FAIR PROMOTES ELECTRIC AVIATION

INFOSHEET #1

ELECTRIC AIRCRAFT - BATTERY, HYBRID AND FUEL CELL

The next step for aviation to become more sustainable may be to follow the auto industry and electrify shorter trips. This development is on the brink of becoming reality as numerous companies around the globe are working on this. In this infosheet you will get a brief introduction and overview of the field of electric aircraft along with selected examples.

An electric aircraft is an aircraft powered by electric motors. The first electric aircraft (with solid wings) flew in 1973 for 14 minutes. An electric aircraft can be either fully electric or hybrid electric. Two major types of energy storage technologies for electric airplanes dominate the field: battery electric and hydrogen fuel cell electric.

The advantage of electric motors over combustion engines is that they are more efficient. The largest portion of potential energy that is available in the fuel used in both piston and turbine engines is converted into heat. Electrical engines only lose a fraction of their potential energy due to electric resistance. This means that an electrical aircraft can fly with more than 90% potential energy transference to the axis in the powertrain while a turboprop aircraft has a potential energy of 20–25% at low altitudes and up to 35% efficiency at high altitudes. A turbofan engine is rather effective but still not close to an electric engine. Electrical engines also have a much faster acceleration from zero to maximum effect compared to both piston and turbine engines. Another upside is less maintenance since an electrical driveline has fewer moving parts that wear during operation compared to a fossil-fuel engine.

BATTERY ELECTRIC AIRCRAFT

A battery electric aircraft is an electric aircraft that stores its energy in batteries.

Photo credit: www.pipistrel-aircraft.com

The Slovenian company Pipistrel has developed three electric aircraft. Pipistrel's Taurus Electro model was the first two-seat electric airplane in serial production available on the market in 2007. The airplane was powered by a 40 kW Li-based battery technology. Today, the Pipistrel Alpha Electro is the world's first electric airplane intended for flight training. It has a flight time of 1 hour plus a 30-minute reserve. The theoretical range is 600 km. The electric motor is 60+ kW and weighs 20 kg. The 21 kWh battery pack can either be replaced in minutes or recharged in less than an hour. The aircraft is certified in accordance with Federal Aviation Administration (FAA) regulations. Pipistrel has a third model, the Pipistrel Velis Electro, which in June 2020 became the world's first EASA-type certified electric airplane. It is fully approved for pilot training. The Velis

PROS AND CONS WITH ELECTRIC AIRCRAFT

+ LESS NOICE
+ REQUIRES SHORTER RUNWAYS
+ LOWER CO_2 EMISSIONS
+ LOWER COST OF OPERATIONS
– SHORTER RANGE
– LOWER CRUISING SPEED

Electro has an entirely liquid-cooled powertrain, including the batteries. This is next generation technology that enables about a doubling of the powertrain lifetime. Flight training is the main purpose for the Velis Electro. The commercial range is around 100 km or 50 minutes.

MagniX is a company founded in Australia in 2009 and now located in Seattle. It creates electrical motors designed to replace conventional engines. The electrical motor magni250 produces 375 horsepower (280 kW) for smaller airplanes, such as the nine-seat Eviation Alice aircraft. The magni500 is a 750-horsepower (560 kW) electrical motor designed to fit in models like the de Havilland Beaver, Cessna Caravan and Beechcraft King Air. The range will be around 160 km. In 2019, the Havilland Beaver, retrofitted with the magni500 system, made its first flight in Vancouver, Canada. It is operated by Harbour Air and is intended for short flights (30 minutes plus 30 minutes back-up) to the nearby villages from Vancouver. A certification process was started after the demonstration flight and will take around two years. The first 30-minute test flight with a turboprop aircraft, the nine-seat MagniX's 208B Cessna Grand Caravan, took place in 2020 in partnership with AeroTec. The aircraft was equipped with the magni500 engine. The MagniX electrical engines has a lifetime of around 30,000 hours, which is a lot more compared to conventional engines used today.

Photo credit: MagniX.

Heart Aerospace is a Swedish start-up developing a 19-seat electric aircraft, the Heart ES-19. Its range is 400 km, and it has a cruising speed of around 300 km/h for aluminium aircraft. The aircraft will be equipped with 4 engines of 400 kW each, which means a total power of around 1600 kW. The engines will be powered by 4 batteries of 180 kWh each. The goal is to have the aircraft certified and ready for commercial flights in 2026. The plane should be able to use short runways, 750 m, and focuses on regional travel. The company is working a lot with simulations to develop the aircraft. In late 2020, the electric propulsion system was ready, and real tests have started.

