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AEROSPACE SINGAPORE

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AEROSPACE SINGAPORE

MAY - AUGUST

INSIDE:

Highlights from the inaugural **SINGAPORE AEROSPACE INDUSTRY SOLAR ADOPTION REPORT**

A GREEN RECOVERY

Sustainability for Aviation in a Post-pandemic Landscape


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MESSAGE

PLOTTING A GREEN RECOVERY FOR AVIATION

A few months into the second year of the global pandemic, aviation recovery remains tenuous in the Asia-Pacific (outside of China domestic travel) as compared to Europe and US. Vaccination rates across the region are low (Singapore is an exception), and there is a greater reliance on border closures, quarantines, and lockdowns to control infection. A new wave of infections led by the Delta variant has dampened the optimism experienced at the start of the year.

Against this sombre backdrop, aviation has been plotting its green recovery. Singapore Airlines announced its intention to achieve net zero emissions by 2050, joining a growing movement by the industry. The European aviation industry associations collectively announced in February, a 'Destination 2050' plan for net zero emissions. The EU is also moving towards new legislative proposals for climate neutrality in Europe by the same year, including aviation. These plans are more ambitious than the current International Civil Aviation Organisation (ICAO) target of 50% reduction by 2050, which was set in 2009. However, as aviation growth has outpaced carbon savings in the years since, there is growing public concern over aviation emissions and this target will need revision.

In this issue of Aerospace Singapore, we examine the important subject of aviation sustainability in our feature article. We also publish the findings of our association's inaugural aerospace industry solar adoption report. This presents a consolidated view of progress made by the aerospace industry in Singapore towards implementing solar energy. Solar remains the most promising renewable energy source for Singapore, and a national target has been set of at least 2 gigawatt-peak (GWp) by 2030.

Happy reading. Keep safe and go green!

SIA KHENG YOK / Chief Executive, AAIS

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ROLLS-ROYCE BEGINS TESTING ITS MOST POWERFUL HYBRID-ELECTRIC PROPULSION SYSTEM FOR AIRCRAFT

The tests are part of the company's 2.5-megawatt (MW) Power Generation System 1 (PGS1) demonstrator programme

Equipment being prepared prior to testing at Testbed 108 in Bristol UK. Photo: Rolls-Royce

Rolls-Royce has started testing the first elements of a powerful hybrid-electric power and propulsion system for aircraft at its newly renovated Testbed 108 in Bristol, UK.

The company announced on 3 June 2021 that it had begun testing its AE2100 engine element and specialist controls and thermal management system, supported by a system integration generator. Later this year, a fully operational generator and a 3,000-volt power electronics system, currently completing testing at its facility in Trondheim, Norway, will be brought together to start full PGS1 system testing. The generator can be used either for hybrid-electric propulsion systems or as part of a "more-electric" system for larger aircraft.

Alan Newby, Rolls-Royce's director for aerospace technology and future programmes said, "We know that in a post COVID-19 world people will want to connect but do so more sustainably. Electrification offers a new way to power short-haul aircraft and we want to be at the forefront of pioneering this technology."

Newby explained that the tests would enable Rolls-Royce to validate its digital modelling and find out what is physically and technically possible. The generator, for example, is about the size of a beer keg but would need to produce enough electricity to power around 2,500 homes and do so continuously.

Testbed 108 and PGS1 are supported by the UK Aerospace Technology Institute's MegaFlight project, while the 2.5MW electrical generator, motor and power electronics design, make and testing in Trondheim has received support from the EU Clean Sky 2 programme.

Once ground tested, Rolls-Royce's PGS1 can provide a technology basis for future hybrid aircraft programmes.

PANTA HOLDINGS ACQUIRES FOKKER SERVICES

Panta Holdings, a Dutch strategic investment company, has acquired aviation aftermarket businesses Fokker Services and Fokker Techniek from Fokker Technologies/GKN Aerospace. The acquisition took effect 1 April in a move to expand Panta's aerospace footprint.

Privately owned by investor Jaap Rosen Jacobson, Panta focuses on developing companies that are going through strategic transformation. The company has had prior experience in the aerospace industry. Part of its current investment portfolio is a majority stake (71.2%) in Canadian listed Avcorp Industries Inc, a supplier of airframe components and component repair, and Netherlands Aircraft Co. N.V., a start-up to develop an aircraft based on the Fokker 100 regional jet. Past holdings include several airlines and leading companies including VLM Airlines N.V. that was sold to Air France - KLM in 2008.

Fokker Services is focused on the maintenance, modifications and support of commercial, regional and military aircraft types, while Fokker Techniek handles aircraft conversion, completion and upgrades for VIP and special-mission markets. The companies have global facilities in the Netherlands, Singapore, and the United States. Under the new ownership, they will continue to invest in technology innovations, advanced processes and engineering excellence to serve the aerospace aftermarket.

BOEING 737 MAX 10 COMPLETES ITS FIRST FLIGHT

The largest airplane in Boeing's 737 MAX family begins a comprehensive test programme

The Boeing Company announced on 18 June 2021, that its 737-10 aircraft – the largest of Boeing's 737 MAX family – had successfully completed its maiden flight. The aircraft took off from Renton, Washington, and completed a roughly 2.5-hour flight over Washington State before landing at Boeing Field in Seattle at 12:38pm.

The first flight of the MAX 737-10 aircraft heralds months of testing and safety certification work, before the jet is expected to enter service in 2023. In a statement to the media, Boeing noted that it "will work closely with regulators to certify the airplane".

Boeing had carried out design and training changes on the MAX family following two fatal crashes of a smaller 737 MAX version which grounded the model for nearly two years. Operations of the MAX resumed in the US in December 2020.

The 737-10 can carry up to 230 passengers and has a range of 3,300 nautical miles (6,100 km). According to Boeing, the aircraft incorporates environmental improvements, cutting carbon emissions by 14% and reducing noise by 50% compared to today's Next-Generation 737s.

The 737-10 landing at Boeing Field in Seattle. Photo: Boeing

"Our team is committed to delivering an airplane with the highest quality and reliability," said Stan Deal, president and CEO of Boeing Commercial Airplanes.

FRENCH COMPANIES TO STUDY USE OF 100% SAF ON SINGLE-AISLE AIRCRAFT AND HELICOPTERS

Airbus, Safran, Dassault Aviation, ONERA and the French Ministry of Transport have announced in June 2021, a joint in-flight study to analyse the compatibility of unblended Sustainable Aviation Fuel (SAF) with single-aisle aircraft and commercial aircraft engine and fuel systems, as well as with helicopter engines.

Scheduled to commence at the end of 2021, the project, known as VOLCAN (VOL avec Carburants Alternatifs Nouveaux), will mark the first time that in-flight emissions are measured using 100% SAF in a single-aisle aircraft.

The study will support efforts currently underway at Airbus and Safran to prepare for the large-scale deployment and use of SAF, as part of the wider initiative to decarbonise the industry. It will also contribute to the companies' goal of achieving 100% SAF certification in single-aisle commercial aircraft and the new generation of business jets.

The tests will be performed with an Airbus A320neo test aircraft powered by a CFM LEAP-1A engine. Safran will focus on compatibility studies related to the fuel system and engine adaptation for commercial and helicopter aircraft and their optimisation for various types of 100% SAF fuels.

ONERA, the French national laboratory for aeronautics and space, will support Airbus and Safran in analysing the compatibility of the fuel with aircraft systems. Dassault Aviation will contribute to the material and equipment compatibility studies and verify 100% SAF biocontamination susceptibility.

The project has the support of the "Plan de relance aéronautique" (part of the French government's COVID-19 recovery plan), which has committed €1.5bn of public funding to R&D and innovation, particularly for the development of "clean planes" over the next three years.

HONEYWELL DEEPENS ITS REACH INTO THE UAM SEGMENT

The company is continuing to expand upon existing efforts to serve with new partnerships and investments

Honeywell is deepening its reach into the emerging Urban Air Mobility (UAM) market with a slate of recent announcements on new collaborations and investments. In May 2021, Honeywell signed a long-term agreement with global Japanese firm DENSO, establishing an alliance focused on developing electric propulsion units for UAM. The following month, Honeywell announced that it had been selected by German-based Lilium to develop the 7-Seater Lilium Jet's avionics and flight control systems. Beyond providing systems and parts, Honeywell has revealed that it will also be taking stakes in Lilium and Vertical Aerospace in the UK.

Electric propulsion systems for UAM

"As electric propulsion for aircraft takes shape, Honeywell will be at the forefront with partners like DENSO," said Dave Marinick, president, Engines & Power Systems, Honeywell Aerospace. DENSO is the number two global automotive parts manufacturer (behind Bosch). The Japan-based company supplies OEM and aftermarket components and systems for most of the world's carmakers including powertrain systems, vehicle electronics, electrification systems and cockpit systems, as well as automated driving technologies.

Drawing from their automotive and aerospace backgrounds, the companies will develop and manufacture electric propulsion systems for aircraft, with a focus on air taxis and delivery vehicles. DENSO and Honeywell have also revealed that they are in advanced discussions with current and prospective customers and intend to deliver flight test configurations of the electric propulsion systems within the next year.

Bespoke Avionics and Flight Control Technologies

Honeywell, one of the first major aerospace manufacturers to create a dedicated Urban Air Mobility business unit, has also drawn on its experience providing avionics systems for commercial airliners to design a flight control system for UAM. Honeywell will supply its compact fly-by-wire system on the all-electric 7-Seater Lilium Jet. The flight control component will be responsible for controlling its moveable parts, including the 36 control surfaces and ducted fans that provide the UAM vehicle high levels of maneuverability.

Alongside the flight control system, Honeywell will supply its next generation integrated avionics system, which will provide a simplified user interface for the pilot to fly the Lilium Jet. The selection of Honeywell's next-generation UAM avionics system is the result of ongoing collaboration between Lilium and Honeywell to converge on the specific technical requirements suitable for the Lilium Jet. The avionics system is designed to reduce training time and will support operation by a single pilot, freeing up greater passenger capacity.

Photo: Lilium

Stakes in UAM Start-ups

In addition to its selection as a provider of the flight control system for the 7-Seater Lilium Jet, Honeywell has also become an investor in Lilium by participating in the common stock private investment in public equity (PIPE) offering announced in connection with Lilium's SPAC merger with Qell Acquisiton Corp.

In the same vein, Honeywell will also be backing Vertical Aerospace through its subscription to a PIPE offering as the UK start-up merges with US-listed Broadstone Acquisition Corp. Honeywell will also be providing the flightdeck and fly-by-wire system on Vertical Aerospace's VA-X4 eVTOL aircraft.

Both Lilium and Vertical Aerospace expect their aircraft to be ready for commercial operations by 2024.

IATA TRAVEL PASS ROLLED OUT IN SINGAPORE

Travellers arriving in Singapore by air may use the IATA Travel Pass to prove a negative pre-departure COVID-19 PCR test

Since 1 May 2021, passengers arriving by air have been able to use the IATA Travel Pass to share their pre-departure COVID-19 Polymerase Chain Reaction (PCR) test results with their airline during check-in, as well as on-arrival at the immigration checkpoints at Changi Airport.

Photo: IATA

This is part of an ongoing collaboration between the Civil Aviation Authority of Singapore (CAAS) and IATA to facilitate seamless and efficient travel through digital certificates of COVID-19 tests.

The IATA Travel Pass is a personal secure digital wallet solution that can be used by passengers to obtain and store their COVID-19 test results from accredited laboratories.

Following the successful trials by Singapore Airlines in March 2021 on flights between Singapore and London, the Singapore health and border control authorities have accepted the IATA Travel Pass as a valid form of presentation of COVID-19 pre-departure test results for entry into Singapore. The information presented on the IATA Travel Pass is in a format that satisfies Singapore's prevailing COVID-19 pre-departure test requirements for entry into Singapore.

CAAS director-general Kevin Shum said, "This latest collaboration with IATA demonstrates our shared commitment to drive the adoption of digital health certificates and restore international air travel. As we work to safely rebuild the Changi air hub, we will continue to explore other solutions that can provide similarly secure and verifiable means of sharing health certificates for safe international travel."

