FINANCING

Sustainable Aviation in the EMEA Region

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MUFG Bank Ltd
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Contents

Introduction

Original equipment manufacturers (OEMs) and airlines are currently facing increased pressure from politicians, investors and more importantly, the general public to improve their CO_2 footprint. Decarbonization is a major challenge for the aviation sector given the size of the machinery in operation, the need for energy dense fuels and slow incremental changes in technology. Currently, this sector emits more than 900 million tonnes of CO_2 a year (over 1% of global emissions), and if nothing is done to change this, it is predicted this will double by 2050.

The International Air Transport Association (IATA) recognizes that the aviation industry has global challenges that must be addressed to tackle climate change and has adopted a set of ambitious targets to reduce CO_2 emissions from air transportation:

- Fuel efficiency – Average improvement of 1.5% per year from 2009 to 2020
- Carbon-neutral growth - Cap on net aviation CO_2 emissions from 2020
- Reduction in net aviation CO_2 emissions of 50% by 2050, relative to 2005 levels

In order to achieve these targets, IATA has proposed four pillars to the key stakeholders in the industry:

1. Improved technology, including Sustainable Aviation Fuels (SAF)
2. More efficient aircraft operations (fuel efficiency and design)
3. Infrastructure improvements, including modernized air traffic management systems
4. A single global market-based measure, to fill the remaining emissions gap

The industry is on track for the short-term fuel efficiency goal, and the International Civil Aviation Organization (ICAO) has put in place the CORSIA system (Carbon Offset and Reduction Scheme for International Aviation) to achieve the mid-term carbon-neutral growth goal.

Within the EU, net zero CO_2 reduction from all flights within and departing from the EU can be achieved by 2050 through joint, coordinated and decisive industry and government efforts. The European aviation industry is committed to reaching this target and to contribute to the goals set in the European Green Deal and the Paris Agreement.

In recent years, an impressive number of technological solutions contributing to the 2050 goal have been proposed and many related projects have been initiated. These consist of numerous aircraft (airframe and engine) technologies as well as sustainable aviation fuels, operational and infrastructural measures. We believe only through fundamentally new technology of aircraft and engines can aviation achieve a long-term sustainable reduction in emissions output and, as such, this should be the primary focus for the aviation industry in terms of achieving a true green footprint.

In order to encourage and incentivize green financing in aviation, an approach following the Transition Pathway Initiative ("TPI") is being pursued by some selective airlines and lessors. This approach builds the foundation for aviation entering the green financing space.

Aircraft and Engine Design

New aircraft and engine technology that can make a contribution to CO_2 reduction is distinguished by the time factor of its availability on the market. In many studies a distinction is made between upcoming technology and future technology:

Upcoming Technology

Upcoming technology is currently available in the marketplace or is estimated to enter service in the next few years, but has not fully materialized yet in airlines' fleets. Upcoming technology commonly enters the market through a major upgrade of an already existing aircraft type. Such major upgrades typically involve major changes to the airframe and engines.

Some examples of recent new technology introductions would be the B787 series "Dreamliner" with a carbon composite frame and a fuel saving of almost 20% compared to older replacement aircraft, the A220 which is a single-aisle aircraft that sits between the short and medium range category and is extremely fuel efficient and the upcoming A321 XLR which has longer range than other A321 but also over 20% fuel saving per seat.

