

## AVIATION

**8.2** bn. That is the number of airborne passengers anticipated in 2037 – just over the size of the world's population today. This staggering rate of growth collides with the energy transition to a lower carbon world, spurred by the Paris Agreement. Aviation is seeing the 'dawn of a third era', according to Rob Watson, Director of Rolls-Royce Electrical. The world's first flight in 1903 was followed by the Jet Age half a century later. Now, the industry must evolve to meet the strictest environmental goals ever penned (see **Box 1**).

Aviation energy efficiency needs to improve by more than 3% per year up to 2040 (it was less than 1% in 2014–2016) at a time when global activity is soaring – up 140% since 2000, according to the International Energy Agency's (IEA) sustainable development scenario. Clearly, the pressure is on. Highly ambitious goals demand creative solutions – enter sustainable aviation fuels (SAFs).

'Developments in SAFs today break down into three areas. Do they work technically? Are they sustainable? Can they be produced economically?' comments Jonathon Counsell, Head of Sustainability at IAG. 'We've proven that they work technically and that they're sustainable. The next challenge is making them scalable and economically attractive. Now we're in the phase of building facilities and the key to that is getting incentives in place.'

**Tangible progress?**

Plans for the first commercial waste-to-jet fuel plant in the UK and Europe have been submitted. British Airways, along with Altalto Immingham, a subsidiary of renewable fuels company Velocys, and Shell, has requested permission for a site in Immingham in north-east Lincolnshire, UK.

If successful, the plant will take hundreds of thousands of tonnes of household and commercial solid waste and turn it into clean burning SAFs. It is claimed this will cut net greenhouse gases (GHG) by 70%, will improve air quality with up to 90% reduction in soot from aircraft engine exhausts, and is equal to taking 40,000 cars per year off the road. It will also have an almost 100% reduction in sulphur oxides (SO<sub>x</sub>) and provide a lower emissions processing of the UK's waste than today's incineration or landfill.

# Greener aviation gains height



**Sustainable aviation fuels (SAFs) offer a major relief value to the pressure building in the skies, but they bring their own challenges. Michelle Meineke reports.**

British Airways will purchase jet fuel produced at the plant, feeding SAFs straight into the UK's legacy carrier and one of the world's top 20 biggest airlines.

If the project goes ahead, it will truly be a win-win for airlines and the environment. It would also provide an invaluable template for what else can be achieved worldwide.

**Pen to paper**

Greener fuel only works if the economics do. Policies that de-risk investments into SAF production plants are much-needed to sustain investors' momentum, be they government or private sector.

Loan guarantees, capital grants, off-take agreements, public-private partnerships for early stage plant development and more research and development (R&D) will all help.

R&D is especially critical to exploring more affordable feedstocks, such as agricultural residues and municipal solid wastes. Pricing carbon will also give financial forecasters more clarity. Currently, they are waiting on the impact of the inevitable yet also entirely unknown. For now, broader momentum is clearly building. The Chief Technology Officers of seven of the world's leading aerospace manufacturers

Interest in sustainable aviation fuels is growing, with a number of new pathways being developed that will significantly increase the spread of acceptable feedstocks

*Photo: British Airways*

**Aiming high**

The International Air Transport Association (IATA) has adopted a set of ambitious targets to mitigate carbon dioxide (CO<sub>2</sub>) emissions from air transport. This includes an average improvement in fuel efficiency of 1.5% per year from 2009 to 2020; a cap on net aviation CO<sub>2</sub> emissions from 2020 (carbon-neutral growth); and a reduction in net aviation CO<sub>2</sub> emissions of 50% by 2050, relative to 2005 levels. Each is a very tall order for a global industry, let alone one that is historically boom-and-bust with rapidly rising customer numbers.

A multifaceted approach is the only chance of success. This includes the deployment of SAFs, more efficiency in aircraft operations (see **Box 2**) and a single global market-based measure. The latter is addressed by the newly launched Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), in which SAFs play a key but not total role towards compliance. CORSIA is the only market-based measure to address emissions from international aviation and became mandatory on 1 January 2019. All aeroplane operators with international operations must monitor, report and verify their CO<sub>2</sub> emissions. Compliance will mitigate 2.5bn tonnes of CO<sub>2</sub> and generate over \$40bn in climate finance between 2021 and 2035. ●

## Holistic improvements

Improving fuel efficiency extends beyond changing the fuel itself, to the architecture, materials, manufacturing and many other facets of the industry. Continual efforts mean every new generation of aircraft today is on average 20% more fuel efficient than the model it replaces. Much of the focus on rethinking fuel efficiency is something simple yet pivotal – weight.

