AVIATION

Thrust issues

The process of decarbonising air travel started years ago, but concern about oil supply problems, especially in light of the Russo-Ukrainian war, is adding impetus to the sector's efforts

Paul Sillers

Aviation has yet to end its 70-year dependence on the highly polluting cocktail of hydrocarbons known as kerosene, but several initiatives are propelling the industry towards a cleaner future. These are focused on sustainable aviation fuel (SAF), liquid hydrogen and electrical power.

SAF can be obtained from a range of renewable sources – for instance, forestry waste, used cooking oil, food packaging and even disposable coffee cups that would otherwise be destined for landfill. Because much of the biomass that's used in its production absorbs carbon from the atmosphere, SAF has "the potential to reduce greenhouse gas emissions by up to 80% compared with conventional jet fuel", according to Shell.

Several airlines have pledged to adopt SAF. For instance, BA's owner, International Airlines Group, has committed to powering 10% of its flights with the fuel by 2030. In May it took delivery of a batch of SAF made in the Lincolnshire refinery of US oil firm Phillips 66. This will be added to the pipeline infrastructure that feeds UK airports.

Meanwhile, United Airlines has agreed to buy up to 52.5 million gallons of SAF from Finnish refiner Neste over three years to fuel its services from Amsterdam's Schiphol airport. The airline's chief sustainability officer, Lauren Riley, reports that "demand from customers to limit their flying emissions is growing exponentially. This agreement means that customers taking flights from Amsterdam and, potentially, other airports will be partners in our sustainability efforts."

Despite these leading examples, more concerted action is required to ensure industry-wide adoption, according to Simon Burr, director of engineering and technology in Rolls-Royce's civil aerospace arm. Barriers to the large-scale use of SAF remain, he says. Chief among them are its current lack of "availability, scalability and affordability. We therefore need action on a global scale in forums such as the general assembly of the International Civil Aviation Organization. It's vital that governments agree on a long-term decarbonisation target."

Promoting the use of SAF is a key part of Rolls-Royce's sustainability strategy. The company has successfully tested several of its engines to verify their compatibility with the fuel. Its next-generation engine demonstrator, UltraFan, is set to undergo similar trials.

"Thanks to rigorous testing, we know our engines can operate on SAF," says Burr, who adds that, if production can be scaled up sufficiently, "uptake will improve affordability and create an environment where more airlines can adopt SAF as part of their flight to net zero".

Liquid hydrogen is another cleaner alternative to kerosene that's come on to the industry's radar. The UK government is pumping £27.2m into a scheme led by GKN Aerospace to develop a hydrogen propulsion system for smaller aircraft that could be scaled up. The H2Gear project is aiming to enable flights by 2026, using a system that converts hydrogen into electricity using a fuel-cell system. The process emits no CO_2.

Partners in the initiative include Aeristech, Intelligent Energy and the universities of Birmingham, Manchester and Newcastle, while easyJet will provide insights into operational requirements and options for flight demos.

"Technology is a key driver to achieve our decarbonisation targets, with hydrogen propulsion a front-runner for short-haul airlines like us," says easyJet's director of flight operations, David Morgan. His company is optimistic that "it could begin flying customers on planes powered by hydrogen combustion, hydrogen-electric power or a hybrid of both by the mid- to late 2030s".

While the arrival of hydrogen-fuelled aircraft will create a new category of cleaner air travel, another approach is to retrofit existing planes with the technology.

ZeroAvia's HyFlyer II project is developing hydrogen engines for demonstration on a 19-seater aircraft that it hopes will fly next year. The Anglo-American company will work with Canada's MHIRJ Aviation Group to design and equip regional jets (aircraft designed to carry no more than 100 people on short-haul flights) with a 600kW powertrain.

At the annual summit of the World Economic Forum at Davos in May, the founder and CEO of ZeroAvia, Val Miftakhov, declared that the hundreds of regional flights taking place daily across North America "can and should be zero-emission well before the end of this decade". He called his firm's collaboration "a giant step forward in delivering hydrogen-electric engines to the regional jet segment".

The venture has obtained airsafety experimental certificates for its prototype aircraft from the UK and US airworthiness authorities; passed significant flight tests; and established partnerships with original equipment manufacturers and global airlines. It's on track to start commercial operations in 2024.