Photo credit: Heart Aerospace.

FUEL CELL AIRCRAFT

Aircraft powered by fuel cells store their energy for the engines in the form of hydrogen, which is converted into electricity through the fuel cells.

ZeroAvia is a company located both in United Kingdom and the United States. In June 2020 ZeroAvia held the first test flight of the six-seat Piper M-class equipped with an electrical motor. In September 2020, the first test flight with the Piper M-class aircraft powered with hydrogen and fuel cells was done in Cranfield, UK. It was equipped with a system from the Swedish company Powercell. The next step is a 400 km zero emission flight. ZeroAvia is also working towards having a 19-seat aircraft that uses fuel cells instead of batteries ready for the market by 2023. It will have a range of 560 km and be equipped with a 600 kW hydrogen-electric powertrain. The company also hopes to have an aircraft for 50 to 100 passengers in 2030 and for around 200 passengers in 2040.

H2FLY is a German spin-off from the German Aerospace Center (DLR). The company operates the HY4, which was developed by DLR, H2FLY, Pipistrel, Stuttgart Airport, Hydrogenics and the University of Ulm. HY4 is a four-seat aircraft powered by a hydrogen fuel cell system with electrical propulsion. The 80 kW motor has a cruising speed of 145 km/h and a range of 750 to 1500 km. The HY4 has a special design with two fuselages, each with room for two passengers. In 2016, the HY4 made a successful test flight. A lithium battery was covering peak power loads during take-off and when climbing. In November 2020, the HY4 made 35 take-offs, flying up to 2 hours per flight using a hydrogen powertrain within the EU project Modular Approach to Hybrid-Electric Propulsion Architecture (MAHEPA).

	MODEL	PASSENGERS	PLANNED MARKET INTRODUCTION	POWER (KW)	RANGE (KM)
BATTERY	Pipistrel Velis Electro	2	2020	57.6	100**
	Phinix	2	2018*	60	300
	Bye Aerospace eFlyer8	8	2024 – 2026	n/a	930
	MagniX - Havilland Beaver	6	2019*	560	160
	MagniX - Cessna Caravan	9	2020*	560	n/a
	Heart ES-19	19	2026	4x400	400
	Eviation Alice	9+2 crew	2022	n/a	1000
	Wright 1	186	2030	n/a	500
FUEL CELL ELECTRIC	ZeroAvia Piper M-class	6	2020*/2023	n/a	n/a
	ZeroAvia	19	2023	600	569
	H4Y	4	2016*	80	750-1500
	H2FLY	40	2030	1400	1850
	De Havilland Canada DCH-8 Q300	40	2024	n/a	740
HYBRID ELECTRIC	Ampaire Cessna 337	3	2019*	n/a	640
	Ampaire Eco OtternSX	19	2024	1000	320
	Boeing Sugar VOLT	135	2030-2050	n/a	n/a
	EAG HERA	70+	2028	n/a	1480

*first test flight **commercial range

HYBRID ELECTRIC AIRCRAFT

There are two types of hybrid electric aircraft: parallel hybrid and serial hybrid. A parallel hybrid is a plane with both an electrical engine and an internal combustion engine, which work in parallel to provide thrust for the aircraft. In a serial hybrid, the propellers are powered by one or several electrical motors and the electricity comes from batteries or fuel cells and from a generator powered by a turbine engine.

Ampaire is an American company developing a hybrid electric aircraft called the Electric EEL. The aircraft is a converted conventional three-seat Cessna 337 (Skymaster). One of the two motors are powered by a pack of batteries. It has a range of 640 km. The first test flight in 2019 used both the conventional and the electric powertrains. Ampaire is working with Mokulele Airlines in Hawaii to demonstrate the benefits of electrical flying. In November 2020, the Electric EEL aircraft had a 20-minute flight from Maui's Kahului Airport across the island to Hana and back on a single charge. It was the world's first demonstration flight along an actual airline route. Ampaire is also working on future projects, including rebuilding of a 19-seat DHC6 (Twin Otter) turboprop aircraft into the Eco Otter SX. The range of this hybrid electric plane will be 320+ km using a 1 MW power source. This project is in cooperation with National Aeronautics and Space Administration (NASA). The company aims to receive FAA certification in 2023, with passenger service commencing in 2024.