Category (Baseline Fleet)	Year 2016 Materiality	Upgrade route	Start-year	Number of years for full phase-out	Improvement Opportunity
Regional Jets	2.39%	A220, E195-E2	2016	20	20%
A320	20.72%	A320neo	2016	25	20%
737 NG	11.17%	737 MAX	2017	25	14%
757	2.38%	A321LR, A321XLR	2016	15	30%
A330	5.53%	A330neo	2019	15	14%
767	4.35%	787	2016	10	20%
Large Twin Aisle	23.27%	A350, 777-X	2016	24	25%
747-400	9.53%	787, 777-X, A350	2016	8	30%
A380	11.34%	A350, 777-X	2017	36	15%
Turboprops	1.63%	N/A	N/A	N/A	0%
Other (787, A350, miscellaneous, legacy)	7.69%	N/A	N/a	N/A	0%

Table 1 Fuel Efficiency Improvements (Sustainable Aviation - Decarbonization Roadmap, 2020)

These upcoming technologies can be found on the latest generation aircraft or the generation aircraft that will enter service in the next one to five years. In the short term, replacing the older generation aircraft by aircraft of the latest generation is the quickest way to reduce the CO_2 footprint of the aviation sector.

Future Technology

Future technology can be described as technology that will be available in aircraft that are still to be developed. Generally, it is estimated that this technology will be available after 2030. Overall it is expect that these new technologies can bring 30% improvement in the fuel efficiency and improvement in the CO_2 emissions compared to today's aircraft.

These new technologies can be divided into:

Evolutionary aircraft technologies

Continuous progress is being achieved in all areas of evolutionary technologies, namely aerodynamics, materials and structures, propulsion and aircraft equipment systems. Some examples of technologies which have recently made noticeable progress are: natural and hybrid laminar flow control, new high-bypass engine architectures as well as aircraft systems such as electric landing gear drives and fuel cells for onboard power generation. By applying combinations of evolutionary technologies, fuel efficiency improvements of roughly 25% to 30% compared to today's aircraft is deemed possible. However, further improvements of the tube-and-wing configuration powered by turbofans are becoming more and more difficult to conceive after 2035.

Revolutionary aircraft technologies

In the longer term towards 2050, radically new aircraft configurations will be required to reduce fuel burn and carbon intensity significantly. The novel airframe configurations that are currently seen as most promising are:

The Blended Wing Body (BWB) design
Also known as the Hybrid Wing Body (HWB), this design is mainly a large flying wing, which contains a payload area (passenger cabin or cargo storage area) within its center section. The shape of the center body and the outer wings are smoothly blended. Its aerodynamic shape allows generating lift by the entire aircraft, which is thus significantly higher than for conventional tube-and-wing configurations. While for a long time blended wing bodies were thought to be a solution optimized for very large aircraft of several hundred seats, it has recently become realistic to design small blended wing bodies of 100 to 200 seats.

Figure 1 Blended Wing (IATA, 2020)

The Strut-Braced Wing (SBW) design
This concept utilizes a structural wing support to allow for larger wing spans without increasing structural weight. By increasing the span, the induced drag is reduced and therefore less thrust is needed, which allows installing smaller and lighter and more fuel efficient engines.

Figure 2 Strut-braced wing (IATA, 2020)

The Double-Bubble fuselage design
This design consists of a fuselage that can be thought of as consisting of two blended side-by-side tubes. The wide flattened fuselage body generates additional lift. Therefore, the wings can be designed smaller and lighter to carry the aircraft weight, which leads to a significant fuel burn reduction.

The Box-Wing aircraft design
The box-wing configuration connects the tips of the two offset horizontal wings. For a given lift and wingspan, this configuration assures minimum induced drag and offers savings in fuel consumption compared to conventional aircraft.

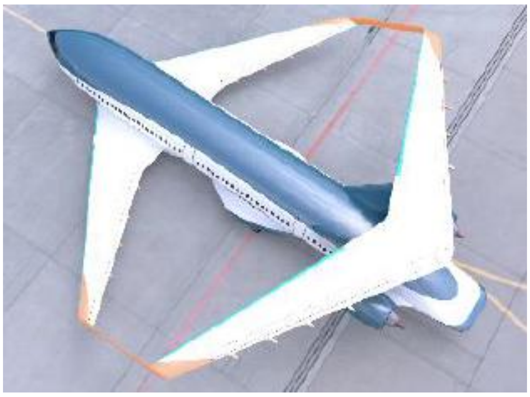

Figure 3 Box-Wing (IATA, 2020)

Alongside aircraft design, new propulsion technology will also make a significant contribution to improve the fuel efficiency and lower the emissions of future aircraft. The most promising propulsion technologies are:

- **Open Rotors.** The open rotor is a fuel-saving engine-architecture that is a hybrid between a propeller and a turbofan engine, characterized by two counter-rotating, unshrouded fans. It allows a reduction of fuel burn and CO_2 emissions of typically 30% compared to conventional turbofan engines.