ZeroAvia is also developing a 5MW modular powertrain for use in 40- to 80-seat turboprop aircraft – a project with supporters including United Airlines and Alaska Airlines.

As urban road networks struggle to accommodate commuter traffic, the only way is up. That's the rationale behind the evolution of a new category in aviation: advanced air mobility – a mash-up of urban air mobility (flying taxis) and commuter aircraft.

"These aircraft will introduce all-electric flying, which is quieter and more efficient, enabling us to reduce travel times dramatically," says Matheu Parr, customer business director at Rolls-Royce.

The company is planning to introduce both all-electric and hybrid-electric engines for service by the mid-2020s. To this end, it's using next-generation test aircraft, including the Spirit of Innovation. Powered by a 400kW unit, it can claim to be the world's fastest all-electric vehicle, having topped 387mph during a test flight.

Rolls-Royce has also been collaborating with manufacturers Rotax and Tecnam to flight-test a hybrid-electric aircraft powered by parallel-hybrid propulsion – tech that could be applied to larger planes.

Data obtained from testing is already being applied in the urban air mobility market. A Rolls-Royce unit has been chosen by Vertical Aerospace for the VX4. This all-electric vertical-takeoff aircraft is designed to transport a pilot and four passengers, emission-free, over 100 miles at 200mph. The Bristol-based firm is aiming to secure certification for the VX4 in 2025 and has obtained conditional orders and pre-order options for up to 1,350 aircraft from players including Virgin Atlantic and American Airlines.

Whichever alternative source of power turns out to be the prevalent choice, one certainty is that tomorrow's skies will feature a broader spectrum of vehicle types. This presents an opportunity for disruptors to shape the future of energy-saving propulsive technology.

Bedford-based firm Blue Bear Systems Research is leading a seven-member consortium that's been developing "a highly power-dense, quiet and efficient propulsion module with zero tailpipe emissions". The design can be adjusted for general aviation aircraft, large cargo drones, air taxis and regional airliners. Co-funded by the government's Aerospace Technology Institute programme, the Integrated Flight Control, Energy Storage and Propulsion Technologies for Electric Aircraft (Inception) project is focused on optimising the conversion of electrical energy into thrust.

The Inception project started in January 2021 and production of the completed design is under way, with wind-tunnel testing due to start imminently. The plan is to install the module on an aircraft platform, aiming for airworthiness certification in 2026.

The industry needs to have more faith in disruptive new entrants if it's to have a greener future, argues Blue Bear's CEO, Dr Yoge Patel.

"The UK is one of the most inventive nations, attracting lots of investment – and Blue Bear has had great government support," she says. "But how do you get that brand credibility when you're a startup?"

The next big challenge, once you have established a foothold in aviation, is staying in the game, Patel says. And the third is to grow your business, either organically or through investment, without losing the innovative culture that "keeps you sharp, stops you becoming complacent and prevents you from being process-driven".

Her firm, for instance, "set out to become an agile systems integrator. It was also important to create an agile culture and not to be dependent on any of the large companies".

Vertical integration has been crucial to the Inception project. As well as producing the engine, Blue Bear provides all the testing and evaluation infrastructure too.

"We aren't dependent on a third party for that. We also do our own certification and assurance," Patel explains. "We have verticals that we've joined together to allow us to go from an idea to the delivery of flight-tested goods."

That level of control is unusual for an SME. And, while this has given the firm freedom, there is a crucial factor over which it has no sway: the regulation of the next generation of energy-efficient engines that will serve many forms of aviation, potentially using the same airspace.

"The rules and procedures will change," Patel says. "The way the industry supplies evidence of airworthiness also needs to change if we're to do this more quickly and thoroughly. Along with funding, that is an absolute barrier."

Rolls-Royce has been developing an engine for Vertical Aerospace's all-electric VX4 aircraft – a new entrant to the so-called urban air mobility market

Above: Spirit of Innovation, Rolls-Royce's all-electric test aircraft, has been breaking speed records. Far right: GKN Aerospace's H2Gear project is aiming to enable hydrogen-powered flights by 2026. Right: Rolls-Royce has successfully trialled sustainable aviation fuel in its engines

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