CAAS and IATA will be working on further enhancements to the IATA Travel Pass. This includes enabling QR code scanning by immigration officers and back-end transmission of health credentials from the IATA Travel Pass to the airlines' and immigration authorities' systems for pre-boarding and pre-arrival clearance, as well as including digital vaccination certificates in the IATA Travel Pass.

"Having the confidence of an aviation leader like Singapore in IATA Travel Pass is hugely significant," said IATA director general Willie Walsh. "The success of our joint efforts will make IATA's partnership with the government of Singapore a model for others to follow."

Travellers to Singapore intending to use the IATA Travel Pass should check with the airline they are travelling with for eligibility to use the IATA Travel Pass.

NEW CONTINENTAL-NTU CORPORATE LABORATORY LAUNCHED TO DRIVE URBAN MOBILITY SOLUTIONS

Singapore's Nanyang Technological University (NTU) and German technology company, Continental, have jointly launched a new $50 million corporate laboratory. The Continental-NTU Corporate Laboratory aims to accelerate innovation in Singapore's automotive industry and translate research outcomes into practical and viable urban mobility solutions for the future.

The lab was officially launched on 9 April 2021 by Minister for Transport Mr Ong Ye Kung. In his welcome remarks at the launch ceremony, NTU President Professor Subra Suresh said, "NTU and Continental will pool their best minds in autonomous robotics, navigation, artificial intelligence (AI), cybersecurity, smart materials, sensing, and communication technologies to develop real-world applications that leverage data and digital technologies."

Over the next five years, the Corporate Lab will work on 16 industry-focused projects under three research thrusts:

- Smart robotics and navigation technologies to enable last mile delivery in an urban environment under different weather conditions;
- AI and software engineering to enhance automotive software development and security testing as well as more human-like interaction tools; and
- Leveraging innovative materials and communication technologies to develop advanced sensors, touch-responsive interfaces, and connectivity solutions to enhance safety and comfort of users.

SCOOT BECOMES WORLD'S FIRST LCC AWARDED DIAMOND STATUS IN GLOBAL AIRLINE HEALTH SAFETY AUDIT

Scoot, the wholly owned low-cost arm of Singapore Airlines, has been awarded the Diamond status in a global health safety audit of airlines, becoming the first low-cost carrier (LCC) in the world to be accorded this highest attainable standard.

The audit was jointly conducted by the Airline Passenger Experience Association (APEX), an international airline association, and aviation strategy firm SimpliFlying. Assessing the health safety measures adopted by Scoot in response to the Covid-19 pandemic against a 58-point checklist across 10 stages of the customer journey, the review spanned check-in and other pre-departure processes, inflight measures as well as postflight.

Only airlines that reach hospital-grade standards of health and safety, scoring at least 200 points above the baseline Gold standard, were awarded the Diamond status. The standards were based on independently verified, validated, and certified airline health safety measures.

"Scoot has raised the bar for health and safety among LCCs by being the first LCC in the world to certify for a Diamond standard. Measures such as vaccinating all front-facing staff, adjusting its onboard services to a contactless one that can be accessed from one's personal devices, and coming up with a 24/7 running Covid-19 risk assessment framework make the airline stand out among others," said SimpliFlying CEO Shashank Nigam. "Taking these above and beyond measures in ensuring health safety will help Scoot bolster trust among travellers," he added.

Scoot has implemented measures ranging from increased cleaning and distancing, contactless check-in and digital pre-departure test verification tools amongst other initiatives. Photo: Scoot

ST ENGINEERING AND TEMASEK SET UP JV FOR FREIGHTER AIRCRAFT LEASING

ST Engineering's wholly-owned aviation asset management unit has signed an agreement with Temasek to set up a 50-50 joint venture (JV) for freighter aircraft leasing. The plan aims to capture growing demand for freighter aircraft as e-commerce and air cargo volumes expand across the globe.

The JV targets to build a portfolio valued at about US$600m (or about S$800m) within five years, investing in passenger aircraft to be converted into highly efficient freighters. ST Engineering will provide the associated maintenance, repair and overhaul services to these aircraft. In addition, ST Engineering will be the asset and lease manager to the JV, consistent with the Group's aviation asset management business model.

The portfolio will primarily comprise narrowbody aircraft that will provide an option to operators to reuse older passenger aircraft by giving them a new lease of life as fuel efficient freighters. On the supply side, the JV expects to purchase passenger aircraft feedstock at lower prices as passenger aircraft value has been affected by travel restrictions arising from the COVID-19 pandemic. The JV intends to finance these aircraft through a mix of equity and debt.

"This joint venture represents a significant step by ST Engineering in growing our aviation leasing business as we expand beyond passenger aircraft and engines to include freighter aircraft assets as part of our portfolio," said Jeffrey Lam, president of commercial aerospace at ST Engineering. "As we embark on this exciting venture with our partner, Temasek, we also welcome and look forward to working with other potential like-minded partners who are looking to invest in the strong freighter aircraft leasing market. In the medium to long-term, the JV intends to securitise the leasing income streams by way of a business trust to unlock capital."

APPOINTMENT OF BOARD MEMBERS FOR THE CIVIL AVIATION AUTHORITY OF SINGAPORE

Singapore's Ministry of Transport has announced the appointment of 12 individuals to the Civil Aviation Authority of Singapore (CAAS) Board for a period of three years from 1 July 2021 to 30 June 2024. The Board will continue to be chaired by Mr Edmund Cheng and will comprise members from relevant sectors such as aerospace engineering, logistics and freight forwarding, finance and investments, legal, technology, as well as the union.

Of the 12 members, three were newly appointed. They are Professor Lam Khin Yong, Senior Vice President (Research) at Nanyang Technological University; Chairman of the Public Transport Council Mr Richard Magnus, and Chairman and Senior Partner at Allen & Gledhill LLP, Ms Christina Ong.

Mr Chandra Mohan K Nair of Tan Rajah & Cheah, Ms Choo Oi Yee of iSTOX Private Limited and Professor Wee Chow Hou of Nanyang Technological University will step down from the CAAS Board with effect from 1 July 2021.

The full list of the 13-member CAAS Board is as follows:

- Mr Edmund Cheng (Chairman)
  Deputy Chairman, Wing Tai Holdings Limited
- Ms Cham Hui Fong
  Deputy Secretary-General, National Trades Union Congress
- Mr Mark Chong
  Group Chief Technology Officer, Singapore Telecommunications Limited
- Professor Chong Tow Chong
  President, Singapore University of Technology and Design
- Mr Chua Kwan Ping
  Senior Director (Air and Sea), Ministry of Transport
- MG Kelvin Khong
  Chief of Air Force, Ministry of Defence
- Professor Lam Khin Yong
  Senior Vice President (Research), Nanyang Technological University
- Mr Richard Magnus
  Chairman, Public Transport Council
- Ms Christina Ong
  Chairman and Senior Partner, Allen & Gledhill LLP
- Mr Kevin Shum (until 1 August 2021) / Mr Han Kok Juan (with effect from 2 August 2021) Director-General, Civil Aviation Authority of Singapore
- Mr Tan Pheng Hock
  Board Director, Frasers Property Limited
- Mr Wong Kang Jet
  Principal Private Secretary to Deputy Prime Minister, Prime Minister's Office
- Ms Mary Yeo
  Vice President, Global Strategic Partnership, UPS Asia Group Pte Ltd

SINGAPORE FLYING COLLEGE JOINS LIST OF CAAS ACCREDITED UNMANNED AIRCRAFT TRAINING ORGANIZATION

The Singapore Flying College (SFC), which has been providing pilot training since 1988, is now an Unmanned Aircraft Training Organization (UATO) accredited by the Civil Aviation Authority of Singapore (CAAS). The SFC joins a handful of other approved UATO in Singapore, including the Institute of Technical Education (ITE), Avetics Global, Garuda Robotics, MIRS Innovate, Apollo Global Academy and CWT Aerospace Services.

As of 1 February 2021, users who operate unmanned aircraft (UA) in Singapore for recreational or educational purpose with a UA of total weight exceeding 7kg, or for any other purposes regardless of the UA weight are required by CAAS to obtain a UA Pilot License (UAPL). Only a certified UATO can conduct the training and practical assessment for the issuance of a UAPL.

The SFC's UAPL training programmes are designed to ensure that learners develop strong theoretical knowledge foundations with topics covering principles of flight, air law, navigation & meteorology and human factors, among others. This is supplemented by learning practical skills with simulator and practical flight training, during which mission planning, decision-making processes, and airmanship, will be covered.

Only after passing the evaluation with a certified AFE (Authorized Flight Examiner) from the SFC will an applicant be eligible to apply for the CAAS UAPL.

FEATURE

A GREEN RECOVERY:

Sustainability for Aviation in a Post-pandemic Landscape

Text by: Chan Mun Wei

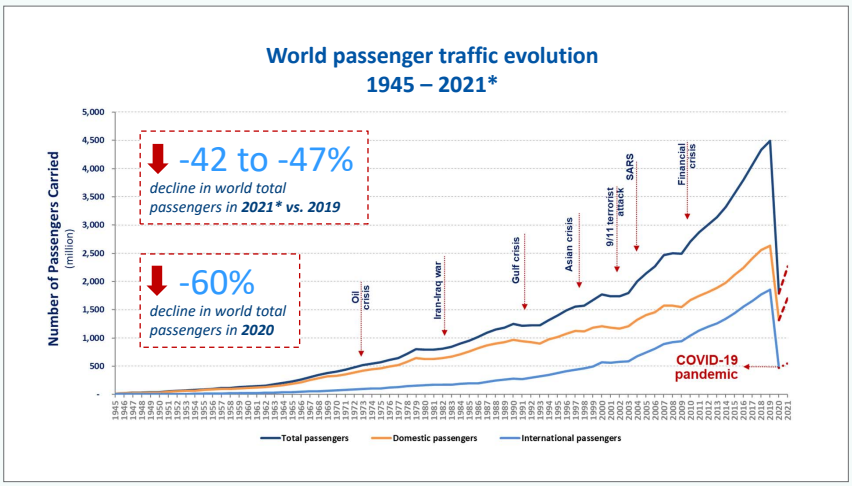
On 1 January 1914, the world's first fixed-wing scheduled passenger flight took off from St. Petersburg, Florida for a 23-minute trip to a nearby city, Tampa. The Benoist XIV airboat carried one passenger who paid US$400 – equivalent to more than US$10,000 in today's value. Percival Fansler, founder of the St. Petersburg-Tampa Airboat Line, declared, "What was impossible yesterday is an accomplishment of today, while tomorrow heralds the unbelievable". While the service lasted only four months, it ferried more than 1,200 passengers and was a pioneer of the market demand for air travel.

The carriage of commercial passengers and freight has grown steadily over the decades. By creating a global, convenient and rapid transport network, aviation has enabled international trade, tourism, job creation and economic prosperity. According to a September 2020 factsheet published by the International Air Travel Association (IATA), aviation provides 11.3 million direct jobs and supports another 76.4 million indirect jobs globally, contributing 4.1% of the world's Gross Domestic Product (GDP). There were 4.5 billion air passengers in 2019, 3.6% higher than the previous year and in fact the highest annual number ever. In December 2019, IATA sanguinely forecasted that in 2020, the global airline industry would see incremental improvements in passenger numbers (up 4% to 4.7 million) and net profit (up 13% from US$25.9 billion to US$29.3 billion).

No one could see the storm coming fast and furious. COVID-19 was an unseen and unanticipated scourge that hit economies and communities hard the world over. International passenger traffic dropped 60% in 2020 with 1.8 billion air passengers compared to the previous year's 4.5 billion, according to analysis by the International Civil Aviation Organization (ICAO). In an April 2021 press release, IATA projected a modest industry recovery in the latter part of 2021, with overall passenger numbers of 2.4 billion for the full year, an improvement upon the 1.8 billion who travelled in 2020, but well below the 2019 peak of 4.5 billion. Compared to the passenger business, air cargo had fared better throughout the crisis. IATA projected that total air cargo volumes for 2021 would reach 63.1 million tonnes, a 13.1% increase over 2020. This meant the cargo business would have recovered relative to pre-crisis levels as 2020 saw a full-year decline of 9.1% compared to 2019.

