Sustainable Tomorrow
MALAYSIA AVIATION GROUP

Malaysia Aviation Group

SUSTAINABILITY REPORT 2020-2021

mag malaysia aviation group

malaysia airlines · MASwings · firefly · amal · Enrich
Journify · maskargo · AeroDarat · mabacademy · mabengineering

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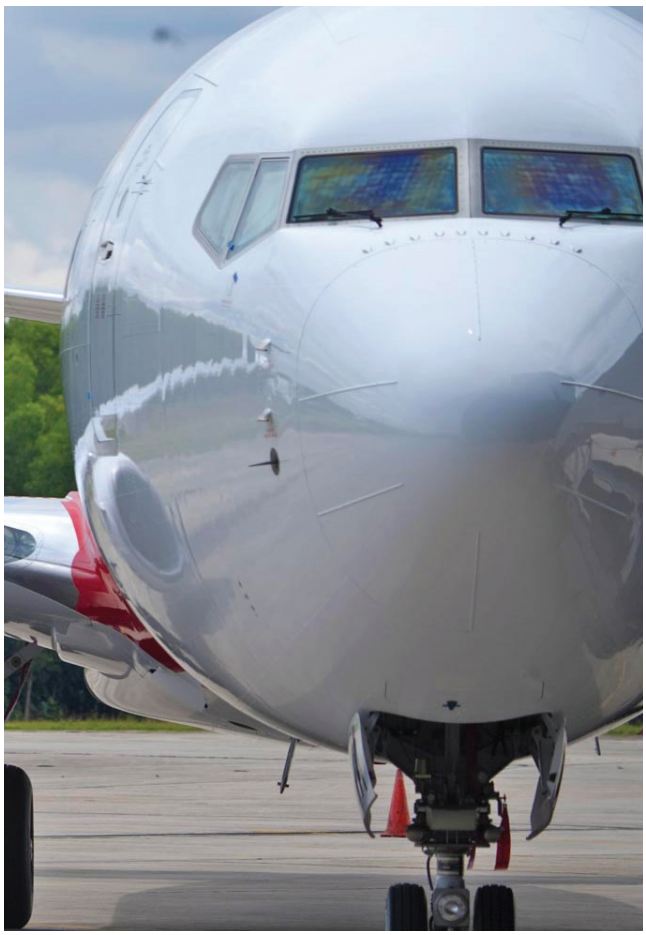
About the Report

The Sustainability Report 2020 & 2021 by Malaysia Aviation Group (MAG) carries with it the objective to inform everyone – especially internal stakeholders – about the Group's overall sustainability goals and prioritised matters from the year 2020 to 2021. The topics covered in this report comprise of the following sustainability focus areas:

- **Environment**
- **Social**
- **Governance**
- **Safety**

This report was prepared in close collaboration with key Business Units from across MAG, mainly from Malaysia Airlines Berhad. The information shared by each Business Unit was collected by the Sustainability Office and consolidated into this report.



Reporting Period

The reporting period in this report publication covers MAG's activities in 2020 and 2021.

Disclaimer in respect of forward-looking statements:

The data included in this report has been collected and processed with utmost care. Nevertheless, errors in transmission cannot be ruled out entirely. Information published in this report with regards to the operational business of Malaysia Aviation Group should not be used for forward-looking analysis and terms such as 'believe', 'expects', 'forecast', 'intend', 'estimate', 'count on' and such should not be used for other report analysis and proposals.

Message from Group Chairman

Sustainability is one of the six key pillars in driving MAG's Long-Term Business Plan 2.0 of becoming Asia's Leading Travel and Services Group. Starting our journey way before Sustainability became the buzz word circa 2010, from fuel saving measures to digital innovation across the Group, we designed the **MAG Sustainability Blueprint** to be to be all-encompassing, to accelerate and support our numerous initiatives in the future.

The Blueprint was launched in April 2021, covering environmental, social, safety, governance and economic factors, in line with the United Nation's Agenda for Sustainable Development, with several Sustainable Development Goals in mind.

The Group seeks to integrate sustainability through minimising environmental impacts, positively enhancing the communities we operate in, ensuring safety excellence, ensuring compliance within the organization and driving profitability for the benefit of both our stakeholders and employees.

Our Sustainability Report is a reflection of our hope for a better future for all. Because the choices we make today will influence our tomorrow, we believe that our customers should be just as involved as we are in pushing for a more sustainable future for generations to come. Transparency is therefore crucial to MAG's success, and we invite you to explore how we operate and our efforts in building a 'Sustainable Tomorrow' in this report.

Tan Sri Wan Zulkiflee Bin Wan Ariffin
Group Chairman Malaysia Aviation Group

Message from Group Chief Executive Officer

During the global pandemic in 2020, we took a critical look at our organisation and business strategy to reset and embark on a new course. This will see us redefine and anchor our business operations on becoming Asia's Leading Travel and Aviation Services Group, which is focused on the delivery of highly customised, end-to-end travel solutions.

In tandem, we also took a serious look at our sustainability efforts and redefined the overall framework. This helped to align all our pre-existing programmes and initiatives with the MAG Sustainability Blueprint. Hence, our Sustainability approach is based on five (5) focus areas: Governance, Economic, Environmental, Social, and Safety & Security. Through our interpretation of this model, the five goals are Profitability & Resilience, Environmentally Responsible, Empowering Expertise, Safety Leadership and Beyond Compliance.

Championing sustainability is an important cause that we at MAG embrace as a Group, even prior to the development of our Sustainability Blueprint. MAG has previously introduced and explored several key initiatives to reduce our carbon footprint and tackle climate change issues, ranging from our fuel efficiency programme in line with CORSIA where we are targeting a reduction of 1% Y-o-Y fuel consumption, reducing cabin wastage and waste sent to landfills, to exploring electric ground handling equipment and other initiatives.

As the national carrier, we have also played a key role in driving socio-economic development efforts in both Malaysia and the markets we are present in – be it in the form of supporting the region's logistics and supply chain, championing equality and fair employment practices, or leading corporate social responsibility campaigns to give back to the community at large.

Today, we have further underlined our sustainability commitment by pledging our support for the oneworld Alliance's goal to achieve net-zero carbon emissions by 2050, and by joining IATA's 25by2025 initiative to boost gender balance in the aviation industry. Our sustainability efforts in 2020 also emphasised on good governance, where it is fundamental for us to build trust with our stakeholders and employees to ensure transparency, accountability, and garner support for MAG's overall vision.

I invite you to read our first Sustainability Report as it captures the actions we took that are consistent with our promise of delivering the best of Malaysian hospitality to the world. With the launch of our Sustainability Blueprint and the publishing of this Sustainability Report, I am hopeful and strongly believe we have laid the right foundations for our sustainability programmes and initiatives.

The journey ahead of us will be a long and challenging one, but it will surely be the one that provides a brighter and better future for people from all walks of life. I look forward to working together with all of you towards driving a 'Sustainable Tomorrow'.

Izham Ismail
Group Chief Executive Officer

Message from Group Chief Sustainability Officer

Since the MAG Sustainability Blueprint was launched in 2021 to promote socio-economic development and achieve net-zero carbon emissions by 2050, the sustainability team have been striving toward making MAG and the aviation industry more sustainable and better for everyone. We want to impact the world positively, ensuring that the steps we take are both sustainable and beneficial for all. It is my sincerest hope that this first Sustainability Report will be a milestone charter in encouraging all of you to join our journey toward serving our customers with its signature Malaysian Hospitality in a sustainable way.

Philip See
Group Chief Sustainability Officer

MAG at a Glance

Malaysia Aviation Group

MAG comprises of various aviation-related businesses, aimed at serving the needs of Malaysia and Malaysians.

Airline Transportation Services

	malaysia airlines	amal	maskargo	firefly	MASwings
Business Modal	Malaysian Base Jet Operator	Muslim Haji/ Umrah Operator	Cargo and Warehousing operator	Regional Turboprop Operator	Rural Air service Operator
Focus Regions/ Countries	Malaysia South East Asia North Asia South Asia Australia/New Zealand Europe Middle East	Malaysia Indonesia Saudi Arabia	Malaysia South East Asia China Australia Amsterdam	Malaysia Singapore Indonesia Thailand	East Malaysia Indonesia
Fleet	A333(15x) A359(6x) A332(6x) B738(44x)		A330-200F(3x)	ATR-72 500(9x) B738(3x)	ATR-72 500(10x) DHT6-400(6x)
Hubs	KLIA(KUL)	KLIA(KUL)	KLIA(KUL)	SZB(Subang)	Kota Kinabalu(BKI)/Kuching(KCH)

Non-Airline Transportation Services

AeroDarat | mabacademy | mabengineering | Rimrich | MHholidays | MAB Pesawat | MAB Leasing | Journify

Note:
1. A public service obligation managed on behalf of the goverment of Malaysia.
2. Fleet info as per 2021 planning

2020: 3,850million
2021: 11,145 million
MAG Capacity for
(available seat-kilometres)

Total Employees
2020 : 12,134
2021 : 10,859

102 Fleet

150 Countries

MAG's vision is anchored on becoming Asia's leading Travel and Aviation Services Group. To achieve that, MAG has focused on five strategic pillars under its Long-Term Business Plan (LTBP) 2.0: becoming a premium APAC carrier, expanding domestic and ASEAN routes, strengthening commercial partnership, revenue diversification and digital as the cornerstone for the business, while focusing on talent development and sustainability principles.

MAG's current airline business portfolio serves the global, domestic and segmented markets. The portfolio comprises of Malaysia Airlines – the national carrier of Malaysia, Firefly and MASwings – the regional airlines focused on serving communities across Malaysia, and AMAL by Malaysia Airlines – leading one-stop pilgrimage travel solutions centre.

MAG also focuses on non-airline transportation services such as maintenance, repair and overhaul (MRO), cargo, ground handling and training that houses MAB Engineering, MASkargo – the one-stop cargo logistic and terminal operations service provider, Aerodarat – the one-stop ground handling solution provider and MAB Academy – the one-stop Aviation and Hospitality Centre of Excellence.

In 2021, MAG introduced Journify app, an integrated one-stop travel and lifestyle digital platform. The app represents MAG's e-commerce & travel services business portfolio, focusing on providing end-to-end travel solutions while complementing its established strength and expertise in the airline and aviation services business.

With its clear business portfolios, MAG is set to achieve its vision of becoming Asia's Leading Travel and Aviation Services Group, focused on delivering highly customised, end-to-end travel solutions by 2023.

MAG's Fleets

malaysia airlines

A350-900 (6X)

A330-200 (6X)

A330-300 (15X)

B737-800 (44X)

firefly

ATR 72-500 (9X)

B738 (3X)

MASwings

ATR 72-500 (10X)

DHT6-400 (6X)

maskargo

A330-200F (3X)

Malaysia Airlines Berhad is the national carrier of Malaysia, delivering premium services and offering superior connectivity with seamless journeys to 1,000 destinations across over 150 countries.

Firefly operates out of the Penang and Subang hubs. It provides connections to various points within Malaysia, Southern Thailand, Singapore and Sumatra, Indonesia.

MASwings is The Pulse of Borneo's is East Malaysia's first commuter airline, catering to Sarawak and Sabah's travel population's air travel needs by providing affordable fares, convenient schedule and connections within Borneo's two states

MASkargo is the cargo business arm of the Malaysia Aviation Group operates scheduled and chartered air cargo, as well as warehousing, cargo logistic and cargo terminal operations services.

Aerodarat Services provides ground handling services in KL International Airport and 15 other airports across Malaysia, including ramp and cargo services.

MAB Academy offers quality education, hospitality and service training for Malaysia Aviation Group and other international airlines and organisations.

MAB Engineering is an internationally recognised Maintenance Repair and Overhaul (MRO) facility by Malaysia Airlines Berhad that carries out aircraft maintenance activities for the Group.

AMAL by Malaysia Airlines collaborates with Malaysia Airlines to offer scheduled and charter services to Jeddah and Madinah for Hajj and Umrah ibadah with global presence in key markets like Indonesia, China, Pakistan and parts of Africa.

Other Business: These are dedicated aircraft leasing companies established to provide customised and competitive aviation leasing solutions and asset management to the Group's airlines. The fleet includes all owned and managed aircraft operated by the Group, featuring a range of narrow-body and wide-body aircraft.

MAG Sustainability Blueprint

MAG Sustainability Goal

"MAG is committed to promote socio-economic development and achieve net-zero carbon emissions by 2050"

(E)ENVIRONMENTAL
Better Planet

Energy Management
Waste Management
Water Management
Noise & Emission Management
Fuel Efficiency

Environmentally Responsible

(S)SOCIAL
Better Communities

Learning & Development
Occupational Health
Talent Management
Culture & Engagement
Corporate Social Responsibility

Empowering Expertise

(G)GOVERNANCE
Building Trust

Ethical Operations
Regulator Compliance
Supply Chain Management
Internal Controls

Beyond Compliance

(S)SAFETY & SECURITY
Safer Skies

Flight Safety
Occupational & Ground Safety
Talent Management
Safety Culture
Security

Safety Leadership

(E)ECONOMIC
Better Business

Direct & Indirect Economic Benefits
Efficient Operations
Branding & Customers
Cyber Risk Management
Business Continuity

Profitability & Resilience

SUSTAINABLE DEVELOPMENT GOALS

MAG Sustainability Blueprint has been established to align with the UN Sustainable Development Goals (SDGs), with priority on SDGs Goal 8 (Decent Work & Economic Growth), Goal 12 (Responsible Consumption & Production), Goal 13 (Climate Action), and Goal 5 (Gender Equality). In this report, we have outlined our key contributions to the SDGs and how these goals are related to our Sustainability Report.

The Logo

Sustainable Tomorrow
MALAYSIA AVIATION GROUP

The four sustainable elements are placed within the wau, which is a representation of Malaysia Aviation Group.

The colour green is used to represent nature, peace, growth, harmony, freshness, safety and health. The Italic font is used to represent movement – us moving forward towards a better tomorrow.

MAG Sustainability Targets

Our ambition is to achieve net-zero by 2050, reducing all carbon emissions from operations. In addition to that, we are also formally committing to other targets across the organization in all aspects – social, governance, safety, and environmental. These targets are in alignment with IATA's targets, Malaysia's national targets, as well as our industry partners' targets, such as oneworld. Through consistent monitoring and effective collaboration, we are hopeful we can achieve these long-term targets in the years to come.

Environmental

- Net-Zero Emission by 2050 (as our commitment to ICAO/IATA)
- 1% fuel burn reduction year on year for all fleet
- Develop voluntarily passenger offset by 2023
- Towards waste circularity by 2050

Social

- Promoting **diversity** and inclusion in workplace: Increase the number of **women in senior positions by 25% by 2025**
- **Accelerate** opportunity, equity for better community by 2025

Governance

- **Zero** bribery and corruption case in MAG by 2023
- **Utilize** digital platforms and data analytics to entire supply chain by 2025
- **Combat** wild-life and human trafficking with awareness campaigns on wildlife trafficking once a year

Sustainability Journey

We strive to operate in a sustainable manner by embedding sustainable principles and practices in all aspects of our business. We started our journey with the development and formulation of our Sustainability Blueprint in 2019 and it became our foundation in progressing towards sustainability as an airline company.

DEC 2019
MAG began developing the Sustainability Blueprint.

FEB 2020
MABA CSR: Community services at rural area N-GAP CSR

MAY 2020
MAG ferried Chinese medical experts across the nation (COVID-19)

JUNE 2020
MAB CSR: rescue (repatriation) flights to Australia

JUNE 2020
First ADS 3Rs programme with Alam Flora

JUNE 2020
Aerodocs to replace manual updating process

FEB 2021
MASkargo delivers first Pfizer vaccines to Malaysia

APR 2021
Introduction of Quarantine Package for passenger

MAY 2021
MAB collaborates with Unique Biotech to convert kitchen waste into pet food & fertilizer

JULY 2021
MAG mass Vaccination Programme with MAHB PPVIN

NOV 2020
Officially embed Sustainability as part of the Corporate Scorecard

JULY 2020
MAB & FY Introduces complimentary Hygiene Kits for Passenger

OCT 2020
MAG Partners with UN World Food Program

Q4 2020
Ground GPU usage for FY Fleet

SEPT 2020
MASwings signed MoU with Islamic Relief Malaysia for humanitarian and aid relief

APR 2021
Official launch of the MAG Sustainability Blueprint.

AUG 2021
GE appointment for FES2.0 for MAB Fuel Efficiency Program.

OCT 2021
Signed MoU with Petronas Research & Petronas Dagangan Berhad

2021
100% vaccinated COVID-19 workforce & 7-star rating by airline rating for COVID-19 preventive measures

2021
7149 Safety Reports & 4319 Safety Investigations conducted

DEC 2021
MAG takes action to help Employee impacted by the floods

Q4 2021
Sign-up for UN WEP Signatory through Statement of Support.

DEC 2021
MAG operates inaugural flight using Sustainable Aviation Fuel (SAF).

DEC 2021
Establishment of Women@MAG framework

Towards a Better Planet

We place high priorities on managing our carbon footprint. Carbon accounting will be our main key initiative in 2022 to set the baseline and strategize our net-zero roadmap.

Carbon Footprint

MAG adopted the GHG Protocol corporate standard, which covers the accounting and reporting of the six greenhouse gases.

Decarbonization: NET-ZERO BY 2050

To strategize our net-zero roadmap by carbon accounting activity and the initiatives to be conducted to ensure we will be able to meet the target by 2050.

Waste Management

Develop internal waste circularity framework to reduce waste-to-landfill and increasing recycling rate by 2030.

Accounting for our Carbon

MAG adopted the GHG Protocol Corporate Standard which covers the accounting and reporting of the following six greenhouse gases covered by the Kyoto Protocol – carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6). These gases refer to gases that contribute to the greenhouse effect by absorbing infrared radiation emitted under Malaysia Aviation Group's operational control in the years 2019, 2020 and 2021.

Current initiatives to reduce carbon emission:-

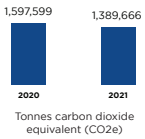
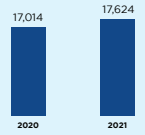
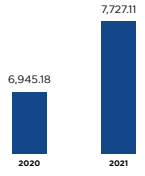
- **Scope 1:** Various initiatives conducted from fuel department and operations team that will elaborate further under MAG adaptation to IATA Pillar's Strategy.
- **Scope 2:** MAG has collaborated with Sustainable Energy Development Authority Malaysia (SEDA) in the installation of solar panels at MABKargo facilities, which reduces the subsidiary's reliance on Malaysia's electrical grid, thus decreasing Scope 2 GHG emissions. Solar panels resulted in 7000MWh generated annually. Thus, MAG was able to avoid emitting almost 5000T of CO2 annually.
- **Scope 3:** Eight of the fifteen categories in this scope are relevant to MAG; one of these categories is waste management. The Group is actively working on better waste management through the implementation of the 3Rs Programme, waste centralization as well as waste compliance throughout all subsidiaries. We will share Scope 3 data once it has been finetuned and further validated.

SCOPE 1
Direct GHG emissions owned or controlled by MAG include aircraft engines, auxiliary power units, ground support vehicles and refrigerant consumption.

SCOPE 2
Indirect GHG emissions from the generation of purchased electricity consumed by MAG facilities.

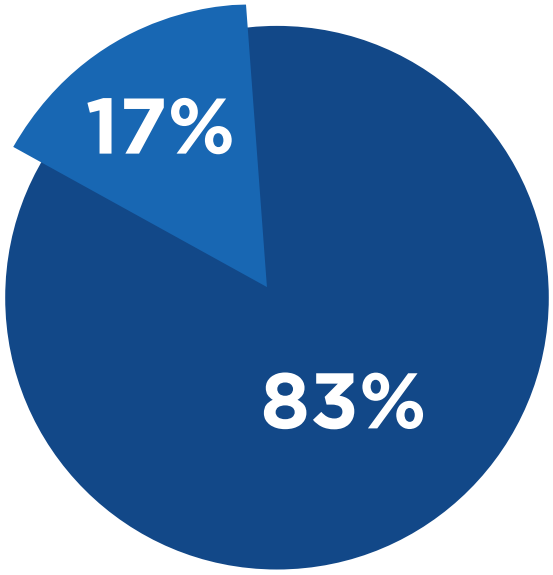
SCOPE 3
Emission from indirect source/ supply chains, which includes upstream and downstream activities.

