CAAM

Safe Sustainable Skies

THE MALAYSIAN GREEN SKIES INITIATIVE AND ACTION PLAN

ISSUE 04
REVISION 00

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Foreword

Malaysia remains dedicated to reducing carbon emissions in aviation, in sync with global efforts led by the International Civil Aviation Organization (ICAO). Since 2013, the Civil Aviation Authority of Malaysia (CAAM) has developed our State Action Plan (SAP) on carbon dioxide (CO_2) reduction, updating it in 2016 (Issue 02) and 2021 (Issue 03), respectively.

We are set to advance our goals with the latest Malaysian Green Skies Initiative and Action Plan (Issue 04), welcoming new airlines and cargo operators while integrating more mitigation measures.

The success of our emissions mitigation strategy is contingent upon the collaborative involvement of every stakeholder in Malaysia's aviation industry. Our initiatives focus on aircraft technology, operations, sustainable fuels and market-based measures, aligning with ICAO's sustainable vision and Malaysia's 2050 emissions goals.

This SAP is published in line with ICAO Resolution A39-2, which outlines ICAO's policies and practices for environmental protection and climate change, States are encouraged to develop their action plans with clear objectives. These objectives include reporting international aviation CO_2 emissions, articulating policies and measures and identifying specific assistance needs.

Malaysia's dedication to environmental stewardship in the aviation sector is unwavering. The Malaysian Green Skies Initiative and Action Plan is a testament to our commitment to reducing greenhouse gas (GHG) emissions and fostering a sustainable aviation future. As we move forward, we are confident that our collective endeavors will lead to a greener, more sustainable aviation industry.

(Dato' Captain Norazman Bin Mahmud)
Chief Executive Officer
Civil Aviation Authority of Malaysia

Abbreviations

A-CDM	=	Airport Collaborative Decision-Making
ACT-CORSIA	=	Assistance, Capacity-building and Training on CORSIA
ANSP	=	Air Navigation Services Provider
ATC	=	Air Traffic Controller
ATM	=	Air Traffic Management
CAAM	=	Civil Aviation Authority of Malaysia
CCO	=	Continuous Climb Operations
CDO	=	Continuous Descent Operations
CORSIA	=	Carbon Offsetting and Reduction Scheme in International Aviation
EASA	=	European Union Aviation Safety Agency
EV	=	Electric Vehicle
GHG	=	Greenhouse Gas
IATA	=	International Air Transport Association
ICAO	=	International Civil Aviation Organization
KLATCC	=	Kuala Lumpur Air Traffic Control Centre
KLIA	=	Kuala Lumpur International Airport
LCCF	=	Low Carbon Cities Framework
LTAG	=	Long-Term Aspirational Goals
MADB	=	Malaysia Aviation Decarbonisation Blueprint
MAL	=	Malayan Airways Limited
MBM	=	Market-Based Measures
MOT	=	Ministry of Transport
NAICO	=	National Aerospace Industry Corporation Malaysia
NDCs	=	Nationally Determined Contributions
NETR	=	National Energy Transition Roadmap
PBN	=	Performance-Based Navigation
PETRONAS	=	Petroliam Nasional Berhad
PMS	=	Point Merge System
RNAV	=	Area Navigation
RNP	=	Required Navigation Performance
RNP-AR	=	RNP Authorisation required
RTKs	=	Revenue Tonne Kilometers
SAF	=	Sustainable Aviation Fuel
SAP	=	State Action Plan
SID	=	Standard Instrument Departure
STAR	=	Standard Arrival Route
UNFCCC	=	United Nations Framework Convention on Climate Change

Acknowledgement

The Civil Aviation Authority of Malaysia (CAAM) extends its gratitude to the Ministry of Transport (MOT), relevant Government Agencies, Petroliam Nasional Berhad (Petronas), airlines operators and the aviation stakeholders whose invaluable contributions were instrumental in the successful completion of the Malaysian Green Skies Initiative and Action Plan.

CAAM also recognises the unwavering technical support provided by the International Civil Aviation Organisation (ICAO), European Union Aviation Safety Agency (EASA) through EU-South East Asia Cooperation on Mitigating Climate Change impact from Civil Aviation (EU-SEA CCCA) CORSIA and International Air Transport Association (IATA). Malaysia has greatly benefited from the project's support in training personnel, conducting research on mitigation measures and offering guidance on the implementation of these measures to curb CO_2 emissions in international aviation.

Furthermore, the ICAO Secretariat has been pivotal in coordinating this assistance and has provided consistent and invaluable guidance throughout the development of the Malaysian Green Skies Initiative and Action Plan.

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1 Background and Objective of the Malaysian Green Skies Initiative and Action Plan

1.1 The Malaysian Green Skies Initiative and Action plan is a strategic document developed in response to the global challenge of climate change and the specific impact of commercial aviation on the environment. The plan is part of Malaysia's commitment to ICAO and its initiatives to reduce CO_2 emissions from international aviation.

1.2 In response to the sustainability initiative, MOT has published the Malaysia Aviation Decarbonisation Blueprint (MADB). The objective of the establishment of the MADB is to unify and coordinate the efforts of various stakeholders within the aviation industry and the CAAM towards achieving environmental commitments and advancing the national green economy.

1.3 Malaysia is set to launch the Malaysian Green Skies Initiative and Action Plan as its updated SAP, which builds upon the commitments made in the MADB by integrating measures and policy imperatives essential for the Malaysian aviation sector to achieve ICAO Long Term Aspirational Goals (LTAG). The MADB defines a through array of short, medium and long-term strategies that can be implemented concurrently or incrementally, aligning with and enhancing the initiatives outlined in the Malaysia Green Skies Initiative and Action Plan.

1.4 The aviation industry is a significant contributor to global CO_2 emissions and its growth is expected to continue, potentially increasing its environmental footprint. Recognising this, Malaysia has been working on strategies to mitigate the sector's impact on climate change.

1.5 The primary objective of the Malaysian Green Skies Initiative and Action Plan is to outline a comprehensive strategy for reducing CO_2 emissions from international civil aviation. This includes setting targets and also identifying mitigation measures. The plan aims to balance the economic growth of the aviation sector with environmental sustainability, ensuring that Malaysia plays its part in the global effort to combat climate change.

Figure 1: Key Components of the Malaysian Green Skies Initiative and Action Plan

1.6 In pursuit of attaining its emissions reduction targets by 2050, Malaysia is committed to the execution of strategic measures that align with the ICAO vision for sustainable aviation. The core focus of the Malaysian Green Skies Initiative and Action Plan is to evaluate the nation's advancement towards the realisation of LTAG of net-zero emissions by 2050.