While COVID-19 continues to be a clear and present challenge for the aviation industry and global economy, it has to some extent shifted attention away from a far more long-term and dangerous threat, which is that of global warming. A common theme between COVID-19 and global warming is that both crises point to the need for responsible stewardship of the physical environment. Health experts believe that the coronavirus that caused COVID-19 most likely originated in bats and made the jump to humans at one of the crowded open-air markets in Wuhan, China, where animals were slaughtered on the spot and sold as fresh meat for customers. Likewise, climate change is caused by the continual burning of fossil fuels and deforestation for agriculture and other uses, which generate carbon dioxide (CO2) and other greenhouse gases that warm the Earth.

Since the pre-industrial period (i.e. between 1850 and 1900), human activities and the consequent emission of greenhouse gases have increased Earth's global average temperature by 1 degree Celsius. Global warming leads to harmful and potentially irreversible changes to the Earth's long-term weather patterns, and we are seeing



Source: ICAO Economic Impact Analysis of COVID-19 on Civil Aviation (June 2021)

the tangible effects in melting glaciers, rising sea levels, extreme weather and declining biodiversity. These physical changes affect our food and water, safety, livelihoods and quality of life. Recognising the serious risks posed by global warming, 197 countries signed the Paris Climate Agreement in 2015 with the goal of limiting the increase in global average temperature to below 2 degrees Celsius by 2100 (as compared to pre-industrial levels), and pursuing a stretch target to limit warming to below 1.5 degrees Celsius.

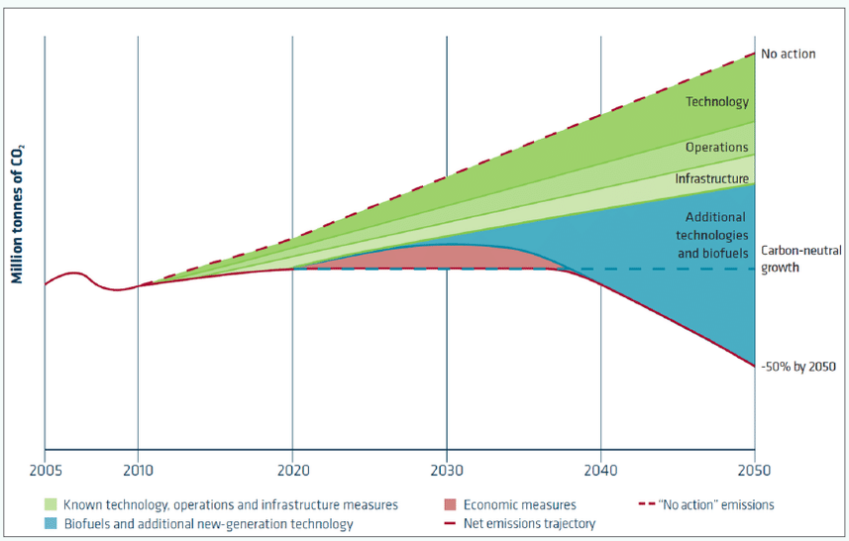
To reach the 2 degrees Celsius goal, greenhouse emissions would need to decline by about 25% from 2010 levels by 2030 and reach net zero emissions around 2070. The more ambitious 1.5 degrees Celsius goal requires a steeper decline of about 45% from 2010 levels by 2030 and net zero emissions around 2050.

In 2019, commercial aviation contributed about 2% of global greenhouse emissions. By 2050, the emissions could triple given the projected long-term growth in passenger air travel and freight. To reduce aviation's emissions and steer the industry closer to the decarbonisation pathways necessary to achieve the Paris Climate Agreement's objectives, IATA adopted a set of targets to mitigate CO2 emissions from air transport:

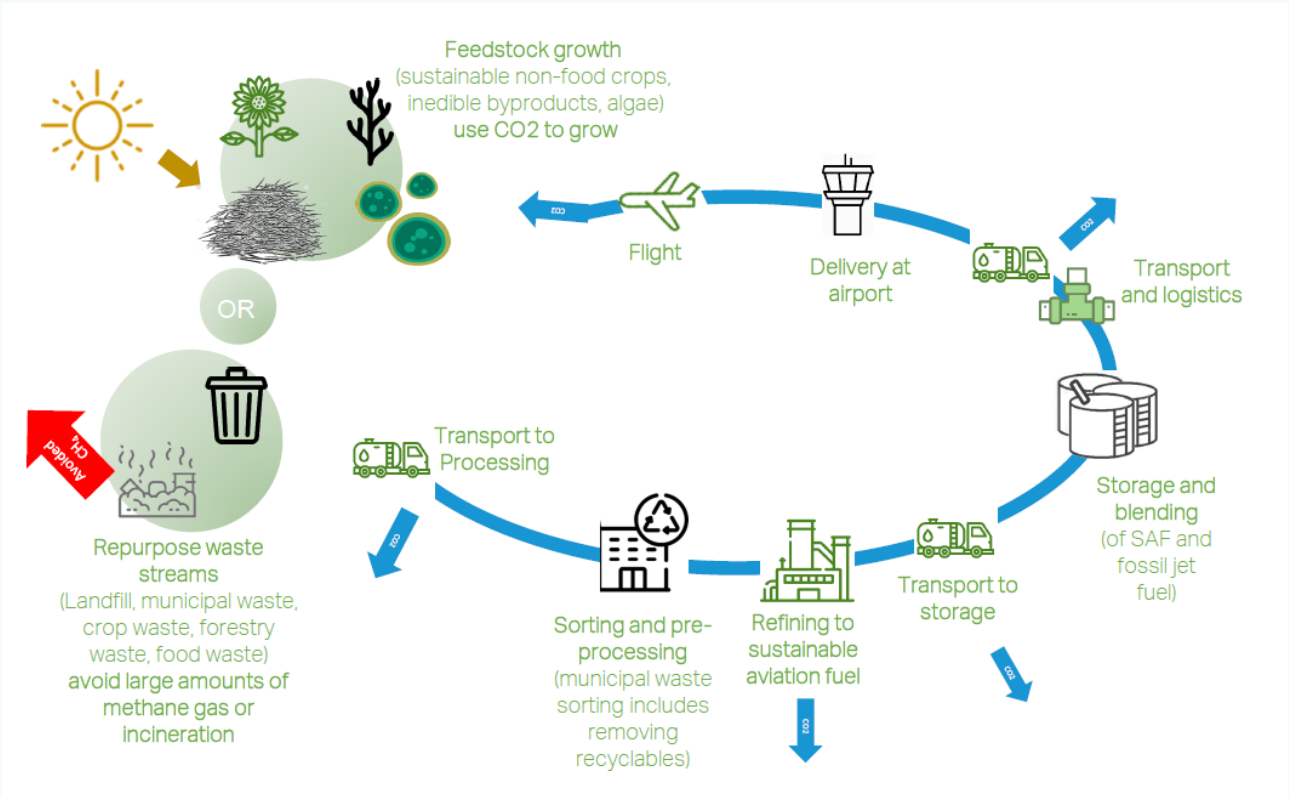
- An average improvement in fuel efficiency of 1.5% per year from 2009 to 2020.
- A cap on net aviation CO2 emissions from 2020 (i.e. carbon-neutral growth).
- A reduction in net aviation CO2 emissions of 50% by 2050, relative to 2005 levels.

Given that the aviation industry has been battered by the COVID-19 situation, the challenge is for all players in the ecosystem to marshal the bandwidth and resources to tackle global warming. At the Global Sustainable Aviation Forum in September 2020, industry leaders reiterated that long-term climate action should be a priority alongside near-term economic recovery. Both strategies are equally important and linked. For aviation to drive global economic recovery and provide economic and social benefits, a green-minded recovery is needed to ensure a prosperous and sustainable industry for the long term. Improving fuel efficiency, for instance, helps airlines to lower costs, raise productivity and reduce their emissions. IATA has stayed the course, before and during the COVID-19 situation, in pushing for the adoption of a four-pronged sustainability strategy:

- A single global market-based measure, to fill the remaining emissions gap.
- Improved technology, including the deployment of sustainable aviation fuels.
- More efficient aircraft operations.



Source: IATA Aircraft Technology Roadmap to 2050 (December 2019)



Carbon Lifecycle of Sustainable Aviation Fuel (Source: IATA)

- Infrastructure improvements, including modernized air traffic management systems.

What is the current state of play for these sustainability strategies and other measures that can move the needle in helping the industry to "build back better" towards a green and safe future?

CORSIA AS A MARKET-BASED MEASURE

Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) is a global scheme whereby airlines will purchase carbon offsets to compensate for growth in CO2 emissions above 2020 levels. This will stimulate global demand for carbon offset credits, which are certified instruments that represent an emissions reduction of one metric tonne of CO2, such as through land restoration programmes or processes to remove industrial greenhouse gases. When CORSIA was launched in 2016, it was projected to mitigate an annual average of 164 million tonnes of CO2 between 2021 and 2035, equivalent to about 18% of emissions from international air travel in 2019.

Under CORSIA, airlines would set their baseline using the average of emissions in 2019 and 2020. Because of the pandemic-induced downturn, emissions in 2020 have dropped sharply and the average of the actual emissions in 2019 and 2020 is expected to be equivalent to the sector's total emissions in 2010. Thus, the CORSIA baseline would be about 30% more stringent than it would have been without the COVID-19 crisis. This means that as airlines recover in the post-pandemic phase, the cost of compliance with the CORSIA requirements would be significantly higher. The ICAO Council agreed in July 2020 to disregard the 2020 emissions and set the CORSIA baseline using 2019 emissions only.

SUSTAINABLE AVIATION FUELS

Sustainable Aviation Fuel (SAF) is a clean substitute for fossil jet fuels. Rather than being refined from petroleum, SAF is produced from sustainable resources such as waste oils from biological origin, agricultural residues, or CO2 from non-fossil fuel sources. SAF is a drop-in fuel, which means that it can be blended with fossil jet fuel and requires no special infrastructure or equipment changes. SAF can reduce up to 80% CO2 emissions compared to conventional jet fuel. This is because of a fundamental timeframe difference – fossil fuels release carbon that has been stored for

millions of years, whereas SAF releases CO2 emissions that were recently absorbed from the atmosphere during biomass production. SAF has other benefits such as much less particulate matter and pollution produced, as well as improved fuel efficiency of 1.5% to 3% because of higher energy density than conventional jet fuel.

Airbus is partnering with Safran, Dassault Aviation, ONERA and the French Ministry of Transport to launch an inflight study at the end of 2021 to study the compatibility of unblended SAF with single-aisle aircraft and commercial aircraft engine and fuel systems, as well as with helicopter engines. This collaboration, known as VOLCAN (VOL avec Carburants Alternatifs Nouveaux), will for the first time, measure inflight emissions and contrail formation using 100% SAF in a single-aisle aircraft. The various SAFs used for the VOLCAN project will be provided by TotalEnergies. The study will support efforts at Airbus and Safran to prepare the industry for large-scale deployment of SAF, which will contribute to achieving 100% SAF certification in single-aisle commercial aircraft and the new generation of business jets.

Maiden flight of a Beluga super-transporter using sustainable aviation fuel from the Airbus Broughton plant in the UK (Photo: Airbus)

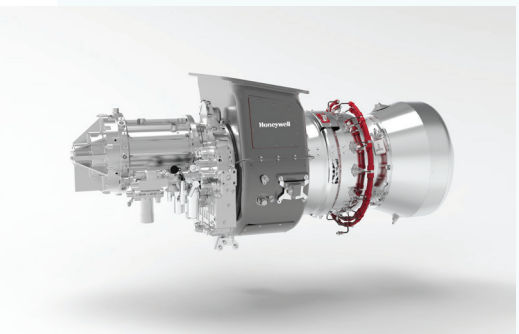
Sustainable Aviation Fuel tanker truck at airport (Photo: Neste)

Currently, SAFs are more expensive than traditional jet fuel. Estimates range from two times, for some waste-based sources, to up to ten times, for synthetic fuels using carbon capture. This is mainly due to the small production runs. About 100 million litres of sustainable aviation fuel is produced annually, less than 1% of jet fuel used by the industry. Because of the environmental benefits and projected cost reductions from economies of scale, production facilities are being expanded. One of the manufacturers of SAF is Neste, a Finnish oil refining company with a refinery and regional headquarters in Singapore. Looking ahead beyond the COVID-19 economic uncertainties, Neste is investing EUR 1.5 billion to expand its Singapore operations, which will have the capacity in 2023 to produce up to one million tonnes of SAF annually. Neste will then be able to enhance its raw material pre-treatment, such as processing low-quality waste and residual raw materials.