Carbon Accounting Exercise for Year 2020 - 2021

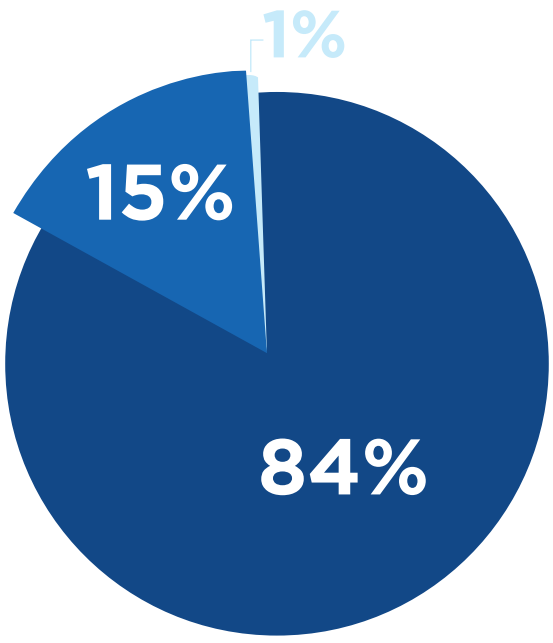
Metric		Emission/Conversion Factor
Scope 1	 Tonnes carbon dioxide equivalent (CO_2e)	Direct GHG emissions owned or controlled by MAG include aircraft engines, auxiliary power units, ground support vehicles and refrigerant consumption.
Scope 2	 Tonnes carbon dioxide equivalent (CO_2e)	Indirect GHG emissions from the generation of purchased electricity consumed by MAG facilities
Renewable energy	 MWh	Total renewable energy generated by solar photovoltaic at MAG's facilities

Scope 1 and Scope 2 Breakdown

Scope 1 to Direct Emission: Fuel Consumption 2020

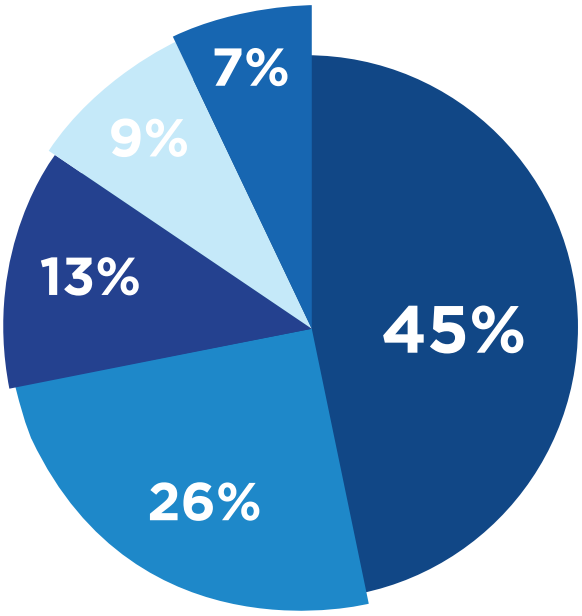


Scope 1 Direct Emission: Fuel Consumption 2021

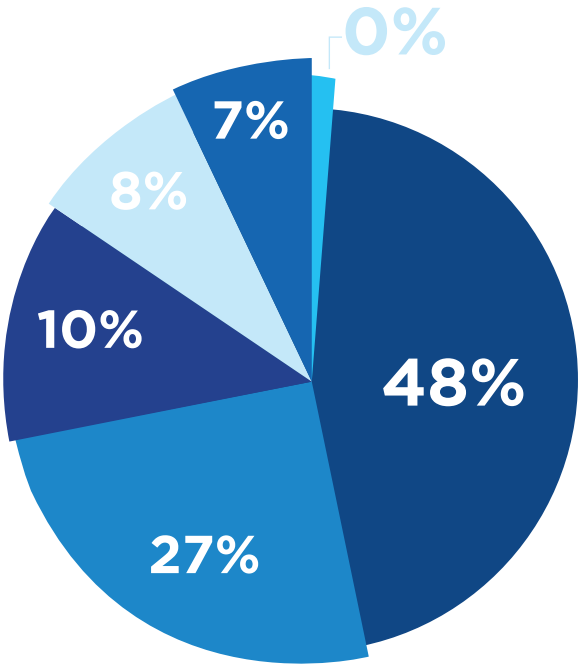


- Jet Fuel Consumption International
- Jet Fuel Consumption Domestic
- Company Vehicles
- Other

Scope 2 Indirect Emission: Electricity 2020



Scope 2 Indirect Emission: Electricity 2021



- MAB Kargo
- MAB Academy
- Firefly
- MAB Engineering
- Flight Management & Administration Building
- MASwings

Climate Change

Aligning with IATA's Aspiration

As guided by the Civil Aviation Authority of Malaysia (CAAM), Malaysia Airlines subscribes to the ICAO Carbon Offset Reduction Scheme for International Airlines (CORSIA). We are in the Baseline Period of CORSIA, which will fully come into effect in 2027. As part of our sustainability efforts, MAB has participated in IATA's Carbon Reduction Strategy; a set of ambitious targets to mitigate CO2 emissions from air transport.

MAG is committed to supporting the net-zero target and we are in the midst of developing our pathways towards net-zero emissions by 2050. In fact, MAG is currently developing our long term SAF Roadmap and have demonstrated it via two SAF flights since December 2021. The two SAF flights used renewable waste and residue raw materials, such as used cooking oil and animal fat waste. We are also working closely with aircraft manufacturers and other industry players to continue enhancing our infrastructure and operational efficiency through several initiatives, including aircraft and ground efficiency programmes.

In line with IATA's aspiration, MAG plans to publish our Net-Zero Emissions (NZE) pathways in 2023 as part of our significant contribution and commitment towards the net-zero target by 2050.

Policy and System

Fuel efficiency initiatives are embedded in policy documents across our operations departments. In most cases, the initiatives are embedded within the default procedures, whilst in other cases, the policy would encourage the use of fuel-efficient techniques, aircraft technologies and SAF for better operations

These are apparent in in-flight operations manuals, where the highest priority is placed onto the safe operations of a flight. Fuel efficiency procedures exist as a supplemental/optional procedure to be practiced when the situation allows for it.

- The **Skymetrix** fuel management system is used to manage the backend financials of uplifted fuel and payments. Any fuel savings reported by the GE Fuel Insight system will then be crosschecked with Skymetrix to ensure true savings.
- The **Electronic Voyage Report** records fuel-related data. This data is analysed every month to identify areas where enhancement is required.
- **The GE Digital** Fuel Insight and FlightPulse system addresses key areas of our operations that impact our ability to achieve peak environmental efficiency – from fuel burn at key flight segments, efficiency of flight planning, performance of fuel-efficient procedures and a mobile application to assist pilots in planning efficient measures for their flights.

Supporting IATA Fly Net-Zero Strategy

In 2021, IATA member airlines have agreed to commit to net-zero carbon emissions from their operations by 2050. With this commitment, air transport is in line with the Paris Agreement's goals of limiting global warming to 1.5°C. Achieving net-zero by 2050 will require a combination of maximum elimination of emissions at the source, and also offsetting and carbon capture technologies. The following are the main components of the emissions reduction plan based on IATA's Net-Zero pathways strategy: the use of Sustainable Aviation Fuel (SAF), investment in new aircraft technology, continued improvement in infrastructure and operational efficiency, the use of approved offsets including carbon capture, and storage technology. Although, the pathways to net-zero will be evolving, MAG will model its own net-zero target based on IATA's aspiration.

65% Sustainable Aviation Fuel (SAF)

13% New technology, electric and hydrogen

3% Infrastructure and operational efficiencies

19% Offsets and carbon capture

IATA's four Pillar strategy

Adaptation to IATA's Four-Pillar Strategy

Lever 1: Sustainable Aviation Fuel (SAF)

1. Background

MAG sees SAF as a crucial lever for advancing towards sustainable aviation and our long-term plans to reduce CO2 emissions will be implemented through several key initiatives at the Group level.

2. SAF Approach

As part of our commitment to net-zero emissions by 2050, MAG is currently exploring using SAF as the foundation of the strategy as it could reduce net emissions by 80%, lower than conventional jet fuel. SAF can be produced from sustainable feedstocks such as recycled cooking oil, household waste, agricultural residue and renewable energy.

3. Our Plan

MAG is currently working with the government and other industry partners to develop a robust policy and supply chain framework for SAF implementation at the national level. We plan to increase the use of SAF in our flights by 2027, but this plan would need strong collaborations between the government and industry leaders to support the global SAF production in a more effective approach.

Taking Action Towards Climate Change

Malaysia Airlines' First Flight using Sustainable Aviation Fuel

Malaysia Airlines operated its inaugural flight using sustainable aviation fuel (SAF) in partnership with PETRONAS Dagangan Berhad (PDB) and Neste in December 2021. The flight marks Malaysia Airlines' commitment to make SAF the cleaner and more viable energy option for regular flights by 2025.

This successful operation was a result of the supply deal between PETCO Trading (UK) Ltd, which is PETRONAS' marketing and trading arm in Europe, and Neste, the world's leading producer of renewable diesel and SAF refined from waste and residues.

SAF is recognised globally as the most feasible option to reduce aviation emissions in the near term. Neste MY Sustainable Aviation Fuel is produced from sustainably-sourced 100% renewable waste and residue raw materials, such as used cooking oil and animal fat waste.

In its neat form and over the lifecycle, Neste MY Sustainable Aviation Fuel reduces greenhouse gas emissions by up to 80% compared to fossil jet fuel use.

Malaysia Airlines aircraft refuelled with Sustainable Aviation Fuel.

MAB team during the first Malaysia Airlines flight using Sustainable Aviation Fuel from Amsterdam.

Lever 2: New Technology

The COVID-19 pandemic unleashed a wave of difficulties for airlines as there were fewer flights and even fewer passengers. As the number of passengers travelling worldwide has about halved compared to 2019's records, some companies have shut down while others are barely hanging on.

One of our strategies to sustain the business during our major restructuring in 2021 was to exclude the Airbus A380 from our network plan. Currently, MAG operates a fleet of 74 aircrafts, comprising of 6 A350s, 21 A330-200s/300s and 47 737-800s, Firefly with 12 ATR-72s and 3 B737s, and MASwings utilizing 8 ATR-72s and 6 DHC6s.

In the future, we plan to improve the technology with:

1) Boeing Max 8 fuel efficiency - **Fuel efficiency is around 14% better than the current B737-800**
2) New Generation Wide Body (NGWB) – **Fuel burn efficiency is around 10 - 12% better than the A330ceo**

Lever 3: Operational Efficiencies

Typically, fuel cost consists of 30 - 35% of total cost in the airline industry. This makes fuel cost a major risk for the sustainability of an airline as it is directly driven by global crude oil price as well as movements of forex against the Malaysian Ringgit. Focus is then placed on controlling the volume of fuel we consume via the fuel efficiency programme, targeting a reduction of 1% each year primarily from flying efficiencies and technologies.

The savings also translates directly into the reduction of CO2 emissions as 1kg of fuel burn is equal to 3.16kg of CO2 emissions. Hence, the fuel efficiency programme brings significant benefits to the environment due to the number of flights operated each year.

Malaysia Airlines is actively participating in CORSIA. As a result, any excess carbon emission above the baseline set during the pilot phase of CORSIA implementation will have a negative impact on our Economic Sustainability goal. MAB will need to purchase carbon credits from the carbon market in order to offset against the excess carbon emission.

How We Measure Our Progress

Fuel efficiency is tracked by analysing the fuel burn for each sector operated against the fuel burn targets for each segment. For each segment, a key indicator of fuel-efficient practice is tracked for its execution and quality using the Fuel Efficiency System by GE Digital. This system allows the team on ground as well as the pilots to evaluate opportunities to improve the efficiency of flights as well as reporting on key areas of fuel burn. On ground, the usage of Auxiliary Power Unit (APU) is monitored at each transit and ground activity. This will soon change as the policy will encourage the minimal use of APU and to increase usage of a more fuel and energy efficient Ground Power Unit (GPU) instead.

Key Indicators for Fuel Saving

Key Indicators	Our Progress	Implications
Idle Reverse Thrust Success Rate	92% compliance rate	Savings of 15 - 33kg (avoidance of 50 - 100 kgCO2 emission) of fuel per flight depending on fleet type.
Single Engine Taxi in Success Rate	73% compliance rate	Savings of 21 - 35kg (avoidance of 60 - 110 kgCO2 emission) of fuel per flight depending on fleet and airport.
Reduced Acceleration Altitude Success Rate	83% compliance rate	Savings of 20 - 50kg (avoidance of 60 - 160 kgCO2 emission) of fuel per flight depending on fleet type.
Reduced Drag Landing Success Rate	91% compliance rate	Savings of 15 - 22kg (avoidance of 50 – 60 kgCO2 emission) of fuel per flight depending on fleet type.
Final Fuel Optimization	63% Compliance Rate	Savings of up to 100kg (avoidance of 30 kgCO2 emission) of fuel per flight depending on route and fleet type.

Key Initiatives

- **Flight Operations Programme**

Emphasis is placed on best practices for fuel conservation which includes, but are not limited to, single engine taxi, landing with idle reverse thrust, continuous descent approach and RNP-AR GPS-guided approach.

We will leverage on data analytics through GE Digital Fuel Insight System to find areas of improvement and opportunities for best practice application.

Planning for a flight is also a critical step towards achieving efficiency. This is why the team has adopted new processes to increase the accuracy of the flight plan, ultimately achieving an accurate fuel prediction and fuel burn during flight.

- **Aircraft Maintenance Programme**

This programme focuses on maintaining an optimal aircraft performance and equipment weight through modifications and an efficiency-driven maintenance programme (e.g.: engine compressor washes, aircraft exterior cleaning and lightweight paint).

- **Ground Operations Programme**

Focus on reducing the use of Auxiliary Power Unit (APU) on ground, using a more energy efficient Ground Power Unit (GPU) and ground-based Air Conditioning units instead.

Optimizing aircraft take-off weight by estimating zero fuel weight in near-real time, minimizing the amount of unnecessary fuel carried (maintained within safety margins).

Improving Fuel Burn through Robust Data Analytics

Malaysia Airlines Partners with GE Digital to Modernize the Airline's Fuel Analytics Platform

Malaysia Airlines chooses Fuel Insight and FlightPulse to transform its fuel efficiency programme.
GE Digital's Aviation Software solutions help operators meet sustainability goals by monitoring and reducing fuel usage and emissions.

We have implemented various initiatives including efficiency measures, investments in sustainability solutions, and waste reduction across all operations to address sustainability goals. The fuel efficiency programme has been running for more than a decade, contributing to a 15% fuel burn improvement recorded over the past eight years. Data analytics have been a cornerstone of the programme with various improvements made in systems infrastructure and capabilities. As a part of this focus, we have embraced technologies by GE Digital to facilitate more efficient, digitally-connected operations.

Smaller Steps Taken to Achieve Net-Zero by 2050

Our target is to achieve a sustained performance of 1% fuel burn reduction year on year for each fleet (excluding fleet replacement factor) until point of maturity. This is defined by >80% compliance rate of best practices in-flight operations, after which the target will be to sustain zero escalation of fuel burn as the aircraft ages. The team have so far met and exceeded this target, delivering more than 1% fuel burn reduction and avoidance purely from operations improvements.

Airline	Year	Fuel Consumption (tonnes)	CO2 Emission (tonnes)	Fuel Savings and Avoidance (tonnes)	Percentage Saved and Avoided
Malaysia Airlines & AMAL by Malaysia Airlines	2020	405,323	1.28 mil	4.495	1.11%
	2021	359,953	1.14 mil	4.994	1.39%
MASkargo	2020	35,037	110,717	966	2.76%
	2021	77,969	246,382	934	1.20%
Firefly	2020	9,200	30,641	652	7.01%
	2021	6,067	20,155	523	8.62%

Source MAB-MAG integrated Fuel Management System (IFMS,Skymetrix)

Note MASwings is working on their fuel efficiency programme beginning 2022.

Lever 4: Carbon Offsetting

One way the aviation sector is addressing climate change now is through carbon offsetting. We look at what is being done to make up for global flight emissions, from passenger voluntary offsetting programmes to CORSIA mandatory offsetting, a global effort to stabilise CO2 output.

Beginning in 2027, all countries will be required to participate in CORSIA, which will apply to almost all international routes, where we are starting to develop our carbon offsetting framework and exploring certified carbon markets that are available.

Following the work that we've done to identify our carbon footprint, we will be taking a phased approach to offset our carbon emissions. This approach consists of three stages, starting with ancillary integration, followed by the setting up of a voluntary offset portal, and finally, mandatory airline offsets imposed by CORSIA. We have launched the first phase and are currently launching the second phase.

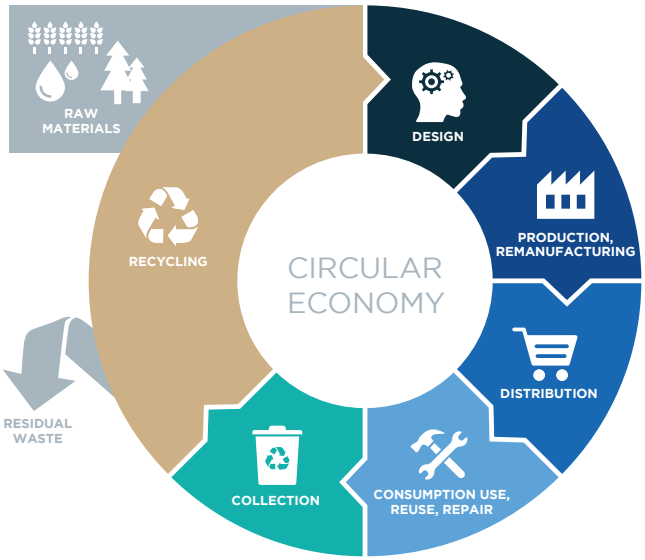
Objectives:

- To encourage passengers to donate to sustainable projects that contribute to the conservation of forests and helping local communities, in line with the SDGs.
- To give passengers the option to offset their carbon footprint voluntarily and to become responsible flyers through credible projects.
- To offset remaining mandatory offsetting for CORSIA requirements through eligible CORSIA Projects

Waste Management

As part of our pledge for a sustainable and net-zero carbon future, we have embarked on several initiatives to contribute to the circular economy within MAG's airlines and non-airlines businesses. This has simultaneously supported MAG's organisational sustainability targets, as well as those at the national level through the Malaysia Plastic Circularity Roadmap 2021-2030, and globally through the 2030 Agenda for Sustainable Development encompassing the 17 Sustainable Development Goals (SDGs).