Figure 2: Strategic Initiatives in the Malaysia Green Skies Initiative and Action Plan

1.7 Overall, Malaysia’s commitment to the environmental stewardship in the aviation sector remains steadfast. The Malaysian Green skies Initiative and Action Plan will serve as a testament to its dedication to reducing carbon emissions and fostering a sustainable aviation future.

2 Malaysia’s Civil Aviation

2.1 The story of Malaysia’s aviation industry is one of growth, innovation and adaptation. From humble beginnings to becoming a key player in the region aviation landscape, Malaysia’s aviation sector has undergone remarkable transformation over the decades.

2.2 Malaysia’s aviation journey traces back to the early 20th century when aviation pioneers laid the groundwork for air travel in the region. With the establishment of national carriers like Malayan Airways Limited (MAL) in the 1940s, Malaysia signified its ascent into the global landscape of commercial aviation.

2.3 Malaysia’s strategic location in Southeast Asia positioned it as a vital hub for international air travel. Kuala Lumpur International Airport (KLIA), inaugurated in 1998, further solidified Malaysia's status as a gateway to the region, facilitating seamless connections between continents.

2.4 Malaysia’s aviation sector has been characterized by a commitment to innovation and excellence. From pioneering aircraft maintenance and engineering facilities to investing in state-of-the-art air traffic management systems, Malaysia has continuously pushed the boundaries of technological advancement in aviation.

2.5 The establishment of the Kuala Lumpur Air Traffic Control Centre (KLATCC) ensured efficient management of air traffic, contributing to the smooth operation of Malaysia's aviation network. From pioneering aircraft maintenance and engineering facilities to investing in state-of-the-art air traffic management systems, Malaysia has continuously pushed the boundaries of technological advancement in aviation.

2.6 Like all industries, Malaysia's aviation sector has faced its share of challenges, including economic downturns and global pandemics. Despite these setbacks, Malaysia's aviation industry has demonstrated resilience, adapting to changing circumstances and emerging stronger in the face of adversity.

2.7 Looking ahead, Malaysia's aviation story is increasingly focused on sustainability and responsible growth. With a growing emphasis on environmental stewardship, Malaysia is committed to reducing carbon emissions, embracing sustainable aviation fuels, and integrating green technologies into its aviation infrastructure.

2.8 Today, Malaysia's aviation industry stands as a global player, renowned for its innovation, efficiency, and hospitality. With world-class airlines, cutting-edge airports and a robust regulatory framework, Malaysia continues to play a pivotal role in shaping the future of aviation in the Asia Pacific region and beyond.

2.9 Malaysia's aviation journey is a testament to ambition, resilience and growth, showcasing a country's ability to rise to new levels while upholding a strong dedication to excellence and sustainability.

2.10 In pursuit of sustainability in aviation, Malaysia is committed to enhancing stakeholder engagement through consultation sessions and workshops aimed at sharing knowledge, experiences and recommendations on aviation environmental initiatives. This collaborative approach underscores our dedication to fostering dialogue and cooperation within the aviation community and external stakeholders.

2.11 Furthermore, Malaysia places a strong emphasis on partnerships with international bodies such as ICAO, EASA and IATA to drive sustainable practices, capacity-building support and training facilitation. As part of our commitment, Malaysia is actively promoting the development and deployment of SAF.

2.12 To this end, the Government of Malaysia has established a working group led by the National Aerospace Industry Corporation Malaysia (NAICO), in collaboration with the MOT, CAAM, related Government agencies, airlines operators and national petroleum producer Petronas. This collaborative effort aims to frame SAF initiatives and determine optimal policies, legal frameworks and fiscal solutions to advance SAF development and deployment in Malaysia.

3 Government's Commitment Towards Climate Change

3.1 Malaysia employs a diverse range of strategies aimed at reducing greenhouse gas emissions, fostering sustainability, and enhancing resilience against climate impacts. The government has crafted thorough policy frameworks, epitomised by the National Climate Change Policy, which serves as a compass for climate action across sectors. These policies meticulously outline strategic pathways for mitigation and adaptation, underscoring international cooperation as a critical component in the collective fight against climate change.

3.2 In 2019, MOT released the National Transport Policy 2019-2030, which articulates a foundational principle for transitioning to a green transportation ecosystem. This policy signifies a pledge to initiate measures that mitigate pollution, noise and waste within the transportation sector, with the overarching goal of minimising environmental impact.

3.3 Malaysia has committed to reducing its greenhouse gas emissions intensity by 45% by 2030 relative to 2005 levels, as detailed in its Nationally Determined Contributions (NDCs) under the Paris Agreement. This pledge reflects Malaysia's contribution to global efforts to limit global warming to well below 2° Celsius.

3.4 Malaysia has introduced the LCCF to encourage sustainable urban development and reduce greenhouse gas emissions in urban areas. This initiative involves integrating low-carbon technologies, green infrastructure, and sustainable transportation systems into urban planning and development, exemplifying the government's dedication to environmentally conscious urban environments.

3.5 Investments in sustainable transportation infrastructure are evident through initiatives like the expansion of electric vehicle (EV) charging stations, the promotion of public transit and the implementation of policies to curb vehicle emissions. The introduction of incentives reflects a concerted effort to encourage the uptake of EVs and hybrid vehicles.

3.6 In a dedicated stance towards biodiversity conservation and deforestation mitigation, Malaysia has enacted proactive measures, including the establishment of protected areas, the adoption of sustainable forestry practices, and robust reforestation efforts. Committing to maintain at least 50% of its land area under forest cover, the government actively combats illegal logging and promotes sustainable land use initiatives.

3.7 Malaysia is an active participant in climate negotiations and agreements, engaging in forums such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. By collaborating with other nations and organisations, Malaysia shares best practices and facilitates technology transfer, emphasising its commitment to collective climate action.

3.8 In August 2023, Malaysia's Ministry of Economic Affairs launched the National Energy Transition Roadmap (NETR) to expedite the country's Green and Sustainable Growth Agenda. The NETR is a seminal document that charts Malaysia's course towards a cleaner, more resilient future, in line with the '*Ekonomi MADANI'* framework.

3.9 Building upon existing policies like the Twelfth Malaysia Plan (2021-2025) and the National Energy Policy 2022-2040, the NETR addresses the energy trilemma of security, affordability and sustainability. By decreasing Malaysia's carbon footprint, the NETR aims to propel sustainable economic growth, spur innovation, and uphold social justice. It underscores Malaysia's commitment to future generations and highlights the importance of collective stewardship and responsibility in achieving a low-carbon future.

