien
Telephone Number	230-6036000
Fax Number	230-6375306
E-mail address	airportinfo@aml.aero

2. Current State of Aviation

Air transport plays a leading role in the economic and social development of the country. Aviation is more or less the modern 'navel string' to the rest of the world in the middle of the Indian Ocean. Mauritius is a small island and does not have much involvement in manufacturing as well as research and development.

While air travel supports the Mauritian economy, trade and tourism, and connects us to the world separated by great distances and vast ocean, it also contributes to greenhouse gas emissions. Thus, the Action Plan expresses how the parties, in good faith, intend to reduce greenhouse gas emissions from aviation activities.

Mauritius has one international airport, Sir Seewoosagur Ramgoolam International Airport and one domestic airport, Plaine Corail Airport, situated on an island about 619 km to the North-East of Mauritius. We also have an airstrip at Agalega, another island approximately 1019 km to the North of Mauritius. Though we are a small country yet we have a very vast Flight Information Region. It covers more than nine million square kilometres (9,000,000 km²) and the perimeter is about 12,260 km. We have an average of sixty traffic daily. We have also overflying traffic on the Australia-Africa and South East Asia-Africa routes.

Annually we have about 24,000 commercial flights, 4,900 overflights, 3,000 Military and surveillance traffic, 12,000 local flights mostly helicopters. As Tourism is one of the pillars of the economy, the policy of the government is to double the tourism capacity within the next decade.

The main stakeholders are:

- The Department of Civil Aviation which regulates all the aviation activities and is the service provider of air navigation services;
- Our National Carrier, Air Mauritius which is the only airline operator in Mauritius; and
- Airports of Mauritius Co Ltd (AML), the licensed aerodrome operator for Sir Seewoosagur Ramgoolam International Airport.

We have set an ambitious goal to reduce greenhouse gas (GHG) emissions from both domestic and international operations, which should contribute to the global efforts to minimise aviation's carbon footprint, thus safeguarding our ominous environment.

In 2010, the ICAO has set three aspirational goals to address the climate impact:

- (i) An annual improvement of 2% in fuel efficiency from 2009 until 2020.
- (ii) To achieve Carbon Neutral Growth from 2020 to stabilise the net CO₂ emissions, and
- (iii) Reduction of carbon emissions by 50% by 2050 compared to 2005 levels.

In 2022, the ICAO has updated the aspirational goals to address the climate impact as follows:

- (i) To continuously improve CO₂ efficiency to achieve a carbon neutral growth from 2020 and to achieve long-term goal of net-zero carbon emissions by 2050; and
- (ii) To achieve an aspirational global fuel efficiency improvement rate of 2% per annum from 2021 to 2050, calculated on the basis of volume of fuel used per revenue tonne kilometre performed.

This Action Plan identifies **four key measures** that are expected to have the greatest environmental impact to contribute to the ICAO aspirational goals and the climate change:

- Re-fleeting of Air Mauritius Aircraft (From 2019 to December 2021);
- Restructure of the Mauritius Flight Information Region (FIR);
- Dynamic Flight Plan (DFP); and
- Optimised Aircraft Maintenance - Engine Wash.

The Action Plan also highlights that these measures will benefit many international airlines including the overflying trans-oceanic flights as our FIR covers a very vast area where the benefits are really tangible.

Through these measures, the Mauritius aviation sector contributes to the Paris Agreement and the United Nations Framework Convention on Climate Change (UNFCCC), henceforth recognising the urgency of pursuing the goal of limiting global warming to 1.5°C.

The Action Plan is a living document and will be reviewed on a regular basis through:

- Annual reporting on the progress towards achievement of the Action Plan's fuel efficiency target;
- A review of the Action Plan, that will occur in three years; and

- Semi-annual meetings between different stakeholders creating a synergy.

The COVID-19 Impact

The impact of the COVID-19 crisis on all aspects of the economy and society is well known and Aviation has been particularly acutely impacted since March 2020. This has had a devastating impact on travel and tourism and on the frontline companies operating the aviation system and the rest of the supply chain. However, shocks to air traffic growth in the past have always been followed by a rebound in traffic and, while this may take longer than in previous crises, traffic will eventually return back. According to IATA, global passenger traffic (Revenue Passenger Kilometres or RPKs) will not return to pre-COVID-19 levels until 2024. The recovery in short haul travel is still expected to happen faster than for long haul travel. As a result, passenger numbers will recover faster than traffic measured in RPKs. This impact will also be applicable to the Mauritian context and the passenger load will be lower than the initially projected values till 2023-24.

The effect of the COVID-19 pandemic will not be visible in this State Action Plan. The most recent data in the State Action Plan will primarily be from 2019, which is the last normal year. Additionally, since the Revenue Tonne Kilometre (RTK) value has not yet been published for the year 2020, thus, the baseline is taken from the year 2019.

3. Baseline/Fuel Statistics/CO₂ Emissions

3.1 Historic Fuel Emissions of National Airline and the Mauritius Baseline

To quantify the impact of Mauritius mitigation measures discussed in Section 4, a baseline scenario covering Mauritius emissions from international aviation is presented below.

In accordance with the ICAO Doc 9988, the data set out in Table 1 and Figure 1 reflect the annual historic international fuel consumption and a “do nothing” or “no-mitigation” scenario for the forecasted years up to the 2050.

The scenario does not consider the impact of the COVID-19 pandemic due to a lack of available data and assume a business-as-usual scenario. Moreover, since the RTK data for the year 2020 has not yet been published by ICAO, the historic data have been gathered up to the year 2019 where all information are readily available.

The COVID-19 impact is expected to be accounted in the next Mauritius State Action Plan update when sufficient data will be available and stakeholders will be in a better position to forecast their growth rate and suggest appropriate mitigating measures.