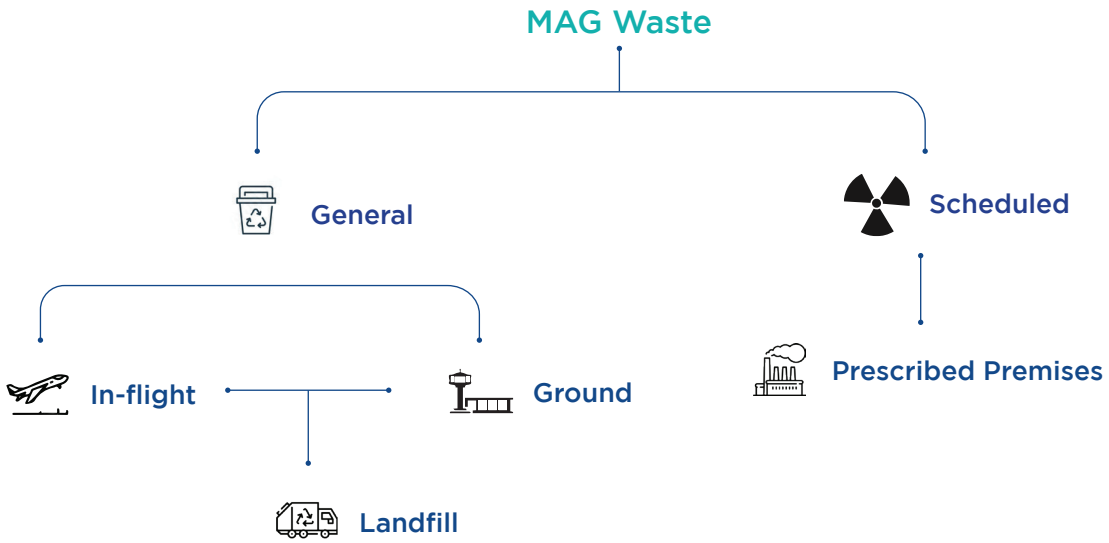
We have commenced the development of our waste circularity framework in order to reduce the adverse impacts of the generation and management of our waste. This framework will be presented for board approval in 2022.



Waste in MAG

Waste in MAG can be separated into two types, which are Scheduled Waste and General Waste.

Scheduled Waste is defined as any waste that possesses hazardous characteristics and has the potential to adversely affect the public health and environment; whereas General waste is waste that does not exhibit significant toxic characteristics. General Waste can be broken down even further, into Ground Waste and In-flight Waste.



Comprehensive Waste Management Strategy

3Rs Across MAG

Reducing the quantity of waste we generate is made easier by following the 3Rs: reduce, reuse and recycle. They preserve energy, landfill space, and natural resources. Additionally, communities need less land and money to dispose of waste in landfills when they follow the 3Rs. A new landfill's location has become more challenging and expensive as a result of environmental rules and community opposition. In MAG, we are continuously encouraging our community to practice 3Rs to reduce waste to landfill and also to help our MAG staff to know that they can help to conserve our environment by their small action. A series of events with Alam Flora has been conducted and we are planning to centralize the waste process and to make the 3Rs practise a regular practise in MAG.

Recycling collections for KUL stations:

Recycling collections for KUL station

Year	Total Collection (Kg)
2020	11506
2021	14679

In-flight Waste Initiatives

We have re-engineered our containers by introducing biodegradable materials for the meal box and cutleries, and e-menu card for our passengers.

Other than that, MAG is currently in the midst of developing the ESG Procurement Blueprint to ensure only recyclable and compostable products are used for all in-flight equipment.

(1) Scheduled Waste

Proper management of scheduled waste is highly important to avoid any contamination of water and/or air pollution that can occur due to improper handling of scheduled waste. Our scheduled waste is handled by Certified Environmental Professional in Scheduled Waste Management (CePSWaM). As scheduled waste is highly regulated, we have appointed prescribed premises such as Kualiti Alam, Kitaran Recovery, and Riyaland Sdn Bhd to manage our scheduled waste disposal.

(2) Ground Waste

We believe in the saying "One man's trash is another man's treasure," as this rings true for the waste from our aircraft cabin, which is of value to some.

One of the ongoing initiatives we have, that is related to Ground Waste, is the 3Rs Wheels with Alam Flora, where departments can trade in their ground waste for cash. We are also in the process of developing our waste framework in order to centralize the waste management process in the organization. Our focus for general waste is to further strengthen the 3Rs principle in the company: Repurpose, Reduce, and Recycle.

MAG employees during a recycling collection.

REPURPOSE

Old uniforms, seat leather, life vests, pallets, plastics, etc.

REDUCE & SEGREGATE

Fully utilize digital platform to reduce A4 paper usage.

RECYCLE

3Rs programme across the company. Employees can trade in waste for cash.

(3) In-flight Waste

In-flight Waste is generally divided into two types:

1. Cabin Clearing Waste (non-food)

- Waste generated by customers on board including packaging from amenity and hygiene kits, and garbage from lavatories is cleared by our Aircraft Interior Clearing (AIC) vendors and collected by Alam Flora Environmental Solution (AFES). This waste is segregated at the sorting center and then sent to the local recycling center to be repurposed.

2. Catering (galley waste)

- Everyday, food waste accounts for about 25% of 1000 kilograms of kitchen waste. IFO has collaborated with Unique Biotech to reduce the dumping of food waste through black larvae technology. This technology recycles food waste through the farming of black soldier fly larvae, which eventually converts the waste to animal feed and fertilizers.

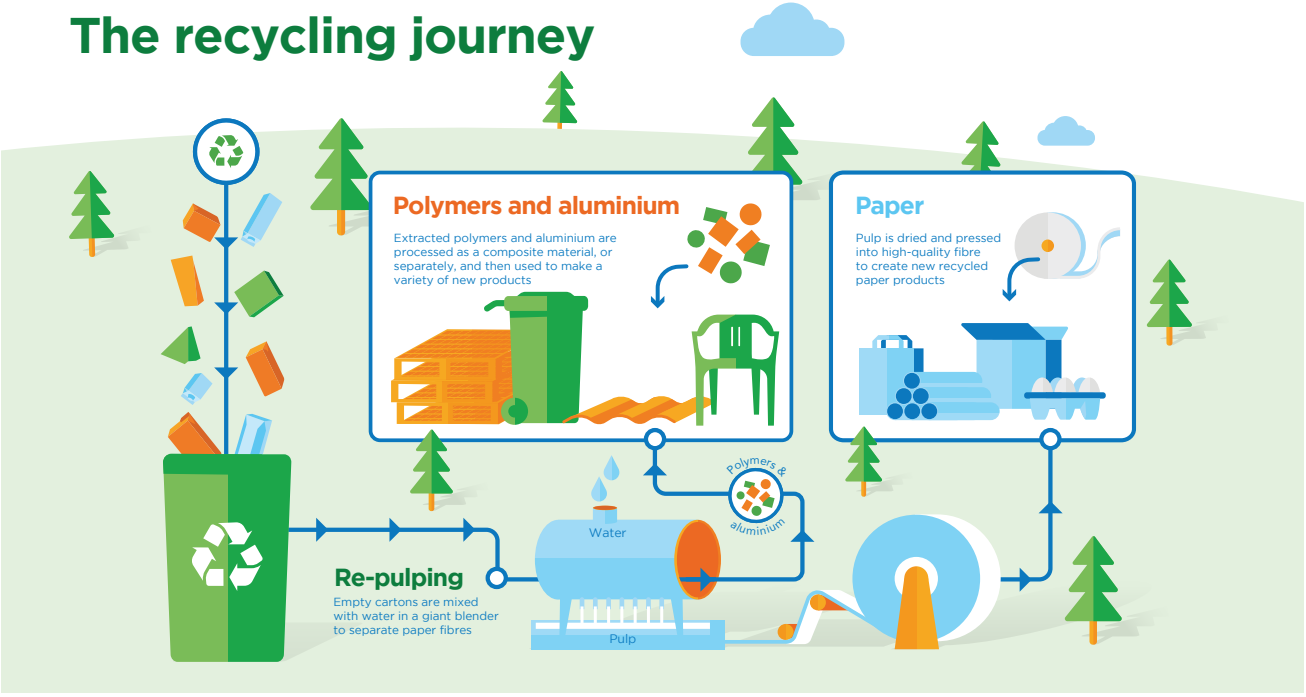
Previous

In 2019, 11,000 boxes disposed daily, along with aluminum container/cover and plastic disposable cutleries.

Now

In 2021, biodegradable materials are used for meal box & cutleries. The items will disintegrate after few weeks of disposal.

Effective 01 November 2021, all waste from Domestic Peninsular, Crossing and Regional flights were segregated for our recycling initiative. This is done in collaboration with Tetra Pak (M), and a local recycler focused on Tetra Pak packaging (juice), pre-capped containers (water & juice), and peanut packaging. Pre-segregation is done by our cabin crew through the return of all recyclable items to dedicated stowage, and further segregation is performed by our Kuala Lumpur caterer, Brahims SATS Food Services Sdn. Bhd. (BSFS). All segregated items are collected by the local recycler and recycled into various products, such as recycled boxes



Luxury Upcycling with THESELINA

"As the parent company of the national carrier Malaysia Airlines, MAG continues to forge ways to promote socio-economic development and achieve our commitment of recording net-zero carbon emissions by 2050."

Philip See

These luxury handbags were crafted and conceptualized with respect and care for the environment by the THESELINA team, comprising of professional seamsters and seamstresses.

Every material used is handpicked and repurposed from Malaysia Airlines' aircraft leather seats, belts and buckles, tablecloths, life vests, the iconic cabin crew kebaya uniforms, handbags, and more.

We believe that our customers should be able to enjoy the finer things in life while remaining conscious of our role in caring for the planet. We are proud to show the fruits of what our collaboration with high-end designer Selina Yeop Jr of THESELINA has brought. Through the repurposing of aircraft materials into bespoke designer bags, it has allowed us to reduce wastage whilst alleviating our flag-bearing brand to the world.

Firefly and MASwings Participate in World Cleanup Day

Firefly team together with media members and resort staff during the clean-up session

In Conjunction with World Clean-up Day 2019/2020, Firefly Cleans the Beaches & Islands of Langkawi

In a bid to save nature and fight the menace of plastic and other rubbish, a team of 20 participants consisting of staff from the airline, resort and media members travelled to Langkawi where the clean-up drive was carried out at a few locations. The Frangipani Langkawi Resort & Spa, a well-known eco-resort, hosted the teams' stay and showcased more than over **300 Green Practices**, which aids in keeping the resort sustainable. Being the only resort in Langkawi with a **100% all-natural filtration system**, which utilises aquatic plants to treat waste water and turning into Grade-A drinking water, the resort shows true commitment in reducing its carbon footprint on the environment.

MASwings, in collaboration with Malaysia Airport and NGOs, has conducted several gotong-royong programmes in the effort to minimise human impact on the environment:

a) Beach cleaning initiated by MASwings in collaboration with MAB team and Malaysian Nature Society (NGO). A truck load of rubbish was collected that consisted of plastic bottles, food containers, glass bottles, rusted metal, and other general items.

b) Housekeeping project in collaboration with MAB team to dispose of old document and files for recycling. This project has resulted in addition storage space for all business units.

c) Check-in counters clean-up in collaboration with Malaysia Airport. The project was to remove old baggage tags, boarding passes, and papers not accessible during daily cleaning.

Gotong Royong programmes organised by MASwings team, MAHB and local NGOs

MASWings team during the Go Green initiatives.

Truth be told, it is already late for us to realise that this earth is getting old and polluted over the years, BUT it will never be too late for us to start any initiative to protect and care for it.

Kudos to MASwings Support Services & Finance (SSF) team for their fast action to embark on MASwings' Go Green initiatives. The team has been organising a few late afternoon sessions for gardening and planting trees within MAB/MW Administration Building compound. It is an ongoing and work-in-progress effort so far.

The Community Garden utilised recycle products such as recycle tires as plant pots, shredded paper as part of the fertiliser, and rainwater collected in drums for watering the plants. What a wonderful feeling and view to admire indeed, especially during working hours. Together, let us heal the world – making it a better place for everyone to live in by starting small within our MAG premises.

Nurturing the MAG Community

We **progressively engage and motivate employees** in driving a high-performance culture. We instil and promote MAG core values throughout the organisation and our communities, anchoring on the values of Genuine, Efficient, and Progressive. It is our commitment to develop and nurture the capabilities of our people to be future ready, ensuring their well-being, and being a responsible corporate citizen in the communities in which we serve.

Learning & Development

On-going employee development through training and education is essential for employee retention and providing a sustainable pipeline of skilled and future-ready workforce.

Occupational Health

A **safe and healthy working environment** will boost employee morale, and in some cases, bring about productivity gains.

Talent Management

The sustainability of any organisation is dependent on effective human capital management and talent retention strategies.

Culture & Engagement

Equitable employee engagements will stimulate a high-performance culture, advocate a **sense of belonging**, and strengthen the brand positioning as an employer of choice, enabling us to attract the most highly skilled employees.

Corporate Social Responsibility

CSR includes initiatives, programmes and voluntary contributions made by our organisations to **support and empower deserving local and international communities**.

Responding to the COVID-19 Pandemic

In 2020, we were hit with one of the biggest global pandemics: the COVID-19 pandemic. Our emphasis since then has been to respond to the impact of this pandemic in a timely and effective manner.

Operations

We took measured approaches to mitigate financial and operational risks. At the start of the pandemic, we suspended global operations, especially in highly-affected regions due to travel restrictions. As we continued to closely monitor the situation, our employees were given the opportunity to work from home. The health and safety of our customers, employees, and suppliers were prioritized, and we implemented every precautionary measure to ensure our passengers felt safe.

The pandemic posed significant challenges for the worldwide supply chain. During this time, we maintained a synergetic relationship with our suppliers as we realize the importance of minimizing supply chain disruptions. To help reduce this problem, we successfully used our passenger planes to provide cargo services, known as the Passenger-to-Cargo (P2C) and Cargo-In-Cabin (CIC), neither of which required any aircraft modifications.

Passenger Safety

COVID-19 safety policies were introduced at airports and onboard all our flights to maximize passenger safety during the pandemic. The usage of face coverings was mandated on our flights and temperature screenings on all passengers were conducted as part of our additional health and safety measures during check-in and boarding. Malaysia Airlines was also among the first to trial the IATA Travel Pass, working closely with the government to ensure passengers can consolidate and carry all necessary information for travelling into one application.

Nation & Government

We are fully committed to supporting the nation and the government, and to complying with border restrictions. In the early days of the pandemic, MAB operated repatriation flights from Egypt and New Zealand to reunite Malaysians with their loved ones as border restrictions were imposed worldwide. The group also played a very active role in transporting not only test kits and vaccinations for COVID-19, but also medical equipment and medical experts to Malaysia.

Although we have not been able to operate normally, we made sure to keep our priorities and strategies in place as we begin planning our return to normal operations once border restrictions are lifted.

Placing Employee Wellbeing at the Centre

Supporting Our People through the Pandemic

We believe in leaving no one behind. Therefore, we have used this difficult time to bond with all our employees. We made it a priority to foster wellbeing among employees during and post-COVID-19 by ensuring our employees always feel safe and heard in the workplace. Health & safety measures in the office were introduced, as well as social distancing and Work-From-Home when possible. We also launched the MAG Employee Assistance Programme to support employees with personal or work-related problems.

MAG Employee Assistance Programme (EAP)

MAG's Employee Assistance Programme (EAP) was introduced in March 2020, focuses on 4 psychosocial health intervention dimensions to support employees in managing their well-being effectively.

PSYCHOLOGY

Main Areas
- Mental Well-being
- Emotional Well-being

Covering mental and emotional well-being through our digital platform, **MHeart**

SOCIAL

Main Areas
- Financial Well-being
- Diversity & Inclusion

Looking after the well-being of our MAG Family through **financial literacy programmes** and ensuring an **inclusive and diverse** culture at MAG

SPIRITUAL

Main Areas
- Spiritual Well-being

A holistic look at employee well-being through our discussions with amazing guests in the **Sembang Santai** series, and **Dakwah Bawah Pokok** talks

Webinar series in collaboration financial institutions to educate employees in managing financial concerns during on-going MCO

Partnered with Naluri for Digital Programme support such as Resilience Programme and Counselling

Drive awareness of MHeart Programme in Naluri app

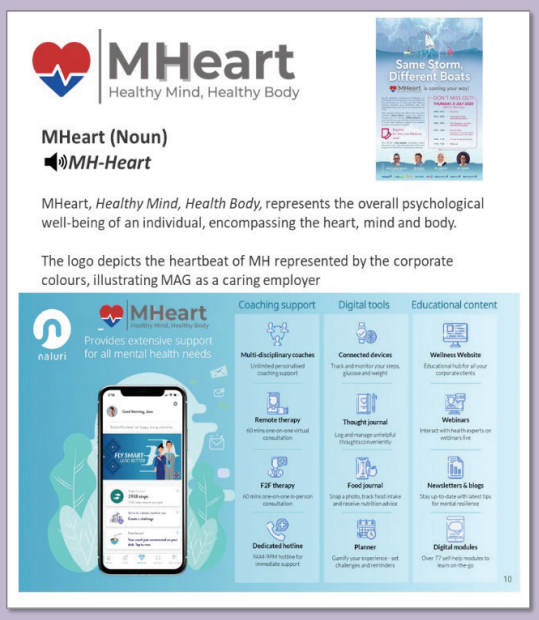
Webinar series in collaboration with external guest focusing on Social Sustainability topics

Monthly **Sembang Santai Live** sessions with external guests

Dakwah Bawah Pokok a virtual spiritual talks with employees

Employee Assistance Programme (EAP) Initiatives Conducted (2020 & 2021)

Since 2020, we are leveraging on digital platform to stay connected to the employees in providing education & awareness on individual well-being and support systems that enable coping with the pandemic situation positively.



6379
Total members started registration

Webinars in 2020 & 2021

1. **Same Boat Different Storm** - Launch of the Mheart Programme for MAG
2. **For A Better Tomorrow** - Financial literacy webinar to inform and educate MAG employees on financial matters (moratorium, loans, etc)
3. **Recover Restart Re-energise** - Health webinar to educate MAG employees on benefits and risks of the COVID-19 vaccine by medical experts
4. **Navigating Finances** - Financial literacy knowledge on savings and money management from a local financial expert
5. **Understanding First Signs** - Special Mental Health Webinar hosted for Top and Middle management teams to understand the first signs of distress from employees, and how to manage it properly

Sembang Santai in 2020 & 2021

Dakwah Bawah Pokok in 2020 & 2021

- These unique initiatives are conducted by a religious teacher who will go to departments and divisions across the Group to listen and hear people, and to renew their faith in themselves and the organisation. It is just like a 'counsellor' going around to listen to employees who are keen in seeking **guidance on how to manage oneself when facing life challenges**.
- Also known as "open floor session", the sessions are short and casual, typically 20 mins with a small group of employees. The sessions are conducted face-to-face. However during the pandemic, it was done online.

COVID-19 Employee Vaccination Programme

Total Vaccination: 100%

GCEO Captain Izham, Minister of Health Malaysia Khairy Jamaluddin, and Head Corporate Safety Oversight of MAG Dato Razin at the industry vaccination centre (PPVIN), KLIA

Vaccination plays a vital role in the restart of domestic and international air travel and tourism. MAG remains steadfast in our commitment to adopting the highest safety and hygiene standards in air travel. We believe to operate a flight with a fully-vaccinated crew is important as we prepare to welcome our passengers to fly confidently with us.

Through COVID-19 Immunisation Policy in July 2021, MAG made it compulsory for all of its employees to be vaccinated with the COVID-19 vaccine. To expediate the vaccination among the employees, MAG joined the KLIA Vaccination Programme organized by Malaysia Airport Holdings Berhad.

During this vaccination programme, MAG managed to get more than 70% of employees vaccinated and the remaining were vaccinated through MySejahtera's allocation.

To ensure a safe environment and community, all our vendors and foreign workers also received their vaccination during the programme in KLIA, with more than one thousand foreign workers under MAG being vaccinated.

MH Rangers – MAG employees volunteering at the vaccination centre.

Volunteering at Vaccination Centres

To further support the nation's biggest COVID-19 immunisation drive, MAG continues to mobilise its employees from across the Group to volunteer at several mega vaccination centres namely Axiata Arena, Bukit Jalil and KL Convention Centre.

MAG Ghostbuster Squad

MAG Ghostbuster was formed in 2020 and initiated by Captain Rohaizan Mohd Rashid, Head of Training in MAB Academy to meet MOH's requirement of contaminated workplace disinfection in an expedient manner. The KUL employees worked together to form this taskforce to ensure that MAG's safe working environment is being maintained.

MAG Ghostbuster Squad during a disinfection of the workplace.

Functions

1. Quick Response Team to conduct disinfection at any and all contaminated workplaces.
2. Periodic disinfection in high volume areas (e.g., MABA).
3. Training of other personnel.