3.10 Additionally, Malaysia has launched renewable energy programs in line with the NETR to promote the adoption of alternative energy sources, including solar power and hydroelectricity, as substitutes for fossil fuels. Through inter-agency coordination, Malaysia is driving the transition towards sustainable and clean energy solutions, contributing to a greener future for aviation and beyond.

3.11 Malaysia's initiatives towards climate change embody a commitment to sustainable development and environmental stewardship, aiming to mitigate greenhouse gas emissions, bolster resilience and contribute to global efforts to address climate change.

4 Kuala Lumpur Air Traffic Control Centre (KLATCC): Navigating the Path to Sustainability

4.1 The KLATCC serves as a critical nerve center in the intricate web of global air travel, overseeing the safe and efficient movement of aircraft in the Kuala Lumpur region. Against the backdrop of mounting concerns about the environmental impact of the aviation industry, KLATCC has emerged as a proactive player in aligning its operations with the ICAO decarbonisation goals and objectives. This exploration delves into the multifaceted initiatives undertaken by KLATCC to achieve ICAO's ambitious decarbonisation targets, emphasising the role in shaping a sustainable future for aviation.

4.2 KLATCC has embarked on a journey of route optimisation to enhance fuel efficiency and minimise carbon emissions. By leveraging cutting-edge technologies, data analytics and collaborative decision-making processes with airlines, KLATCC aims to contribute to ICAO's goal of achieving a 2% annual fuel efficiency improvement. The strategic adjustment of air traffic routes not only reduces fuel consumption but also aligns with ICAO's emphasis on enhancing the environmental performance of the aviation sector.

4.3 At the heart of KLATCC's commitment to environmental sustainability lies the implementation of eco-friendly practices within its operational framework. The centre has embraced energy-efficient systems, renewable energy sources and green building standards in its infrastructure. These sustainable practices not only reduce the environmental impact of KLATCC's facilities but also echo ICAO's call for the aviation industry to adopt cleaner technologies and methods in pursuit of decarbonisation.

4.4 KLATCC actively engages in research and development initiatives aimed at exploring innovative solutions to address the environmental challenges of aviation. By investing in technology-driven projects, the centre contributes to ICAO's overarching objectives of fostering industry-wide collaboration and driving advancements that lead to a more sustainable aviation sector. This commitment to continuous improvement aligns with ICAO's call for the exploration and implementation of new technologies to achieve decarbonisation goals.

4.5 KLATCC places a strong emphasis on equipping its personnel with the knowledge and skills necessary to support environmental sustainability objectives. Through comprehensive training and awareness programs, the centre ensures that its staff is well-versed in the latest developments in green aviation practices. This aligns with ICAO's vision of building a skilled and environmentally conscious workforce capable of implementing and adapting to sustainable practices.

4.6 Additionally, the design of shorter Approach and Departure Procedures were introduced at Kuala Lumpur International Airport (KLIA) to facilitate further fuel saving

to airlines operating in and out of KLIA, which in turn contributes to the reduction of carbon emissions.

4.7 The SIDs and STARs procedures are designed to shorten the distance that an aircraft has to fly in both en-route and Terminal Control Area of the airspace, thereby reducing fuel burn, exhaust emissions and noise pollution in the vicinity of the airports. Moving forward we will also witness the reduction in terms of traffic congestion, as well as flight delays, which will benefit the air traffic controllers (ATCs) and the industries as a whole.

4.8 The Area Navigation (RNAV) and Required Navigation Performance (RNP) will bring benefit to both the operators and the ANSP, whereby airline will be able to fly to the station that are not fitted with ground aids, given more direct routing and increases flight safety and efficiency. On the other hand, it also enables the ANSP to take advantage by designing airways, SIDs and STARs that will assist ATC in minimising traffic conflict and flights spacing for arrivals and departures.

4.9 In conclusion, the KLATCC stands at the forefront of the global effort to achieve ICAO's decarbonisation goals and objectives. Through a holistic approach encompassing route optimisation, sustainable practices, research and development, collaboration, and staff training, KLATCC exemplifies how a key player in the aviation ecosystem can drive positive change. As the industry grapples with the challenges of environmental sustainability, KLATCC's initiatives serve as a beacon, illustrating the potential for transformative action in pursuit of a greener and more sustainable future for aviation on the global stage.

5 The Current State of Aviation's Journey Towards Decarbonisation

5.1 The global COVID-19 pandemic has significantly impacted the aviation industry, leading to a 55% drop in aircraft movements in Malaysia in 2020. However, the sector showed resilience with a strong rebound in passenger traffic in November 2023, reaching 77% of pre-pandemic levels. Passenger traffic increased by 27.4% in November 2023, with international traffic surging by 51.8% and domestic traffic rising by 8.8% compared to the previous year.

5.2 Despite these challenges, Malaysia remains committed to reducing carbon emissions in the aviation sector, in line with international efforts led by the ICAO. Malaysia produced its first SAP on CO_2 emission reduction in 2013, followed by the second in 2016 (Issue 02) and the third version in 2021 (Issue 03).

5.3 Malaysia has established a Task Force on Carbon Offsetting and Reduction Scheme in International Aviation (CORSIA) and Aviation Environment Matters. This Task Force, which includes government agencies, operators, and other stakeholders, is tasked with ensuring the effective implementation of CORSIA and other environmental initiatives.

5.4 Under this Task Force, two sub-task forces have been formed: one focusing on CORSIA and the other on SAF. These sub-task forces, led by airline operators, provide significant assistance and contribute valuable output to CAAM in formulating regulations and developing a comprehensive SAP on carbon emission reduction.

5.5 These Task Forces are crucial in defining Malaysia's strategy for cutting carbon emissions in aviation, aligning with global efforts for a sustainable future. Apart from that, CAAM Stakeholder Engagement Committee (CSEC) was formed to tackle operational improvement measures.

5.6 Moving forward, the Malaysian Green Skies Initiative and Action Plan will be updated to report the progress of the mitigation measures development and implementation, identify more mitigation measures, integrating new airline and cargo operators. It will serve as input to the MADB Steering Committee in reviewing the progress towards net-zero carbon emission by 2050.

5.7 **Enhance Collaboration Within Stakeholders**

5.7.1 Improved collaboration among all stakeholders involved in air travel, including airlines, airports, air navigation service providers and regulatory bodies, can lead to more efficient operations. By working together, these stakeholders can identify and implement strategies to facilitate smoother operations and contribute to overall emission reductions.