AIRCRAFT TECHNOLOGY IMPROVEMENTS

Each new generation of aircraft has double-digit fuel efficiency improvements, i.e. up to 20% more fuel efficient. This has led to today's modern aircraft producing 80% less CO2 per seat than the first jets in the 1950s. To formalise and complement the market-driven improvement in fuel efficiency, ICAO agreed on a CO2 emissions standard in February 2016, which applied to all new aircraft designs from 2020 and newly-built existing models from 2023.

Although currently in early stages of research and development, aerospace manufacturers are investigating fully electric and hybrid-electric aircraft. As battery technology improves, increased energy storage may make electrically-powered commercial flight a reality. Already, several small-scale demonstrators are showing how it can be used for training flights and two-person operations. The biggest challenge is overcoming the relatively low power density of batteries compared to jet fuel. With today's technology, to electrify a Boeing 737 completely would require a battery of the same size as the plane itself. Galvanized by President Joe Biden's ambition to slash the United States' world-leading emissions to net zero, the American National Aeronautics and Space Administration (NASA) is working with companies to demonstrate ways to power aircraft via batteries rather than jet fuel, with the aim of phasing in electric flights within the next 15 years.



Honeywell has announced it is developing a power source for hybrid-electric aircraft, which will be able to run on aviation biofuel. It can be used to operate high-power electric motors or charge batteries for heavy-lift cargo drones, air taxis, or commuter aircraft. (Photo: Honeywell)

In July 2020, UK-based Electric Aviation Group (EAG) unveiled the design of its Hybrid Electric Regional Aircraft (HERA), touted as the 'world's largest commercial hybrid electric plane' that can seat 70 people and has a 'whisper-quiet' take-off (Image: EAG).

Another promising green technology is using hydrogen to power a fuel cell to generate electricity or directly combusted for mechanical power. Hydrogen produces no carbon emissions when combusted, instead the end product is water. Furthermore, hydrogen has high power density suitable for aviation – three times that of jet fuel and more than 100 times that of lithium-ion batteries. However, there are technical challenges to be overcome, such as how to store liquid hydrogen, the most promising fuel option, feasibly and safely onboard aircraft.

EFFICIENT AIRCRAFT OPERATIONS

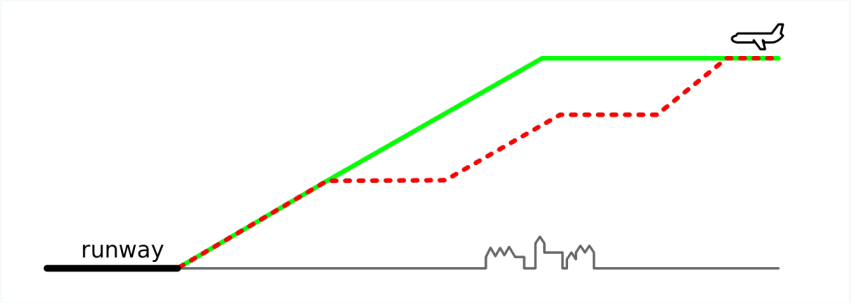
Aircraft operations can encompass a broad range of activities including the flying of the airplane, the control and monitoring of the aircraft by the air traffic management system, and various airport activities. Operational opportunities to reduce fuel

NASA's X-57 Maxwell is an experimental aircraft designed to demonstrate that an all-electric airplane can be more efficient, quieter and more environmentally friendly than airplanes powered by traditional engines (Image: NASA)

consumption and on-ground delays represent a big win for all stakeholders – reduced fuel costs for airlines, on-time arrivals and departures for passengers, and reduced emissions for the environment. Furthermore, operational improvements can be cost-effective as they do not require purchase of new equipment or expensive technologies.

Air Traffic Flow Management (ATFM) is one means of ensuring efficient airport operations. It entails regulating air traffic to avoid exceeding airport or air traffic management capacity, and ensuring that available capacity is used efficiently. ATFM uses updated flight information to predict traffic demand and adjusts the flow of flights into or out of congested airports to smoothen air traffic flows. The Civil Aviation Authority of Singapore (CAAS) has a Distributed Multi-Nodal ATFM arrangement with its regional counterparts for regulation of flights prior to departure, thereby avoiding airborne delays during their arrival phase which contribute to safer, greener and more cost-efficient operations.

Another example of efficient aircraft operations is use of the Continuous Descent Operations (CDO) technique whereby aircraft would remain in a smooth continuous descent profile prior to landing, instead of descending with a stepped profile. This means an aircraft descends with reduced thrust and a quieter profile. It is also more fuel and environmentally efficient than a stepped descent. Airlines estimate that each continuous descent approach can save 150kg of jet fuel (equivalent to 500kg of CO2 emissions). Continuous descents are being implemented at hundreds of airports all over the world, including Changi Airport. The Joint Aviation Innovation Research (AIR) Lab, established by CAAS and Thales in Singapore, has worked with a start-up, Aeroficial Intelligence, on a Proof of Concept (POC) use case to generate CDO profiles and calculate CO2 emissions using AIR Lab's Open Application Programming Interfaces (APIs). Chris Lee, the Deputy Director leading partnerships in AIR Lab shared that, "The collaboration with Aeroficial Intelligence was part of AIR Lab's participation in the Singapore Aviation Accelerator by Starburst. It was an enriching journey for both corporates and start-ups as we worked together to leverage modern technologies to enable meaningful POCs like sustainable aviation. Most importantly, such collaboration would contribute towards building local aviation capabilities."



Schematic descent profile of a conventional approach (red) and a continuous descent approach (green) (Source: Wikipedia commons)

By developing and scaling innovation technologies and solutions, start-ups have a growing role in making aviation more efficient and sustainable. In the UK, the Aerospace Technology Institute (ATI) and its sponsors, Boeing and GKN Aerospace, offer the ATI Boeing Accelerator programme that supports the growth of world-class start-ups and boosts the competitiveness of the UK aerospace industry. Each ATI Boeing Accelerator cohort has 8 to 10 start-ups, which will receive equity investments and the opportunity to collaborate with leading companies in the industry. AireXpert, one of the participating start-ups in the second cohort, offers a software-as-a-service platform that streamlines communications across an airline's network during unscheduled maintenance events, thus reducing delays, operating costs and compliance risks.

NET ZERO

Increasingly, businesses across different industries are taking the lead in climate action by setting net zero targets. This entails working towards overall zero CO2 emissions by balancing carbon dioxide emissions with removal through a mix of emission reduction measures and use of carbon offsets. Aviation is moving towards net zero too. The oneworld global aviation alliance – which includes major airlines such as British Airways, Qantas and American Airlines – signed a joint commitment in September 2020 to reach net zero emissions by 2050. A working group has been set up by oneworld to ensure that members collaborate on a roadmap for meeting the goal and adopting best practices throughout the coming decades.

On 24 May 2021, the Singapore Airlines Group announced its commitment to achieve net-zero emissions by 2050. Mr Goh Choon Phong, Chief Executive Officer, Singapore Airlines, said, "We have remained focused on our sustainability goals even as we navigated the COVID-19 pandemic. We know that this is also an increasingly important issue to both our customers and staff." The Group will use multiple levers to achieve this goal. These include investing in new-generation aircraft, achieving higher operational efficiency, adopting low-carbon technology such as SAFs, and sourcing for high quality carbon offsets. The airline has started working with its partners to chart a detailed pathway to achieving net zero.

THE FLIGHT PATH AHEAD

Commercial aviation has to weather two storms – the more immediate COVID-19 crisis and the longer-term climate emergency. While the industry has been battered by the pandemic, it can do its part by facilitating trade and ferrying goods, including the carriage of vital vaccines to communities around the world. As for global warming, the industry has to adopt a suite of measures to reduce its carbon footprint. The path to net zero will not be easy, but each positive step in reducing emissions can improve operational efficiency, make the industry more resilient to climate-related risks, and signal to governments, customers and other stakeholders that the industry is committed to responsible growth for the long term.

The world has become a global village, thanks to aviation bringing people together. Just like we need a village to raise a child, we need a concerted effort between countries and across the public, private and people sectors to tackle the twin crises of COVID-19 and climate change.

WHAT IS NET ZERO?

MEASURES TO LOWER EMISSIONS + **MEASURES TO REMOVE EMISSIONS** = **NET ZERO**

For Example:
- Investment In Green Technologies
- Shift To Electric / Hydrogen Powered Engines

For Example:
- Afforestation & Reforestation
- Direct Air Capture
- Soil Carbon Sequestration

Balance between amount of greenhouse gases produced and amount removed from the atmosphere.

MINI-FEATURE

SUNNY DAYS AHEAD!

Highlights from the Singapore Aerospace Industry Solar Adoption Report (SAISAR) 2021

In the context of increasing interest towards the use of renewable energy, the Association of Aerospace Industries (Singapore) (AAIS) has partnered with JTC to publish the inaugural Singapore Aerospace Industry Solar Adoption Report. The report aims to provide a glimpse of the industry's sustainability efforts, with a specific focus on the gains from implementing solar energy. It hopes to inspire companies from all industries to learn and be ready in greening their energy use.

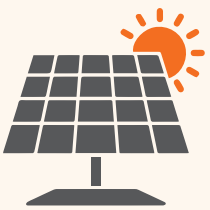
Highlights from SAISAR 2021

19,650 kWp

Total deployed solar capacity by the aerospace industry (as of June 2021)

Approximately[1]

65,000 solar panels



installed within aerospace facilities around Singapore

Total electricity produced annually

21,180 MWh

This amount of electricity is sufficient to power

4,900

4-room flats[2] in Singapore for **1 year**

By using solar energy, the Singapore aerospace industry avoids

8.65 million kgCO_2

of carbon emissions of in a year, which would be produced if the energy had been supplied by the national grid[3].

This is equivalent to the CO_2 absorbed by

393,360 mature trees[4]

Amount of building, hangar and car park roof space used

123,053 sqm

This amount of space, equivalent to **17 soccer fields** has been repurposed for economic and environmental benefits.

SOLAR ENERGY AS SHARE OF RESPONDENTS' OVERALL ENERGY CONSUMPTION

10.69%

weighted average

The aerospace industry contributes 4.4% of Singapore's current total installed solar capacity, and 8.3% of private-sector installations in Singapore.

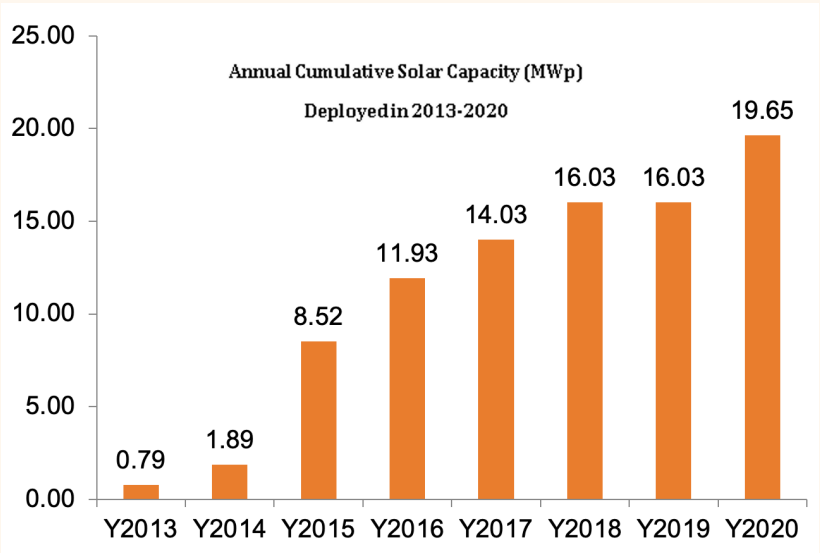
1. Approximation assumes an average power rating of 300W per commercial solar panel (96 cell) measuring 1m x 1.9m
2. A 4-room Housing and Development Board (HDB) apartment consumes a monthly average of 359.1 KWh of power in 2019
3. This is using the grid system-wide emission factor of 0.4085 kgCO_2 per kWh for 2019
4. This is based on an estimate of 22 kg of CO_2 absorbed by a mature tree annually, published by the European Environment Agency in 2012

MINI-FEATURE

Annual average growth rate of solar capacity (from 2013 to 2020)

83.6%

The industry's solar adoption looks set to grow incrementally. There are 2 projects scheduled to be operational in 2021 and a potential pipeline of 12 additional projects planned for implementation in the near future.