Commitment from Vendors during MAG Vaccination Programme

We believed that an employer's action matters! To ensure everyone in MAG can work in a safe environment during this pandemic, MAG has taken the initiative to vaccinate more than 1000 of our vendors' staff. Their staff consisted of foreign workers that were vaccinated during our KLIA vaccination programme in July 2021.

Connecting and Re-Connecting Communities

MAG has always played a major role in connecting communities, especially with the advent of COVID-19. Despite border restrictions caused by the pandemic, our staff worked tirelessly to ensure flights could still operate, not only to reunite families and loved ones, but also to deliver humanitarian aid. Here, we celebrate our employees going above and beyond the call of duty during a difficult time for everyone by sharing their stories.

Humanitarian aid by Malaysia Airlines to Da Nang.

MASkargo Flies Humanitarian Aid to Da Nang

In spite of the restrictions and closure of international borders, MASkargo flew more than 30 tonnes of humanitarian aid to the Da Nang International Airport in Vietnam on Tuesday, 20 October 2020.

Flight MH 7982, utilising an A330-300 passenger aircraft, departed from Kuala Lumpur at 7pm and arrived in Da Nang at 8.40pm. The team in Da Nang made quick work of unloading the shipment despite the heavy weather.

"This flight is a great achievement for the MASkargo team as we manage to uplift 37 tonnes, establishing a new P2C payload record", said Mohd Zulkefly Ujang, MASkargo's Chief Operation Officer.

This charter flight was made for a well-known humanitarian aids agency, aided by MASkargo, known as Chapman Freeborn Airchartering Pte Ltd.

Sharing the Chapman Freeborn's feedback on the airline's services, MASkargo Charter Team said, "Our client is very pleased with the whole project. Big thanks go out to the loadmaster who managed to get extra 5,000kgs of cargo on board, overcoming all the 'trimming odds'."

Anton Lomakin of Chapman Freeborn also conveyed his appreciation to the MASkargo Commercial Team, who were at hand 24/7 to resolve all out-of-office issues and accommodate everchanging requirements. Last, but not least, was their utmost gratitude to the flight operations team who ensured all permits and slots were approved despite the short notice.

Rescue & Repatriation Flights

In the early days of the pandemic in 2020, MAB operated repatriation flights from Egypt and New Zealand.

Egypt:
In partnership with educational platform MedicMesir, Malaysia Airlines brought students, who were stranded in Egypt, back to Malaysia.

New Zealand:
Following the travel ban instituted by the Government of New Zealand on 20 March 2020, Malaysia Airlines operated chartered rescue flights sponsored by the Government of the Netherlands from Auckland & New Zealand to Kuala Lumpur to ferry Dutch nationals. Once in KLIA, passengers boarded the repatriation flight operated by Dutch national carrier KLM back home to Amsterdam.

Malaysian students onboard their flight from Cairo to Kuala Lumpur.

Malaysia students at the airport on the way to board their flight from Kuala Lumpur to Langkawi.

Malaysia Airlines Delights First-Time Fliers to Langkawi

Malaysia Airlines made the first-time experience of flying on an airplane memorable for 40 teachers and students from Sekolah Kebangsaan LKTP Tenggaroh Selatan, Kota Tinggi, Johor with a surprise send-off by the airline's Group CEO Captain Izham Ismail who also presented them with exciting goodies.

MASwings Blood Donation Drive

The Malaysian Red Crescent Society's (MRCS) Kota Kinabalu branch is on its mission to continuously organize its blood donation campaigns to reach out and educate the public on the importance of blood donation, especially to the younger generations.

The MOU was signed by MASwings Chief Operating Officer, Captain Nasaruddin A Bakar and MRCS-KK Chairman, Tuan Remy Martin Gunsalam at a simple ceremony held at MAB/MASwings Administration Building. Captain Nasaruddin in his short welcoming note mentioned that the MOU signed is the first ever between MASwings and MRCS-KK under its corporate social responsibility agenda. He also added that the collaboration is significant as in another means to help the community at large to ensure that the blood supply never runs out for those in need and most importantly the collaboration is associating with a strong partner such as Malaysian Red Crescent Society-KK. An honour for MASwings.

The blood donation drive took place at the Riadah Room of MAB/MW Admin Building. It kicked off at 9am and ended by 4pm which resulted in MRCS-KK successfully collected a total of 76 pints of blood out of 100+ MAG family who participated.

MASwings COO, Captain Nasaruddin during the MOU signing session

MASwings staff contributing to the Blood Donation Drive.

MASkargo Flies in Largest Vaccine Shipment To Date

Friday, 21 May 2021 was a busy morning for the team in MASkargo as they prepared for the arrival of more than a million doses of COVID-19 vaccines.

MH361 arrived at 7.50am with 500,000 doses of Sinovac from Peking, China in three units of temperature-controlled air cargo containers (RAP). This was followed by the arrival of MH6125 with 559,200 doses of AstraZeneca vaccines from Amsterdam at 8.45am. The shipment was built up like normal cargo as the AstraZeneca vaccines were packed in special boxes containing ice gel packs. Therefore, the use of RAP was not required.

Due to the sensitivity of the product, pre-alerts were shared with the task force to ensure the proper handling of the precious shipments according to the set SOPs. After necessary clearance, the vaccines were then carefully loaded onto awaiting Pharmaniaga trucks. The trucks then left the MASkargo warehouse under armed escort by the Royal Malaysian Police.

In total, MASkargo has made around 147 vaccine trips in years 2020 - 2021.

MASkargo uplift COVID-19 vaccines wrapped in special boxes.

Anugerah WOW winners receiving their awards from Group CEO, Captain Izham Ismail.

Celebrating Our Very Own MH Family – Anugerah WOW

"It's never about what we do, but rather about how we do the things that define us."

Anugerah WOW is about rewarding employees who demonstrated excellence in their Way of Working (WOW).

It is about creating a discipline of action culture and taking accountability for all aspects of our business, including operational excellence, customer satisfaction and financial profitability.

In 2022, we will introduce sustainability-specific awards, such as the Green Ranger Award & SPOT Award, as part of Anugerah WOW to acknowledge more employees in their contribution towards MAG's sustainability journey.

MH Rangers

MH Rangers was established to create a ready pool of talents to volunteer in supporting customer service quality initiatives and ad-hoc company activities to raise our team spirit and to unite MAG.

This enterprise empowers MAG employees to voluntarily make a difference in helping and improving our performance while conveying Malaysian Hospitality at the same time.

MH Rangers during their volunteering activities.

Women@MAG

MAG is committed to empowering women, and we are striving towards creating a gender-balanced workforce. In 2021, we've developed a framework for Women@MAG in order to foster a climate of inclusivity, diversity, and equity within MAG. The mission of Women@MAG is to drive engagement, performance, and productivity of female employees for the group to ensure that we can:

- Attract and retain talent
- Build employees' trust and commitment
- Promote creativity and innovation
- Promote a community that embraces mutual respect and is cohesive.

Our roadmap consists of 4 phases; Phase 1 (Laying the Foundation), will be done in 2022, where we officially launch and increase the awareness of Women@MAG within the workforce. In the subsequent phases and ensuing years, we hope to develop and implement policies that will cement the cultural/mindset shift to meet long term objectives, as well as collaborate with like-minded organizations to strengthen Women@MAG as an establishment. By 2025, Women@MAG aims to increase the number of women in senior positions in MAG by 25%, and to also possess a financially stable model to sustain Women@MAG over the years.

Employee Category	Female	Women Rep (%)	FTE Gap to achieve 25%
Top Management	2	14%	2
Senior Management	68	47%	-
Middle Management (Manager)	94	40%	-
Management Pilot	0	0%	13
Pilot Group	35	3%	356
Tech Group - Engineer	28	7%	105
Grand Total	227	11%	386

Table of Women Employment in MAB

Building Trust

Good governance is important in building trust with our stakeholders and employees – together ensuring transparency, accountability as well as supporting MAG's purpose and how this purpose relates to other sustainability focus areas. MAG focuses on below four matters :

ETHICAL OPERATIONS

Describes MAG's values, principles, standards and norms of behaviour such as the code of conduct.

REGULATORY COMPLIANCE

Our business is highly regulated by legislation, regulations, and mandatory standards at the international, national, and state levels.

INTERNAL CONTROLS

The primary purpose of internal controls is to help safeguard MAG and further its objectives.

SUPPLY CHAIN MANAGEMENT

This includes impacts that are either caused or contributed to by our organization, or that are linked to our relationship with a supplier.

Building Trust
Ethical Operations and Regulatory Compliance

The **Business Integrity Department (BID)** is tasked to establish the Corporate Governance Framework and Policies for Malaysia Aviation Group. In conducting their practices, BID is guided by the following principles:

Effective Management

- Effective management of whistle-blowing programme on bribery, corruption, and fraud cases within the organization.

Transparency & Efficiency

- Transparency and efficiency in investigation process involving bribery, corruption, and fraud cases within the organisation.

Adopt the practices

- Reports directly to BGRC.
- Adopt the practices of ISO 37001 & enhanced Anti-Bribery Management System (ABMS).

Ethical Operations & Regulatory Compliance

Governance & Compliance

- Review, revise and ensure compliance of all governance and compliance policies within the business operations.

Whistle-blowing Programme Governance

- Encourage the employees and our stakeholders to safely and securely report any non-compliance within the business operations.
- Non-compliance reported cases against the Corporate Approving Authority Policy (CAAP).

Anti- Human/ Wildlife Trafficking

- Awareness initiatives on the issue of human and wildlife trafficking.
- Updates on reported and investigated incidents.

Internal Controls

Internal controls are the procedure implemented by the organisation to ensure the organisation is trustworthy, transparent and compliant.

Personal Data Protection & Privacy

- Development of any personal data protection regulations which may impact MAG.
- Prevent data breach incidents.
- Record of any and all data disclosure requests.

Beyond Compliance
Whistle-blower Programme

The whistle-blower system has been implemented to allow anyone, internally and externally, to raise concerns and alerts directly to BID if the whistle-blower has in good faith believe that the COBC, policies and standards or a law or regulation has been or is about to be violated.

Since 2016, the investigators have received and managed more than 421 concerns and alerts through various communication methods. After performing the necessary due diligence, substantiation and in-depth investigations, more than 183 corrective and/or disciplinary actions have been taken.

Continuous efforts are being carried out to increase awareness within MAG about whistleblowing channels. In 2017, a whistle-blower campaign was initiated. Since then, this has been an ongoing exercise carried out also in all of BID's in-person and online training sessions. In 2021, BID has also began issuing monthly bulletins published on PulseDAILY to further educate MAG employees about the various channels of whistleblowing.

Statistics

Types Of Cases	2020	2021
Abuse of or Fraud with Company Benefits	1	4
Accounting and Auditing Matters		
Accurate Books & Records		
Conflict of Interest		3
Data Privacy	2	
Disclosure of Confidential Information	23	
Discrimination or Harassment	3	12
Embezzlement		1
Falsification of Contracts, Reports or Records		
Employee Relations	8	3
Improper Supplier or Contractor Activity		3
Improper Use of Intellectual Property		
Misuse of Assets or Services		
Offensive or Inappropriate Communication		2
Retaliation		
Sexual Harassment		4
Substance Abuse		
Theft		
Unfair Trade Practices, Deception and Fraud	4	4
Violation of Policy	12	7
Time Abuse	3	
Confidentiality and Misappropriation	1	1
Export Control Violation	1	
Antitrust Activity		1
Misleading Sales, Marketing & Advertisement		1
Total	**64**	**46**

Anti-Human & Wildlife Trafficking

MAG takes an active stance against human and wildlife trafficking.

We have officially signed the Buckingham Declaration in June 2017, which unites the world's leading organisations and wildlife charities under a common purpose – one that has created a global movement for change against wildlife trafficking.

MAG is also working closely with MAPO* on human trafficking, a crime that ranks among the worst forms of human rights abuse. Criminals rely on air transportation to traffic victims from one place to another and we intend to put a stop to this. We continue to work together with various government agencies and NGOs to train and empower our staff, especially our cabin crew and ground staff, to be our eyes in the skies and on ground to report any suspicious activities.

Statistics

Reported Cases and Incidents:

- 2020: No reported case on human or wildlife trafficking.
- 2021: No reported case on human or wildlife trafficking.

*__MAPO:__ Ministry of Home Affairs' Council for Anti-Trafficking in Persons and Anti-Smuggling of Migrants

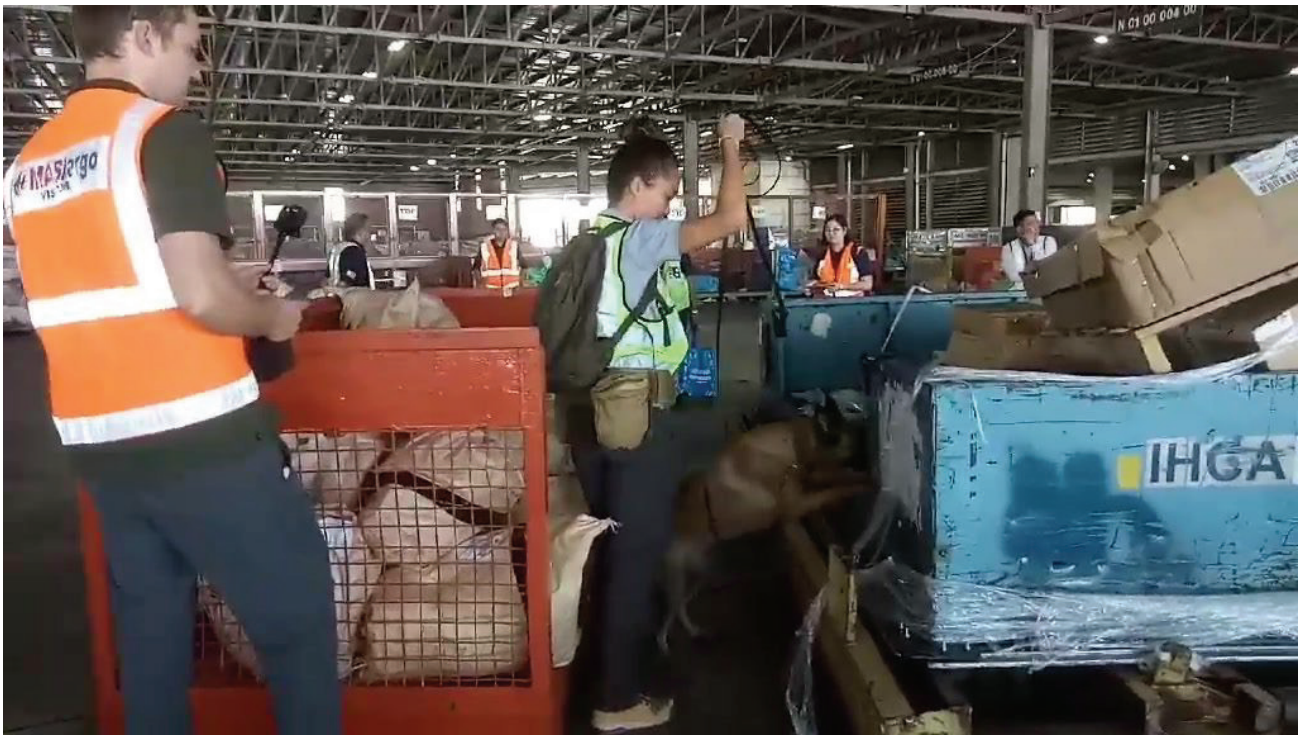
Governance Sustainability Efforts

The Scooby Doo Project

The international illegal wildlife trade (excluding timber and fisheries) is estimated to be worth up to USD23 billion a year, making it the fourth largest illegal global trade (after drugs, counterfeiting and human trafficking) and covers a broad range of endangered species. Malaysia, with its high biodiversity and its strategic location between East and West, has put the Group in a hotspot area for potential illegal wildlife trafficking.

Realising the urgency of the issue, BID has taken the lead on rolling out a Group-wide anti-wildlife trafficking programme, with priority placed on cargo business units and frontline employees. BID has also taken further initiative in engaging and collaborating closely with local enforcement authorities to prevent any illegal trafficking of wildlife through our services.

One of the BID-driven key initiatives in fighting wildlife trafficking is the Scooby Doo project, a collaboration between MAG and RIMBA, an NGO which trains and provides MAG with 2 K9 units specially trained to detect any illegal wildlife smuggling in consignments at the MABKargo complex.



Scooby Doo exercise with external K9 Unit

Governance Sustainability Efforts

Personal Data Protection & Privacy

The airline business collects and processes personal data of its customers on a daily basis.

Due to the rapid growth of digital transformation where businesses are relying on big data, the importance of responsible processing of personal data and maintaining the privacy of our customers have become extremely important.

- **Briefing and training programme conducted by the Business Integrity Department (BID)**

  Briefing sessions to all MAG employees, including vendors, on processing personal data, i.e., call centre services, social media services team, ground handlers and other MAG employees at stations where Malaysia Airlines operates.

- **Appointment of data protection officer**

  Every department, subsidiary and station must appoint at least 1 data protection officer who shall report on data protection compliance checklists at least once for every quarter to BID for the purpose of compliance.

- **Establishment of privacy mailbox**

  A privacy hotline at privacy@malaysiaairlines.com. This email is available 24/7 every day for all employees, vendors and the public to address their concern regarding any data breach or potential data breach of their personal data or privacy.

- **Collaboration with IT, Risk & Governance team**

  Constant communication updates with the IT, Risk & Governance team in terms of technical updates for data security. We have also started certain initiatives with regards to this area, such as conducting briefings for awareness. This includes cybersecurity briefing sessions by the IT team

Goverment Authorities	KUL	Station	No of request
MKN	✓	✓	1
MOTAC		✓	3
Department for Work & Pensions UK		✓	5
Embassy/Consulate/High Commissioner/Court	✓	✓	30
Ministry of Transport	✓	✓	3
Ministry of Foreign Affairs	✓		1
Federal Bureau Investigation (FBI)	✓		1
Public Security Bureau China		✓	1
Directorate of Revenue Intelligence India		✓	1
Agensi Anti-Dadah Kebangsaan (AADK)		✓	1
National Crime Agency Control, UK		✓	1
Securities Commission Malaysia	✓		2
MAQIS		✓	1
TLDM		✓	1

Data Breach Cases and Data Disclosure Requests in 2020 - 2021

New Way of Working

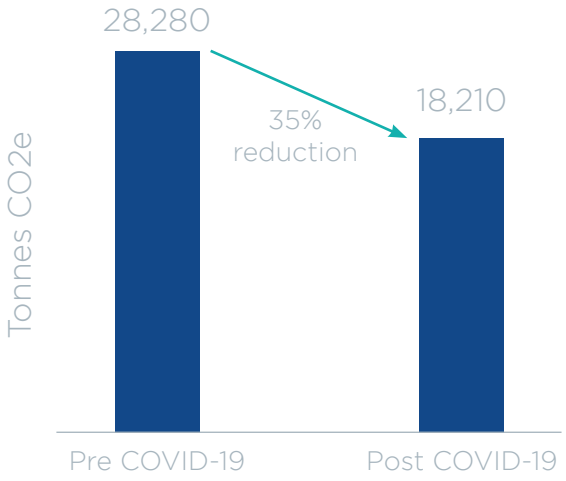
Since 2019, MAG has embarked on a Working-from-Home **(WFH)** working style with the objective to see how we can reduce employees' carbon footprint gradually.

When COVID-19 hit, everyone started working from home due to Movement Controlled Order (MCO) and we started to strategize how our employees can still be effective and efficient while they work from home.

From there, we explored all online platforms and made sure all MAG staff can fully utilize them. Besides this new working style being very effective in maintaining our employees' performances, it has also helped in reducing carbon emission, lease cost, mental health issues and able to control COVID-19 spread among our employees as well.

We are still maintaining the practice of working from home as we believe this positively contributes to the environment.

Employee Commute Annual Emission



Enhanced Health & Safety

Temperature screening in the workplace, personal protective equipment, social distancing and more.