5.7.2 The CSEC initiative fosters collaboration within the aviation industry to enhance air traffic management and promote a shared understanding of air navigation

services among stakeholders, crucial for decarbonising aviation. It advocates for efficient air traffic management through communication and consultation on best practices, aiming to decrease fuel consumption and emissions.

5.7.3 Stakeholder engagement ensures inclusive addressing of technical aspects, potentially leading to sustainable practices. The initiative supports national guidance on implementing Aviation System Block Upgrade (ASBU) solutions for efficiency and environmental gains. Information sharing on air navigation services spurs innovation and sustainable strategies, while feedback on plans helps evolve the regulatory framework for sustainability.

5.7.4 The CSEC Technical initiative is vital for aligning air navigation services with decarbonisation goals, contributing to a reduction in the industry's carbon footprint through improved communication, stakeholder involvement and technical advancements.

6 Emission Scenario of International Aviation in Malaysia

6.1 Baseline Scenario

6.1.1 The baseline scenario outlines the historical progression of CO_2 emissions, as well as the projected future trend should no mitigation actions be taken. This scenario encompasses the annual historical data on CO_2 emissions, from international aviation for the most recent years available.

6.1.2 The Malaysian Green Skies Initiative and Action Plan adheres to the ICAO's methodology as per Doc 9988 - Guidance on the Development States' Action Plan on CO_2 Emissions Reduction Activities. This plan involves the reporting of CO_2 emissions generated by international flights conducted by air operators attributed to Malaysia. An international flight is characterised by the operation of an aircraft that takes off from an aerodrome in one State and lands at an aerodrome in another State or its territories. Consequently, the fuel data compiled for this plan is exclusive to international flights and has been gathered from six local commercial airlines, including two cargo operators.

Figure 3: The Airlines Involved in The Malaysian Green Skies Initiative and Action Plan

6.2 Historical Data Collection

6.2.1 In the development of this action plan, historical data essential for our calculations has been meticulously collected and provided by the respective airline operators. The structure and units of measurement of this data are in accordance with the ICAO Form M (Fuel Consumption and Traffic), Form A (Traffic – Commercial Air Carries) and Form C (Traffic by Flight Stage) which includes parameters such as fuel consumption and Revenue Tonne Kilometers (RTKs) for international flights.

6.2.2 The aggregated data spans a significant five (5) year period, from 2019 to 2023 and encompasses all airlines attributed to Malaysia that have conducted international operations, including cargo flights during this timeframe. This comprehensive dataset is crucial for understanding the baseline emissions and operational characteristics of the aviation sector in Malaysia.

6.2.3 The aggregated data can be summarised as follows:

Year	International CO_2 emission (tonnes)
2019	8,244,138
2020	2,223,087
2021	1,450,121
2022	3,079,300
2023	6,122,378

Table 1: Historical Data Collection

6.3 Forecast Business as Usual Baseline

6.3.1 To establish a business-as-usual baseline scenario extending to 2050, certain assumptions were made to guide the projection process. Firstly, it was assumed that the fleet fuel efficiency would remain consistent with the levels observed in 2023.

6.3.2 In addition to the fuel efficiency assumption, air operators were asked to submit their own internal projections for growth from 2024 to 2050. These projections would have included estimates of factors such as increased passenger demand, the addition of new routes, and the expansion of fleet sizes. The figures provided by the air operators were then collected and combined to form an aggregate growth projection for the industry as a whole.

6.3.3 This aggregation process is crucial for creating an accurate baseline scenario, as it considers the individual expectations and strategies of various operators within the industry. By incorporating these diverse perspectives, the projection can reflect a more realistic outlook on how the business-as-usual scenario might unfold over the next few decades. This baseline scenario serves as a critical reference point for evaluating potential future strategies and their impacts on the industry's environmental footprint and overall sustainability.

6.3.4 The subsequent table present the projected values up to 2050, derived from these assumptions.

Year	International CO_2 (tonnes)
2024	6,596,708
2025	7,495,311
2026	8,332,537
2027	8,683,671
2028	9,074,436
2029	9,305,108
2030	9,487,302
2031	9,733,782
2032	10,000,488
2033	9,880,682
2034	10,049,444
2035	10,329,421

2036	10,761,604
2037	10,942,399
2038	11,125,794
2039	11,311,817
2040	11,608,866
2041	12,163,537
2042	12,466,653
2043	12,770,340
2044	13,841,005
2045	14,164,608
2046	14,489,828
2047	14,817,008
2048	15,602,013
2049	15,943,697
2050	16,288,081

Table 2: Baseline Scenario for International Flight

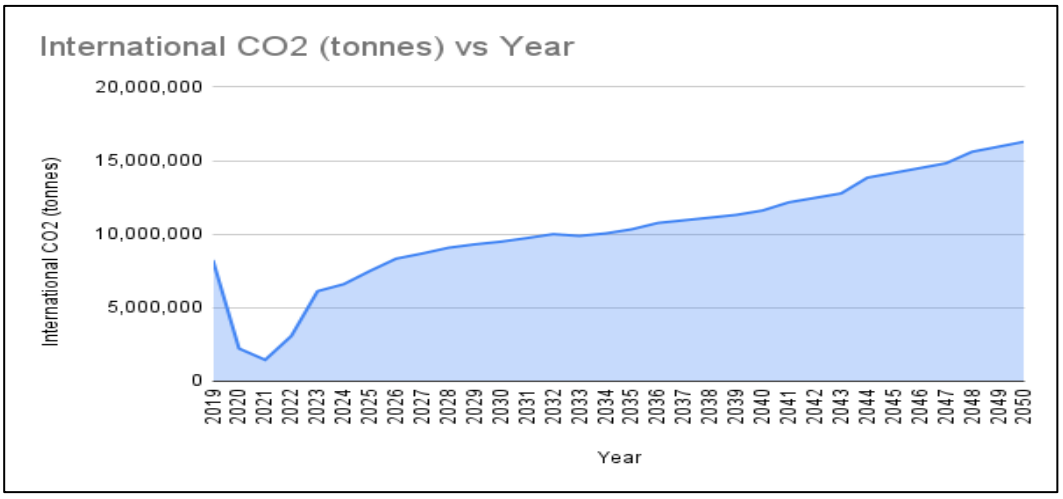

Figure 4: Graph of Baselines Scenario for International Flight

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7 Mitigation Measures to Mitigate CO_2 Emission and Expected Result

The MADB has developed three comprehensive scenarios that delineate clear decarbonisation goals for the sector, encompassing short-term, medium-term and long-term timeframes.