Year	International RTK (tonne kilometres)	International Fuel Consumption (tonnes)	International Fuel (litres) ('000)	International CO ₂ emissions (metric tonnes)
2007 <i>(historic)</i>	827,804.00	248,660.49	315,301.50	785,767.14
2008 <i>(historic)</i>	789,148.00	240,185.10	304,554.71	758,984.90
2009 <i>(historic)</i>	664,521.00	192,699.13	244,342.50	608,929.26
2010 <i>(historic)</i>	783,203.28	213,371.76	270,555.39	674,254.77
2011 <i>(historic)</i>	785,291.57	228,376.91	289,581.92	721,671.04
2012 <i>(historic)</i>	937,951.11	218,356.17	276,875.62	690,005.50
2013 <i>(historic)</i>	712,158.00	200,836.11	254,578.93	634,642.09
2014 <i>(historic)</i>	744,271.50	212,619.92	269,670.53	671,878.95
2015 <i>(historic)</i>	751,060.00	210,702.73	267,153.40	665,820.63
2016 <i>(historic)</i>	786,600.00	221,769.93	281,632.82	700,792.98
2017 <i>(historic)</i>	845,400.00	230,254.57	292,090.32	727,604.45
2018 <i>(historic)</i>	905,300.00	230,627.02	292,850.92	728,781.38
2019 <i>(historic)</i>	848,100.00	208,302.81	264,456.36	658,236.88
2020 <i>(forecast)</i>	886,264.50	210,737.80	263,422.24	665,931.42
2025 <i>(forecast)</i>	1,104,446.92	223,346.37	279,182.96	705,774.52

Year	International RTK (tonne kilometres)	International Fuel Consumption (tonnes)	International Fuel (litres) ('000)	International CO ₂ emissions (metric tonnes)
2030 <i>(forecast)</i>	1,376,341.67	236,709.32	295,886.65	748,001.46
2035 <i>(forecast)</i>	1,715,172.13	250,871.79	313,589.74	792,754.87
2040 <i>(forecast)</i>	2,137,416.52	265,881.61	332,352.02	840,185.90
2045 <i>(forecast)</i>	2,663,609.87	281,789.48	352,236.85	890,454.76
2050 <i>(forecast)</i>	3,319,342.50	298,649.12	373,311.41	943,731.23

Table 1. Mauritius historic emissions from international aviation 2007-2019 and forecasted emissions from 2020-2050.

3.2 Data Sources and Methodology

The fuel consumption data from 2007 to 2019 represent the historical emissions as reported by Air Mauritius airline to the DCA. The international RTK data have been taken from the ICAO.

For all the years, the international CO₂ emissions is calculated by multiplying the international fuel consumption in tonnes by 3.16, which is the fuel conversion factor for Jet-A1 fuel as suggested by the ICAO. The forecasted international fuel consumption in tonnes has been calculated using the conversion factor of 0.8 kg/litre as suggested by the ICAO Doc 9988.

The ICAO Environmental Benefit Tool (EBT) has been used in developing and forecasting the future baseline fuel consumption. In the absence of the default regional growth rate, we have used a growth rate of 5% as anticipated by our national airline for the next five years ignoring the COVID-19 outbreak. Air Mauritius will review the growth rate and inform the DCA for the most appropriate percentage growth before the periodic updating of the State Action Plan.

Method B, Case 1 from the ICAO Doc 9988 (Guidance on the Development of States' Action plan on CO₂ Emission Reduction Activities) has been used in the ICAO EBT for generating the baseline scenario. The ICAO recommended to use Method B when the fleet size is more than ten aircraft and fuel data exist for at least two years and most preferably when historical data of at least five years exist for the ICAO EBT to yield more accurate forecast.

Since the fleet size of Air Mauritius has been over ten aircraft from 2007 to 2019 and the historical fuel data exist for at least 13 years, thus, Method B justifies the use of this formula.

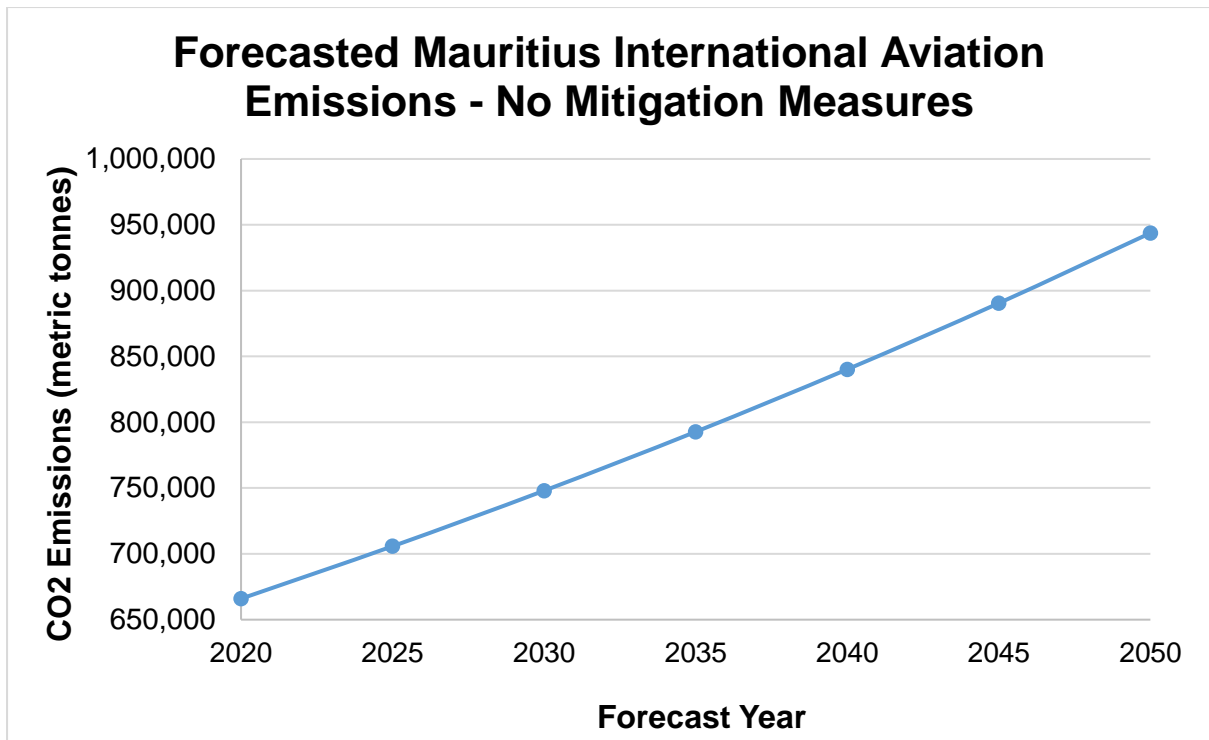


Figure 1. All international aviation emissions forecasts being operated by our national carrier registered in Mauritius 2020-2050.