Upskilling

Employees received trainings to upskill and reskill to remain agile (simulator training, online webinar and training).

FRSAG

The Fatigue Risk Safety Action Group (FRSAG) actively monitored safety fatigue reports and placed mitigating measures where necessary.

Safety is our DNA

Aviation Safety

Management of change during COVID-19 Pandemic

Safety Culture

Management of change during COVID-19 Pandemic

COVID-19 Response

Management of change during COVID-19 Pandemic

Safety Goals

- Rated as World's Safest Airlines by 2030
- Establish an Aviation Safety Culture Certificate Program by 2025
- Enhance security capabilities by using 100% state of the art technology by 2035

2020-2021 TWO YEARS SAFETY SNAPSHOT

Safety & Security as one of Key Focus Area in Sustainability Blueprint

SAFETY & SECURITY

0 Major Air on Ground Accident
Occupational Workplace Death
Stop Work Order
Positive Drugs and Alcohol

100% Completion of Safety Business Plan

398 Management of Change (MoC) implemented.

8,936 Safety Assessments/ Investigations conducted

12,355 Safety Reports

PARTNERSHIP THROUGH ENGAGEMENT

13 WauSafe publications

28 FDA engagement sessions

43 Turun Padang, webinar, workshop, townhall sessions

85 Safety courses conducted

521 Manuals maintained electronically by Enterprise Document Management System

1,502 Participants in Safety Day

HEALTH & COVID-19

100% COVID-19 vaccinated workforce

27 Chapters of COVID-19 Safety and Health Manual

9,754 COVID-19 online course participants

Safe & Guard
Bureau Veritas Health, Safety and Hygiene Certification

ASSURANCE & COMPLIANCE

3 YEARS AOC Certification until Aug 2024

24 MONTHS IOSA Certification until Jul 2024

12 MONTHS ISAGO Certification until Dec 2023

Best Safety Management Award
from KILAT Conference

3 STAR SOHELP
DOSH Certified

AELB
radiation workplace certified for Cargo and Engineering Operations

CORSIA & EU-ETS
2019-2020 verified submission ahead of time

Aviation Safety

Malaysia Aviation Group is the premier group of airlines and aviation services in the Asia-Pacific region that places safety and security first in its business conduct. Safety was identified as one of the key focus areas in our Sustainability Blueprint, with the goal being Safety Leadership. The sustainability matters in the safety focus area are Flight Safety, Ground Safety, Safety Culture and Security. The aim is to achieve zero accidents and 100% compliance. "**Safety and Security is our DNA**" is one of the six beliefs in MAG's Long-Term Business Plan 2.0.

The COVID-19 Pandemic from 2020 to 2021 had been one of the most challenging periods in the history of the aviation industry. MAG was greatly impacted, like many other global airlines. The lockdowns significantly reduced passenger traffic and along with it, flying operations. There were many changes that occurred because of the everchanging requirements set by authorities due to the COVID-19 pandemic. Each change went through a Management of Change and Risk Management Process. The control and mitigation measures were in-place to ensure the identified risk was kept to as low as reasonably practicable.

Some of the emerging risks included skill-fade among the workforce, psychological stress, extended flight duty period, new flying environment for crew, new work-from-home arrangements, new cargo operations as well as aircraft technical dispatch reliability. Each one of these risks were addressed including but not limited to, increasing simulator and training sessions, provision of counselling services, flight crew fatigue monitoring, augmenting crew complement, monitoring cargo and maintenance operations.

Despite these challenges, Malaysia Airlines managed to obtain a three-year Air Operator Certificate (AOC) from the Civil Aviation Authority of Malaysia (CAAM) for the first time and were recertified in the IATA Operational Safety Audit 2021 (2021). AeroDarat Services Sdn Bhd (ADS) also maintained the IATA Safety Audit for Ground Operation (ISAGO) certification in 2021.

IATA IOSA IATA Operational Safety Audit

IATA ISAGO IATA Safety Audit for Ground Operations

Embedding Safety into Our Culture

To further enhance safety practice in MAG, Safety Culture was registered as a sustainability matter in the safety key focus area of the Sustainability Blueprint. The Top Management's commitment to safety is spelled out in the Safety Policy and was demonstrated further by incorporating Safety Briefing as the first agenda in Board Meetings and in the MAG Townhalls at the beginning of 2020. Apart from the Top Management, the Management Pilots have been active in their leadership role of promoting the safety culture in MAG. The MAG Safety Culture launch programme was done during the 2021 MAG Safety Day by the MAG Chairman.

Safety Culture

The aviation Safety Management System (SMS) framework, pillars and elements were consistently applied throughout MAG and this is reflected in the achievement and maintenance of the AOC, IOSA, and ISAGO certifications. Two series of workshops have been conducted to further refine the Safety Culture in MAG. The five elements of Safety Culture are used as guides to further enhance Safety Culture in MAG. The five elements are Just Culture, Reporting Culture, Learning Culture, Informed Culture and Flexible Culture. These elements of Safety Culture were already in existence in MAG and will be further improved.

Just Culture	100% safety incidents, which involved human behaviour, will undergo Just Culture assessment.
Reporting Culture	7947 Safety Reports received in 2021, of which 82% are Hazard Reports and 18% are Incident Reports, were logged and investigated.
Learning Culture	100% completion of Safety Management System module in 2021 and five safety courses introduced: SMS for Airlines, Safety Investigation, Safety Risk Management, Safety Auditor Training and Fatigue Risk Management Training.
Informed Culture	Safety and Health Updates in MAG Townhalls, Quarterly Safety & Health Update at Board of Directors, Board Safety and Security, and Safety Review Board meetings to keep internal stakeholders informed. Minimum twice a year engagement with external stakeholders, like oneworld and Association of Asia Pacific Airlines (AAPA).
Flexible Culture	To manage change and adapt to the needs of the world, there were 173 changes made in total, 151 due to operations and 22 due to COVID-19. Some of the changes included work from home, remote and virtual audit, and online safety health training and promotion.

COVID-19 Response and Engagement

During the COVID-19 pandemic in Malaysia, MAG underwent the four phases of the Disaster Management Cycle.

Continued airline safety through extensive health and hygiene practices based on ICAO Annex 9 Facilitation Standard, and Recommended Practices and International Health Regulations 2005 (IHR 2005).

Participation in CAPSCA's Publication of Multi-agency Pandemic Preparedness Plan and Table-Top Exercise in June 2019 to stockpile of face mask and influenza vaccine for crew.

Activation of Emergency Operations Committee, setting out MAG COVID-19 Safety and Health Policy, and publishing the MAG Safety and Health COVID-19 Manual. We also carried out the vaccination programme for our workforce that achieved 99% coverage. Besides that, we implemented ICAO Council's Aviation Recovery Task Force's aviation public health measures, that consists of 4 domains, 22 areas and 197 recommendations.

During this stage, we have introduced MH Fly Confidently programme to passengers. Our efforts helped us achieve the independent assessment 7-star rating by AirlineRatings.com in December 2020, and Health and Hygiene certification audit by Bureau Veritas in December 2021.

MAG COVID-19 Internal Control

The MAG COVID-19 Safety and Health Policy outlines the four main principles of managing COVID-19 within the organization. They are:

- Flight Safety and Security
- Customer Safety and Health
- Workforce Safety and Health
- Regulatory Compliance

Engineering Operations Readiness 2020-2021

The Engineering & Maintenance (E&M) team has taken several actions to ensure operational & maintenance readiness, such as through the Enhanced Cabin Maintenance Programme, Cargo Inspection & Repairs, and Interior & Exterior Cleaning.

Enhanced Cabin Maintenance Programme

In 2020, E&M embarked on a fleetwide aircraft cabin sweep in order to address long outstanding defects and restore cabin appearance in the most cost efficient way.

In 2021, E&M obtained the issuance of MAB Design Organization Approval (DOA), a design document for alternative repairs/fabrication methods. This has cost-saving potential as it provides in-house alternatives instead of replacement of parts via issuance of DOA documents.

It includes Engineering Note, Repair Instruction, Local Modification, and has one-off savings, i.e., cost tracked by the components repaired under each document. Its continuous savings are savings achieved whenever components are fabricated/repaired using these references. This is tracked via workshop activities, such as Signwriter, Fiberglass, and Aircraft Sheet Metal.

E&M also underwent a process change of Component Process Centre. This reduces the number of scrap components which could be repaired, thus red

Cargo Inspection & Repair

The team launched **fleet-wide cargo inspections for all B738, A333, A33F and A350 aircrafts.** Cargo inspections and repairs were performed both on active aircrafts and LTP aircrafts. To date, the E&M team has successfully completed all the repairs at the cargo area for all B738 aircrafts.

During MCO, E&M launched **fleet-wide cargo inspections for all B738 aircrafts.** Cargo inspections were performed both on active and LTP aircrafts. Several defects were found during the inspection such as punctured floorboards as well as sunken, dented and torn sidewalls. Driven by the spirit to ensure our aircrafts are fully ready once MCO was lifted, the E&M team **successfully completed** all the repairs at the Cargo area for all B738 aircrafts.

Interior & Exterior Cleaning

E&M Team has taken the opportunity to perform interior and exterior cleaning while aircrafts were on Long Term Parking (LTP).

Sustainability Governance

Board

- Chairperson: Group Chairman MAG
- Members: Board members
- Frequency: Half yearly

BGRC

- Chairperson: Board Member
- Members: Board of Directors, GCEO, Head ERMD, Head Internal Audit, Head BID, GCFO, GCSO, GCSTO
- Frequency: Half yearly

Sustainability Strategic Committee

- Chairperson: GCEO
- Members: GCSO, COO, CFO, CHCO, other GEXCO members by invitation
- Frequency: Quarterly

GEESS Working Group

- Chairperson: Group Chief Sustainability Officer
- Frequency: Quarterly

Governance | **Environment** | **Economic** | **Social** | **Safety & Security**

MABA | **MK** | **ADS** | **AMAL** | **MW** | **FY**

MAG Sustainability Initiatives

Sustainability Strategic Committee:

Frequency: Quarterly

Key Role:
To provide guidance to the overall sustainability agenda and align it to MAG Sustainability Blueprint and UN Sustainable Development Goals.

GEESS Working Group:

Frequency: Quarterly

Key Role:
To provide guidance and assist in decision making for any sustainability-related matters under each of the 5 Focus Areas.

To provide alignment between different BUs in MAG for any cross-functional sustainability project.

Closing Remarks

In recent years, MAG has taken the initiative to include sustainability in its corporate strategy. We have defined the group's overall direction towards sustainability and set high-level targets, hoping to move towards our goal by launching our sustainability blueprint. This blueprint will continue to serve as a driver to accelerate and support our initiatives in the future.

A sustainability office has been formed within the organization, with a working group responsible for tracking sustainability initiatives and reporting. This is to ensure that the organization continues to receive guidance and periodic updates toward our sustainability goal of promoting socio-economic development and achieving net-zero carbon emissions by 2050.t

Looking forward, we will implement enhanced measures across the organization to ensure we meet our targets, such as through transitioning to SAF and enabling passengers to offset their carbon emissions when flying. We are also looking into reducing our carbon footprint on the ground even further by shifting to electric ground vehicles and utilizing solar panels in our hangars and office buildings. Although most of our emissions arise through flying activities, we will continue to empower our employees to play their part in reducing their individual carbon footprint by launching internal campaigns to reduce, reuse & recycle in the office. Employees are also encouraged to commute efficiently when not working from home by carpooling or taking public transportation as personal vehicles are one of the biggest contributors to carbon emissions.

We recognize that designing a system to gather information regarding sustainability reporting is critically important. Since this is the first sustainability report published by MAG, we also acknowledge that excellent sustainability reporting may not be accomplished easily during our early years. However, we are confident that our reporting will improve after repeated trials, and we look forward to helping our stakeholders better grasp of our sustainability data in the years to come.

Appendix
List of Abbreviations and Acronyms

ADS	Aerodarat Services
AELB	Atomic Energy Licensing Board
BGRC	Board Governance Risk Committee
BID	Business Integrity Department
CePSWaM	Certified Environmental Professional In Scheduled Waste Management
CH4	Methane
CIC	Cargo-In-Cabin (CIC)
CO2	Carbon Dioxide
CORSIA	Carbon Offsetting Reduction Scheme for International Aviation
DOA	Design Organization Approval
E&M	Engineering and Maintenance
EOC	Emergency Operation Committee
EPM	Engineering Procedural Manual
ERMD	Enterprise Risk Management Department
FRSAG	Fatigue Risk Safety Action Group
FY	FlyFirefly Sdn. Bhd (Firefly)
GCEO	Group Chief Executive Officer
GCFO	Group Chief Finance Officer
GCHCO	Group Chief Human Capital Officer
GCOO	Group Chief Operations Officer

GCSO	Group Chief Sustainability Office
GCSTO	Group Chief Strategy Officer
GEESS	Governance, Environment, Economic, Social, Safety & Security
HFCs	Hydrofluorocarbons
IFO	In-Flight Operations
KLIA	Kuala Lumpur International Airport
MAG	Malaysia Aviation Group
MK	MASkargo
MoC	Management of Change
MW	MASwings Sdn Bhd (MASwings)
N2O	Nitrous Oxide
NGO	Non-Government Organization
NGWB	New Generation Wide Body
P2C	Passenger-to-cargo
PFCs	Perfluorocarbons
SAF	Sustainable Aviation Fuel
SDG	Sustainable Development Goals
SF6	Sulphur Hexafluoride
SMS	Safety Management System
SSF	Support Services & Finance
WOW	Way of Working

Email: sustainability@malaysiaairlines.com

Sustainable Tomorrow
MALAYSIA AVIATION GROUP

Appendix

General Industry Overview of SAF

By Malaysia Aviation Group

mag
malaysia aviation group

malaysia airlines · MASwings · firefly · amal · Enrich
Journify · maskargo · AeroDarat · mabacademy · mabengineering

Table of Contents

Introduction

Sustainable Aviation Fuel (SAF) is one of the key elements in decarbonizing airline operations as part of the industry's commitment to reduce carbon emissions by 2050. This report will focus on the latest progress of global SAF readiness in terms of the policy and incentives involved to push forward the implementation of SAF in the aviation industry.

Several studies illustrate that implementing SAF would not only deliver benefits to the environment but would also provide several key benefits to the economy and society to a more significant extent. In addition, the rollout of SAF could also help some business travelers offset their Scope 3 emissions as part of their corporate net-zero targets. For the airlines, the implementation of SAF would support them in meeting some regulatory requirements, such as CORSIA and ReFuel EU (Fit 55).

Feedstock and technological pathways are the main key components involved in SAF production. A range of different sustainable feedstocks has been identified as the potential natural source that could be processed with several certified production pathways in producing neat SAF. As the development of the production pathway would require huge investments, more active collaborations and support are required from public and private sectors to accelerate the production in a more cost-effective manner. This will ensure the entire supply chain is sustainable in the long run.

There are several key challenges that industry players are currently facing in developing and implementing SAF globally. Firstly, the cost differential compared to conventional jet fuel (CJF) makes SAF 3 - 8 times higher due to its high production cost based on technological pathways. The high cost is also a direct impact from the level of supply and demand in the industry. Secondly, the current SAF demand is relatively low due to its low availability in the market. This is because high investments are required in areas of technology and production pathways. Hence, fuel producers would require a strong demand from the industry players in order to commit to the long-term SAF production plan.

Currently, there is still a lack of support from the global government in terms of introducing the right incentives, policies, and strategic framework to push SAF at a commercial scale production. Nevertheless, some governments have taken significant steps to cushion the cost impact by providing financial support to create a level playing field for this latest green energy.

As part of the commitment to achieve net-zero emissions by 2050, a collaborative effort between the government and key industry leaders is essential to ensure the right policies and framework are being implemented to support the commercial production of SAF in this new exciting journey.

Sustainable Aviation Fuel (SAF): A Background

As the global demand for air travel (from leisure and business travelers) continues to grow post-pandemic, the main challenges in the aviation industry are to keep delivering social and economic benefits while ensuring a reduction in flight emissions.

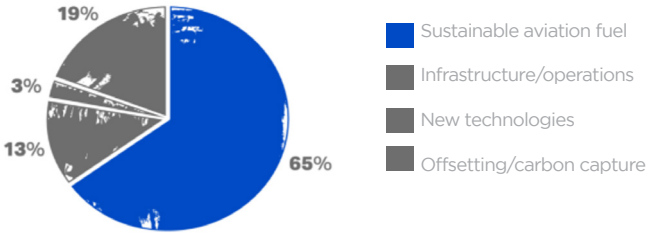
One of the latest innovations to make air travel more sustainable is the production of SAF for commercial use in the airline industry. Although the utilization of SAF at most major airports is not at the optimum level, this most recent invention is a stepping stone towards 'eco-friendly travel' that could contribute to the industry's emissions reduction strategy.

What exactly is SAF?

SAF is produced from sustainable resources (feedstocks) that are certified to be blended with conventional jet fuel. The chemical and physical characteristics of SAF are almost identical to fossil-based jet fuel and it can be safely used interchangeably in the aircraft engines.

There are several types of feedstocks being used to produce SAF, such as agricultural residue, forestry waste, municipal solid waste (MSW) from homes and businesses, industry gases waste, used cooking oil (UCO), sugarcane, algae and, the most advanced invention, power-to-liquid (PtL), which uses water, CO2 and renewable electricity.

Contribution to achieving Net-Zero Carbon in 2050



IATA Strategy Towards Net Zero

Why SAF is so important?

The demand for commercial air travel is expected to rise in the future as the air traffic (RPK) has been forecasted to grow around 3.9% per annum for the next 20 years (Airbus Global Market Forecast: 2021).

However, the air travel services have indirectly had a major impact on the environment. The effect is significant and growing rapidly. According to research, aviation is responsible for around 2% to 3% of all manmade global carbon emissions and the industry could use up to 22% of the global carbon budget by 2050, if no drastic action is taken (ASECU: 2017).

Due to the growing demand in air travel services, the global aviation industry has pledged for carbon-neutral growth by 2020 and net carbon emissions reductions of 50% below 2005 levels by 2050 in order to sustain growth while promoting the measures to counter global warming (CNG: 2020).

Therefore, the transition from using fossil fuel to SAF is essential as it would reduce CO2 emissions by around 80% compared to the current conventional jet fuels (BP: 2021)

Is it safe to use SAF?

Aircrafts that are certified with the current requirements of jet fuel can use SAF. This is because SAF can be up to 50% blended with conventional jet fuel to power any aircraft that has similar specifications (IATA SAF Fact Sheet).

Quick Snapshot on what has been the progress of SAF globally and in Asia

SAF has been gradually introduced to the market via several test flights for the trial period, followed by numerous commercial flights conducted by the airlines with their respective partners in the industry. Following this significant milestone, the frequent usage of SAF at several selected airports in the world is expected to spur the demand for the industry exponentially.

Brief targets set in some countries by various partners from the aviation sector are outlined in the diagram below. These commitments indicate the specific targets and timeframe that have been established, and are good indicators of SAF for future market development.