Category	Decarbonisation Target		
	Short (2024-2029)	Medium (2030-2040)	Long (2041-2050)
Aircraft Technology	1%-6%	7%-13%	18%
Operational Improvement	2%-2.5%	2.5%-4.0%	5%
SAF	0.2%-3.7%	5.1%-19.9%	46.2%
MBM	3.8%-8.0%	16.8%-23.1%	30.8%

Table 3: Decarbonisation Target

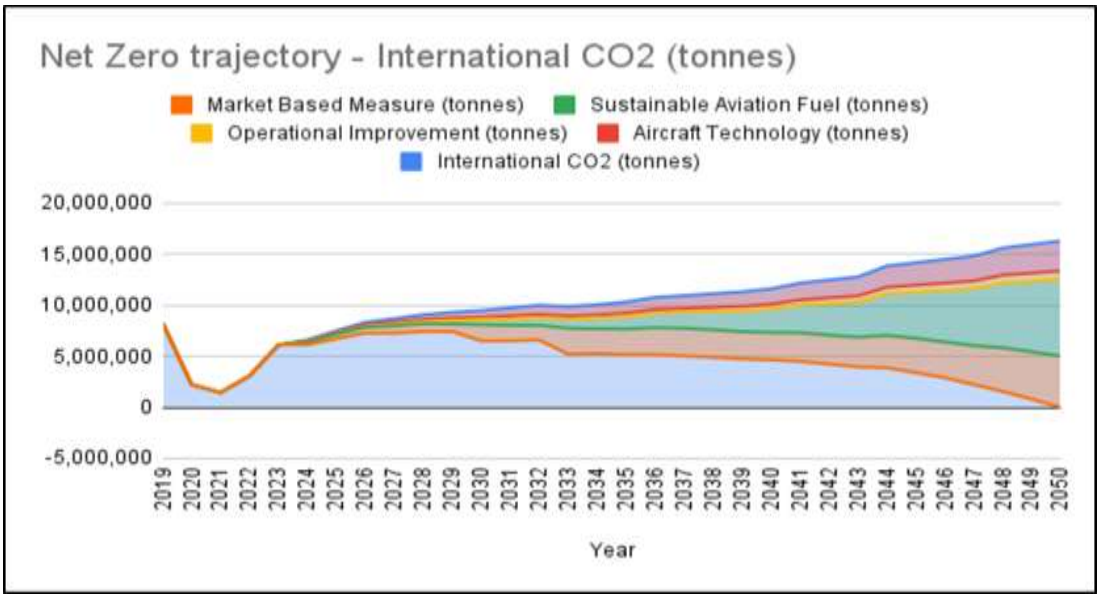

Figure 5: Mitigation Measures on CO_2 Emission and Expected Result

7.1 Short-term Target (2024 – 2029)

The combination of these four categories of measures provides a comprehensive framework for mitigating international aviation emissions and working towards a more sustainable and environmentally friendly aviation sector.

Target	Aircraft Technology	Operational Improvement	SAF	MBM
Short-term (2024-2029)	Reduction of 1%-6% through: • Fleet renewal program.	Reduction of 2%-2.5% through: • Optimum flight level through Continuous	Reduction of 0.2% - 3.7% through: • Voluntary purchase of SAF.	Reduction of 3.8%-8.0% through: • Offsetting required

		Climb/Descent Operations; • Reduce contingency fuel; • Single Engine Taxi; • Reverse Idle Thrust; • Optimal Flap Landing; • Fuel Load Optimisation; • PMS; • Increased utilisation of RNP-AR at 14 airports; • RNP-AR to be made the primary approach.	• Blending mandate as laid out in NETR is being worked on.	under CORSIA • Voluntary offsetting

Table 4: Short-term Target (2024 - 2029)

7.1.1 Aircraft Technology (1% - 6% reduction)

7.1.1.1 Fleet Renewal Programs

The process of updating aircraft technology by the airline operators in Malaysia, particularly through the implementation of fleet renewal programs, can lead to a significant reduction in emissions. Specifically, these advancements can result in a decrease ranging from 1% to 6% in the emissions produced by aircraft. This reduction is attributed to the introduction of newer, more efficient engines and aerodynamic designs that inherently consume less fuel and produce fewer pollutants.

7.1.2 Operational Improvement (2% - 2.5% reduction)

By implementing these operational improvements, airlines can achieve a 2% to 2.5% reduction in carbon emissions from aviation. These strategies focus on optimising flight profiles, reducing unnecessary fuel burn, and adopting more efficient operational procedures and technologies.

7.1.2.1 Optimum flight level through Continuous Climb/ Descent Operations (CCO/CDO)

Aircraft will maintain optimal altitudes during climb and descent phases, which are more fuel-efficient. CCO/CDO allows aircraft to climb or descend smoothly without levelling off, which reduces fuel consumption and consequently, emissions.

7.1.2.2 Reduce Contingency Fuel

Airlines will carry less extra fuel for emergencies, relying on better weather forecasting and fuel management to minimise the amount of unused fuel, which reduces the overall weight of the aircraft and fuel consumption.

7.1.2.3 Single Engine Taxi

Aircraft will taxi on the ground using only one engine to save fuel. This practice reduces emissions during the ground phase of flight operations.

7.1.2.4 Reverse Idle Thrust

During landing, aircraft will use reverse thrust at idle power to reduce the need for more fuel-intensive reverse thrust operations. This conserves fuel and lowers emissions during the landing rollout.

7.1.2.5 Optimal Flap Landing

Aircraft will use the most fuel-efficient flap settings for landing, which can vary depending on the aircraft type and landing conditions. This reduces the amount of fuel burned during the approach and landing phases.

7.1.2.6 Fuel Load Optimisation

Airlines will optimise the amount of fuel loaded based on actual flight conditions and requirements, rather than overestimating fuel needs, to minimise excess weight and fuel burn.

7.1.2.7 Point Merge System (PMS)

This system helps in monitoring and improving operational efficiency, ensuring that all operational improvements are effectively implemented and continuously optimised.

7.1.2.8 Increased Utilisation of Required Navigation Performance – Authorization Required (RNP-AR)

The expansion of RNP-AR to become the primary approach method at 14 airports in Malaysia represents a significant step towards operational efficiency. RNP-AR allows for more precise and efficient flight paths, reducing the amount of airspace needed for approaches and departures. By increasing its use at specific airports, airlines can save fuel and reduce emissions.