Overcoming Implementation Challenges

1. Many aerospace companies are located near airports. Tests are needed to ensure rooftop solar panels do not interfere with radar and navigation systems or cause reflective glare for pilots, which is a safety concern.

2. For aerospace facilities that operate in the evening, additional upfront investment and space are required to install batteries (to store electricity for on-site usage during these hours). An alternative is to sell surplus solar energy generated in the daytime to the grid.

93%
of respondents employ **solar leasing aka power purchase agreement (PPA)**

VS

7%
of respondents that own the solar system

In solar leasing, a company leases its space to a solar vendor that will install, own and operate the solar panels. The company can choose to buy all or part of the solar energy generated. The contract duration for solar leasing varies between 10 and 25 years.

Benefits:
- No upfront capital costs for the company.
- Lower cost of electricity compared to buying from electricity retailers.
- More predictable energy pricing with the ability to lock in fixed electricity prices via negotiation with solar vendor.
- Limited risks from owning and operating an energy asset by only paying for solar energy generated.
- Solar developers install, manage and pay for the maintenance of solar panels.
- Enhance value of property/facility.

FACILITATING THE ADOPTION OF SOLAR ENERGY

To help more companies access the benefits of solar deployment and make industrial estates more environmentally friendly, JTC has introduced the SolarRoof initiative. It allows companies to engage an appointed system operator (Sembcorp Solar) to install solar panels on the roofs of their facilities and tap on agreed solar rates. There are two types of solar deployment business models offered by the operator:

1. Rooftop licensing – Property owner licenses its roof area to vendor for solar panel installation at no cost. The electricity generated from the solar system is then sold to the grid and the property owner will receive the rooftop license fee ($/m2 of roof area).

2. Solar leasing – Property owner allows a solar vendor to install solar PV on their roof at no cost. The property owner will then purchase the generated electricity from the solar vendor at a discounted rate on the solar rates.

For more information, please refer to **JTC's Solar Deployment Infokit** available via the QR code.

CREATING THE FUTURE:

TOWARDS THE WORLD'S FIRST ZERO EMISSION AIRCRAFT

Global aircraft manufacturer, Airbus, has revealed new concepts for the world's first zero-emission commercial aircraft which could enter service by 2035. The concept aircraft rely on hydrogen as a primary power source - an option which Airbus believes holds exceptional promise as a clean aviation fuel for aerospace and other industries to meet their climate-neutral targets.

Codenamed "ZEROe", each concept represent a different approach to achieving zero-emission flight, exploring various technology pathways and aerodynamic configurations. Airbus is studying a variety of concepts to determine which option has the potential to scale up to larger aircraft. A final selection for the launch of the ZEROe programme can be expected by 2025.

"POD" CONFIGURATION / TURBOPROP DESIGN

This innovative configuration features "pods" that act as standalone turboprop motors, each driving eight-bladed propellers via a distributed hydrogen fuel cell propulsion system. The aircraft features removable fixtures for quick assembly and disassembly. It would seat up to 100 passengers, and can travel more around 1,000 nautical miles, making it a greener option for short-haul trips.

"BLENDED-WING BODY" DESIGN

In this concept, the wings merge with the main body of the aircraft . Two hybrid hydrogen turbofan engines provide thrust. An exceptionally wide fuselage opens up multiple options for hydrogen storage and distribution, and for cabin layout. This aircraft would be able to take up to 200 passengers with a range of 2,000+ nautical miles.

TURBOFAN DESIGN

In the turbofan configuration, two hybrid hydrogen turbofan engines (modified gas-turbine engine running on hydrogen) provide thrust. The liquid hydrogen will be stored and distributed via tanks located behind the rear pressure bulkhead. The aircraft would seat between 120 to 200 passengers, and have a range of 2,000+ nautical miles, making it capable of operating transcontinental flights.

ADVANCED AIR MOBILITY
ARE WE READY FOR IT?

Advanced Air Mobility (AAM) is expected to become an increasingly important part of the transportation landscape in the coming years. Efforts and significant funds are being poured into the advancement of electric vertical takeoff and landing (eVTOL) aircraft as well as the development of matching ground infrastructure. Driven by aerospace companies, start-ups as well as governments, AAM is preparing to take off in many parts of the globe.

Following the success of its inaugural webinar series on AAM last November, the Association of Aerospace Industries (Singapore) (AAIS) launched a second series in May 2021 entitled, "Gearing up for AAM". While the first series explored the developments, challenges and potential of AAM in Singapore, the focus this time around, was to find out about global AAM happenings and updates and learning what this could mean for Singapore. Featuring experts from industry, academia and regulators from all corners of the world, this series explored airworthiness considerations, UTM developments and the AAM supply chain.

Speakers and moderators from the second AAM webinar series by AAIS

AIRWORTHINESS CONSIDERATIONS

Regulation and certification are expected to be key in enabling implementation and scalability of AAM. Aviation authorities have been working closely with AAM providers for the past several years, to better understand and develop a suitable regulatory framework. A different approach is required given the need to account for the rapidly changing technology in this space. Standards for type certification, for example, would have to be open to multiple concepts because of the wide variety of aircraft, engine and propulsion systems, and level of automation.

In the first session of this AAM webinar series held on 5 May 2021, regulatory expert Mr Michael Daniel shared how aviation authorities are evolving their approach to regulation and certification to keep up with changing needs and emerging technologies like AAM. With 34 years in the aviation regulatory environment, Mr Daniel discussed AAM airworthiness from the point of view of international and national aviation authorities. He covered the developments at the International Civil Aviation Organisation (ICAO), and the approaches taken by Federal Aviation Administration (FAA), the European Aviation Safety Agency (EASA) and Civil Aviation Administration of China (CAAC) in advancing type certification for this new class of aircraft.

Professor James Wang, director of Nanyang Technological University's eVTOL Research and Innovation Centre, complemented this discussion from the perspective of an aircraft designer, drawing on his experience as an eVTOL pioneer, and career in rotorcraft development. He generously shared the considerations for designing eVTOL, with certification and commercialisation in mind.

AIRSPACE MANAGEMENT

A pragmatic approach to commercial and scalable application of AAM would involve overcoming the challenges of how to fly safely, efficiently and sustainably in an urban environment. Traffic management systems should be able to prevent VTOLs from colliding with one another, with manned aircraft, drones or with other flying objects. This would require the integration of airspace and developing a traffic management system that encompass existing Air Traffic Management (ATM) systems as well as new systems, procedures, and

roles established in low level, urban airspace.

Such guidance, usually referred to Unmanned Aircraft System Traffic Management (UTM), are highly complex, given the need to process various parameters including airspace design, route planning, terrain and severe weather avoidance, congestion, and contingency management. It also requires key foundations and infrastructure such as reliable 4G/5G networks, geo-mapping and geo-fencing facilities, airspace structure models and regulatory inputs, among many other factors.

The second part of the webinar series explored airspace management with a particular focus on technology developments, and the progress being made in the United Kingdom. Held on 12 May 2021, the session featured Ms Elizabeth Chau, Head of UAM at NATS and Mr Frank Erb, Director Digital Aviation Market Development at Thales.

Ms Chau provided a glimpse of how the UK is preparing for AAM and shared a powerful visualisation of airspace movements above the UK. She also highlighted three interested projects being undertaken by NATS towards understanding and developing an integrated airspace management system. Mr Erb discussed developments in UTM and how Thales is extending its ATM capabilities into this space. This was followed by a panel discussion on future directions, for example on the technology options for implementing tracker ID for UA, including Automatic Dependent Surveillance-Broadcast (ADS-B).

EmbraerX recently completed its first eVTOL "flight" simulation, with realistic flight control parameters using certification control rules. (Image: EmbraerX)

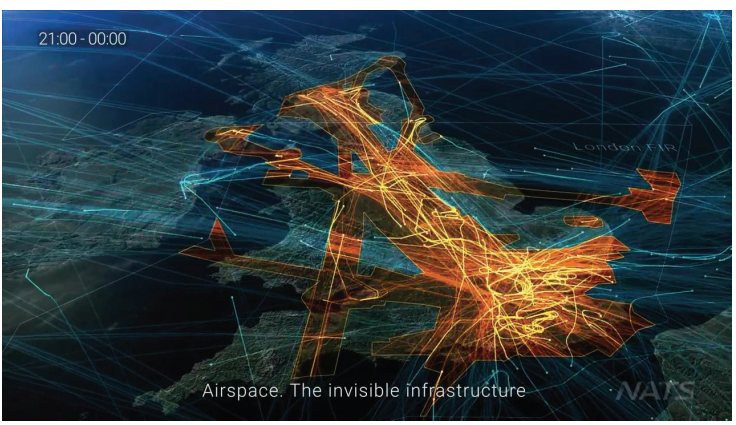
SUPPLY CHAIN

The AAM market is at an early stage of development, with no platforms yet certified by aviation authorities. Yet, it promises opportunities that benefits society and the economy. With the global market size estimated to reach to $1.5 trillion market by 2040, according to Morgan Stanley, nations around the world are engaged in a highly competitive race to achieve technological superiority and market dominance in this arena. This is also driving the rapid evolution of a supply chain, often involving non- aerospace suppliers.

The third and final part of the webinar series explored the AAM Supply Chain with a particular focus on design and manufacturing of eVTOL vehicles. Held on 19 May 2021, the session featured Mr Ian Lam, general manager of Schaeffler Aerospace and Ms Evelyn Khoo, business development manager for composite materials at Solvay as its speakers.

Both speakers discussed how their companies were drawing on prior experience in the aerospace and automotive markets to position themselves as suppliers. Mr Lam drew useful comparisons between the supply chains for the AAM and automotive sectors. In particular, he highlighted the relative scale of these sectors, noting that AAM production volumes were expected to be higher than in aerospace. Ms Khoo spoke of Solvay's co-development approach to the use of composite materials in AAM.

The series highlighted some unique challenges and food for thought regarding AAM but also opportunities that could be a powerful catalyst for the aerospace sector and the wider economy. It is timely for us to understand how to position for, and address this developing opportunity.



Visualisation of airspace movements above the UK. Image: Screengrab from NATS' UK24 video

WHERE AVIATION TAKES OFF

Airfields of Singapore

Change is the only constant, and as we find ourselves reimagining air travel for the future, we can draw inspiration from our heritage and history. In this series of essays commissioned by *Aerospace Singapore*, Mr Goh Yong Kiat, an industry veteran and avid researcher, provides a glimpse of Singapore's rich aviation history and continuous evolution of the aviation and aerospace industries on this tiny island nation.

An aerial view of Seletar airfield in late 1945. Photo: Sgt Breeze, RAF official photographer, Public domain, via Wikimedia Commons

Vickers Vildebeest Mark IIs at RAF Seletar, January 1937. Photo: Imperial War Museum, Public domain, via Wikimedia Commons

It is an amazing fact that there are five active airfields on this small island city state. The story of Singapore airfields goes way back to 16th March 1911, when the first flight in Singapore took place at the old Racecourse at Farrer Park. In fact, besides the Farrer Park racecourse, pioneer aviators had also made the field at Balestier Plain their landing grounds. The two open fields in the city became the first unofficial airfields in Singapore and heralded the start of aviation.