SAF Progress - Global

Country	Organisation	Target (%)	Timeframe	Date of Declaration
European Union	European Commission (Biofuels Flightpath)	3-4 (2 Mt)	2020	2011
European Union	European Commission (Transport White Paper)	40	2050	2011
Norway	Norwegian Ministry of Climate and Environment	0.5	2020	2018
Germany	Aviation Initiative for Renewable Energy in Germany (AIREG)	10	2025	2011
Nordic Countries	Nordic Initiative for Sustainable Aviation (NISA)	3-4%	2020	2014
Netherland	Bioport Holland	1%	2015	2013
United States	Federal Aviation Administration (FAA)	5%	2018	2006

Source: IATA (2015), IATA SAF Roadmap

SAF Progress – Asia Pacific

Country	Organisation	Target (%)	Timeframe	Date of Declaration
Indonesia	Indonesian Aviation Biofuels and Renewable Energy Task Force (ABRETF)	5%	2025	2014
Australia	Australia Initiative for Sustainable Aviation Fuels (AISAF)	50	2050	2012
Japan	Initiatives for Next-generation Aviation Fuels (INAF)	10	2020*	2014
India	Clean Skies for Tomorrow Community in partnership with WEF & McKinsey	10%	2030	2021
China	Started feasibility study with RSB in 2021	TBA	TBA	2020

Source: ICAO (2022), WEF (2021) & RSB (2020)
**Introduction of Bio Jet Fuel for the 2020 Olympic and Paralympic Games in Tokyo*

SAF History - Key Milestones on the development of SAF

2007
Resolution A36-22

2008
First test flight with aviation biofuel

2009
Approval first alternative fuels for aviation
(Fischer-Tropsch)
ICAO Conference Rio

2010
Resolution A37-19

2011
SUSTAF
First Commercial Flight
Approval of HEFA
(Hydroprocessed Esters And Fatty Acids)

2012
>1500 flights

2013
26 weekly Flights from JFK to AMS
Resolution A38-18
Destination Green

2014
Approval of SIP
(Sugar to Hydrocarbon)
Flying Green (FIFA WC) KLM AMS / AUA AirFrance Lab'line
CAEP
Alternative Fuels Task Force
Fueling Aviation with Green Technology

2015

2016
Regular SAF supply via common hydrant system started at OSL in partnership with Neste, SkyNRG & Air BP
UAL became the first airline to introduce SAF into normal business operations, commencing daily flights from LAX, supplied by AltAir.

2017
73rd IATA AGM – Agreed on resolution to deploy SAF, including calling for constructive government policies, committing to only use fuels which conserve ecological balance and avoid depletion of natural resources
Resolution A39-3

2018

2019
Commercial SAF flights exceed 250,000 and more than 45 airlines gain experience using SAF

2020
Two new technical SAF Certifications approved by ASTM increasing the approved technical pathways for SAF production to seven

2021
MAB operated inaugural flight using SAF from AMS to KUL, in partnership with Petronas and Neste

2022
ReFuelEU mandate – 2% by 2025, 5% by 2030

Source: IATA (2015). (2021) & Neste (2021)

Airlines benefit immensely from the usage of SAF. Unlike conventional jet fuel, SAF is less harmful for the environment, and can even positively impact not only the environment, but also the economy and society as a whole. This section explores the ways in which utilizing SAF results in a net advantage for both airlines and the world at large, especially with regards to the environment, the economy and social factors. Here, the importance of customer demand and regulatory requirements in encouraging airlines to implement SAF are also addressed.

Environmental Benefit

Reduce CO2 emissions

Reduce CO2 emissions by around 80%

- As climate change poses a significant threat to the economic, social and environmental well-being, deployment of SAF is inherently a strategy to reduce greenhouse gas (GHG) emissions as they emit less emissions during the entire life cycle, compared to the current jet fuel.

- Aside from that, SAF could also improve local air quality and promote cleaner skies with less open air burning from agricultural residues.

Case Study of India

- Approximately 90% of CO2 emissions come from open-air burning, making them a substantial contributor to air pollution across the country.
- With new opportunities in SAF feedstock supply chain, local farmers can enjoy better incentives when selling their agricultural residues, instead of burning them.
- In fact, a major reduction in open air burning does not just eliminate air pollution in the country, but also helps to reduce economic cost associated to health risks (acute respiratory infection) by around $357m annually.

Reduce CO2 emissions

CORSIA Requirements

- Aims to stabilise net CO2 emissions from international civil aviation at 2020 level.

- Participation in CORSIA will commence on a voluntary basis with a pilot phase (2021 – 2023) and first phase (2024 – 2026). The second phase will run from 2027 to 2035, will apply to all countries that have an individual share in the international aviation activity of above 0.5%.

- Airlines can comply with CORSIA through several measures, including utilising SAF at a commercial scale in fulfilling one of CORSIA requirements, ensuring the fuel burn has lower CO2 emissions.

Airlines Obligations

- Ensuring the supply of SAF is critical to airlines in meeting their CORSIA requirements by 2027.
- The requirement for carbon neutral growth from 2020 onwards will be increasingly challenging as the aviation sector is expected to grow at a rate of 3.5% annually.
- Hence, this could lead to the demand for increasing volumes of SAF in the market as part of the measures to achieve the emissions reduction targets.

Source: Deploying SAF at Scale in India (2021) & UK SAF Roadmap (2020)

Economic Benefit

Country

Utilise land that is unviable for food crops, but is suitable for SAF feedstock growth (mostly developing countries)

- SAF is able to assist some countries that have large amounts of marginal or unviable land for food crops, but are suitable for producing SAF crops or other sources of feedstock, such as municipal waste.
- Many of these countries are developing nations that may substantially benefit from a new sector, such as SAF production, without jeopardizing their capability to produce food locally.

Project Solaris (South Africa)

- A joint effort between Boeing and South African Airways.
- Focus to produce SAF using nicotine-free tobacco, while allowing local farmers with specialised skills to continue production of tobacco without it being used for smoking

Country

SAF could increase a country's GDP and FDI through intensive investment (CapEx)

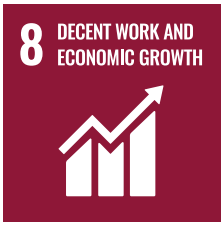
- For a country to transition towards SAF, it would require a huge effort to build new infrastructure and technological capabilities, such as production pathways, processing and blending facilities well as other essential infrastructure required at the distribution point.
- This effort would require extensive amounts of investment from the private and public sectors to ensure SAF's supply chain, infrastructure and production are well-developed in a sustainable approach.
- The capital invested by local and foreign investors into the domestic market will eventually spur the local economy to a large extent.

Case study of India

- By 2030, the aggregate GDP of India for SAF industry would be around $2.8b annually.

Case study of United Kingdom

- Development of domestic industry for SAF production could generate around £2.7b of total Gross Value Added (GVA) to the country (£742m annually) by 2035.



Source: Deploying SAF at Scale in India (2021) & UK SAF Roadmap (2020)

Economic Benefit

Airlines

SAF could potentially offer a solution to the price fluctuations related to fuel cost volatility that the aviation industry is facing

- The airline industry's single largest operational cost is often jet fuel.
- Long-term planning and budgeting for operational expenditures is extremely difficult due to the fluctuating price of crude oil.
- SAF could be a solution to this problem since its production can be distributed over the globe, across several different feedstocks, minimizing airlines' exposure to the fuel price volatility that comes with having a single energy source.

Russia-Ukraine Crisis

- Global oil prices have been volatile and impacted due to the conflict.
- In February 2022, the price of crude oil has jumped more than 30% a barrel, the highest level since 2008.
- The invasion has added new price pressures as the various sanctions towards Russia would impact global oil supplies.

7 AFFORDABLE AND CLEAN ENERGY

Source: Deploying SAF at Scale in India (2021) & UK SAF Roadmap (2020)

Social Benefit

Job Creation

Stimulate job creation in green economy

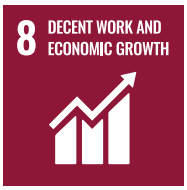
- Generally, a new industry would stimulate job creation in the local community.
- Several case studies outlined that most production (refinery) facilities are often developed close to the feedstock sources, generating additional employment and economic activity. India is a good example of this.
- In addition, this industry also provides an opportunity for exporting talent with specific expertise and skillset in the sustainable biofuel production to another continent.
- Apart from that, the SAF industry also has the potential to provide guaranteed additional income for the local farmers when they sell their agricultural residues.

Case Study of United Kingdom

- Producing 1 million tons of SAF by 2035 will create around 13,600 jobs (both for domestic workforce and exports), of which 5,200 jobs would be at 14 operational plants across the country.

Case Study of India

- More than 120,000 jobs could be created across the supply chain especially in R&D and logistics operations in achieving 360,000 tons of SAF production annually by 2030.
- Indian farmers will receive around 10-15% additional incomes from SAF industry by selling their agricultural biomass for energy production.



Source: Deploying SAF at Scale in India (2021) & UK SAF Roadmap (2020)

Social Benefit

Improve Waste Management

Catalyst for efficient waste management

- Reducing landfills could help the environment, especially when it comes to the leaching of waste into groundwater.
- The SAF ecosystem could enhance efficiency in waste collection by improving the segregation of municipal solid waste (MSW) management in the local community.
- With better segregation, major cities, especially in developing countries, could potentially reduce the amount of waste that ends up in the landfills.

Case study of India

- As huge dumping grounds reach maximum capacity, landfill space constraints are rising in Delhi.
- By improving the segregation of MSW, Delhi could reduce the amount of waste release to the landfills significantly.
- Additionally, better segregation also promotes circular economy as it helps each metropolis earn an extra income of $7-9m annually by selling their landfill waste products to another industry.

Source: Deploying SAF at Scale in India (2021) & UK SAF Roadmap (2020)

Why SAF Is Important to Airlines

The aviation industry generates around 3% of total CO2 emissions and 12% of total transport emissions globally. According to recent studies, the total impact on global warming could be two to four times larger due to additional non-CO2 emissions and overall radiative forcing mechanisms (WEF: 2021).

Due to this issue, global airlines have started to take several measures to address these issues, including meeting several demands in the current market.

1. Customer Demand

Leisure Travelers

Based on a global travelers survey report shared by Shell, around 85% of leisure travelers have stated their willingness to pay for offsetting their emissions.

However, the awareness level for this group is still low. More effective communications from global airlines will probably be required to encourage the passengers to participate in supporting the decarbonisation efforts.

One of the ways to motivate the passengers to play their part in supporting carbon reduction is through offering some attractive rewards, such as loyalty points, express check-in, priority boarding, seat upgrades and complimentary meals on board.

Source: Decarbonisation Aviation by Shell (2021)

Corporate Travelers

Cargo Customers

Corporate flyers such as financial intuitions, consultancies and cargo customers are more likely to be the largest group in contributing to lower-emission travel.

This is due to their net-zero goals at corporate level that require emission reduction from every staff travel and transporting goods.

Furthermore, air travel accounts for such a small fraction of their expenses, hence many of these consumers are less price sensitive than leisure travelers.

According to a report produced by Shell, around 30% of Fortune 100 corporations have signed up to the Science Based Target initiatives (SBTi) which requires companies to set goals that align with the Paris Agreement.

These commitments can play a significant role in stimulating demand for SAF as companies face pressure from employees, investors, customers and other stakeholders to achieve the net-zero emissions.

Source: Air Cargo News; Business Traveller; Company Websites (2021); Green Air; Science-Based Targets (2021); Deloitte analysis
Notes: More than 29% of the Fortune 100 companies have climate change commitments. The analysis above includes only those who pledged to the SBTi.

Why SAF Is Important to Airlines

Examples of aviation-related commitments of large corporates

- **Microsoft** partnered with Alaska Airlines and KLM to cover CO2 emissions of its employee commercial travel with SAF and/or SAF credits.
- **Deloitte** entered SAF agreements with America Delta and United - avoiding the emission from approximately 5,000 Mt of CO2.
- **Amazon Air** purchased about 23 million litres of SAF and expectes to reduce emissions by up to 20%.
- **FedEx** has committed to purchasing 13 million litres of SAF from Red Rock Biofuel as a part of its long-term net-zero strategy.
- **Shell and America Express GBT** formed and alliance to help increase supply of SAF in order to become net zero by 2050.

Source: Air Cargo News; Business Traveller; Company Websites (2021); Green Air; Science-Based Targets (2021); Deloitte analysis
Notes: More than 29% of the Fortune 100 companies have climate change commitments. The analysis above includes only those who pledged to the SBTi.

2. Regulatory Requirements

1. Japan Sets SAF Target for Airlines by 2030

Airlines would need to replace **10%** of their fossil jet fuel with SAF by next decade. This move is part of the Japanese government's efforts to reduce the aviation industry's carbon emissions.

2. US Sustainable Skies Act

- The legislation would establish a blender's tax credit for SAF, which will spur the production of SAF and help the U.S. airline industry reach its goal of eliminating net carbon emissions by 2050 while also supporting jobs and energy security.
- The Sustainable Skies Act calls for a performance-based $1.50 – $2 per gallon blender's tax credit for SAF, which will encourage producers to make more SAF and enable U.S. airlines to use more of it.

3. ReFuelEU Aviation Initiative (EU Legislation in Progress)

- In 2021, the European Climate Law was adopted, setting into law the EU target for 2030 of reducing greenhouse gas (GHG) emissions by at least 55% compared with 1990's levels, in line with priorities set out in the EU Green Deal.
- The package includes a proposal to ensure a level playing field for sustainable air transport, also known as the **ReFuelEU Aviation initiative.**

EU Fit for 55

ReFuelEU

Total shares in fuel mix	2025	2030	2035	2040	2045	2050
Percentage of SAF used in air transport:	2%	5%	20%	32%	38%	63%
Of which: sub-mandate Synthetic fuels (or e-fuels):	-	0.7%	5%	8%	11%	28%

- **Boosting SAF uptake in air transport**
  Obligations on fuel suppliers to blend an increasingly high level of SAF into existing jet fuel uploaded at EU airports, including a minimum share of synthetic fuel. This is to help increase the uptake of SAF by airlines.
- **All flights from EU airports to use SAF**
  Every flight departing from EU airports will carry a minimum amount of SAF by 2025.
- **To avoid fuel tankering**
  There will also be an obligation on all airlines (EU and non-EU) departing from EU airports to uplift the jet fuel necessary prior to departure. This is done to avoid additional emissions from the extra weight of aircrafts carrying excessive amounts of fuel.

Source: Fit for 55 and ReFuelEU Aviation by EASA (2022), Nikkei Asia (2022) & IATA (2022)

Utilizing SAF poses some vital challenges to airlines. The implementation of SAF among airlines is not a common practice yet because this type of fuel is not made widely available, owing to the need for substantial investment in the necessary technology to produce SAF. Crucially, a lack of funding causes production costs to remain high, which culminates in the cost of SAF remaining exorbitantly expensive for airlines to purchase. This makes conventional jet fuel a more cost-effective fuel for airlines, thus negatively affecting the demand for SAF. Government intervention is therefore essential in allowing airlines to implement SAF. Nevertheless, a lack of awareness and knowledge regarding SAF and sustainable policies in general causes nations to be unsupportive towards the aviation industry's growing propensity to use SAF and practice sustainability as a whole. In this section, these challenges are expounded upon, along with solutions proposed to encourage the aviation industry's move towards SAF.

Major challenges to scaled SAF deployment

1 **Low availability of SAF due to high Investment and technology maturation** - High CapEx and front-loaded investments required, mostly in areas of technology that are not widely used.

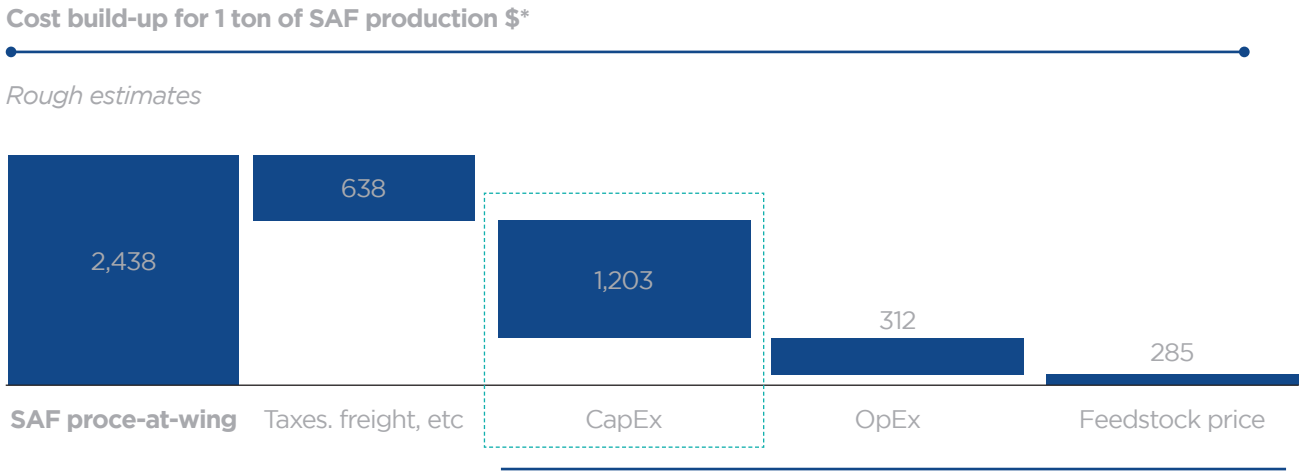


Figure 1: Cost for 1 ton SAF production

*Model assumes a GAS-FT pathway using agricultural residue feedstock

Source: WEF, McKinsey & Clean Skies for Tomorrow (2021) and Roland Berger Report on SAF (2020)

The global SAF supply chain is currently facing a "chicken and egg" issue with supply and demand. However, the extensive support needed for technology and infrastructure development makes it far from being a reality.

For SAF production to become prevalent, the production cost must come down significantly. This means extensive capital investments are required to scale up the entire SAF production in order to meet the economies of scale.

According to the report produced by Clean Skies for Tomorrow, McKinsey and WEF , the study revealed that CapEx contributes the highest cost for 1 ton production of SAF.

Generally, SAF's CapEx constitutes of refinery (processing & blending facilities), production pathways (technology) and potential infrastructure at the distribution point (storage or new fuel hydrant, etc.).

Major challenges to scaled SAF deployment

2 **Cost Differential** - SAF price is 3 - 8 times higher than conventional jet fuel. This is due to its high production cost, which directly impacts the level of demand in the market.

The price difference between SAF and fossil-based jet fuel remains prohibitively high. It is the current fundamental obstacle preventing the production and use of SAF from taking off.

Figure 2 explains that SAF production cost in the market currently is 3 - 8 times greater than the normal fossil-based jet fuel. The production cost of SAF is heavily dependant on the technology or production pathways used to produce neat SAF.

Indicative SAF Costs by Production Pathway

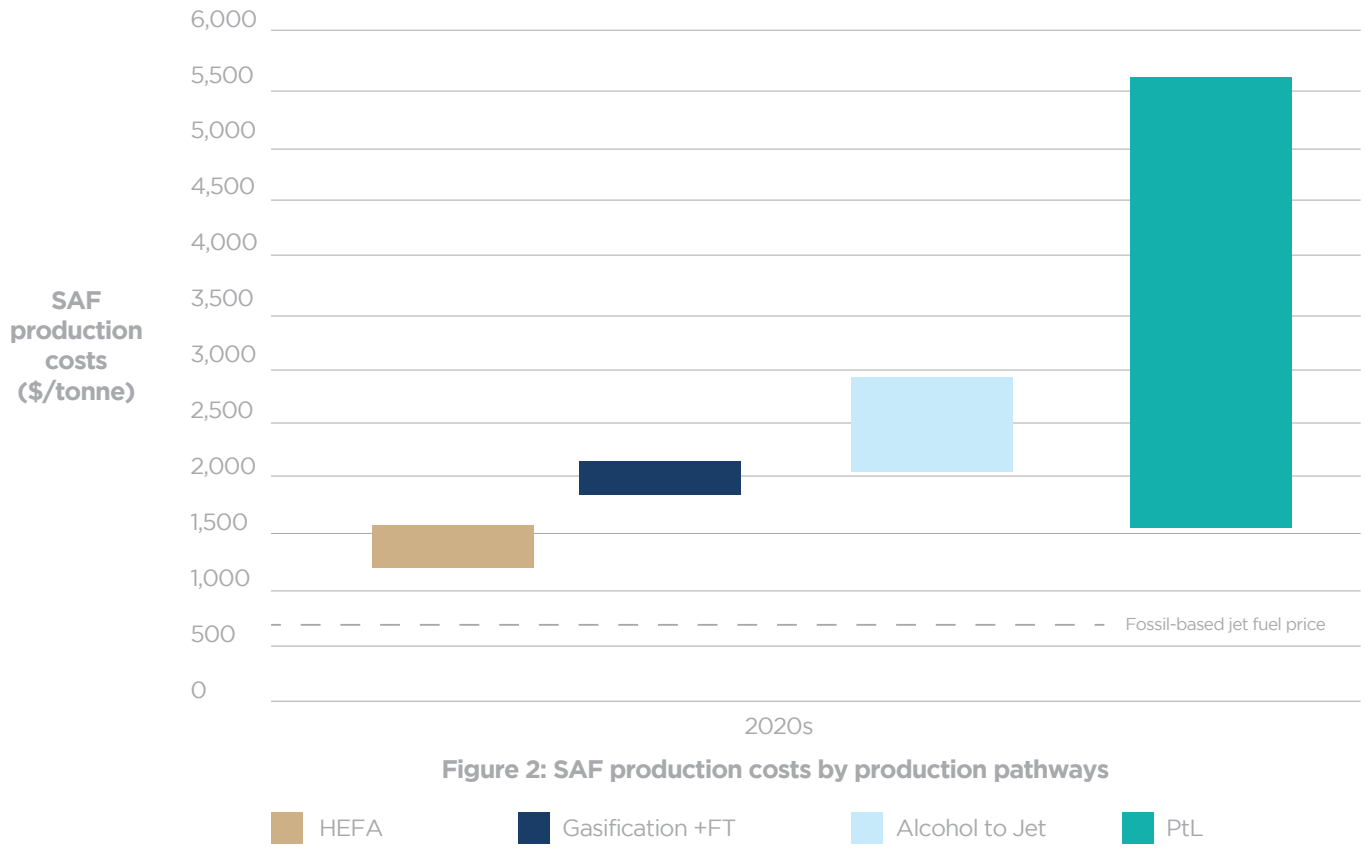


Figure 2: SAF production costs by production pathways

Government support such as tax exemptions, subsidies (for SAF development projects) and SAF blending mandate (at national level) are essential in order to bridge this cost differential, drive demand as well as establishing greater certainty for potential investors.