7.1.2.9 RNP-AR To Be Made The Primary Approach

Making RNP-AR the standard approach procedure at these airports will further enhance efficiency and reduce emissions by ensuring that all flights use the most efficient approach paths available. By standardising these approaches,

air traffic flow can be managed more effectively, leading to reduced circling and expedited landings, which in turn contribute to the overall reduction in emissions. These operational improvements not only benefit the environment but also enhance safety, increase capacity and improve the overall efficiency of air travel.

7.1.3 Sustainable Aviation Fuels (SAF) (0.2% - 3.7% reduction)

The carbon emission reduction potential of 0.2% to 3.7% through the use of SAF reflects the expected decrease in CO_2 emissions when these fuels are used instead of traditional jet fuels. As the production of SAF scales up and the industry moves towards higher blending ratios, the potential for carbon emission reductions is expected to increase.

7.1.3.1 Voluntary purchase of SAF

The proactive adoption of SAF through voluntary purchases can significantly contribute to a reduction in emissions within the aviation sector. SAF derived from renewable resources and waste, offer a lower carbon footprint than traditional jet fuels. Voluntary purchases by airlines and industry stakeholders show commitment to sustainability, driving SAF demand. Growing market encourages investment in production and technology, potentially reducing costs and increasing supply.

7.1.3.2 Blending mandate requirements

The NETR mandates a certain percentage of SAF to be blended with conventional jet fuel. This blending mandate is a strategy to gradually increase the use of sustainable fuels in the aviation sector. By requiring a minimum blend percentage, the policy aims to create a consistent demand for SAF, which can stimulate investment in production capacity and technological development.

7.1.4 Market-Based Measures (MBM) (3.8% -8.0% reduction)

The combined effect of mandatory and voluntary offsetting can lead to a significant reduction in the net carbon emissions from aviation. The percentage range (3.8%-8.0%) suggests that while mandatory offsetting under CORSIA provides a baseline level of emission reduction, voluntary offsetting can further increase the impact. The actual reduction achieved will depend on factors such as the growth in air travel, the effectiveness of the offset projects and the level of participation in voluntary offsetting programs.

It’s important to note that while offsetting is a critical tool for managing emissions in the short term, it is most effective when paired with other strategies that directly reduce emissions, such as improving fuel efficiency, adopting sustainable aviation fuels and investing in new technologies.

7.1.4.1 Offsetting required under CORSIA

CORSIA is a global scheme adopted by the ICAO to address international aviation emissions. Under CORSIA, airlines are required to offset any carbon emissions that exceed the baseline following the growth factor provided by ICAO. This means that for every tonne of CO_2 emitted above the threshold, airlines must purchase carbon offsets from approved projects that reduce emissions elsewhere. The reduction percentage (3.8%-8.0%) includes the estimated impact of these mandatory offsetting activities on the overall carbon emissions of the aviation industry.

7.1.4.2 Voluntary offsetting

In addition to the mandatory offsets required by CORSIA, some airlines and passengers choose to participate in voluntary carbon offsetting programs to meet their own internal target. These programs allow airlines and individuals to invest in projects that reduce carbon emissions, even if they are not required to do so by regulation. Voluntary offsetting can include a wide range of projects, like renewable energy, energy efficiency, and reforestation, helping reduce aviation's carbon footprint.

7.2 Medium-Term Target (2030 – 2040)

For the medium term, from 2030 to 2040, the civil aviation sector in Malaysia has set decarbonisation targets that are to be achieved through a combination of strategies focusing on aircraft technology, operational improvements, the use of SAF and the implementation of MBM. Each area has specific measures contributing to decarbonisation goals.

Target	Aircraft Technology	Operational Improvement	SAF	MBM
Medium-term (2030-2040)	Reduction of 7%-13% through: • Fuel-efficient aircraft • Aerodynamics improvement • Use of lightweight materials	Reduction of 2.5%-4.0% through: • Increment of airline operational efficiencies • Increased utilisation of RNP-AR • Transition to PBN at all airports • Enhance A-CDM implementation	Reduction of 5.1% - 19.9% through: • Increased purchase of SAF • Higher blending mandate	Reduction of 16.8% - 23.1% through: • National Carbon Market Strategy • CORSIA offsetting

Table 5: Medium-term Target (2030 – 2040)

7.2.1 Aircraft Technology (7% - 13% reduction)

The sector aims to achieve a 7% to 13% reduction in carbon emissions through advancements in aircraft technology. As these technologies are adopted and further developed, the efficiency of air travel improves, leading to a decrease in the carbon footprint of the aviation sector. This reduction is particularly significant when considering the long operational life of commercial aircraft, which can span several decades.

7.2.1.1 Fuel-efficient aircraft

This refers to the development and deployment of new aircraft models that are designed to use fuel more efficiently than their predecessors. These aircraft often feature improved engines with higher thermal efficiency, reduced aerodynamic drag, and advanced avionics that enable more efficient flight management. By replacing older, less efficient aircraft with newer, fuel-efficient models, airlines can significantly reduce their carbon emissions.

7.2.1.2 Aerodynamics improvement

Enhancements in aerodynamics can lead to reduced air resistance and drag, which in turn lowers fuel consumption. This can be achieved through design improvements such as more aerodynamically efficient wing shapes, winglets and advanced computational fluid dynamics (CFD) simulations to optimise airflow around the aircraft. Better aerodynamics can contribute to reduction in fuel burn and emissions.

7.2.1.3 Use of lightweight materials

The use of lightweight materials in aircraft construction, such as advanced composites, high-strength alloys, and modern polymers, can lead to a significant reduction in the overall weight of the aircraft. A lighter aircraft requires less fuel to operate, which directly translates to lower carbon emissions. These materials also often offer better durability and maintenance advantages, further contributing to operational efficiency.

7.2.2 Operational Improvements (2.5% - 4.0% reduction)

The reduction of 2.5% to 4.0% in carbon emissions through operational improvements reflects the potential gains from these strategies. By focusing on efficiency improvements and adopting new technologies and procedures, the aviation industry can make significant progress in reducing its environmental impact. These operational enhancements are often incremental but can lead to substantial cumulative reductions in carbon emissions over time.

7.2.2.1 Increment of airline operational efficiencies

Airlines will focus on optimising their operations to improve fuel efficiency, such as through better flight planning, reduced engine thrust during takeoff and more efficient use of aircraft weight. This can include optimising flight routes, improving load planning, reducing unnecessary weight on aircraft and enhancing maintenance practices to ensure engines and other systems operate at peak efficiency.

7.2.2.2 Increased utilisation of RNP-AR

The expanded use of RNP-AR will allow for more precise and fuel-efficient flight paths, reducing the amount of airspace needed for approaches and departures. By increasing the use of RNP-AR, airlines can take advantage of more direct and fuel-efficient flight paths, leading to reduced emissions.