4. Measures to Mitigate CO₂ Emissions

In addition to the measures listed in the first Mauritius Action Plan dated 28 May 2014, four new mitigating measures have now been identified for implementation to mitigate the CO₂ emissions from international flights in Mauritius and thirteen measures have been identified to mitigate the CO₂ emissions at the domestic level.

It is worth reporting other mitigating measures that will have effect on the Domestic Sector. AML and Airport Terminal Operations Ltd (ATOL) have already taken some measures and have planned to implement some mitigating measures which would be beneficial to the domestic CO₂ emissions in terms of airport improvements in the following areas:

- a) Airfield improvements;
- b) Reduce energy demand and prefer cleaner energy sources; and
- c) Conversion of Ground Support Equipment (GSE) to cleaner fuels.

International Measures to Mitigate CO₂ Emissions:

- 1. Re-fleeting of Air Mauritius aircraft.
- 2. Restructure of the Mauritius Flight Information Region (FIR).
- 3. Dynamic Flight Plan (DFP).
- 4. Optimised aircraft maintenance - Engine wash.

Domestic Measures to Mitigate CO₂ Emissions:

- 5. Painting of aircraft lead-in line / stop line for different aircraft type.
- 6. Replacement of all old generation induction motors with new generation motors of standards IE3 or 4, permanent magnet type.
- 7. Re-development of an optimised Building Management System (BMS). To enable smart / accurate control of pumping systems, air systems to manage power consumption.
- 8. Installation of LED lights instead of classic lights by ATOL and AML.
- 9. Implementation of solar lights at the airport car park facilities.
- 10. Implementation of a solar farm at the airport.
- 11. Replacement or conversion of all fresh air handling units into demand control type units (DCV – Demand Controlled Ventilation).
- 12. Replacement of existing old motors and transformers by newer efficient ones.
- 13. Installation of reflector films on glass panels to reduce heating from sun rays.

14. Installation of motion sensors in baggage claim area.
15. Splitting of the roof light switching in two parts – Check-In and Boarding.
16. Installation of PIR sensors to switch off lights when not required and to switch air conditioners to fan mode when no presence is detected in offices.
17. Replacement of diesel-powered vehicles to electric vehicles.

INTERNATIONAL MEASURES TO MITIGATE CO₂ EMISSIONS

4.1 Re-fleeting of Air Mauritius Aircraft

Air Mauritius airline is the sole contributor to the international CO₂ emissions in Mauritius. Therefore, Air Mauritius plays an important role in the overall aviation emissions reduction.

Prior to the COVID-19 pandemic, Air Mauritius already had the plan to phase out the four engines Airbus A340 aircraft and to replace them with the new technologically advanced Airbus A350 XWB composites aircraft. In this regard, Air Mauritius has placed an order of six new Airbus A350 XWB aircraft to replace the old six Airbus A340 aircraft which had an average age of nearly 20 years old. Four Airbus A350 XWB have already been delivered to Air Mauritius and Air Mauritius is planned to take delivery of two A350 XWB in 2023 and 2025 if all goes as per their plan.

Air Mauritius has also taken delivery of two new Airbus A330 neo aircraft which are fitted with a better fuel-efficient Rolls Royce Trent 7000 engine. It should be noted that Air Mauritius is the first airline in the world to operate both the Airbus A350 XWB and A330-900 aircraft.

Currently, Air Mauritius is operating a young fleet of aircraft for its medium to long haul flight destinations. All the airbus A340 four engines aircraft, A330 conventional aircraft and A319 aircraft have been completely phased out from their fleet until December 2021.

In general, turboprop engines are more fuel efficient compared to jet engines. However, turboprop engine aircraft fly slower compared to jet engine aircraft. For this reason, turboprop aircraft are mostly favoured for either non-commercial flight or for short range commercial flight. Air Mauritius operates three ATR 72-212A turboprop aircraft for its short range commercial flight to Rodrigues and Reunion Island.

Overall, it can be said that Air Mauritius is now operating a young and/or fuel efficient aircraft to all its destinations, from short-haul to long-haul destinations. Current aircraft being operated by the national carrier are ATR72-212A, Airbus A330-900 and Airbus A350-900 XWB.

Since Air Mauritius has recently embarked on the renewal of their current fleet, another renewal of their fleet is not expected to happen soon. Air Mauritius will inform the DCA in case a re-fleeting program will be initiated.

Title	Re-fleeting of Air Mauritius aircraft
Description	<p>Renewal of the National airline fleet, thereby operating a fleet of young technologically advanced aircraft which are more fuel efficient compared to conventional aircraft or A340 four engines aircraft.</p> <p>This measure would cause a significant reduction in the CO₂ emissions.</p>
Category	Technology and Standards
Measure	Purchase of new aircraft
Action	<p>Replacement of the aging aircraft which were on average 20 years old and conventional aircraft with new composites light weight and fuel efficient engine aircraft.</p> <p>To reduce the amount of fuel burn and consequently reducing the CO₂ emissions.</p>
Start date	October 2017
Date of full implementation	2025 onwards
Economic cost	High
List of stakeholders involved	Air Mauritius Ltd (Airline)
Point of Contact	CEO/ Chief Operating Officer Air Mauritius Ltd

4.1.1 Incremental improvements/benefits of Measure 4.1

The phasing out of Air Mauritius airbus A340 four engines aircraft started as from mid-2018 to 2019 and the historic carbon emissions or fuel burn in litres for the year 2019 have shown a decrease compared to 2018 as four airbus A340 aircraft were phased out.