- **Boundary Layer Ingestion.** This concept is a method to reduce the propulsion power consumption of an aero engine. The basic idea is to use an inflow with the lowest velocity possible for thrust generation to minimize the required propulsion power for the necessary thrust. It is a technique in which an air pump is used to extract the boundary layer at the wing or the inlet of an aircraft. Improving the air flow can reduce drag. Improvements in fuel efficiency have been estimated as high as 30%.

- **Electric aircraft propulsion**. This is when electricity is used as a clean propulsive energy for aircraft. Due to their large weight per unit of stored energy, batteries as primary energy storage for aircraft propulsion place limitations on the size and range of fully battery-powered aircraft. Various categories of hybrid-electric aircraft propulsion exist as well, which use liquid fuel as a primary energy source. They benefit from the high energy efficiency of electric motors and use batteries as an additional energy source for peak loads. While today about 65% of electricity generation comes from fossil sources and produces significant amounts of CO_2, it is likely that the share of renewable electricity will increase noticeably in the next decades, thanks to governments' and industries' current investments in clean energy.

In the appendix a timeline of expected future fuel efficiency improvements compare to predecessor aircraft or engine of the same category is shown.

Sustainable Aviation Fuels

Alongside new aircraft and engine technology, the replacement of the currently used kerosene (fossil fuel based aviation fuel) with sustainable aviation fuels (SAF) can help to reduce the carbon emissions of aircraft. It is expected that SAFs can produce typically up to 80% lower CO_2 emissions on a lifecycle basis than conventional (fossil) jet fuel. Currently, a variety of pathways from biogenic sources are certified for aviation use, and more are under development, including non-biogenic fuels such as Power-to-liquid.

SAF types can be distinguished by:

- **Drop-In Fuels**

  Drop-in fuels are a synthetic and completely interchangeable substitute for conventional kerosene. Drop-in fuels have very similar physical and chemical properties to conventional jet fuel and can be blended with it over a wide percentage range. The use of drop-in fuels does not require an adaption of the engine, the aircraft fuel system or the current fuel distribution network.

- **Non-Drop-in Fuels**

  Non drop-in fuels are not completely interchangeable with the conventional kerosene, used for today's aviation engines. The use of non-drop-in fuels require the development and introduction of a new type of engine like the electrical engine or an engine powered by hydrogen.

All SAF types considered today are drop-in fuels. The main obstacle to wide implementation of SAF is not technical, but economic, as SAF is not yet produced at competitive cost compared to conventional jet fuel.

Sustainable aviation fuels (SAFs) have a major potential in reducing the climate impact of the aviation industry as the net CO_2 emissions over the life-cycle can currently be reduced up to 80% and in the future up to 100%. Especially in the short term, using sustainable drop-in fuels presents a major opportunity to achieve in-sector emission reductions while using the existing fleet.

Development of the SAF market can lead to regional business opportunities, job creation and might position the European Union as a frontrunner in this upcoming industry. Despite the many benefits, major challenges remain for a successful deployment of SAF. Stringent sustainability criteria should form the basis of the policy framework and the industry actions.