The ideas are broad and touch on all aspects of the value chain. For example, Emirates Airline unveiled a new first-class suite on board its newest Boeing 777-300ER aircraft last year, featuring virtual windows, reducing the weight of traditional windows. And KLM is contributing towards TU Delft's research into an innovative flight concept known as the Flying-V. The Flying V's improved aerodynamic shape and reduced weight uses 20% less fuel than the Airbus A350. While shorter in length, the Flying V has the same wingspan and passenger capacity of what is currently the world's most advanced aircraft. Dirt also plays a role. Mucky aircraft are heavier, increasing drag and using more fuel. Dry washing Emirates' 250-plus aircraft saves 11.7mn l/y of water, for example (little point improving the environmental credentials of fuel if it intensifies water scarcity).

Meanwhile, the European Commission's ongoing €3.8mn (\$4.2mn) Flight Phase Adaptive Aero-Servo-Elastic Aircraft Design Methods (FlIPASED) project encompasses improving fuel efficiency by 10% by examining aerodynamics, structural design, aeroelastic simulation and control design up to December 2022. ●

released a joint statement in June 2019 calling for more government support for technology development and production facility investment. One of their main objectives is supporting the commercialisation of SAFs, as around 185,000 commercial flights have proven that today's aircraft are ready to use them.

'Countries that introduce policy support are making the most progress with plants for SAFs, including the US, the Netherlands and the UK. In the next five years, our main challenge is getting the first SAF project built and running. Nobody has done that so far and building the first one is key to building confidence,' Counsell stresses.

### Sustaining high standards

The complex logistics of aviation need careful navigation when

introducing SAFs. In the last 24 hours alone, more than 90,000 flights and more than 6mn people have flown and landed safely. To enable this, more than 7,000 litres of jet fuel per second moved through the global distribution system, explains Simon Blakey, Senior Lecturer in Mechanical Engineering for the Low Carbon Combustion Centre at the University of Sheffield. Introducing a significant new component, ie SAFs, into this multifaceted and risk-averse industry means sustaining current operational standards is non-negotiable.

'As more organisations that haven't historically produced jet fuel are exploring SAFs production, it is imperative that the handling requirements for all fuels remain stringent. This includes cleanliness and controls to avoid cross contamination,'

states Martin Hunnybun, Head of Good Practice, Fuels and Fuels Handling at the Energy Institute. 'With another eight pathways for new SAFs currently being worked on, the spread of acceptable feedstocks is going to increase significantly. With that, standards must remain as high as ever,' he adds.

To simplify the explanation of how new SAFs are approved, new proposals are channelled through ASTM and the Commercial Aviation Alternative Fuels Initiative (CAAIFI) for testing and approval. This ensures a standardised process that underpins all new certifications. For now, the highest SAFs blend (with conventional fuel) in commercial flight is 50%.

### Array of choice?

SAFs are not the only greener fuels being explored; battery, electric and solar powered flights are also on the list. While they are no longer just theoretical, it will still be a few decades until they are the norm.

The E-Fan X is the next step in Airbus' electrification journey, potentially putting the company – and world – closer towards achieving zero-emissions flight over the next 20 years when it takes to the skies in 2021. And then there's 'Alice'. Designed to take nine passengers up to 650 miles – roughly London to Switzerland – Alice could be a rare all-electric aircraft if developer Eviation launches her in 2022 as planned. In the UK, the Future Flight Challenge was announced in August 2019 to accelerate the adoption of innovative aircraft, such as electric passenger planes and flying urban taxis. The UK government will provide £125mn, which will be supported by industry co-investment of up to £175mn.

Meanwhile, flying the equivalent of 50 return trips to the moon without a single engine overhaul is a logistical marvel that one of Aeroflot's Rolls-Royce Trent 700 engines achieved when it passed the 50,000 flying hours mark this year. Surely, if the industry has such feats under its belt, then the wide commercialisation of aviation fuels that support the Paris Agreement cannot be too far from reach? The proof of success will be safe, affordable and sustainable airborne miles. Watch this space. ●

# 2008

*marked the first flight using SAF*

# 5

*technical certifications for SAF have been approved*

# 1bn

*passengers could be carried on flights using SAFs by 2025 – approximately 25% of the total number of passengers currently taking to the air every year*

# 5%

*of all airports worldwide handle 90% of international flights, so SAF availability at a small number of airports could cover a large share of demand*

# 42,700

*new aircraft will be launched over the next 20-year period, valued at \$6.3tn, forecasts Boeing*

# 2050

*By mid-century, under a business-as-usual trajectory, ICAO predicts aviation emissions could triple*

Source: IEA, Boeing, UN's International Civil Aviation Organisation (ICAO)



British Airways, along with Altairto Immingham, a subsidiary of renewable fuels company Velocys, and Shell are developing the first commercial waste-to-jet fuel plant in the UK and Europe

Photo: British Airways