AVIATION

Rethinking flight

Airlines plan to cater to ever more passengers in the coming decades. They also say they're investing in new technologies to reduce their environmental impact. *Jennifer Johnson* looks at whether these aims can coexist.

In 1988, as the Cold War was drawing to a close, the Soviet Union successfully tested a hydrogen-powered airliner – to very little fanfare in the international press. The plane's designer, Aleksei Tupolev, was quoted as saying its engine was, unlike traditional jet engines, 'absolutely ecologically pure'.

An article published in *The New York Times* claimed that the Soviet invention would 'revive' US interest in hydrogen as a fuel. However, the low cost of kerosene meant that global airline operators would not need to consider alternative fuels for several decades – until the issue of greenhouse gas (GHG) emissions became impossible to ignore.

Fuel cell flying

Today it appears as though hydrogen-powered planes are no longer one-off engineering novelties but genuine commercial necessities. Though the technology is still in its infancy, several major companies have been willing to throw their weight behind the concept of hydrogen as an aviation fuel, most notably Airbus. The French firm currently has engineers working on a number of different zero-emission concepts that feature hydrogen as a power source. Guillaume Faury, Airbus's CEO, has estimated that a hydrogen plane could realistically enter service by 2035.

Some smaller operators have already managed to get their fuel-cell powered planes off the ground, including the California-based startup ZeroAvia, which completed a short test flight with its six-seater design last year. In December 2020, it was announced that the company had secured £12mn in UK government funding to help it develop a 19-seat fuel cell aircraft by 2023, in partnership with the European Marine Energy Centre and Aeristech. According to the consortium, its goal is to 'make zero carbon flight over meaningful distances a reality for passengers'.

Cranfield Aerospace Solutions (CAeS) – a subsidiary of the UK's Cranfield University – is in the process of designing a hydrogen fuel cell solution that can be retrofitted to existing aircraft. In September, the company completed the purchase of a Britten-Norman Islander, a small aircraft designed to operate on regional routes. It intends to outfit the plane with a hydrogen powertrain and test it in 2023. Like ZeroAvia, CAes also hopes to produce a commercially viable 19-seat hydrogen aircraft, before setting its sights on higher capacity regional planes.

Betting on batteries

While hydrogen fuel cells hold significant promise for the aviation sector, some manufacturers are betting on more traditional battery powertrains instead. Rolls-Royce is one such firm. Its all-electric plane, the *Spirit of Innovation*, took off from the UK Ministry of Defence's Boscombe Down site on 15 September this year and flew for 15 minutes. The lithium-ion battery that powers the plane is made up of 6,000 cells and features a cooling system that Rolls-Royce says 'can withstand the extreme temperatures and high-current demands during flight'.

In the short term, Rolls-Royce is aiming for its ACCEL battery to power a flight at speeds of over 480 km/h. Further into the future, the firm hopes the solution will serve as the cornerstone of new forms of urban mobility, such as 'air taxi' services. It's notable, however, that very few aerospace developers are trying to get any kind of zero emission jetliner off the ground before 2030. This is because lithium-ion batteries are still too heavy to be reasonably fitted to a large commercial aircraft.

Meanwhile, the energy density of liquid hydrogen is only about one quarter of that of conventional jet fuel – meaning that aircraft may have to accommodate fewer passengers to make room for large storage tanks. These design issues won't be easily overcome.

The largest battery-powered plane to have flown to date was a Cessna Grand Caravan, which completed a test flight in Washington state last year. The eCaravan, as it's known, has over 900 kg of lithium-ion batteries on board, as well as a 15 m wingspan and room for nine passengers.

UK budget airline easyJet is hoping to up the stakes significantly and get a 186-seat battery aircraft, designed by partner Wright Electric, into regular operation by 2030. Though larger than other models currently under development, easyJet still intends for these planes to fly short routes of around 500 km – such as London to Paris or Amsterdam.

The jetliner problem

The largest passenger jets in operation today can carry some 500 passengers. Engineers have a complex task ahead of them when it comes to designing zero-emission aircraft with similar capacities. In this regard, Boeing has taken a different tack to rival Airbus and announced that its jetliners will be

The 186-seat Wright 1 plane could be used by airline easyJet for regional routes from 2030

Photo: Wright Electric

The largest battery-powered plane to have flown to date was a Cessna Grand Caravan, which has over 900 kg of lithium-ion batteries on board, as well as a 15 m wingspan

certified to fly on 100% sustainable aviation fuel (SAF) by 2030. The company claims SAF can today reduce carbon dioxide emissions by up to 80% over the fuel's life cycle with the potential to reach 100% in the future.

'Sustainable aviation fuels are the safest and most measurable solution to reduce aviation carbon emissions in the coming decades,' said a statement by Boeing Commercial Airplanes CEO Stan Deal. 'We're committed to working with regulators, engine companies and other key stakeholders to ensure our airplanes and eventually our industry can fly entirely on sustainable jet fuels.'

The potential feedstocks for Boeing's jet fuels include non-edible plants, agricultural and forestry wastes, non-recyclable household waste and industrial plant off-gassing. But as with other biofuels, it is crucial to ensure these feedstocks are sustainable and available in the necessary quantities.

This September, more than 50 airlines and oil companies – including BP, Boeing and Delta Airlines – promised to replace 10% of global jet fuel supply with SAF by 2030. The next few years will determine whether this is a goal that can be realised, and an industry that can be scaled up.

There's little doubt that both Airbus' and Boeing's chosen routes to decarbonisation are ambitious – and significant doubts remain about whether they're even achievable. Aerospace consultant Richard Aboulafia told *Bloomberg* that Airbus' 2035 hydrogen plane target was 'a fable'. For now, zero-emission technologies can only be found on small aircraft travelling short distances. At the same time, passenger demand for flights is projected to skyrocket in the coming years. The aviation industry has precious little time to resolve the tensions between growing its business and shrinking its emissions.

Policy incentives

Even in the most optimistic scenarios, the full commercialisation of zero carbon flight is still well over a decade away – which is why some environmental groups argue that it's necessary to curtail demand for flights in the short term. Domestic flights have become a particular target for campaigners in the UK, as they produce as much as seven times more GHG emissions than an equivalent journey by train.

The Campaign for Better Transport (CBT) urged the government not to cut taxes on domestic flights in its upcoming budget, as doing so would make a 'mockery of our climate commitments ahead of COP26'. It also called for policymakers to ban domestic flights where the equivalent train journey takes less than five hours, and subsidise rail journeys to make them more affordable for passengers.

The think tank Transport & Environment (T&E) made a series of related suggestions in its response to the questions posed by the government's recent 'Jet Zero' consultation. But instead of banning domestic air travel, it suggested that the country should focus on converting all UK-only flights to zero emissions planes in the shortest time possible. T&E suggested that, like Norway, the UK should aim for a zero carbon domestic aviation market by 2040. In the meantime, taxes on kerosene and a mandate to use sustainable aviation fuels wherever possible could also cut emissions.