# Green aviation takes wing with electric aircraft designs

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As the aviation industry recovers to pre-pandemic levels, innovators are exploring solutions to reduce aircraft's carbon footprint. Credit: John McArthur via Unsplash

With the overall rapid growth of air travel, aircraft design is ripe for decarbonization, but widespread electric flight requires better batteries

and lightweight systems.

As the aviation industry emerges from the impact of the COVID-19 pandemic, when passenger numbers plummeted, the number of flights is increasing again. The industry is recovering to pre-pandemic levels of air passenger journeys, with some estimates forecasting over 40% growth by 2050.

In general, crises aside, air passenger travel tends to double every 15 years, with the aviation sector also proving one of the fastest-growing sources of greenhouse gas (GHG) emissions. It currently accounts for 2% of global GHG emissions, but this is forecast to potentially triple by 2050 from 2015 levels on its existing trajectory.

Given that the European Green Deal calls for climate-neutrality by 2050, a green reset is called for to improve the sustainability of aviation. Follow the link to learn more about the measures the EU is advocating to reduce aviation emissions.

Aviation is becoming more efficient with engine improvements, but decarbonizaton calls for alternatives to today's fossil fuel-hungry aircraft.

Hybrid-electric and full-electric propulsion systems offer one answer. Such powertrains are already gaining traction on the ground, with global sales of electric cars doubling last year to 6.6 million.

Numerous projects are under way for aviation to follow suit, but they face many challenges, not least of which is the sheer weight of batteries.

Yet finding environmentally friendly alternatives that are simultaneously high-performance and profitable is of "paramount importance," said Fabio Russo, head of research and development at aircraft manufacturer

Tecnam in Capua, Italy.

## Scalability

Russo led the H3PS (High Power High Scalability Aircraft Hybrid Powertrain) project, which investigated the potential of hybrid-electric systems in so-called "general aviation" (GA) aircraft.

Covering more than 400,000 civilian aircraft around the world, this category includes private planes, business jets, helicopters and more, but not commercial airliners.

As aircraft that tend to be relatively small, the H3PS initiative views them as a first step towards developing electric propulsion systems for wider flights.

"We need environmental solutions today, and the H3PS project was done to prove an efficient, low-weight and scalable solution," said Russo.

"Scalable means you can move this concept from a four-seater aircraft up to an 11-seater or, eventually, more-seater aircraft."

## Hybrid powertrain

The project also involved Rolls-Royce and engine manufacturer Rotax. One of its objectives was to fly a four-seater aircraft powered by what's known as a "parallel hybrid powertrain"—combining both a traditional internal combustion engine and an electric motor.

The hybrid propulsion system can give a power "boost" to the aircraft during flight phases such as take-off and climb, says Russo. With a hybrid, you can, for example, use a fuel engine with a lower power than

normal and fill the gap for the aircraft to take off and climb with an electric motor.

"You can therefore have access to a lower-consumption fuel engine," said Russo.

This approach enables a reduced engine size and weight, allowing the battery for the electric motor to be included without adding significant weight to the system.

Late last year, the project succeeded in taking to the skies with its Tecnam P2010 H3PS aircraft. As the first four-seater to do this using a parallel hybrid system, H3PS highlighted the achievement as "a major milestone on the aviation industry's journey towards decarbonization and R&D on alternative powertrains."

## Battery economy

Nevertheless, Russo emphasized that the project was about demonstrating the feasibility for such aircraft rather than creating a product for market. There is some way to go to make them a reality on a wide scale, he said.

"There are still quite a lot of limits in terms of economics behind developing this kind of engine and aircraft," said Russo.

One key limiting factor is how the batteries deteriorate as they cycle through recharges. This means there is a high cost to keep replacing them on timescales that, at present, Russo estimates may be as little as a few months.


The first flight of the P2010 H3PS hybrid aircraft. Credit: © Tecnam, 2021/22

He believes improvements rest on a real drive, backed by support from the battery-manufacturing industry, to boost battery technology, while reducing shipping and decommissioning costs, and enhancing the circular economy.

"A local economy for battery manufacturing is essential," said Russo. "This will also mean that $CO_2$ is not saved only during operation, but well before and after the battery's use in an aircraft."

He added that for aircraft components as a whole, focus is required on the full end-to-end lifecycle and impact of products.

## Viable hybrids

Russo believes such hybrid aircraft could become more economically viable by about 2030, with the potential to save significantly on emissions in certain flight phases.

One test his team performed indicated a potential 50% reduction in carbon emissions during take-off and initial climb, and 20% during the whole three-hour journey, suggested by the lower amount of fuel used.

"At the end of the flight, when we measured the fuel we consumed, the difference was remarkable," said Russo.

Other projects are investigating how to optimize different components for future electric propulsion aviation systems to make them as lightweight as possible, as well as safe and efficient.

## Electromagnetic interference

For example, the EASIER project has been designing systems to limit electromagnetic interference (EMI) between components that may affect an aircraft's functioning.

The team is also investigating thermal methods to better dissipate heat generated by electrical components. That is all while trying to ensure the aircraft remain lightweight, taking the size and weight of current batteries into account.

Dr. Ignacio Castro, a senior principal engineer at Collins Aerospace, based in Cork, Ireland, is the coordinator for EASIER. He said the project has been looking into EMI filtering and wiring options with lower volume and weight for electrical powertrains in aircraft, plus "two-phase" cooling systems and methods to improve rates of heat transfer to an aircraft's exterior.

He explained that there's a need to prepare now for the long-term future of electric systems. "Any change that we make to an aircraft to make it greener could potentially increase the weight of the aircraft," said Dr. Castro.

"That also increases the amount of fuel consumed, so we might not have an aircraft that is fully ready for flight. We need to make things smaller."

Some of EASIER's upcoming work involves more investigation of the trade-offs between methods. "The idea is that we will see how the thermal systems are affecting the EMI and vice versa, to see what the implications are," said Dr. Castro.

## Trade-offs

There are all kinds of other trade-offs to understand when it comes to manufacturing electric aircraft. For example, while making things smaller decreases weight, it can cause things to heat up faster too—much like a small house warms up quicker when heated. "That's the kind of trade-off with weight, size and efficiency, and it's not that simple," said Dr. Castro.

He added that integrating all the individual technologies into a well-functioning overall aircraft system will be key in future research.

"It's about understanding what the architectures should look like to be made as efficient as possible," said Dr. Castro.

Comparing it to construction, he stressed that you can't just throw bricks together in any way to make a building. "You need to put things together in a way that's smart in the context of power delivery," he said.

## Right direction

Though there are many complex issues to resolve in electric aviation, Dr. Castro believes things are starting to move in the right direction. "I think we're taking the right paths towards hybrid-electric aviation, and there's a lot of interest and many programs," he said. "That would be the first step to start reducing carbon emissions."

Ensuring these new systems run smoothly and safely is also essential. Safety is paramount and a single crash is enough to generate big headlines and plenty of fear.

That means a need to take significant care with developments. "There's a risk saying things are going to be great, particularly when things need to be extremely reliable for aircraft," pointed out Dr. Castro. "It's a paradigm shift in technology."

There is also much investment needed and many questions to address in the coming decades, he said. "The challenge towards net-zero emissions in the EU by 2050 is a huge challenge, and I don't think at the moment anyone has a definite answer," said Dr. Castro. "It's the one-million dollar question."

**More information:** H3PS: cordis.europa.eu/project/id/769392

EASIER: cordis.europa.eu/project/id/875504

EU action to reduce aviation emissions in Europe: ec.europa.eu/clima/eu-action/t … -to-offset-emissions

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