During the year 2021, the last two Airbus A340 aircraft, two A319 aircraft and two A330 conventional aircraft having an average of 23 years old, 19 years old and 13 years old, respectively were phased out from the Air Mauritius fleet.

We have referred to ICAO Doc 9988 Appendix C to estimate the annual fuel savings with the purchase of new aircraft as follows:

Measure	Estimated Benefits
Purchase of new aircraft	Fuel Savings = [0.9% to 1.05%] * a/c' age (year) * old a/c' fuel burn (low/high range)

Consequently, with the phasing out of all the conventional wide body aircraft and the two narrow body jet engine aircraft from the Air Mauritius fleet in 2021, the annual fuel savings with the operations of the newer technologically advanced aircraft have been estimated as:

YEAR	2022
Improvement in International Fuel Consumption (tonnes)	13,997.59
Improvement in International CO ₂ Emissions (tonnes)	44,232.40

4.2 Restructure of the Mauritius Flight Information Region (FIR) (Operational Improvements)

The DCA has embarked on the project to restructure the Mauritius Flight Information Region (FIR) in 2019. The purpose of this project is to **upgrade** its airspace through the implementation of Performance Based Navigation (PBN) with a view to enhancing **Efficiency, Capacity, Interoperability and Safety** as well as to reduce the impact of aviation on the **environment**. The project is in the final stage. The implementation is scheduled for 28 March 2023.

This proposed airspace concept is a first step towards implementation of PBN in line with **AFI Regional Air Navigation System Implementation** aligned with the **ICAO ASBUs** with the following main features:

1. Introduction of RNP4 as the navigation specification within the oceanic airspace of the Mauritius FIR which is presently RNP10.
2. Introduction of RNP1 as the navigation specification within the Mauritius Terminal Manoeuvring Area (TMA); and
3. Provision of RNP1 Standard Arrival Routes (STARs) and Standard Departure Routes (SIDs) to cater for CCO's and CDO's.

There is only one runway equipped with a CAT 1 Instrument Landing System for

approximately sixty aircraft movements per day.

The Air Traffic Services unit provides a controlled service within the FIR. The Mauritius airspace encompasses a FIR of 9,000,000 km² which extends from 57° to 75° East and from 06° to 45° South.

The new airspace structure should take full advantage of the new possibilities offered by the PBN concepts and available technologies to deliver the benefits of:

- Enhance Efficiency.
- Enhance Capacity.
- Enhance Safety.
- Enhanced Functionality.

The airspace review of the Mauritius FIR will help to reduce the CO₂ emissions in terms of the four below departure and approach procedures:

1. Continuous Descent Operations (CDOs).
2. PBN STAR.
3. Continuous Climb Operations (CCOs).
4. PBN SID.

The table below illustrates the measures envisaged in the airspace restructure project:

Title	The restructure of the Mauritius FIR
Description	<ol style="list-style-type: none">1. Introduction of RNP4 as the navigation specification within the oceanic airspace of the Mauritius FIR which is presently RNP10.2. Introduction of RNP1 as the navigation specification within the Mauritius TMA; and3. Provision of RNP1 (STARs and SIDs to cater for CCO's and CDO's.
Category	Operational Improvements – More Efficient ATM Planning, Ground Operations, Terminal Operations, En-Route Operations, Airspace Design and Usage, Aircraft Air Navigation Capabilities

Measure	Measures to improve fuel efficient departure and approach procedures in terms of: 1. CDO. 2. PBN STAR. 3. CCO. 4. PBN SID.
Action	The airspace review initiated by the DCA will benefit the national airline (Air Mauritius) and all foreign operators taking-off and landing in Mauritius. The aim of this airspace review is to improve the flight operations in terms of fuel efficiency.
Start date	2019
Date of full implementation	March 2023
Economic cost	Medium
List of stakeholders involved	ATM, Air Mauritius
Point of Contact	ATM at the DCA

4.2.1 Incremental Improvements/Benefits of Measure 4.2

Following the re-opening of borders due to the COVID pandemic, the scheduled operation of the national carrier Air Mauritius for the year 2022 was as follows:

No.	Aircraft Type	Departure	Arrival	Weekly Total	Yearly Total
1	ATR72	53	53	106	5512
2	A330-900	17	17	34	1768
3	A350-900	27	27	54	2808

We have taken the estimated fuel savings per successful flight as estimated by Air Mauritius to estimate the annual fuel savings with the introduction of CCO/CDO and PBN STAR /SID as follows:

Aircraft type	Operations type	Estimated Fuel savings (kg)	Methodology
ATR72	CDO	18	3.5° Continuous Descent Profile estimate from FCOM
	CCO	N/A	Limited savings can be quantified due to nature of ATR operations
	PBN STAR	20	Savings of 2 mins during descent
	PBN SID	20	Savings of 2 mins during climb
A330-900	CDO	55	Eurocontrol (2017) Methodology
	CCO	20	Eurocontrol (2017) Methodology
	PBN STAR	125	Reduced track miles and IFSET application (25% fuel saving in descent)
	PBN SID	138	Reduced track miles and IFSET (25% fuel saving in climb)
A350-900	CDO	60	Eurocontrol (2017) Methodology
	CCO	25	Eurocontrol (2017) Methodology
	PBN STAR	138	Reduced track miles and IFSET (25% fuel saving in descent)
	PBN SID	154	Reduced track miles and IFSET (25% fuel saving in climb)

The annual fuel savings have been estimated using the ICAO rule of thumb formula from ICAO Doc 9988 and Air Mauritius estimated fuel savings data.