The beginning of civil aviation in Singapore has its roots in military planning. When the British Military Administration ordered the construction of a naval base in Singapore as part of its Far East Strategy in 1923, it needed an airfield to augment it. A piece of land north of Singapore with a seafront in Seletar was selected. It had to be next to the sea as the first British Royal Air Force (RAF) squadron to be based in Singapore was a flying boat squadron.

In addition, a circular grass field was constructed for the operations of RAF landplanes. Shortly after RAF Station Seletar, or RAF Seletar, as it was called, was opened on 1st January 1930, two squadrons of torpedo bombers flew in to take roost.

This was also a time when new and faster flying machines were being developed, and the potential of air travel realised. Pioneer aviators, such as Amelia Earhart, made long-range flights to prove the viability of aircraft for long distance travel. Many attempts were made on air travel from England to Australia, with some loss of lives in the process. Being strategically located along the flight routes between England and Australia, Singapore became a preferred stopping point for these pioneers.

As the only airfield in Singapore, RAF Seletar became an unofficial airport. On 4th March 1930, the first regular air service between Singapore and Batavia (present day Jakarta) was inaugurated by KNILM, an East Indies subsidiary of the Dutch KLM airlines. This was followed by many survey flights from the British Empire Airways. This eventually led to the establishment of regular services from England to the 'Far East' and Australia on both flying boats and landplanes.

RAF Seletar played an invaluable role in the development of civil aviation. Its availability allowed Singapore to keep up to date with the rapidly growing air transport

industry. Seletar was, however, not easily accessible from the city and was essentially, still a military base. Its lack of commercial facilities, remoteness north of Singapore and poor land transportation access made it inconvenient for operators and passengers alike.

The British Government decided that a modern civil airport was required, and chose a site at the Kallang Basin for its proximity to the city centre.

Kallang Airport, Singapore's Marine and Land Airport, with an architecture ahead of its time, was opened on 12 June 1937. It had a circular grassy field giving a free run of 914 metres (3,000 feet) in any direction. Bordered by sea on the south, it offered facilities for flying boats, which could land in the channel

A KLM Douglas DC-3 on the tarmac of Kallang Airport in 1939, on its way to the Netherlands. Photo: Leiden University, CC BY 4.0, via Wikimedia Commons

and a slipway for them to be hauled up for repairs.

With Kallang Airport, Singapore became an important node in air transportation. History was made on 10 May 1941, when a Pan Am (Pan American Airways) Boeing 314 Clipper landed on the waters in front of Kallang Airport, establishing the first scheduled flight to Singapore from the United States.

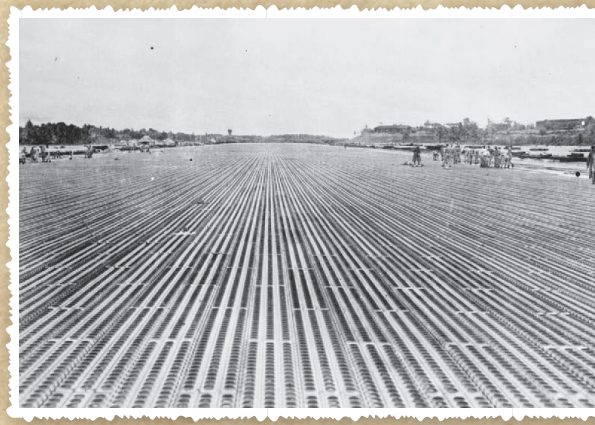
Meanwhile, to cope with the increased strength of the RAF in Singapore, two additional military airfields were constructed at Tengah and Sembawang. Both were completed and quickly occupied by 1936 and 1940 respectively.

Then, Singapore fell to the Japanese forces on 15th February 1941. The Japanese Army took control of Tengah and Kallang, while its Navy commanded over Seletar and Sembawang. To cater for their heavier aircraft, the Japanese built a concrete runway on each of the landing grounds at Seletar and Kallang. At Tengah, they built a new runway intersecting the one built by the British before the war. The Japanese forces also decided to build a runway at the British Army artillery base at Changi.

After the surrender of the Japanese on 15th August 1945, the RAF reoccupied the airfields. They quickly found out that all the four airfields (Seletar, Tengah, Sembawang and Kallang) were in a sorry state. The RAF carried out rehabilitation and transformed Changi airfield to be its largest in the Far East with a 1,830-metre (6,000 ft) long runway, capable of accommodating its heaviest aircraft at the time.

Diagram of airport facilities and approach patterns for Kallang Airport. Image: George Palmer Putnam Collection of Amelia Earhart Papers, Rights held by Purdue University Libraries

At Kallang, the RAF requisitioned the civilian airport and completed the work that the Japanese had begun. The 1,675-metre (5,496 ft) runway was reinforced to withstand heavier post-war transport aircraft. At the end of 1946, the RAF handed Kallang Airport back to the civil authorities.



View of the main runway at RAF Changi, Singapore, soon after its completion. The runway, constructed from 276,680 pierced steel sheets, was able to take the largest aircraft then in service with the Royal Air Force (April 1946). Photo: Imperial War Museum London, Public domain, via Wikimedia Commons

Kallang Airport, December 1950. Photo: Chew Ann Sim Collection, courtesy of National Archives of Singapore

Civil air traffic began to increase at Kallang. At first, the airport could not take planes with an all up weight of more than 30,000 kg. Aircraft exceeding this weight therefore had to be diverted to Tengah and Changi after the RAF opened them to civil traffic.

With further improvements to Kallang's runway, the arrangements for military-civil air traffic at Tengah and Changi were ceased. On 3rd April 1950, Kallang officially became Singapore's only civil airport. Its 140 movements a week, made it the second busiest airport in the Far East after Kai Tak Airport in British Hong Kong.

Soon after that, however, the post-war growth in aviation, passenger traffic and freight found Kallang Airport inadequate and out-of-date. Kallang could not without prohibitive expenditure, be adapted to the foreseeable demands of the next decade. With constraints for further expansion to handle bigger and heavier airliners, in particular the jetliners coming into service, a new site for an international airport was required. The new airport site was identified at Paya Lebar and construction work started in August 1952.

On 19th August 1955, Kallang Airport which had served as Singapore's international airport for 18 years, ceased civil operations at midnight. The following day, on 20th August, the new S$2.3m airport at Paya Lebar with a single 2,438-metre (8,000 feet) runway, was opened to much fanfare and pageantry.

With continual increase in passenger traffic and air traffic, Paya Lebar Airport was upgraded and expanded several times. These improvements continued after Singapore's independence in August 1965. Meanwhile, as part of the withdrawal of British forces from Singapore, all the RAF airfields (Seletar, Tengah, Sembawang and Changi) were progressively handed over to the Singapore government.

As Singapore's economy developed, passenger traffic and air traffic at Paya Lebar continued unabated. The airport's runway and facilities were upgraded and expanded to take in new jumbo jets coming into service. The length of the runway was eventually increased to 3,780 metres (12,400 ft).

With the growth in global aviation, the airport was facing congestion problems. Its inability to cope with rising traffic became critical by the 1970s – annual passenger numbers rose dramatically from 300,000 in 1955 to 1.7 million in 1970 and to 4 million in 1975. Feasibility studies for further expansion of Paya Lebar were conducted, which found too many physical difficulties and constraints.

The military airbase at Changi was considered as the alternative. In June 1975, after many studies and much debate, the Government announced the selection of Changi to replace Paya Lebar as its international airport.

A historic moment for Singapore's civil aviation came on 1st July 1981 when Changi Airport was opened for operations. Five times the size of Paya Lebar, Changi Airport was designed to provide a positive experience for passengers and visitors with iconic designs, layout and quality services. The story of Changi Airport – its expansion from one passenger terminal to four by 2017 and the ambitious plan for a fifth – deserves a story of its own.

Singapore International Airport control tower and terminal building c.1969-71. Photo: NSBReynolds, CC BY-SA 4.0, via Wikimedia Commons

ICCAIA BRIEFING ON INTERNATIONAL COVID-19 RESPONSE

From the onset of the COVID-19 crisis, the aviation system has faced ever-growing challenges. Last year, the International Civil Aviation Organization (ICAO), through the Council Aviation Recovery Task Force (CART), convened twice, in partnership with its Member States, international and regional organizations to addressed the challenges and provide global guidance for a safe, secure and sustainable restart and recovery of the aviation sector.

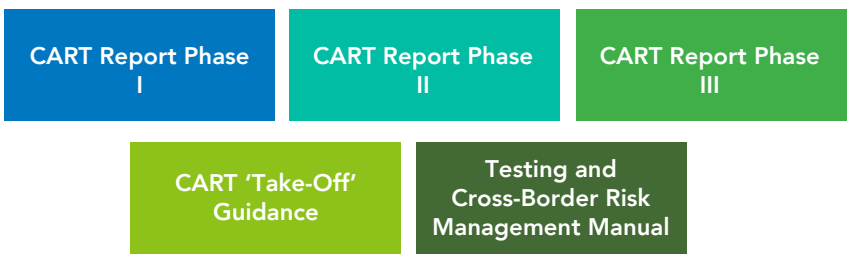
The CART reconvened in early 2021 to review and update its guidance for States to counter the headwinds and accelerate the momentum for aviation restart and recovery. Following the emergence of virus variants, progress in vaccine rollouts and new tools for combating COVID-19, the work of CART has targeted specific issues related to testing and vaccination of passengers as part of a State's multilayer risk management strategy.

In a first-ever partnership, the International Coordinating Council of Aerospace Industries (ICCAIA), Society of Japan Aerospace Companies (SJAC), Malaysia Aerospace Industry Association (MAIA) and AAIS jointly held a webinar on 20 April 2021 to brief aviation and aerospace organisations in the Asian region on the CART Phase III recommendations.

Speaking at the briefing, Permanent Representatives of ICCAIA to the International Civil Aviation Organisation (ICAO), Dan Carnelly and Mitch Fox explained how ICCAIA worked with its member organisations to represent aerospace manufacturers and MROs, providing technical expertise to support the work of ICAO.

On CART III, the major focus had been on standardization of COVID testing certificates, to facilitate international air travel. ICCAIA had made significant contributions to this effort, leading the writing of the 'Aircraft Guidelines' module, contributing towards the 'Take-off Guidance Document' & revisions, working closely with IATA on guidelines to restart aviation, and leading the drafting of the original 'Testing and Cross-border Risk Mitigation Management Manual'.

We look forward to further updates and guidance for recovery through such briefings with ICCAIA.



CART recommendations and guidelines (Source: icao.int/covid/cart/)

AAIS is now an Associate Member of the International Coordinating Council of Aerospace Industries Association (ICCAIA)

We are pleased to announce that AAIS has joined the ICCAIA as an Associate Member. Membership of ICCAIA will help advance the interests of the Singapore industry at an international level.

ICCAIA is an accredited Observer on the International Civil Aviation Organization (ICAO) Council, and acts as the voice of aircraft manufacturers and the MRO community. ICCAIA works through its member associations to represent a consensus view of the whole industry, communicating this to the governing bodies of ICAO including General Assemblies, the Council and the Air Navigation Commission.

As part of this process, AAIS members will have the opportunity to contribute on the ICCAIA Airworthiness Committee, CNS/ATM Committee, Aircraft Noise and Emissions Committee and Security Committee and various technical committees.

We would like to thank the following industry volunteers for participating on ICCAIA committees and sub-groups on behalf of AAIS:

- **Airworthiness Committee** – Mr Mervyn Sirisena, AAIS Panel of Experts
- **Cabin Safety Working Group** – Mr Michael Leung, AAR Engineering Services - Asia
- **MRO Advisory Group** – Mr Sing Kit Yuen, SIA Engineering Company

AAIS invites other members to participate in the ICCAIA committees. Please get in touch with the AAIS Secretariat to register your interest.

INSPIRING YOUR AVIATION JOURNEY

On 26 March 2021, a talent outreach webinar was conducted to share the industry outlook with over 200 students from the Institute of Technical Education (ITE), local polytechnics and universities. This was a joint effort by JTC, AAIS, e2i and the Aerospace Engineering Sector Coordination Team. The programme aimed to provide students with information on the availability of jobs, and the skills needed to seize opportunities in the aviation industry which are available even in the current climate.