7.2.2.3 Transition to Performance-Based Navigation (PBN) at all airports in Malaysia

PBN is a type of navigation that allows aircraft to fly routes based on their performance capabilities, rather than being restricted by the ground-based navigation infrastructure. The full transition to PBN will enhance the efficiency of flight operations across the country, reducing fuel burn and emissions. Transitioning all airports to support PBN can further enhance the overall efficiency of the air traffic system.

7.2.2.4 Enhance Airport-Collaborative Decision Making (A-CDM) implementation

A-CDM is a set of processes and tools that enable different airport stakeholders to share information and make collaborative decisions in real-time. The further development and enhancement of A-CDM will improve coordination among airport stakeholders, leading to more efficient coordination among airlines, airports and air traffic control, reducing delays and unnecessary fuel burn.

7.2.3 Sustainable Aviation Fuels (SAF) (5.1% - 19.9% reduction)

The reduction of 5.1% to 19.9% in carbon emissions through the use of SAF reflects the expected decrease in CO_2 emissions when these fuels are used instead of traditional jet fuels. This range can vary based on several factors, including the type of feedstock used to produce the SAF, the production process, the scale of SAF production and the extent to which SAF is adopted across the industry.

The effectiveness of SAF in reducing carbon emissions hinges on the sustainability of feedstocks and production methods. Advancements in SAF production technology and feedstock diversification are essential for achieving the maximum potential reduction in emissions.

7.2.3.1 Increased Purchase of SAF

Airlines and other aviation stakeholders are encouraged to increase their purchase of SAF. By choosing to buy more SAF, airlines contribute to reducing the carbon footprint of their operations. The increased purchase can be driven by voluntary commitments, corporate sustainability goals or regulatory incentives.

7.2.3.2 Higher Blending Mandate

A blending mandate refers to a policy that requires a certain percentage of SAF to be blended with conventional jet fuel. A higher blending mandate means that a greater proportion of the fuel used in aviation must come from sustainable sources. This mandate is aimed in creating a consistent and growing demand for SAF, which can stimulate investment in production capacity and technological development.

7.2.4 Market-Based Measures (MBM) (16.8% - 23.1% reduction)

The reduction of 16.8% to 23.1% in carbon emissions through MBM reflects the potential impact of these policies on the aviation industry. By creating a financial incentive to reduce emissions and by providing a mechanism to offset unavoidable emissions, MBM can lead to significant emission reductions. The actual reduction achieved will depend on various factors, including the stringency of the emissions cap, the price of carbon allowances, the availability and cost-effectiveness of offset projects and the willingness of airlines to invest in cleaner technologies and operations.

7.3 **Long-term Target (2040 – 2050)**

For the long-term period from 2040 to 2050, the civil aviation sector in Malaysia has set ambitious decarbonisation targets that will require significant advancements and shifts in various aspects of aviation operations. The focus areas include aircraft technology, operational improvements, the use of SAF, and the continued implementation of MBM. Each of these areas has specific measures and expected contributions to the overall decarbonisation goal.

Target	Aircraft Technology	Operational Improvement	SAF	MBM
Long-term (2040-2050)	Reduction of 18% through: • Development and widespread adoption of new propulsion systems • Hybrid-electric aircraft • Aerodynamic efficiency	Reduction of 5.0% through: • Airspace redesign • Higher A-CDM utilisation	Reduction of 46.2% through: • Increased purchase of SAF • Increased blending mandate up to 47%	Reduction of 30.8% through: • Promotion and continuity of carbon offsetting programme

Table 6: Long-term Target (2040 – 2050)

7.3.1 Aircraft Technology (18% reduction)

The long-term target for carbon emission reduction through aircraft technology in the aviation industry is set at 18%. This target reflects the expected decrease in CO_2 emissions through the development and adoption of innovative technologies that enhance the efficiency and reduce the environmental impact of aircraft.

The 18% reduction target is ambitious and will require sustained investment in research and development, as well as regulatory and industry support to facilitate the adoption of these new technologies. It also assumes that these technologies will become commercially viable and widely accepted within the aviation industry. Achieving this target will be a significant step towards making air travel more sustainable and reducing its overall environmental impact.

7.3.1.1 Development and widespread adoption of new propulsion systems

This involves the research, design, and implementation of advanced propulsion technologies that can replace or complement traditional jet engines. These may include more efficient turbofan engines, open rotor designs or even revolutionary concepts like electric or hydrogen-powered propulsion. The widespread adoption of these new systems is expected to significantly reduce the carbon footprint of air travel.

7.3.1.2 Hybrid-electric aircraft

The development of hybrid-electric aircraft combines electric propulsion with traditional jet or turboprop engines. These aircraft use batteries and electric motors to power some or all of the propulsion during certain phases of flight,

particularly during takeoff and climb, which are energy-intensive. This can lead to reduced fuel consumption and emissions.

7.3.1.3 Aerodynamic efficiency

Improvements in aerodynamic efficiency are crucial for reducing drag and improving fuel efficiency. This can be achieved through the design of more aerodynamically efficient airframe shapes, the use of advanced materials that allow for smoother surfaces and the implementation of technologies like active flow control. Enhanced aerodynamics can lead to a significant reduction in the amount of fuel required to operate an aircraft, thereby lowering carbon emissions.

7.3.2 Operational Improvements (5% reduction)

The 5.0% reduction target assumes that these operational improvements will be widely adopted and effectively implemented across the industry. It also assumes that air traffic control systems, airlines, airports, and other stakeholders will work together to create an environment where these improvements can flourish. Achieving this target will require investment in technology, changes in operational procedures and a commitment to collaboration and innovation within the aviation sector.

7.3.2.1 Airspace Redesign

This involves rethinking and restructuring the way airspace is managed to allow for more efficient flight paths and procedures. Airspace redesign can lead to shorter routes, reduced holding patterns, and more direct approaches and departures, all of which can save fuel and reduce emissions. By streamlining air traffic flow and minimising inefficiencies, airlines can operate more effectively and with less environmental impact.

7.3.2.2 Higher A-CDM Utilisation

A-CDM is a set of processes and tools that enable different airport stakeholders to share information and make collaborative decisions in real-time. By enhancing the utilisation of A-CDM, airports can improve the predictability and efficiency of flight operations, reducing delays and unnecessary fuel burn. This can include better slot management, more accurate departure times and improved ground operations, all of which contribute to a more sustainable aviation industry.