YEAR	April 2023 to December 2023
Improvement in International Fuel Consumption (tonnes)	960.26
Improvement in International CO ₂ Emissions (tonnes)	3,034.43

YEAR	2024 onwards
Annual Improvement in International Fuel Consumption (tonnes)	1,280.35
Annual Improvement in International CO ₂ Emissions (tonnes)	4,045.90

4.3 Dynamic Flight Plan

Dynamic Flight Plans (DFPs) are issued whenever there is a major gap between the Actual Zero Fuel Weight (ZFW) and the estimated ZFW used when generating the operational flight plan. The DFP will display the adjusted “Planned Fuel” required in case there is a drop in the ZFW. Consequently, a drop in “Planned Fuel” required is noted.

As a result, this reduces the carriage of unnecessary extra fuel carriage for each flight.

Title	Dynamic flight plan and accuracy of flight planning software
Description	Air Mauritius uses the latest communications means to be able to cater for last minute changes in ZFW. This reduces unnecessary extra fuel carriage for each flight.
Category	Operational Improvements – Best Practices in Operations
Measure	Minimising Operational Weight of: 1. Turboprop Aircraft 2. Wide Body Aircraft
Action	Optimising on the amount of fuel uplift for each flight, thus, reducing unnecessary extra fuel weight carriage per flight.
Date of full implementation	On-going
Economic cost	Low
List of stakeholders involved	Air Mauritius
Point of Contact	The Technical Manager - Air Mauritius

4.3.1 Incremental Improvements/Benefits of Measure 4.3

We have taken the annual unnecessary fuel uplift avoided as estimated by Air Mauritius to estimate the annual fuel savings:

Aircraft Type	Annual Unnecessary Fuel Uplift Avoided (tonnes)
A330-900 / A350-900	90

For calculation purpose, Air Mauritius estimates an average of 300 kg (0.3 tonnes) weight drop whenever a DFP is issued.

With this weight reduction, the annual fuel savings have been estimated using the ICAO rule of thumb formula from ICAO Doc 9988.

Measure	Estimated Benefits
Minimising weight - Widebody	Fuel Savings = weight reduction * flight time * 3.87%

YEAR	2021 onwards
Annual Improvement in International Fuel Consumption (tonnes)	38.31
Annual Improvement in International CO ₂ Emissions (tonnes)	121.1

4.4 Optimised Aircraft Maintenance - Engine Wash

Title	Maintenance task - Engine wash
Description	Air Mauritius conducts engine wash as per their aircraft maintenance program for engine performance and fuel savings. As a result, this also reduces the CO ₂ emissions.
Category	Operational Improvements - Optimised Aircraft Maintenance
Measure	Engine Wash
Action	Optimising engine efficiency and fuel efficiency through periodic engine wash, hence, reducing the CO ₂ emissions.
Date of full implementation	On-going
Economic cost	Low
List of stakeholders involved	Air Mauritius
Point of Contact	The Technical Manager - Air Mauritius

4.4.1 Incremental Improvements/Benefits of Measure 4.4

We have referred to ICAO Doc 9988 Appendix C to estimate the annual fuel savings when performing engine wash as follows:

Measure	Estimated Benefits
Engine Wash	Fuel Savings = [1%] * fuel burn

Consequently, the annual fuel savings when doing periodic engine wash have been estimated as:

YEAR	2020 (Onwards)
Improvement in International Fuel Consumption (tonnes)	1,450.28
Improvement in International CO ₂ Emissions (tonnes)	4,582.89

DOMESTIC MEASURES TO MITIGATE CO₂ EMISSIONS

The measures listed below are categorised as domestic measures and as such, the fuel savings arising out of these measures will not be included in the expected results (Table 2) of this State Action Plan.

These measures are being highlighted as they may have some benefits in achieving the objectives of this State Action Plan.

4.5 Painting of Aircraft Lead-in Line / Stop Line for Different Aircraft Type

Title	Painting of aircraft lead-in line / Stop line for different aircraft type
Description	AML is taking measures to improve parking by painting of Aircraft Lead-in line / Stop Line for different aircraft models depending on their frequency.
Category	Supplemental benefits for domestic sectors – More efficient use and planning of airport facilities
Measure	To improve parking at the Airport.
Action	To decrease follow me services provided by Airfield Vehicles.
Start date	2023
Date of full implementation	2023
Economic cost	Low
List of stakeholders involved	AML - Operations
Point of Contact	Chief Executive Officer - AML

4.6 Replacement of all Old Generation Induction Motors with New Generation Motors of Standards IE3 or 4, Permanent Magnet Type

Title	Replacement of all old generation induction motors with new generation motors of standards IE3 or 4, permanent magnet type
Description	The current electrical motors are operating on an efficiency of 70% or less. A replacement with those of efficiency of 98% and above is possible and ATOL has already embarked on a test case.
Category	Supplemental benefits for domestic sectors – More efficient use and planning of airport facilities
Measure	To enhance terminal support facilities.
Action	Replacement of all old generation induction motors with new generation motors.
Start date	2022
Date of full implementation	2030
Economic cost	7,000,000
Currency	MUR
List of stakeholders involved	ATOL
Point of Contact	Chief Executive Officer – AML/ATOL

4.7 Re-Development of an Optimised Building Management System (BMS) System

Title	Re development of an optimised BMS system
Description	Migration of HVAC BMS from APOGEE to Design CC. To enable smart / accurate control of pumping systems and air systems.
Category	Supplemental benefits for domestic sectors – More efficient use and planning of airport facilities
Measure	To enhance terminal support facilities.
Action	To deploy an optimised BMS system to enable accurate control of pumping systems and air systems.
Start date	2022
Date of full implementation	2025
Economic cost	10,000,000
Currency	MUR
List of stakeholders involved	ATOL
Point of Contact	Chief Executive Officer – AML/ATOL