The webinar was the first of its kind – integrating live-sharing, corporate videos, and virtual shop floor tours by three aerospace companies, namely Singapore Component Solutions, Collins Aerospace and Bombardier Aerospace Services. The company representatives provided an overview of the various departments in their operations, shared on their latest technologies and digitalization initiatives, as well as the internship and career opportunities available.

The rich content of the webinar showcased MRO as an exciting and dynamic industry to work in. Post-event survey feedback showed that students found the session to be insightful in providing an overview of the various operations, the career progression opportunities and the positive longer-term prospects of the aerospace sector. Students also expressed keen interests to learn more about Urban Air Mobility (UAM) and digital trends.

The Inspiring Your Aviation Journey is part of a series of aerospace careers events that will span the year. Students can look forward to more engaging events by AAIS, in collaboration with our members and partners.

GEO CONNECT ASIA 2021

AAIS' Singapore UAS Community participated in the inaugural Geo Connect Asia 2021 show from 24 to 25 March 2021. Held at the Marina Bay Sands Expo & Convention Centre, Geo Connect Asia 2021 was a hybrid conference-led event and platform for focused discussion and business networking on geospatial solutions and location intelligence.

AAIS was a supporting partner of the conference: Mapping the Data-driven Future Economy. Moderated by AAIS member of the Panel of Experts, Robin Thevathasan, the conference panel featured speakers from Nova Systems Asia and Volocopter. The panel discussed UAM business models, market opportunities, airworthiness certification, data collection and mining, etc.

Meetings were also held on-site at our Meeting Pod. The experience gained from this hybrid event will help us better prepare for future hybrid events during the pandemic period.

WOMEN IN AVIATION & AEROSPACE WITH AIRBUS

Achieving gender equality across the many different positions in the aviation industry can be a challenge. While the industry generally performs better than others when it comes to a gender balance, there is still much work to be done, particularly in some of the more technical roles at aerospace manufacturers.

In conjunction with International Women's Day, AAIS and Airbus Singapore co-organised an online talk entitled "Women in Aviation & Aerospace" on 5 March 2020 for students from the local polytechnics and universities.

Kicking off the programme, the students were warmly welcomed by Mr Mads Bondergaard, Airbus Head of Operations APAC and 2nd Vice-President of AAIS. Thereafter, students got to hear from Airbus Quality Customer Services Manager Ms Ivy Tan and Airbus Airline Marketing Director Ms Marie-Amelie Clotteau. They shared their respective career development journeys in the context of a largely male-dominated aviation and aerospace industry.

The final segment of the programme was a lively Q&A session where students participated actively, asking wide-ranging questions such as, "What are the major challenges and setbacks faced as women in this industry?", "How can women in the industry strike a balance in their work and personal lives?", and "How are women empowered by corporate & HR strategies at Airbus?".

GLOBAL DRONE SECURITY NETWORK #3

AAIS collaborated with Singapore UAS Community member, DroneSec, on its third Global Drone Security Network virtual event held on 27 and 28 April 2021. The event was livestreamed and focused on Cyber-UAV security, Drone Threat Intelligence, Counter-UAS and UTM security.

The sessions were streamed live via Youtube. Talks were helmed by Mr Mike Monnick, CTO of DroneSec and featured distinguished speakers from Parrot, CerbAir, Drone Guards, UAV Aerial Works, D-Fend Solutions, Rinicom, Shephard Media and URSA Inc.

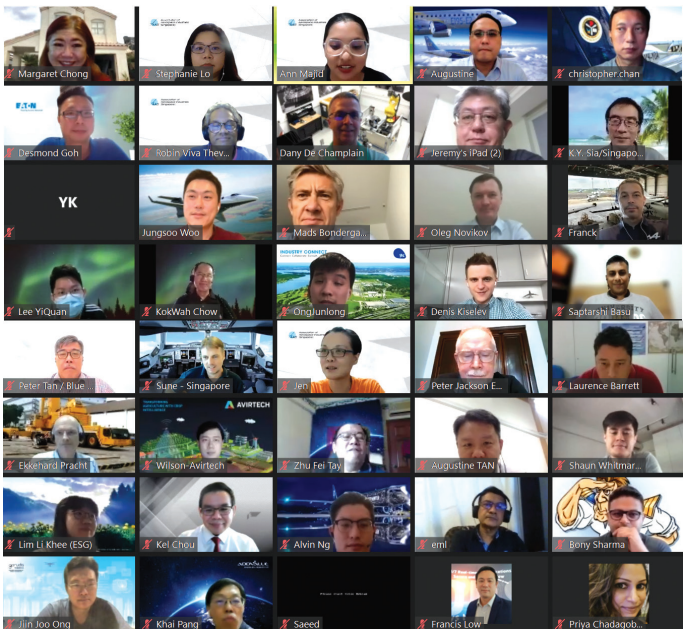
Mr Ong Jiin Joo, CTO of Garuda Robotics, a Singapore UAS Community member, addressed the topic of cybersecurity of internet-connected drones. Mr Ong discussed the risk of using cellular networks for drone communications. He explored the typical attack surfaces and defence mechanisms required for such Internet connected drones, and the impact a well thought out cyber security strategy for drones could have in enabling beyond visual line of sight (BVLOS) operations in cities like Singapore.

AAIS VIRTUAL NETWORKING 2Q2021

AAIS organised our second Networking session for the year on 21 May 2021. Albeit conducted amidst enhanced restrictions under Phase 2 (Heightened Alert), participants were in good spirits and took the opportunity to reconnect with industry colleagues and meet new faces.

The event kicked off with opening remarks by AAIS 2nd Vice President Mads Bondergaard, who provided thoughtful and insightful perspectives for the industry. "The darkest hour is before dawn" he said, reminding everyone to be mindful of mental health and well-being during these challenging times.

AAIS Management Committee member Desmond Goh then introduced attendees to three new AAIS members, namely Singapore Flying College (represented by General Manager, Captain Christopher Chan), Embraer Asia Pacific (represented by Augustine Tai, Services & Support Director (Asia Pacific)) and Ryan Griffin (represented by co-founder Woo Jungsoo).



This was followed by a breakout session for all participants to network. Many interesting discussions were had, and new connections made. AAIS Chief Executive Sia Kheng Yok then capped the event off with a BYOB toast. We thank everyone for making the time for a lively and interesting session!

ASPIRE WEEK 2021 – CAREERS IN AEROSPACE

STEM (Science, Technology, Engineering and Math) applications are becoming increasingly relevant and critical in supporting the growth of the Singapore economy.

In a tech-driven environment where companies emerge and evolve rapidly, it is important that youths are prepared for a future career relating to STEM, Innovation and Entrepreneurship ("SIE") to be able to adapt and thrive in an everchanging landscape.

Jointly organised by Neo Aeronautics, Science Centre Singapore, Singapore Institute of Technology, and supported by AAIS and the Institution of Engineers Singapore, ASPIRE Week took place from 14-20 June 2021. ASPIRE Week is a week-long event aimed at promoting Aerospace themed SIE to students through engaging exchanges and dialogue.

Under the theme "Future of Flying Cars and Aerospace Technology", the event featured subject matter experts who explored various topics relating to aerial mobility and the aerospace industry from multiple angles. We highlight with appreciation, our members who contributed towards inspiring students to careers in Aerospace:

- AAIS Panel of Experts: Mr Robin Thevathasan and Mr Chow Kok Wah
- AAIS Management Committee: Mr Ian Lam of Schaeffler Aerospace
- AAIS members: Mr Shawn Lee of Airbus and Rajarshi Maiti of Rolls-Royce
- SG UAS Community members: Mr Hon Lung Chu of Volocopter, Mr Nicolas Ang of F-drones and Mr Scottz Lip of Ngee Ann Polytechnic

AAIS WEBINARS

In lieu of industry workshops and seminars, AAIS has continued to organise Webinars as a platform for the aerospace industry to engage in mutually beneficial exchanges and learning. Selected sessions are available for viewing on our website. To watch recorded webinars, or join upcoming sessions, visit **aais.org.sg/webinars**.

AEROSPACE & MRO TRENDS FOR SUPPLIERS IN 2021 AND BEYOND

With the vaccine rollout in progress, the world can anticipate that air travel barriers will soon begin to be dismantled, and the aerospace industry can finally rebuild itself. As green shoots begin to appear, the industry prepares to enter a new landscape. In this webinar held on 10 March 2021, NAVEO Consultancy managing director Richard Brown offered his insights on the road to recovery in 2021 and beyond. Besides sharing data on the impact of COVID-19 and the status of recovery, Richard also spoke on market trends and implications for maintenance repair and overhaul.

CHALLENGES OF EMPLOYEE TRANSPORT & THE POTENTIAL OF SMART MOBILITY

Continuing to support employees with transportation has become more challenging during the pandemic as companies implement split team operations and flexible working arrangements. It has been harder to anticipate demand, perform transport planning and keep services viable as buses remain largely unoccupied. In a webinar on 18 March 2021, participants heard from Ms Grace Tan of SIAEC and Mr Nick Stipp of SWAT Mobility as they described the journey that SIAEC and other companies have taken in adopting smart mobility solutions for employee transportation.

ACCELERATING DISTRIBUTED MANUFACTURING IN AEROSPACE WITH AM

This webinar, held on 15 April 2021, was co-organised by the National Additive Manufacturing Innovation Cluster (NAMIC) and AAIS. Speakers at this event included Mr Cai Hounan of Additive Flight Solutions, Mr Lu Weiyao of Flare Dynamics and Dr Zheng Guoying of ST Engineering, who discussed their progress in AM for aerospace and unmanned aircraft applications. Mr Marc Lee of NAMIC also presented the Open Grant Call for parts analysis and design for AM. This was followed by a panel discussion that touched on the certification, qualification and others.

UPLIFTING YOUR AEROSPACE BUSINESS' INNOVATION JOURNEY

IPI Singapore (a subsidiary of Enterprise Singapore) and AAIS co-organised a webinar on 29 April 2021 to discuss business and technology innovation for Aerospace. In particular, the event highlighted the role of IPI Innovation Advisors in assisting enterprises. We were pleased to have Dr Sze Tiam Lin of IPI provide an overview of IPI's innovation services. A rich discussion ensued with Mr Julien Valette of CW Aero Pte Ltd sharing his business challenges and his experience in working through these with the help of IPI Innovation Advisor, Mr Derek Sharples.

OUR NEW MEMBERS (JANUARY TO MAY 2021)

ORDINARY MEMBERSHIP
Air Freight Logistics Singapore Pte Ltd
Air Freight Logistics Singapore is an exclusive GSSA for AirBridgeCargo Airlines, which is a part of Volga-Dnepr Group, and the leading all-cargo carrier in Russia. With 28 offices globally, more than 1,300 highly skilled air cargo experts, and a young modern fleet of 1 Boeing 777 and 17 Boeing 747 freighters, we carry all types of cargo while ensuring full compliance with global industry standards.

ORDINARY MEMBERSHIP
Laminaar Aviation Infotech Pte Ltd
LAMINAAR is headquartered in Singapore with design labs in India and sales office in USA. The company creates innovative solutions and software for the aviation industry, leveraging new technologies and specialists in custom developing the solution. After two proven decades with airlines, the ARMS® enterprise resource management application software is now available for airports, ANSP, and defence organisations.

ORDINARY MEMBERSHIP
Singapore Flying College Pte Ltd
Singapore Flying College (SFC) was established in 1988 as a wholly-owned subsidiary of Singapore Airlines (SIA) group, providing flight training to SIA group and private candidates. Since its inception, it has produced over 3000 pilots and continues to provide ab initio flight training for SIA and its subsidiary airlines. In the post-COVID market, SFC is expanding its horizons into the unmanned aviation training as a CAAS-approved Unmanned Aircraft Training Organization.

ORDINARY MEMBERSHIP
Transfingo Aviation Solutions Pte Ltd
Since 2003, Transfingo has been helping companies stay competitive and focus their core competencies by outsourcing their non-core business activities. The SME business expanded in 2020 when TransFingo Aviation Solutions was created to be a new source of used aircraft rotables, equipment, consumables & expendables, as well as specialized manpower supply and consultancy services to the aerospace industry in Singapore and Asia.