Source: WEF, Clean Skies for Tomorrow: Sustainable Aviation Fuel as a Pathway to Net-Zero Aviation (2021)

Major challenges to scaled SAF deployment

3 **Lack of Policies to Support SAF Take-up** - Some governments have taken steps to cushion the cost impact and to create a level playing field amongst airlines.

The existing policy landscape does not sufficiently incentivize and de-risk SAF investment. It is indeed critical for governments to develop a long-term, strategic policy framework that provides greater confidence for investors and producers in the SAF value chain, allowing them to increase production volumes of SAF.

The best policies, on the other hand, are likely to differ for each nation based on its geographic, economic, social and political characteristics.

Some countries are currently refining their strategies and policies to support the production and use of SAF as part of the effort to deliver their respective net-zero emissions target.

Some countries have made significant measures to mitigate the cost impact as well as to create a level playing field for airlines. This was done through establishing policies that support and incentivize the deployment of SAF as illustrated in Figure 3.

Source: WEF (2021) & Exxon Mobil (2022)

Financial Support (for investments and use)	**Mandates** (To drive volume)
Grants for SAF development projects	1-5% gradual blending mandate for 2022-2030
Green Fuels Green Skies (GFGS) grant for SAF production projects	RefuelEU mandate – 2% by 2025, 5% by 2030
Subsidies for developmental projects	SAF blend 0.5% mandate started in 2020. Considering a 30% target for 2030
Tax exemptions for Biofuel producers who purchase feedstock from local farmers	The use of aviation biofuel has been mandated at the national level in 2013

Figure 3

This section will expand upon the requirements needed to develop and produce SAF, focusing on the following aspects: technological pathways, feedstocks and their feasibility, necessary investment and infrastructure, as well as partnerships, support and collaboration. These factors make it possible for airlines to transition to using SAF.

SAF Requirements – Technological & Production Pathways

1

There are several SAF technological production pathways approved through American Society for Testing Materials (ASTM) and the standard regulating the technical certification of neat SAF in commercial aviation is ASTM D7566.

	 HEFA	 Alcohol-to-jet	 Gasification		 Power-to-liquid
Description	Feedstocks deoxygenated and hydroprocessed to produce a pure hydrocarbon fuel blending component	Utilizes dehydration, oligomerization, and hydro processing to convert alcohol feed stocks to a pure hydrocarbon fuel blending component	Feedstock gasified into a syngas comprised of hydrogen and carbon monoxide. Syngas is catalytically converted to a liquid hydrocarbon fuel blending component in the FT reactor. FT synthesized kerosene with aromatics and a synthetic fuel containing aromatics is produced (FTSPK/A)		Comprising synthetically produced liquid hydrocarbon fuels. CO2, water and renewable energy are the key sources in PtL production.
Opportunity description	Safe, proven and scalable technology	_____	Potential in the mid-term. However, it has significant techno-economical uncertainty.	_____	Proof of concept 2025+, primarily where cheap high-volume electricity is available
Technology maturity	Mature	_____	Commercial pilot	_____	In development
Feedstock	Waste and residue lipids, purposely grown oil energy plants. Transportable and with existing supply chains. Potential to cover 5% - 10% of total jet fuel demand.	_____	Agricultural and forestry residues, municipal solid waste, purposely grown cellulosic energy crops. High availability of cheap feedstock but fragmented collection.	_____	CO2 and green electricity. Unlimited potential via direct air capture.Point source capture as bridging technology.
Infrastructure required	Feedstock refinery Fossil refinery	Ethanol Distilleries Fossil refinery	_____	Biomass Refinery (Biomass Gasifier) Fossil refinery	Solar panel Wind turbine/farm Electrolysis plant (electrolyzer) Synthetic refinery facility
%LCA GHG reduction vs. fossil jet	73% - 84%	_____	85% - 94%	_____	99%

Source: WEF (2020) Sustainable Aviation Fuels as a path a way to Net-Zero Aviation report, IATA on Sustainable Aviation Fuel: Technical Certification & Airbus on Power-to-Liquid, explained (2021)

Figure 4

Feedstocks collected

The feedstocks will be processed at refinery facility to produce neat SAF.

Fossil fuel will be blended with neat SAF at the blending facility to produce SAF.

After SAF blending process is complete, the final SAF product will be transported for distribution.

SAF Requirements - Feedstocks

2

One of the main sources to develop and produce SAF is the **feedstocks.** Feedstock is defined as a renewable substance or resource that could be burned directly or turned into another type of fuel or energy product. Based on the study conducted by IATA, it revealed that the largest cost item for SAF production comes from the feedstocks.

Feedstocks

Several category of feedstocks that could be used to produce SAF:

Feedstock Type	Feedstock Category	Feedstock
1st Gen / crop based	Edible oil crops	Palm Soybean Other (sunflower, canola)
	Edible sugars	Sugar cane Maize
Advanced and waste	Waste & residue lipids	UCO, animal waste, corn oil, fish oil etc
	Purposely grown energy plant	Jatropha, pongamia, Camelina, carinata, Miscanthus, switchgrass
	Agriculture residues	Rice straw Sugar cane bagasse Other (corn stover, cereal residues)
	Forestry residues	-
	Wood processing waste	-
	Municipal solid waste	-
Recycle carbon	Reusable plastic waste	-
	Industrial waste gas	• CO2 from point source capture • Other (e.g. flue gas from steel production)
Non-biomass biased	CO2 from direct air capture (DAC) – Power To Liquid Process	-

Figure 5

Source: World Economic Forum (2020), Clean Skies for Tomorrow: Sustainable Aviation Fuels as a Pathway to Net-Zero Aviation

Technological Pathways

Figure 6 shows the seven technology pathways that can produce drop-in SAFs:

Technology	Maximum Blend (%v/v)	Feedstock
FT & FT – SKA	50	Wastes (MSW, etc.) Coal, Gas, Sawdust
HEFA	50	Vegetable Oils: Palm, Camelina, Jatropha, Used Cooking Oil.
HH-SPK or HC-HEFA	10	Oils produced from (Botryococcus Braunii) Algae
Synthesized Iso-Paraffin	10	Sugarcane, Sugar Beet
ATJ (Isobutanol and Ethanol)	50	Straw,Sugarcane, Sugar Beet, Sawdust, Lignocellulosic, Residues(Straw)
Catalytic Hydrothermolysis Jet Fuel(CHJ)	50	Waste Oils or Energy Oils

Figure 6

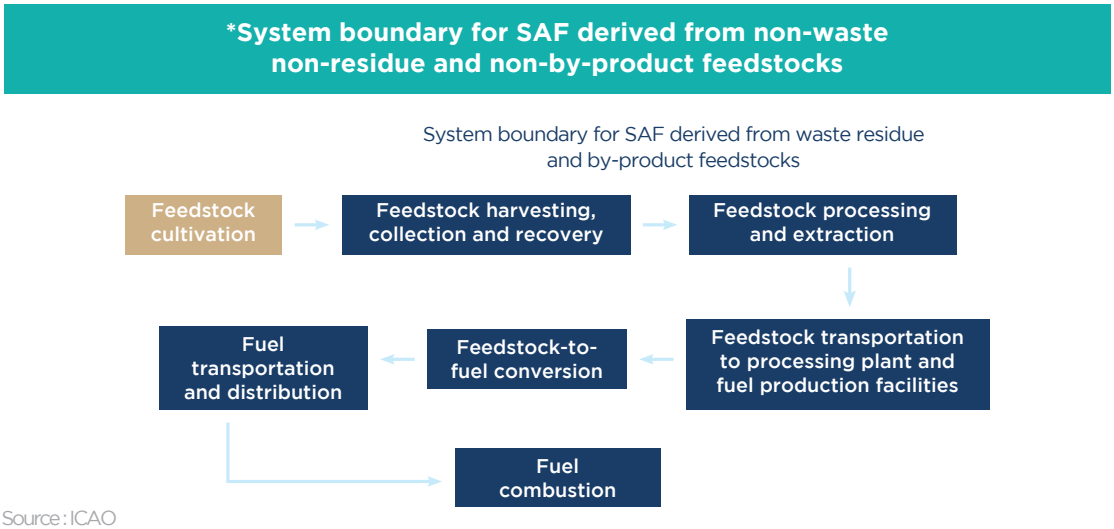
Source: IATA on Sustainable Aviation Fuel: Technical Certification

However, the availability of different feedstocks varies substantially, depending on the region and climate. For this reason, future production of the feedstocks depends on the development of the agricultural system. In other words, proper plantation, cultivation, and harvesting plans are required to ensure long-term supply of the feedstock is sustainable for SAF production.

SAF Requirements – Feedstock Feasibility

3

Not all feedstocks are created equal, and each feedstock provides different carbon reduction benefits based on its LCA (Life Cycle Assessment) of emissions. Each of the feedstocks will result in varying net carbon reduction figures in its usage. Producing an LCA figure includes considerations from the birth of the feedstock (land use considerations), harvesting, processing, transportation, and conversion processes. This makes LCA a major consideration for future feedstock selection to be compared against the financial feasibility of its cultivation.



Source : ICAO

Figure 7 : Example of steps in that fall into consideration of producing an LCA figure for each feedstock

Figure 8 : Definition of how emissions are being classified

Source: ICAO

LCA impacts both Well-to-tank and Tank-to-wake emissions. Each may have different emission rates.

Airlines tend to focus on Tank-to-wake emissions, as this constitutes as scope 1 emissions.

The Well-to-tank figure is defined as indirect (supply chain) emission. Hence, it is logged in scope 3 per carbon accounting.

SAF Requirements – Feedstock Feasibility

4

The chart below shows differing Well-to-wake (WtWa) GHG emissions in gram CO2 equivalent, per Megajoule of Renewable Jet Fuel (MJ RJF). This implies how effective the feedstock and process will be in producing the net CO2 outcome after burn.

FUEL	Direct emissions (gCO,e/MJ)	ILUC emissions (gCO,e/MJ)	Carobon Intensity (gCO,e/MJ)	GHG savings (%)	Reference
Soy oil HEFA	27.9 to 34.9	150.0	177.6 to 184.9	N/A	GREET, 2019;Valin at ai, 2015
Palm oil HEFA	30.5 to 36.5	231.0	216.8 to 267.5	N/A	GREET, 2019;Valin at ai, 2015
Palm fatty acid distillate (PFAD) HEFA	19.4	213.0	232.4	N/A	Sebe'et al, 2014;Malins, 2017
Used cooking oil (UCO) HEFA	19.4	–	19.4	78%	Sebe'et al, 2014
Municipal solid waste (MSW) FT-SPK	14.8	–	14.8	83%	CARD, 2015
Agricultural residue FT-SPK	6.3	–	6.3	93%	GREET, 2018
Energy crop FT-SPK	117	-12.0	-0.3	100%	GREET, 2018; Valin et al, 2015
Power-to-liquids (solar) FT-SPK	1.0	12.52	13.5	84%	Schmidt et al, 2016; Searle & Christensen, 2018
Corn grain alcohol-to-jet (ATJ-SPK)	65.0	4.0	13.5	11%	GREET, 2018; Valin et al, 2015
Sugarcane alcohol-to-jet (ATJ-SPK)	48.11	17.0	65.1	27%	Staples et al, 2014; Valin et el, 2015
Agricultural residue alcohol-to-jet (ATJ-SPK)	14.9	-	14.9	83%	GREET, 2018
Energy crop alcohol-to-jet (ATJ-SPK)	20.3	-	20.3	77%	GREET, 2018; Valin et al, 2015
Molasses synthesized isoparaffins (SIP)	47.0	-	47.0	47%	de Jong et al, 2017; Velin et al, 2015

Figure 9

Source : N. Pavlenko, S. Searle, A. Christensen (2019)

Point to note that Palm Oil HEFA is not the most ideal feedstock selection in terms of its GHG savings properties.

The strongest process with the most CO2 emission reduction is through Power-to-liquids (PtL), as this includes the capture of CO2 from the environment in its production.

These considerations are critical when building pricing models, as pricing of SAF will not be equal across the board, but rather it will be dependent on the effectiveness of the SAF in carbon reduction.

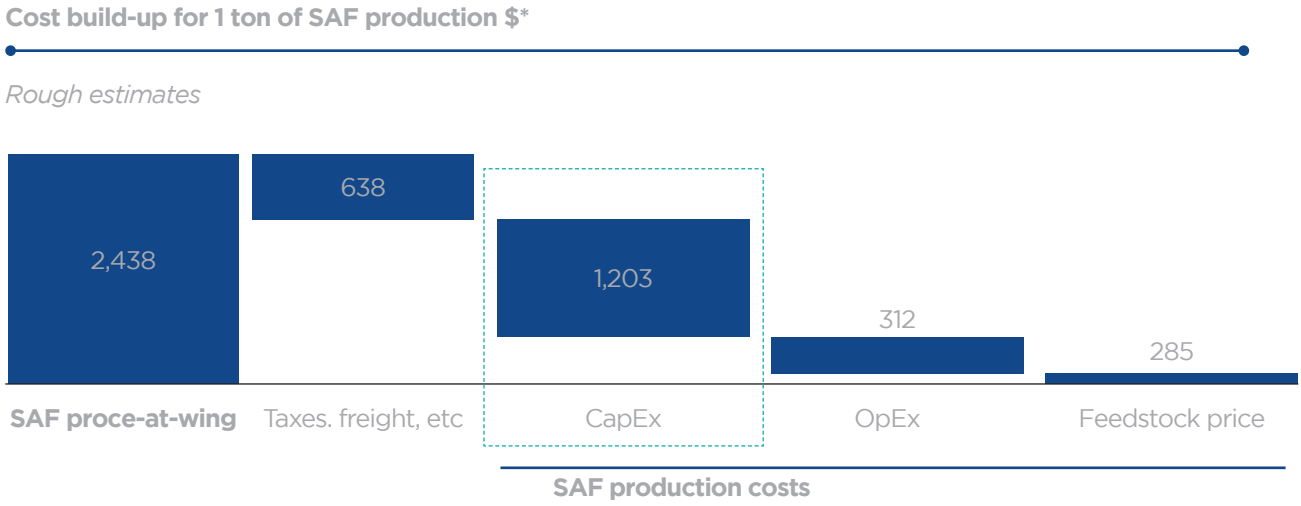
Source : de Jong et al. Biotechnol Biofuels (2017)

SAF Requirements – Investment & Infrastructure

5

Transitioning to cleaner energy would require major investment. This investment is essential to remodel entire processes and ensure the stability of the supply chain as well as the facilities. Experts estimate that total capital investment required is approximately around $170m million per year i.e., $2.5b over a 15-year period for SAF production (WEF 2021). In order to attract this investment, there must be enough clarity about the future demand for SAF in the industry.

Generally, the investment required for SAF production would consist of feedstock cost (raw material), development of processing facilities i.e., refinery & blending terminals (including technology pathways for SAF), logistic and new infrastructure (e.g., SAF hydrant, storage installation at the airport).



*Model assumes a GAS-FT pathway using agricultural residue feedstock

Figure 10

Source: WEF, McKinsey & Clean Skies for Tomorrow (2021) and Roland Berger Report on SAF (2020)

Figure 10 indicate the rough estimation cost for SAF production via Gas-FT pathway using agriculture residue feedstock based on the case study conducted by WEF for India.

The report shows that **49% of the SAF production cost is highly driven from the CapEx** while feedstock price contributes around 12% of the total SAF production cost.

Global SAF production cost for selected feedstocks indicative

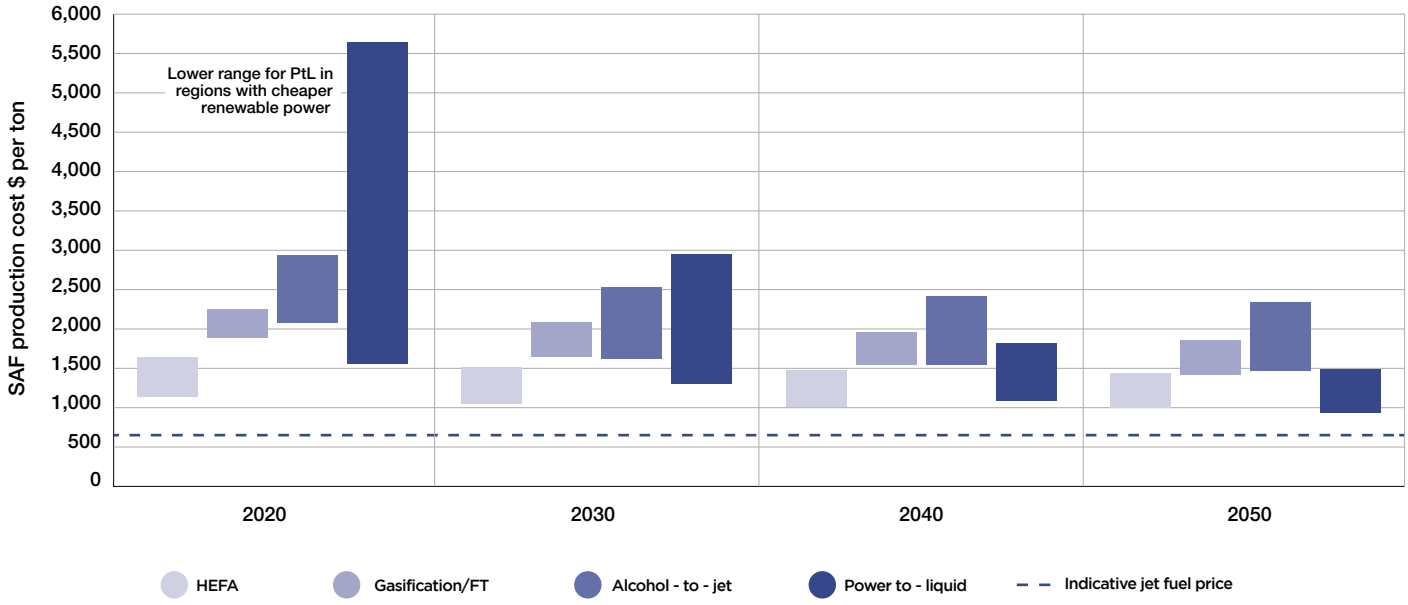


Figure 11

Source: World Economic Forum (2020), Clean Skies for Tomorrow: Sustainable Aviation Fuels as a Pathway to Net-Zero Aviation

Figure 11 illustrates that although SAF is now more expensive than conventional jet fuel, costs could reduce significantly in the next decades as technology advances and the industry reaches economies of scale.