4.8 Installation of LED Lights instead of Classic Lights

Title	Installation of LED lights instead of classic lights by ATOL and AML
Description	ATOL and AML have planned to replace the classic lights by LED lights at the following areas: 1. Apron Floodlights at Parking 11 to 15 by ATOL. 2. Runway by AML. 3. Round roof lights in the Passenger Terminal by ATOL. 4. AML buildings. 5. Apron floodlights by AML. 6. Street lighting by AML.
Category	Supplemental benefits for domestic sectors – Airfield Improvements
Measure	Installation of LED lights instead of classic lights
Action	To replace classical lights with LED lights
Start date	2023
Date of full implementation	2028
Economic cost	19,400,000
Currency	MUR
List of stakeholders involved	ATOL and AML – Technical Services
Point of Contact	Chief Executive Officer – AML & ATOL

4.9 Replacing Existing 132 kWh of Bollard Lights by Solar Lights

Title	To replace the existing 132 kWh of bollard lights by solar lights at the car park
Description	ATOL has planned to introduce solar lights at the car park instead of classic lights which require electrical energy.
Category	Supplemental benefits for domestic sectors – Reduced energy demand and preferred cleaner energy sources
Measure	Use cleaner alternative sources of power generation
Action	To replace the existing 132 kWh of bollard lights by solar panel equipped lights to reduce electrical demand.
Start date	2022
Date of full implementation	2023
Economic cost	5,000,000
Currency	MUR
List of stakeholders involved	ATOL
Point of Contact	Chief Executive Officer – AML/ATOL

4.10 Implementation of a Solar Farm at the Airport

Title	Implementation of a solar farm at the airport
Description	AML has planned to implement a solar farm at the airport with a power generation capacity of 14 MW.
Category	Supplemental benefits for domestic sectors – Reduced energy demand and preferred cleaner energy sources

Measure	Use cleaner alternative sources of power generation.
Action	To install a solar farm as a cleaner alternative source of power generation at the airport.
Start date	2023
Date of full implementation	2025
Economic cost	600,000,000
Currency	MUR
List of stakeholders involved	AML – Technical Services
Point of Contact	Chief Executive Officer - AML

4.11 Replacement or Conversion of all Fresh Air Handling Units into Demand Control type units (DCV – Demand Controlled Ventilation)

Title	Replacement or conversion of all fresh Air handling units into demand control type units
Description	ATOL has planned to change the type of ventilation and air conditioning system to adapt to new regulation in terms of viral filtration systems (air filtration) standards and new energy efficiency measures.
Category	Supplemental benefits for domestic sectors – Reduced energy demand and preferred cleaner energy sources
Measure	Use cleaner heater/cooler equipment and/or minimize heater/cooler utilization.
Action	To change the type of ventilation and air conditioning system to adapt to new regulation in terms of viral filtration systems (air filtration) standards and new energy efficiency measures to reduce the energy demand.
Start date	2023

Date of full implementation	2030
Economic cost	20,000,000
Currency	MUR
List of stakeholders involved	ATOL
Point of Contact	Chief Executive Officer – AML/ATOL

4.12 Replacement of Existing Old Motors and Transformers by Newer Efficient Ones

Title	Replacement of existing old motors and transformers by newer efficient ones
Description	AML has planned to replace existing old motors and transformers by efficient type. Some newer motors and transformers are already energy efficient ones.
Category	Supplemental benefits for domestic sectors – Reduced energy demand and preferred cleaner energy sources
Measure	Reduce electrical demand
Action	To replace old motors and transformers by efficient type to reduce the electrical demand at the airport.
Start date	2023
Date of full implementation	2030
Economic cost	10,000,000
Currency	MUR
List of stakeholders involved	AML – Technical Services
Point of Contact	Chief Executive Officer - AML

4.13 Installation of Reflector Films on Glass Panels to Reduce Heating from Sun Rays

Title	Installation of reflector films on glass panels to reduce heating from sun rays.
Description	AML has planned to make use of reflector films on glass panes to reduce heating from sun rays.
Category	Supplemental benefits for domestic sectors – Reduced energy demand and preferred cleaner energy sources
Measure	Reduce electrical demand.
Action	To install reflector films on glass panels to reduce the heating emitted from sun rays.
Start date	2024
Date of full implementation	2026
Economic cost	500,000
Currency	MUR
List of stakeholders involved	AML – Technical Services
Point of Contact	Chief Executive Officer - AML

4.14 Installation of Motion Sensors in Baggage Claim Area

Title	Installation of motion sensors in baggage claim area
Description	ATOL has planned to install motion sensors in the baggage claim area.
Category	Supplemental benefits for domestic sectors – Reduced energy demand and preferred cleaner energy sources
Measure	Reduce electrical demand.

Action	To install motion sensors in the baggage claim area to reduce the electrical demand.
Start date	2022
Date of full implementation	2023
Economic cost	1,000,000
Currency	MUR
List of stakeholders involved	ATOL
Point of Contact	Chief Executive Officer – AML/ATOL

4.15 Splitting of Roof Light Switching in Two Parts – Check-In and Boarding

Title	Splitting of the roof light switch in the Check-in and Boarding Area
Description	ATOL has planned to split the roof light switch into two parts, one for the check-in and another for boarding.
Category	Supplemental benefits for domestic sectors – Reduced energy demand and preferred cleaner energy sources
Measure	To reduce electrical demand.
Action	To split the roof light switch into two, that is, one for the check-in area and another one for the boarding area.
Start date	2023
Date of full implementation	2024
Economic cost	500,000
Currency	MUR
List of stakeholders involved	ATOL
Point of Contact	Chief Executive Officer – AML/ATOL

4.16 Installation of PIR Sensors

Title	Installation of PIR Sensors
Description	AML has planned to install PIR sensors to switch off the lights when not required and to switch the air conditioners to fan mode when no presence is detected in the offices.
Category	Supplemental benefits for domestic sectors – Reduced energy demand and preferred cleaner energy sources
Measure	To reduce electrical demand.
Action	To install PIR sensors to switch off lights and air conditioners to fan mode to reduce the electrical demand.
Start date	2023
Date of full implementation	2025
Economic cost	300,000
Currency	MUR
List of stakeholders involved	AML – Technical Services
Point of Contact	Chief Executive Officer - AML

4.17 Replacement of Diesel Powered Ground Vehicles to Electric Vehicles

Title	Replacement of diesel-powered ground vehicles to electric vehicles
Description	AML has planned to replace the conventional diesel-powered vehicles for the Technical Services and Airfield Operations vehicles to electric vehicles.
Category	Supplemental benefits for domestic sectors – Conversion of GSE to cleaner fuels
Measure	Electrical operated ground vehicles.