ASSOCIATE MEMBERSHIP
Enterprise Ireland
Enterprise Ireland is the Irish government export and innovation agency. The aim of EI's in Singapore is to connect Southeast Asia-based aircraft operators and engineering firms with their portfolio of world-class client companies which include MROs, Aircraft Delivery Management and Inspection Companies, Precision Engineering and Tooling Firms, IFE Developers, Aviation Software providers and Drone Operators.

ASSOCIATE MEMBERSHIP
Institute of Technical Education (ITE)
ITE is a principal provider of career and technical education and a key developer of national skills certification and standards skilling Singapore for the future economy. It offers three key programmes - (1) Pre-Employment Training for youths after secondary education (2) Continuing Education and Training for adult learners and (3) Industry-Based and Work-Study Programmes with employers.

ASSOCIATE MEMBERSHIP
Ryan Griffin Pte Ltd
RYAN GRIFFIN PTE LTD, incorporated in 2019 by two co-founders, is preparing to launch a private aviation service in mid-2022. Its service, "D.Jet", is to provide the most practical and affordable private air-travel solution in Southeast Asia for those millions of travellers to save time, money and anxiety when flying short in a small group.

ASSOCIATE MEMBERSHIP
Tradenet Services Pte Ltd
TNETS is the leading provider of customs services to the aerospace industry. Established in 2004, TNETS runs one of the largest customs declaration operations globally. With offices in Singapore, Indonesia, Malaysia, Hongkong and United Kingdom, TNETS has reshaped the customs landscape to benefit shippers and forwarders, large and small.

AAIS TRAINING CALENDAR

The Professional Development arm of AAIS offers a spectrum of training and development programmes throughout the year. These range from general or soft-skill courses to industry-specific certification courses.

AEROSPACE & INTERNATIONAL STANDARDS/CERTIFICATION

Understanding & Implementing AS 9100:2016 QMS
16 September 2021
28 October 2021#
25 November 2021

AS 9100:2016 Internal Auditor Course
16 & 17 September 2021
28 & 29 October 2021#
25 & 26 November 2021

Understanding & Implementing AS 9120:2016 QMS
16 September 2021
28 October 2021#
25 November 2021

AS 9120:2016 Internal Auditor Course
16 & 17 September 2021
28 & 29 October 2021#
25 & 26 November 2021

PROBITAS AS/EN/JISQ 9100:2016 Lead Auditor Course#
18 to 22 October 2021
13 to 17 December 2021

ISO 9001:2015 Internal Auditor Course#
9 & 10 September 2021
2 & 3 November 2021

ISO 9001:2015 Lead Auditor Course#
13 to 17 September 2021
8 to 12 November 2021

ISO 14001:2015 Internal Auditor Course#
5 & 6 October 2021
2 & 3 December 2021

IRCA ISO 14001:2015 Lead Auditor Course#
11 to 15 October 2021
6 to 10 December 2021

ISO 45001:2018 Internal Auditor Course#
16 & 17 September 2021
11 & 12 November 2021

IRCA ISO 45001:2018 Lead Auditor Course#
20 to 24 September 2021
15 to 19 November 2021

ISO 9001:2015 + ISO 14001:2015 + ISO 45001:2018 QEHS Internal Auditor Training#
13 to 15 October 2021
15 to 17 December 2021

ISO 22301:2019 Internal Auditor Training#
16 & 17 September 2021
16 & 17 December 2021

IRCA/CQI Certified ISO 22301:2019 Lead Auditor Training#
18 to 22 October 2021

ISO 27001:2013 Internal Auditor Training#
2 & 3 November 2021

IRCA/CQI Certified ISO 27001:2013 Lead Auditor Training#
20 to 24 September 2021
18 to 22 October 2021
22 to 26 November 2021
6 to 10 December 2021

ISO 31000:2018 Introduction#
29 November 2021

ISO 31000:2018 Implementation#
30 November & 1 December 2021

ISO 50001:2018 Internal Auditor Training#
6 & 7 September 2021
25 & 26 November 2021

IRCA/CQI Certified ISO 50001:2018 Lead Auditor Training#
15 to 19 November 2021

ISO 14064 - Part 1: Quantification & Reporting: GHG Emissions & Removals#
20 & 21 September 2021
18 & 19 October 2021
18 & 19 November 2021
6 & 7 December 2021

Integrated ISO 14064 - Part 1 & ISO 14067 GHG & CFP Quantifier Course#
27 to 29 September 2021
25 to 27 October 2021
24 to 26 November 2021
13 to 15 December 2021

ISO 14067 Carbon Footprint of Products: CFP Quantification & Communication#
22 & 23 September 2021
21 & 22 October 2021
22 & 23 November 2021
9 & 10 December 2021

INDUSTRY PRACTICES

International Suspected Unapproved Parts – Identifying, Detection, and Resolution
9 & 10 September 2021

EASA REGULATIONS

EASA Part 21 Subpart J - Design Organisation Approvals (DOA) #
6 to 9 September 2021
(4 half weekdays)

EASA Part 21 Initial Airworthiness#
8 to 11 November 2021
(4 half weekdays)

Airworthiness Accountable Manager#
11 & 12 November 2021
(2 half weekdays)

EASA Part 145 Maintenance Organisation Approvals#
16 to 19 November 2021
(4 half weekdays)

EASA Part M, including SEARIF Part M Continuing Airworthiness#
23 to 26 November 2021
(4 half weekdays)

EASA CS-25 Cabin Safety Design & Certification#
29 November to 8 December 2021 (8 half weekdays)

FAA REGULATIONS

FAR 145 Approved Training Programs – Train the Trainer
6 September 2021

NADCAP

Introduction to Pyrometry
2 & 3 September 2021
16 & 17 November 2021

Nadcap Checklist Review – Chemical Processing
19 & 20 October 2021

Nadcap Checklist Review – Heat Treating
18 & 19 November 2021

NON-DESTRUCTIVE TESTING (NDT)

An Introduction to Non-Destructive Testing (NDT)
4 to 6 October 2021

QUALITY TOOLS & TECHNIQUES

Root Cause Analysis (RCA)
9 & 10 September 2021
11 & 12 November 2021

Supplier Quality Audit (SQA)
23 & 24 September 2021
18 & 19 November 2021

Failure Mode & Effect Analysis (FMEA)
25 & 26 October 2021
27 & 28 December 2021

Supplier Quality Management (SQM)
28 & 29 October 2021
28 & 29 December 2021

Measurement System Assessment (MSA)
23 & 24 November 2021

SAFETY

Modern Safety Management (MSM) #
20 to 24 September 2021
25 to 29 October 2021
22 to 26 November 2021
13 to 17 December 2021

Bowtie Methodology Training#
20 & 21 September 2021
28 & 29 October 2021
25 & 26 November 2021
9 & 10 December 2021

Process Safety Management (PSM) #
22 to 24 September 2021
25 to 27 October 2021
24 to 26 November 2021
13 to 15 December 2021

SAR REGULATIONS

Singapore Airworthiness Requirements (SAR) Part 21#
18 to 21 October 2021
(4 half weekdays)

SPECIAL PROCESSES (NEW)

NDT Level II - Penetrant Inspection Applications for Aerospace Manufacturing Qualification
25 to 28 October 2021

NDT Level II - Magnetic Particle Inspection Applications for Aerospace Manufacturing Qualification
15 to 18 November 2021

Welding Applications for Aerospace Qualification
1 to 3 November 2021

Pyrometry Heat Treat Applications for Aerospace Qualification
8 to 10 November 2021

Shot Peening Applications for Aerospace Qualification
22 to 24 November 2021

Flap Peening Applications for Aerospace Qualification
29 November to 1 December 2021

Legend:

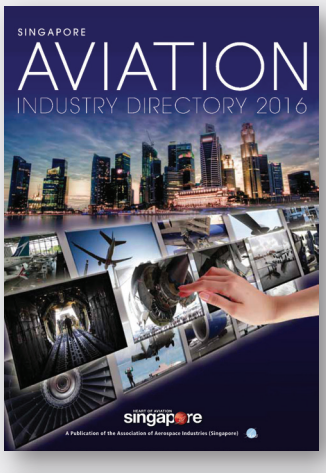
#Virtual Instructor Led Training (VILT)

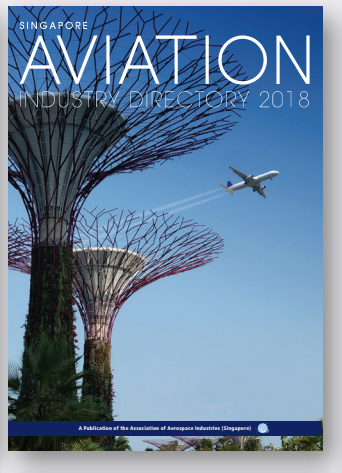
*Information is accurate at time of printing.
AAIS reserves the right to re-schedule or cancel any course due to unforseen circumstance.

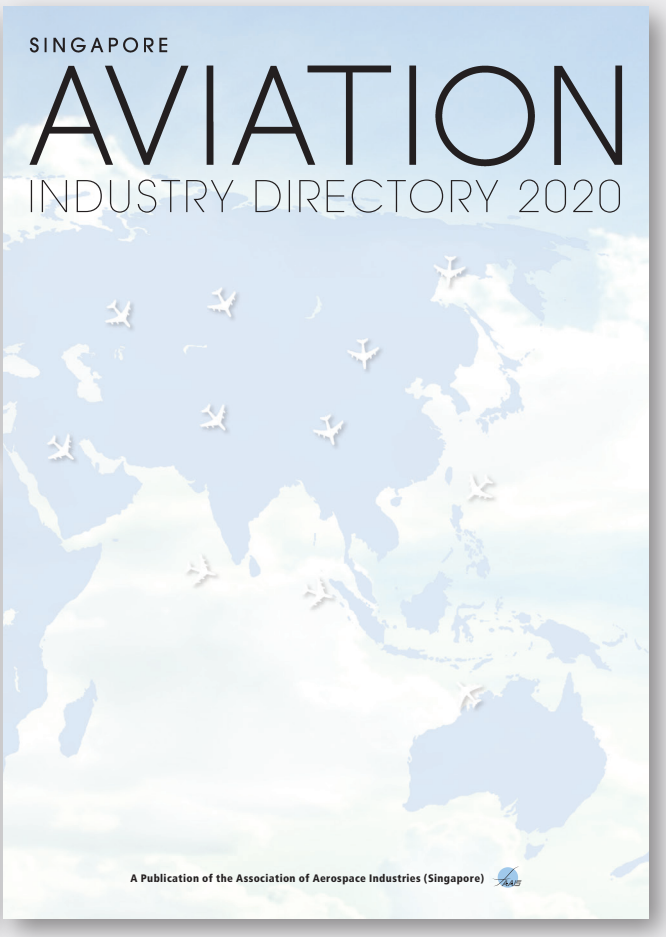
For enquiries, contact Jen Ng at +65 6922 1788 or email us at training@aais.org.sg

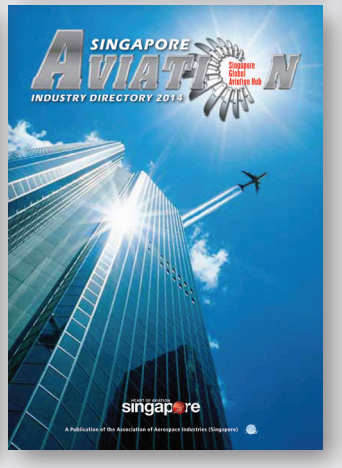
Association of Aerospace Industries (Singapore)

BE SEEN IN THE SINGAPORE AVIATION INDUSTRY DIRECTORY 2022









A one-stop reference for overseas and local investors, outsourcers and procurers of the aviation industry. Distributed to overseas and local aerospace communities, government bodies, international organisations, business associations & professional bodies.

Comprehensive listing of companies in:

Maintenance, Repair & Overhaul	Aerospace Manufacturing	Distributor of Parts & Equipment
Aerospace Supporting Industries	Logistics Services	Legal, Financing & Accounting
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