The development and the application of these criteria are essential for airlines, fuel producers, states and international organisations like ICAO. These criteria aim to achieve carbon reductions combined with positive socio-economic impact while avoiding competition with food and feed supply and negative ecological impacts such as deforestation. The main economic barriers are related to the higher cost compared to kerosene and the investment risks associated with a new market, and this continues to be the biggest bottleneck in producing SAF besides the low quantities being produced at the moment. As such, government support via subsidies in development and production of SAF will become crucial. If this can be achieved SAF will have by far the biggest impact on emissions reduction before new green technology aircraft can be produced en masse.

Aviation Infrastructure

Building on the efforts on the asset side (aircraft and engine technology), airlines all over the world have been pushing key aviation stakeholders towards more efficient operations. The main objectives have been to increase asset productivity and to reduce operating costs, which in turn should reduce CO_2 emissions. Aviation operations are subject to a high number of requirements on the regulatory and safety side, along with weather, logistical and capacity constraints throughout the system which increase the difficulty of implementing efficiency measures and managing them effectively.

For air passenger and cargo transportation, there are two types of operations that generate most of the emissions in the industry: ground operations and flight operations.

Below are a number of examples of how some of the key stakeholders in the industry are starting to reduce the environmental impact of aircraft operations.

Ground operations

At the gate:

- *Auxiliary Power Units (APU)* - While passengers are boarding or disembarking, the aircraft requires electricity and hydraulic pressure for heating / air conditioning, lighting, and cockpit or belly activities. This energy can be generated by the aircraft itself via the operation of an Auxiliary Power Unit (APU) which burns fuel from the tanks. A more environmentally friendly way of powering the aircraft is via electricity provided by the airport. If this electricity is provided via renewable sources then this is a method of reducing CO_2 emissions for the stationary aircraft.

- *Electric Tugs* - Once all passengers are on board the aircraft it pushes-back from the gate. In most cases this means the aircraft needs to move backwards, and since aircraft and engines are not designed to move in that direction, the aircraft needs a source of power. This comes normally in the shape of a tug (a heavy truck vehicle which uses diesel fuel and is capable of pushing aircraft which have a weight of up to 575 tons). For a typical narrow-body aircraft, there are companies which offer an electrical vehicle which is attached to the wheel-system and can turn the wheels without needing an external diesel-burning tug truck.

Taxiing:

- *Single Engine use* - In the past aircraft used both engines when taxiing. In recent years, airlines started using only one engine, which means that at least during the initial movement phase - while the aircraft is moving from the gate towards the runway, it will use only one engine. By doing this, fuel consumption can be reduced by a few hundred litres of kerosene per aircraft per day's utilization.

Flight operations

Most of the fuel consumption of an aircraft occurs when it is in the air. As aircraft engines need to operate at or close to maximum rates (i.e. during take-off), there has been a lot of focus from all stakeholders (airlines, crews, traffic control, manufacturers, regulators) on how to make these operations more environmentally friendly.

- *Ascent and Descent* - Due to airspace around airports being very crowded, each aircraft receives strict indications from air traffic control as to what altitude and speed they need to maintain. This is typically done by levels, i.e. on a descent path, an aircraft will be instructed to go from 15,000 feet down to 12,000 feet and then maintain its flight at that altitude over a certain period. This is done in order to create separation between aircraft in front or behind. However, this is inefficient from a fuel perspective, since aircraft can naturally glide without much need to engage engines. Air traffic control and airlines have partnered on several occasions to test operations with a natural-glide type of descent.

- *Air Traffic Control* - In different parts of the world, governments have agreed on measures to increase efficiency in air transportation systems, specifically in airspace and traffic management. In Europe, this is called the EU Single European Sky, and in the US is called the Next Generation Air Transportation System.

In Europe, SESAR was established in 2004 as the mechanism which coordinates and concentrates all EU research and development (R&D) activities in Air Traffic Management. Airspace in Europe is currently managed by 63 air traffic control centres, and flights crossing borders or different airspace sectors have to adjust their trajectory or speed to avoid conflicts with other aircraft. The inefficiencies today are caused largely by en-route control centres sharing information in a sequential way and updating the trajectory information, which results in non-fuel efficient requirements for aircraft whilst in the air, due to inefficient or longer than needed flight plans.