Action	To replace diesel airport ground vehicles to electric vehicles to reduce the domestic CO ₂ emissions.
Start date	2022
Date of full implementation	2030
Economic cost	30,000,000
Currency	MUR
List of stakeholders involved	AML – Technical Services & Operation
Point of Contact	Chief Executive Officer - AML

5. Mauritius Mitigation Measures – Expected Action Plan Results

Year	International Fuel – Baseline Scenario (litres) '000	International CO ₂ emissions – Baseline Scenario (metric tonnes)	Emissions Savings from Technology and Standards (metric tonnes)	Emissions Savings from Operational Improvements (metric tonnes)	Total Emissions Savings (metric tonnes)	International Fuel after implementation of measures (litres) '000	Remaining emissions after implementation of measures (metric tonnes)
2014 (<i>historic</i>)	269,670.53	671,878.95					
2015 (<i>historic</i>)	267,153.40	665,820.63					
2016 (<i>historic</i>)	281,632.82	700,792.98					
2017 (<i>historic</i>)	292,090.32	727,604.45					
2018 (<i>historic</i>)	292,850.92	728,781.38					
2019 (<i>historic</i>)	264,456.36	658,236.88					
2020 (<i>forecast</i>)	263,422.24	665,931.42	12,951.21	4,582.89	17,534.10	256,486.28	648,397.32
2025 (<i>forecast</i>)	279,182.96	705,774.52	82,170.07	10,244.45	92,414.52	242,626.58	613,360.00
2030 (<i>forecast</i>)	295,886.65	748,001.46	82,170.07	13,074.81	95,244.88	258,210.67	652,756.58
2035 (<i>forecast</i>)	313,589.74	792,754.87	82,170.07	16,687.14	98,857.21	274,484.83	693,897.66
2040 (<i>forecast</i>)	332,352.02	840,185.90	82,170.07	21,297.49	103,467.56	291,423.39	736,718.34
2045 (<i>forecast</i>)	352,236.85	890,454.76	82,170.07	27,181.59	109,351.66	308,980.66	781,103.10
2050 (<i>forecast</i>)	373,311.41	943,731.23	82,170.07	34,691.36	116,861.43	327,084.57	826,869.80

Table 2. Expected impact of mitigation measures to reduce Mauritius international aviation CO₂ emissions.

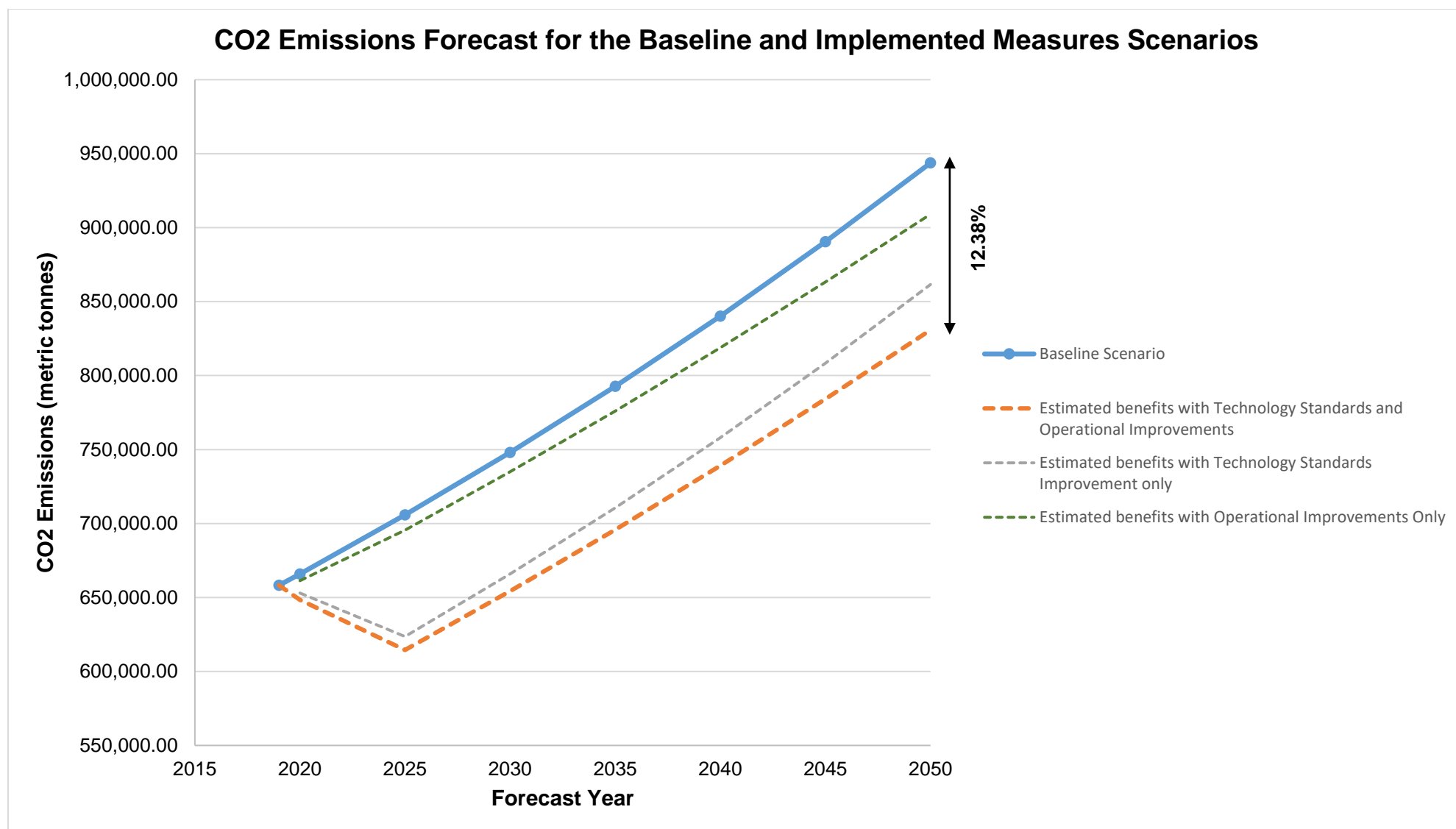


Figure 2. CO₂ emissions forecast for the baseline and implemented measures scenarios.