7.3.3 Sustainable Aviation Fuels (SAF) (46% reduction)

Achieving the 46.2% carbon emission reduction target with SAF requires scaling up production, ensuring sustainability, and having policy support and market incentives. It also necessitates technological advancements, increased production

capacity, and industry collaboration for infrastructure and logistics. The effectiveness of SAF in reducing emissions depends on the sustainability of feedstocks and production methods, emphasising the need for non-competitive, sustainable sources and innovative production technologies.

7.3.3.1 Increased Purchase of SAF

Airlines are encouraged to increase their procurement of SAF. This can be driven by voluntary commitments, corporate sustainability goals, or regulatory incentives.

7.3.3.2 Increased Blending Mandate Up to 47%

Governments or industry bodies may introduce or increase blending mandates that require a certain percentage of SAF to be mixed with conventional jet fuel. The target of increasing the blending mandate up to 47% reflects a significant shift towards the use of SAF. This mandate creates a consistent and growing demand for SAF, which can spur investment in production capacity and technological development. It also signals a clear industry-wide commitment to reducing carbon emissions.

7.3.4 Market-Based Measures (MBM) (30.8% reduction)

Achieving the 30.8% carbon emission reduction through MBM relies on the widespread adoption and effective management of carbon offsetting programs, along with continued industry investment in offsetting. This requires stakeholder commitment, strong governance of offset programs and the development of sustainable offset projects.

7.3.4.1 National Carbon Market Strategy

For carbon offsetting to contribute to the long-term reduction target, it is essential that these programs are sustained over time. This means that there must be a consistent supply of high-quality offset projects, and the demand for offsets must be maintained through regulatory requirements or voluntary actions. The continuity of these programs also depends on the ongoing verification of the environmental benefits and the avoidance of negative social or environmental impacts.

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8 Collaboration

8.1 Enhancing collaboration among airlines, airports, air traffic control and other stakeholders is essential for achieving smoother operations and reducing overall emissions in the aviation sector. The CSEC plays a pivotal role in fostering this collaboration, focusing on improving air traffic management and ensuring a common understanding of air navigation services among all parties involved. This is crucial for the decarbonisation of aviation, as it promotes efficient air traffic management through communication and the sharing of best practices, ultimately aiming to reduce fuel consumption and emissions.

8.2 Malaysia's commitment to a comprehensive strategy for mitigating CO_2 emissions from international civil aviation is evident in its support for airline-led mitigation efforts and the planned implementation of A-CDM by MAHB at KLIA. This initiative is designed to enhance operational efficiency, with the anticipated outcome of reducing average taxi times for aircraft. This, in turn, will lead to fuel savings and contribute to the broader goal of lowering greenhouse gas emissions from aviation. The introduction of A-CDM is a testament to Malaysia's dedication to leveraging collaborative efforts and innovative solutions to address the environmental impact of aviation.

8.3 By enhancing collaboration, Malaysia is further solidifying its commitment to sustainable practices and operational excellence in the aviation industry. This collaborative approach is key to achieving the ambitious targets set for reducing emissions and ensuring that the aviation sector plays its part in the global effort to combat climate change collaboration at higher level through MADB.

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9 Assistance and Support

9.1 In the pursuit of optimising Malaysia's efforts to curtail CO_2 emissions from the aviation industry, there is considerable potential for improvement. To accomplish this goal, Malaysia requires support in several key areas, such as capacity building, knowledge transfer and collaborative initiatives that span policy development and practical implementation.

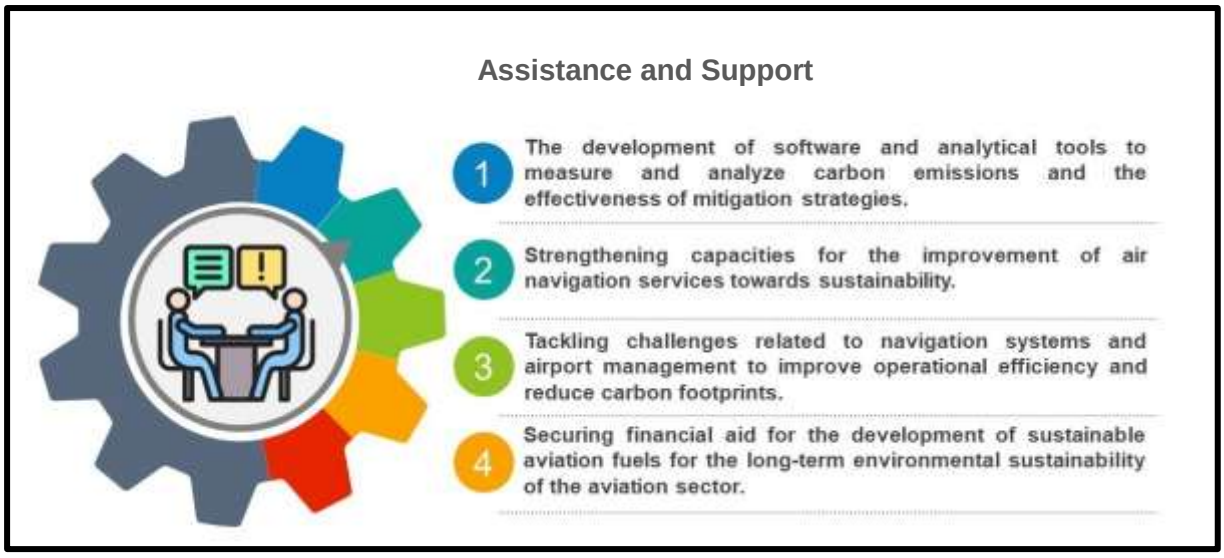

Figure 6: Assistance and Support

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10 Conclusion

10.1 Malaysia remains steadfast in its dedication to addressing the climate change impacts of commercial aviation and achieving the goal of net-zero CO_2 emission by 2050 in CO_2 emissions through the Malaysian Green Skies Initiative and Action Plan.

10.2 The Civil Aviation Authority of Malaysia and attributed operators are committed to implementing all measures to achieve the goal. The plan will be reviewed and updated every three years, with immediate amendments for significant changes. Future plans include preparing for CORSIA's second phase, optimizing air traffic management (ATM), updating airport procedures and encouraging the use of sustainable fuels.

10.3 To execute these initiatives, external stakeholders' technical and financial support is crucial for monitoring emissions, implementing mitigation measures, collaborating on research as well as providing Assistance, Capacity-building and Training for Carbon Offsetting and Reduction Scheme for International Aviation (ACT-CORSIA). These efforts are vital for steering Malaysia's aviation sector toward a sustainable and environmentally responsible future.

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