In 2020, SESAR tested a solution on ground-to-ground interoperability, which is designed to allow the network of those 63 European en-route control centres to exchange information on the flight trajectories in real time. With this enhancement, Air Traffic Management can react better and faster to operational requirements, e.g. changes in flight level requested by the aircraft in order to avoid storms, or route changes requested also by the aircraft in order to shorten the route.

This should improve efficiency of air traffic control and deliver less fuel burn due to changes of altitude or route in flight, less flight time due to improved flow between control centres, and eventually less idle time for aircraft (waiting for air traffic control permissions either on the ground or in the air), offering cost savings to airlines and reductions in CO_2 emissions. Air traffic management has an impact on how far, high, fast and efficiently aircraft can fly. For these reasons the system can have a major influence on an aircraft's fuel burn. According to the Intergovernmental Panel on Climate Change (IPCC), fuel burn could be reduced by 6-12% through improvements in air traffic management.

Aviation Green Financing

In the last decade or so, the aviation industry has come under increased pressure to decarbonise, not only by governmental bodies, but also by international organisations and consumers themselves (e.g. "flight shaming" that started in Scandinavia). As such, airlines have been taking steps for a number of years to become more environmentally friendly. While most of the environmental impact any airline has depends on the aircraft and engine technology available to them, airlines have recently focused as well on their ground operations, in-flight service or flight route planning to minimise their carbon footprint. Similarly, lenders and investors in aviation industry have also become subject to scrutiny from regulatory bodies and shareholders to consider more ESG financing in their lending and investment portfolios.

Aviation until recently was considered a "brown" industry and despite the above mentioned efforts, will not become a true green industry until green technology aircraft and/or engines are being produced. As a result, aviation is not covered yet by the EU taxonomy regime but efforts are under way by the Aviation Working Group to open a door to be included in the EU taxonomy by end of 2021.

However, in the meantime as a means to incentivise the aviation industry to accelerate its efforts to become "greener" lobby groups, third party opinion providers and investor regulatory bodies have formed a view that aviation could follow the Transition Pathway Initiative principles for airlines. These were developed by a project under the leadership of the London School of Economics and the Grantham Institute on Climate Change and define a detailed set of emission reduction targets and KPIs airlines should define in their green frameworks to demonstrate their long term commitment to Sustainability in line with e.g. the Paris Agreement to the UN Framework Convention on Climate Change.

While there have not been many deals done in this segment, we expect more traction in the near term in particular as soon as recovery from COVID pandemic is under way. A recent example of an ESG deal in aviation is the USD 600m sustainability linked Sukuk bond issued by Etihad, the flag carrier of Abu Dhabi, in Nov 2020. The bond was the first ever in the aviation space that has been linked to meeting ESG targets of the airline as follows:

1) a commitment to Net Zero Carbon emissions by 2050;

2) a 50% reduction in net emissions by 2035; and

3) a 20% reduction in emissions intensity in the airline's passenger fleet by 2025.

Etihad's plans to reduce its emissions also include using more fuel-efficient planes and eliminating single-use plastics, both on its flights (i.e. on catering for passengers) as well as on the ground (i.e. in offices and also on crew accommodation).The bond's eligible "use of proceeds" focuses on investment in next-generation aircraft to replace old fleet and research and development into sustainable aviation fuel. Etihad's target is to achieve a single KPI – to reduce

CO_2 emissions intensity in its fleet by 17.8% in CO_2 compared with 2017 levels, and will be tested on December 2024. Failure to meet the targets will trigger a penalty clause linked to purchasing carbon offset credits. The below figure provides an overview of recent green/transition financing deals in aviation:

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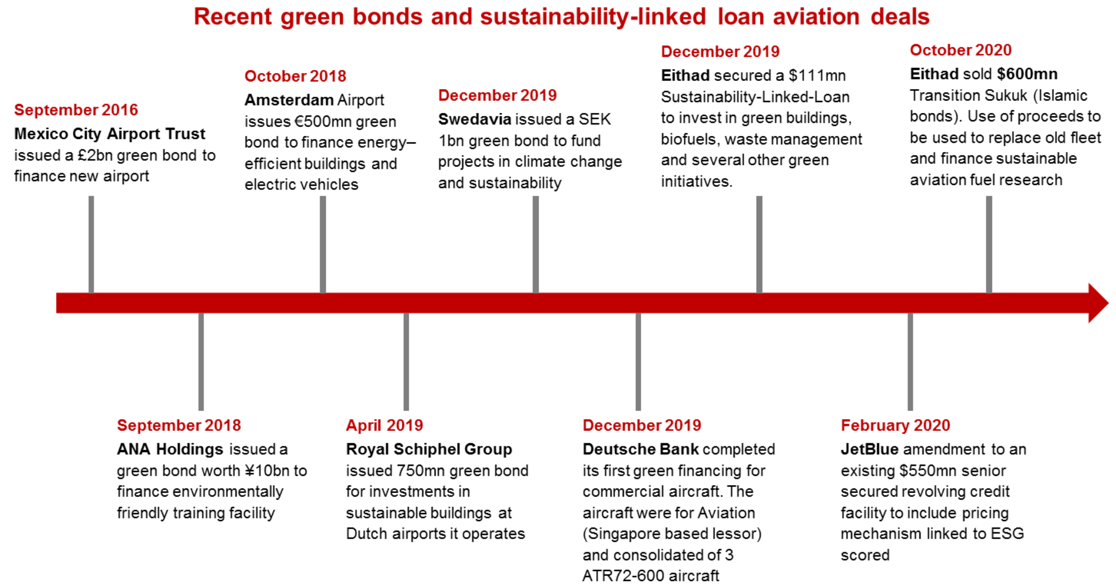

Figure 4 Recent Aviation green bonds and sustainability-linked loans (ICT, The opportunity for green finance in the aviation sector, 2020)

Aviation Green Financing

According to the IEA, aviation's CO_2 emissions have increased dramatically over the last two decades, reaching nearly 1 giga tonne of CO_2 in 2019 or close to 2.8% of global emissions. Since 2000, passenger flight has grown by 5% per year while CO_2 emissions have increased by 2% year on year due to technical and operational improvements. These incremental improvements have served to keep CO_2 emissions growth in check, however in the future with more people flying and more aircraft in operation the annual CO_2 emissions from aviation will need a combination of incremental technological improvements, global co-ordinated policy adjustments and step-changes in technology.

As aviation returns to growth post-COVID, the industry will come under increased scrutiny for its contribution to CO_2 emissions. As ICT notes; "clean aircraft technologies will be key—but not enough" to reduce aviation's CO_2 footprint. Alongside technological developments, airlines will need to start embedding sustainability practices into their business models and governments and policy-makers will also need to take a consistent, coordinated approach to supporting this transition.

We expect that aviation will only become a true green industry once new technology is developed which reduces CO_2 to zero, which is probably 8-10 years away. In the meantime, in particular the development and use of SAF will help aviation transition into becoming a more environmentally sustainable industry. On the financing side, the TPI helps investors and financiers open up to airlines and lessors provided that they follow a clearly defined green framework with measurable emissions reduction KPIs. This can only be seen as the beginning of the financing community venturing into sustainable financing in aviation and more development and commitment is required for this market to grow.

MUFG as an advisor, arranger and lender in the aviation space is well placed to contribute to the transition to a low carbon future. This can be achieved through strategic partnerships and involvement in think tanks, financing newest technology aircraft and supporting lessors and airlines in their transition planning to a net-zero future through the whole value chain of green financing.

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Appendix

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