The data presented in Table 2 and Figure 2 above reflect the expected CO₂ emissions savings from aircraft technology and operational improvements. As mentioned in Section 4, these estimated savings have been calculated using the ICAO rule of thumb formulae provided in the ICAO Doc 9988.

Referring to Figure 2, the impact of improved aircraft technology standards indicates an overall 8.71% reduction of fuel consumption and CO₂ emissions in 2050 compared to the baseline scenario. Operational improvement measures will lead to a reduction of CO₂ emissions of around 3.67% by 2050. Figure 2 shows that the overall CO₂ emissions, including the effects of new aircraft technology standards and operational improvement measures, are projected to improve to lead to a 12.38% reduction in 2050 compared to the baseline.

6. Future Initiatives

All the stakeholders including Air Mauritius airline, Airports of Mauritius Co Ltd and the Air Traffic Management at the DCA are continuously focusing on adopting improved technological measures, operational measures, developing state of the art infrastructures to reduce the overall emission load of aviation.

Any future mitigating measures being sought by any stakeholders post COVID-19 and post publishing of this State Action Plan will be included in the next updated State Action Plan.

7. Conclusion

This State Action Plan provides an overview of the actions undertaken in Mauritius to address the aviation CO₂ emissions and to contribute to the development of a resource-efficient air transport system.

The mitigating measures presented in Section 4 of this Action Plan were completed in January 2023 and shall be considered as subject to update after that date.

8. Appendix

List of mitigating measures as reported in the first issue of the State Action Plan dated 28 May 2014:

<u>Measure 1</u>	Improved air traffic management and infrastructure use
Title:	More efficient use and planning of airport capacities
Action:	Construction of a parallel taxiway and additional Taxiways & commissioning of these TWYs.
Description:	<p>When an aircraft lands, it had to roll to the end of the runway then backtrack to exit via Taxiway C. With the construction of a parallel taxiway and additional taxiways, there is no need, for landing aircraft, to proceed to the end of the runway and backtrack. This reduces considerably the runway occupancy time, thus decreasing:</p> <ul style="list-style-type: none">• holding time of aircraft in the air where applicable; and• holding time of departing traffic.
<u>Measure 2</u>	Improved air traffic management and infrastructure use.
Title:	Pre-departure planning.
Action:	Close coordination and monitoring with adjacent Authority (Gillot) related to departure slots to avoid/minimize delays, holdings and conflicts.
Description:	<p>The route Mauritius/Reunion is the busiest sector within our airspace and we face peak periods daily. Reunion is about 222 km to the South West of Mauritius and the flying time is approximately thirty minutes. Reunion has two airports namely Gillot and Pierrefonds. The traffic in between Gillot and Mauritius very often conflicts with traffic from Europe, Asia and South Africa. Most of the time those conflicting traffic are long distant flights and thus are already in the air and their estimates are available. So prior start up, for traffic to and from Gillot, close coordination is carried out with the adjacent station to provide the best slots and even departure time to avoid conflicting with other traffic optimising the flow of traffic by reducing en-route delays, thus resulting in fuel saving.</p>
<u>Measure 3</u>	Improved air traffic management and infrastructure use
Title:	Sensitisation of ATM personnel introducing best practices
Action:	ATC brief issued.
Description:	ATC staff is being sensitised to improve en-route operations by

introducing collaborative decision-making. Unnecessary Climb or Descent restrictions results in high fuel burn when leveling off and restarting the climb or descent.

ATCs are strictly requested not to impose unnecessary Climb or Descent restrictions. Again good traffic planning and looking ahead will be of help. ATCs are also requested to effect coordination in a timely manner to ensure that the Climb or Descent Profile is not unnecessarily impeded.

Measure 4 Improved air traffic management and infrastructure use
Title: Awareness building among ATM staff
Action: Issuing ATC brief and supplemented by workshop with PowerPoint presentation.
Description: By issuing ATC brief and organising workshop to sensitise the ATC personnel with respect to the vision of ICAO regarding CO₂ Emission Reduction will improve the level of perception of ATM personnel. They may feel part and parcel of such a project to contribute for the benefits of the environment and mankind.

Measure 5 Aircraft related technology development
Title: Aircraft related technology development
Action: Upgrading avionics capabilities of fleet to meet RNP10 to fly direct routes. Regulations regarding PBN and GNSS are in the process of promulgation.
Description: ATR72 has been equipped to fly RNAV and all pilots have been trained and certified.

Measure 6 Improved air traffic management
Title: Reduce engine taxi
Action: Introduction of Taxi In on one engine for the ATR aircraft.
Description: Air Mauritius has decided that, all ATR 72 aircraft will taxi in on one engine after landing. This measure has already been implemented by Air Mauritius since last year.

Measure 7 Improved air traffic management
Title: Rerouting of Operational flight plans (OFPs)
Action: OFPs for long flights destination were revisited and more optional routes retained.

Description: OFPs for London, Paris and Johannesburg optimised.

Measure 8 Improved air traffic management

Title: Operational flight plans OFPs fuel Consumption Review

Action: Optimising fuel uploading to these destinations.

Description: Optimising OFP. OFPs to Paris and Hong Kong have been re-calculated with current ICAO rules with the collaboration of flight planning system provider (SITA).