Based on the study conducted by WEF, the market prices for SAF are expected to be higher than fossil jet fuel even until 2050.

In fact, SAF price would be significantly more expensive than traditional jet fuel i.e., approximately 3x as expensive for the current most cost-effective option: HEFA fuels.

However, cost for Power to Liquid (PtL) would be lower in regions with cheaper source of renewable energy.

SAF Requirements – Partnership, Support & Collaboration

6

Due to the high investment required to develop and produce SAF at a commercial scale, more active collaboration in the industry is required to simplify the process that could help reduce SAF production cost, while maintaining the sustainability of the entire supply chain.

Airlines and other key industry players could play an active role in fostering industry collaboration to ramp up SAF production in more cost-effective manners such as:

Partnership

- The Roundtable on Sustainable Biomaterials (RSB) is an international, multi-stakeholder, independent organisation that collaborates with governments, industry experts and NGOs worldwide to develop effective partnerships, and local, regional and global policies that incorporate best-in-class approach to sustainability.
- Partnership with China and Ethiopia in developing their national roadmap for SAF.
- Clean Skies for Tomorrow initiative (CST) is a global, cross-value-chain coalition working to facilitate the transition to net-zero flying by 2050. They aim to achieve this by accelerating the supply and use of SAF technologies to reach 10% of global jet aviation fuel supply by 2030.
- In partnership with ambitious leaders from the industry, government and civil society, this public-private-partnership is collectively advancing the commercial scale of viable SAF production for broad adoption by 2030, through supply, demand, policy, and financial levers.

Production JV

- KLM, SkyNRG and SHV Energy collaborated to develop the first dedicated European plant for SAF that will specialise in producing SAF, bioLPG, and naphtha, primarily using regional waste and residue streams as feedstock.
- From 2022, the production facility will produce 100,000 tonnes a year, of which KLM is committed to purchase 75,000 tonnes of SAF per annum.

Collaboration

- World's leading producer SAF.
- Currently has an annual capacity of 100,000 tons of SAF.
- Able to produce around 1.5 million tonnes of SAF annually by the end of 2023.

- SkyNRG sources, blends, and distributes SAF throughout the supply chain to over 30 airlines across the globe.
- Its operations are certified by RSB, the highest possible certification standard for SAF.

Direct Supply Contract

Delta's commitment to create a sustainable future continues with its long-term offtake agreement with GEVO, under which Delta will purchase 10 million gallons per year of advanced renewable biofuels.

SAF is expected to be available between 2022-2023.

In addition, Delta also invested $2 million in Northwest Advanced Bio-fuels, LLC for the feasibility study of a facility to produce SAF and other biofuel products.

Support (National)

Imposed 1-5% gradual blending mandate for 2022-2030.

RefuelEU mandate – 2% by 2025, 5% by 2030

- Grants for SAF development projects.
- Direct tax incentives to scale up domestic production of SAF.

Progress on Global SAF

1 **United States**
Announced a dedicated SAF tax credit in 2021 that will help cut costs and rapidly scale domestic production of SAF.

2 **American Airlines**
Agreed to take delivery of 16 million gallons of Aemetis SAF annually over a seven-year period, beginning in 2024.

3 **Delta Airlines**
Purchases more than $1 billion of SAF in 10-year contract with Aemetis.

4 **Brazil**
Provides low interest loans and tax exemptions for SAF production at a commercial scale.

5 **KLM**
Conducted world's first commercial flight using blended biofuel in 2011.

6 **United Kingdom**
Rewards SAF production with the same economic incentives given to road vehicles.

7 **Norway**
SAF blend 0.5% mandate started in 2020. Considering a 30% target for 2030.

8 **Frances**
Imposed a SAF mandate on the aviation industry effective January 2022, which implements 1% blending mandate for all flights departing from France.

9 **Lufthansa**
Started to use biofuel produced from Jatropha as early as 2011 and currently exploring PtL.

10 **Qatar Airways**
Qatar Airways has pledged to use 10% SAF by 2030.

11 **Emirates**
To conduct test flight using 100% SAF by end 2022.

12 **Ethiopia**
Developed a national sustainable aviation biofuel roadmap in partnership with Roundtable on Sustainable Biomaterials (RSB) in 2021.

13 **South Africa**
Established SAF sustainability policy advocacy and development of local SAF sector (sugarcane) with support of RSB.

14 **Russia**
To perform the first flight on locally produced SAF by 2024.

15 **China**
Initiated feasibility study in 2021 with RSB to develop national SAF roadmap.

16 **India**
SAF roadmap established in 2021 in collaboration with McKinsey, WEF and Clean Skies for tomorrow (CST).

17 **Singapore**
CAAS, Temasek and SIA agreed for ExxonMobil to supply SAF for all SIA and Scoot flights from Changi Airport starting Q3 '22.

18 **Indonesia**
The use of aviation biofuel has been mandated at the national level by Ministry of Energy and Mineral Resources in 2013.

19 **Japan**
SAF Roadmap successfully produced in 2015, reviewed six materials including microalgae and municipal waste as part of the primary feedstocks.

20 **Qantas**
In 2019, Qantas Group pledged $50 million for the development of SAF in Australia over the next 10 years.

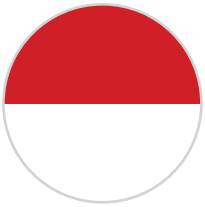
Source: Official Websites

National Initiatives in supporting SAF uptake – Focus Country

- In 2016 under the Oslo Initiative, Avinor Oslo Bioport became the world`s first hub to make aviation biofuel available to airlines on a commercial basis.
- The deployment of SAF at Oslo Airport was in partnership with SkyNRG and AirBP.
- To date, 1.25 million litres of aviation biofuel has been sold to three airlines: Lufthansa Group, SAS and KLM.

- Initiatives for Next-generation Aviation Fuels (INAF) formed in 2014 to develop a supply chain of next-generation aviation fuels in Japan.
- The initiative started in partnership with several key stakeholders, namely: ANA, JAL, NCA, Boeing Japan, Narita Airport, Japan Petroleum Exploration and University of Tokyo Center for Aviation Innovation Research.
- INAF's SAF Roadmap was successfully produced in 2015, reviewed six materials including microalgae and municipal waste as part of the primary feedstocks.

- Australian Initiative for Sustainable Aviation Fuels (AISAF) founded in 2012 to assist on the development and implementation of commercial supply chains for SAF in Australia.
- The initiative was in partnership with The United States Studies Centre at the University of Sydney.
- The focus of AISAF was to support the development of SAF in Australia and collaborate with key partners in the United States and other countries.



- Indonesia's Aviation Biofuels and Renewable Energy Task Force (ABRETF) was established as one of the supporting elements in executing Indonesia's National Action Plan to reduce GHG emission from the aviation sector.
- ABRETF aims to reduce these emissions through utilization of sustainable alternative fuels and renewable energy. The mid-term goal is to reinforce Indonesian utilization of aviation biofuel by 2018.
- According to Ministry of Energy and Mineral Resources Decree No. 25 Year 2013, the use of aviation biofuel has been mandated at the national level.

- The Civil Aviation Authority of Singapore (CAAS), Singapore-headquartered global investment company Temasek and Singapore Airlines (SIA) have selected ExxonMobil to supply and deliver SAF for all SIA and Scoot flights from Changi Airport starting third quarter 2022.
- Under this initiative, SIA, with support from CAAS and Temasek, will use ExxonMobil's blended SAF that will comprise of 1.25 million litres of neat SAF, supplied by Neste and produced from used cooking oil and waste animal fats, and blended with refined jet fuel at ExxonMobil's facilities in Singapore.
- This blended fuel will be delivered to Changi Airport via the existing fuel hydrant system at the airport.

Source: ICAO (2015) & CAAS (2022)

Progress on SAF by Other Airlines - Focus Airlines

- Conducted world's first commercial flight using blended biofuel in 2011.
- In 2021, KLM further expands their effort to stimulate SAF demand in the market by adding 0.5% SAF for all flights departing from Amsterdam.
- In addition to the SAF option, KLM also offers CO2ZERO service to all passengers i.e. an option (voluntary) to purchase an additional quantity of SAF during the booking. KLM plans to spend the full amount raised from the CO2ZERO service to purchase SAF in order to increase global SAF production.

- Lufthansa started to use biofuel produced from Jatropha as early as 2011.
- The first airlines to establish a platform for passengers to compensate their CO2 emissions from their flights by allowing passengers to replace fossil fuels with alternative fuel via "COMPENSAID".
- Currently Lufthansa Group is conducting research to explore electricity-based fuel, known as Power to Liquid ("PtL"), which is produced using water, electricity (from renewable sources/ energies) and CO2.
- The Group plans for its first aircraft to take off using this latest technology in the next few years as part of the carbon neutral travel.

- In 2019, Qantas Group pledged $50 million on the development of SAF in Australia over the next ten years.
- Announced strategic partnership with BP in 2021 to work towards net-zero goals in aviation sector by 2050 and collaborate on the development of SAF in Australia.
- Qantas purchased 10 million litres of SAF in Jan 2022 with BP (ongoing basis for regular scheduled services) for all Qantas flights departing from London Heathrow Airport. Blended SAF would represent around 15% of Qantas annual fuel purchased out of London and it would reduce emissions up to 10% on this route

- With support from Civil Aviation Authority of Singapore (CAAS) and Singapore-headquartered global investment company Temasek, SIA will start using SAF made from used cooking oil and animal fats as part of its effort to reduce global carbon emissions.
- This blended fuel will be supplied by ExxonMobil and Neste for a one-year pilot programme starting from third quarter of 2022.
- The product will comprise 1.25 million litres of undiluted or unmixed sustainable fuel supplied by Finnish biofuel producer and oil refiner Neste, which will produce the fuel at its refinery in Porvoo, Finland.
- The use of greener aviation fuels is expected to reduce about 2,500 tonnes of carbon dioxide emissions over the one-year pilot scheme.

Source: ICAO (2015) & CAAS (2022)

Policy Options to Support and Push Forward SAF Development in the Market

1. Government Grand/ Funding

US Government launched its Sustainable Aviation Fuel Grand Challenge in 2021, which includes several initiatives, including $61 million to fund projects aimed at scaling up SAF production up to 3 billion gallons per year by 2030.

UK Green Fuels, Green Skies (GFGS) competition awarded £15 million in grant to 8 winning companies for the development of SAF production plants in the UK.

2. Subsidies

In Netherlands provides subsidies via CfD scheme for the techniques use for the development of renewable energy or other CO2 reducing approaches. The programme offers a subsidy intensity limit varying from 60 - 300 /tonne of CO2 avoided for a period of 12 -15 years.

3. Low Interest Loans

Renovabio Programme provides low-interest loans of up to BRL100 million to biofuel producers. Total payment term will be up to 96 months including a grace period of 24 months is granted and interest rates are linked to CO2 emissions reduction targets set by the programme.

4. Tax Exemptions/ Incentives

Brazil's National Biodiesel Production and Use Programme provides tax incentives for biodiesel producers who purchase feedstocks from family farmers. The minimum purchase percentages for eligibility vary from 20% to 40% according to the region's socio-economic status.

5. SAF Blending Mandate

French government has imposed a SAF mandate in the aviation industry, effective January 2022. It implements 1% blending mandate for all flights departing from France. It is expected to increase to 2% in 2025 and 5% by 2030.

6. Direct Tax Incentives

US Government announced a dedicated SAF tax credit as part of its Build Back Better Agenda in 2021. This credit will help cut costs and rapidly scale domestic production of SAF.

Source: WEF (2021) & Exxon Mobil (2022)

Policies and Key Drivers that Enable SAF Development in the Market

Industry Body

The International Civil Aviation Organization (ICAO) and its members in 2016 have committed to address carbon emissions in the aviation sector. They aim to achieve this by voluntarily adopting the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) under Annex 16, with the goal of achieving carbon-neutral growth from 2021 by using offsetting programmes.

This development is quite substantial as aviation became the first transport sector to establish a decarbonization plan. Numerous industry players have actively participated towards net-zero carbon emissions by 2050 since the announcement. Airlines are required to report their CO2 emissions on an annual basis and mandatory reporting will commence from 2027, with exemptions for: small islands, least developed countries, land-locked developing countries and states which have less than 0.5% of air traffic (although they can still volunteer).

Although CORSIA allows its industry members to reduce their carbon obligations using SAF, more comprehensive and solid policies from governments would be required to drive SAF implementation at the national level.

Industrial Alliance

oneworld is the first global airline alliance to commit to net-zero emissions by 2050.

In 2021, the alliance and its member airlines also pledged to play an active role towards finding global pathways for SAF technologies with the target of 10% SAF use across the alliance by 2030.

oneworld's commitment on SAF would further support the industry to explore future solutions to solve the climate challenge, while maintaining the positive impacts aviation has for the global society through SAF.

SAF Collective Group

The Sustainable Aviation Fuel Users Group (SAFUG) was established in September 2008 and aims to accelerate the development as well as commercialisation of SAF. The group comprises of 25 airline members (representing 33% of commercial aviation fuel demand) and 5 key players in the aviation industry, namely: Boeing, Airbus, Embraer, fuel industry (UOP) and supply (ASA). SAFUG has also received support and advice from leading environmental organizations, such as the Natural Resources Defense Council and the World Wildlife Fund (WWF).

All participating members are part of Roundtable of Sustainable Biofuels (RSB) and have committed on Sustainability Pledge of SAF minimum requirements :

1. SAF feedstocks should be produced from non-competitive food sources that will minimize biodiversity impacts
2. Total lifecycle of GHG from the feedstocks (plant sources) should be significantly reduced compared to the fossil fuels
3. Development of SAF should provide social and economic benefits to the local community, especially in the developing countries
4. Areas of high conservation value and native eco-systems should not be transformed to SAF production facilities

Source: ICAO

Looking Ahead – Proposed Action Plan

The road to decarbonizing the aviation industry requires a collective effort from the public and private sectors. While the industry is progressing towards more advanced aircraft technologies (such as hydrogen-powered aircrafts), SAF will still remain as the main avenue to achieve net-zero emission target by 2050. In order to achieve this result, drastic actions are required to initiate the right policy and strategy framework to support global SAF production in a commercially meaningful way.

What is required to kickstart SAF globally and industry?

- More robust coordination at an international level.
- More coordinated and recognized policy and framework to foster SAF development and implementation.
- Provide incentives for airlines to use SAF from an early stage.
- De-risk public and private investments in SAF.
- Establish coalitions encompassing all parts of the supply chain.
- Encourage stakeholders to commit to robust international sustainability criteria.
- Advocate research and development (R&D) into new feedstock sources and refining processes.

Figure 12

The state of Sustainable Aviation Fuel (SAF) in 2021

360,000 flights	**100 million litres per annum**	**36 countries with SAF policies**
2016: 500 flights 2025: 1 million flights	2016: 8 million litres 2025: ~5 billion litres	2016: 2 countires 2025: global agreement?
7 technical pathways	**70% average CO2 reduction**	**$13 billion in forward purchase**
2016: 4 pathways 2025: 11 pathways	2016: ~60% reduction 2025: ~80% reduction	2016: $2.5 billion 2025: >$30 billion

Source: IATA 2025 estimates

What are the opportunities that we expect to see take place globally and in Malaysia:

- Government support in establishing appropriate policy mechanisms to allow SAF industry to scale up and deliver the economy of scale benefits.
- National SAF Roadmap & Taskforce – Developing SAF is a long journey that requires the establishment of specific consultative multistakeholder processes in order to align towards the same goal with clear direction, guidance and purpose.
- Availability of sustainable feedstock (preferably local) – ensuring an adequate supply of sustainable feedstock for the local market: algae, UCO, MSW, etc.
- Major investments in refinery facilities and technology pathways – Strategic investment from both public and private sectors.
- Competitive SAF price – to ensure the cost is competitive in order to compete with the current fossil jet fuel. Efficient supply chain framework – the effective configurations of supply chains is key for deploying SAF in a more sustainable way.
- Customer demand – more education to create awareness for both leisure and business travellers.

The ability to scale up the SAF to accomplish sectoral decarbonization by 2050 will be determined by the robustness of a policy, strategy and supporting legislation from global governments. As the SAF journey begins, all stakeholders must act promptly to make the 2050 Net-Zero vision a reality to pave the way for cleaner skies.

Looking Ahead - R&D Roadmap (Macro Level)

Currently, R&D is being pursued around the world to demonstrate new feedstock sources and processing technologies with the aim of reducing fuel costs and broadening the range of supply chain opportunities. Diagram below briefly explains the high-level R&D roadmap for SAF from 2025 - 2050.

	Short-Term 2025 - 2030	**Medium -Term 2030 - 2040**	**Long -Term 2040 - 2050**
Aircraft Type	Conventional Aircraft	Conventional Aircraft	Hydrogen Powered Aircraft (Operational readiness)
Feedstock	Algae Used Cooking Oil (UCO) Municipal Solid Waste (MSW) Palm Oil	CCUS / Hydrogen	Pure Hydrogen
Technology Pathways	FT/HEFA	Power to Liquid (PtL)	• Aircraft feasibility study • Infrastructure investments • Development green hydrogen production
Priorities	• Must be affordable • Highly available	• Further optimization of costs (based on infrastructure investments). • Still SAF, i.e., no infrastructure / technology change required at airport and aircraft.	• To explore how to secure cheap and affordable hydrogen. • To ensure infrastructure is ready to support the network, including diversion points.

Figure 13

Feedstocks: Aspects to Consider for the Immediate Future (2025-2030)

	Algae	Used Cooking Oil (UCO)	Municipal Solid Waste (MSW)	*Palm Oil
Current Investor	• Mitsubishi Corp • Next Gen Oil (Boustead Plantation) • Petronas	• FatHopes	• Cenviro	• Sime Darby Plantation • Bousted Plantation
Pros	• Cultivation of microalgae is more productive than traditional crops. • Produce large quantities of oil per hectare. CO2 from flue gas and nutrients from wastewater can be used for the algae production. • Algae can be grown in locations that are unsuitable for agriculture and seawater.	• It is proven and certified (ASTM) conversion technology (HEFA) with hundreds of flights undertaken. • Positive regulatory framework for waste collection. • Can use existing refinery tech. Generate full circular economy.	• Large volume of feedstock at low cost. No known sustainability issue. • Can promote more integrated and sustainable waste management solution. • Generate full circular economy. • Improve health and environmental outcomes. • Large amount of feedstock all-year round.	• High availability of the feedstock in Malaysia and Indonesia. • High oil yield. • Job creation and provides source of income for local economy (reducing poverty in developing countries).
Cons	High cost for mass production/cultivation via development of biorefinery technologies.	• Possible competing uses for oil. • Volumes limited in long term.	• Some waste could be potentially toxic. • Unregulated waste trade mechanism in some developing countries could contribute to illegal waste disposal.	• Sustainability concerns in some countries, i.e., United States and EU regulations. • Contribute to deforestation, habitat destruction (for local tribes and endanger species) air pollution, health concern and climate change.

** Subject to regulatory approval and compliance*

Figure 14

Potential SAF Action in Malaysia: 2022-2025

2022 - 2023

- Establishment of National Task Force under MITI (NAICO) – policies to support rollout of SAF.
- Feedstock assessment.
- Industry partnership – modelling of feedstock costs, expected SAF costs.
- SAF requirement sizing (2022 - 2025, 2025 - 2030).
- SAF voluntary contribution scheme.

2024

- Target for policy roll out by government, potentially in phases.
- Initial offtake agreement (2025 requirements and onwards, typically a 3 - 5 year commitment range).
- Feedstock investment assessment + partnership.

2025

- Scheduled flight use of SAF.
- Funding scheme available by relevant sectors of the supply chain, fuel suppliers & private/public feedstock producers.

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