Photo credit: Katla Aero.

EVTOL

Electrical aviation is an exciting and innovative field, and the electrical vertical take-off and landing aircraft (eVTOL) are perhaps the most ground-breaking approach. The concept of eVTOLs is basically a merger between a helicopter/drone and an aircraft. eVTOLs can do vertical take-offs and landings, during transit are able to utilise the aerodynamic benefits of having wings in forward movement. As far as infrastructure goes, this gives the eVTOL a major advantage as it only requires a flat surface to land and take off from.

CONCLUSION

Electric aviation currently has its greatest potential in short distances, 200–400 km and where the current alternative for travel involves prolonged actual distances. In these cases, the aircraft is a faster alternative compared with other options. Fuel cell aviation has the greatest potential in mid-range distances, but on the longest distances drop-in bio-jet fuel will probably be the solution for achieving the goal of fossil-free aviation.

WORK PACKAKGE

WP 2 - Guidelines for implementation

AUTHORS

Arne Smedberg, BioFuel Region
Ida Norberg, BioFuel Region
Simon Oja, BioFuel Region

CONTACT INFORMATION

WP Coordinator Arne Smedberg
arne.smedberg@biofuelregion.se

DOWNLOAD AND READ THE FULL REPORT *"ELECTRICAL AVIATION 2021 - TECHNOLOGY OVERVIEW" IN JUNE 2021*

ABOUT FAIR

FAIR is to be seen as a first step of preparing the Kvarken region for an early implementation of electric aviation.

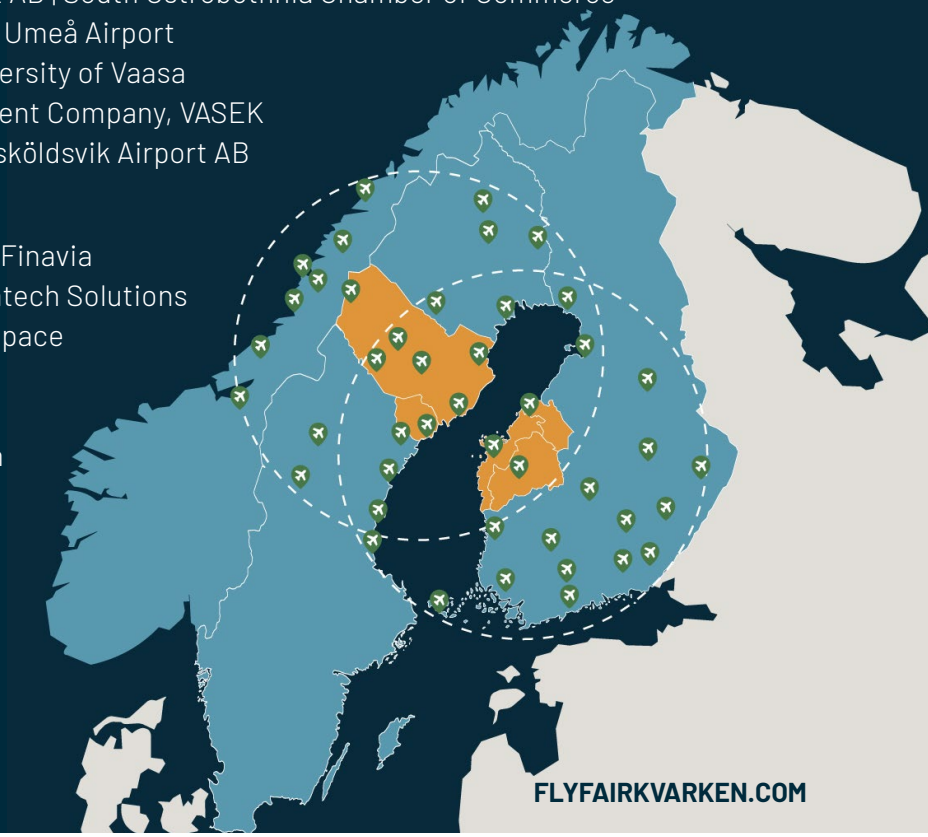
The project increases the knowledge base about electric aviation, investigates the possibilities and surveys both the needs and the required technical investments.

FINANCIERS

Interreg Botnia Atlantica | Region Västerbotten | Regional Council of Ostrobothnia | Kvarken Council (Lead part)
BioFuel Region BFR AB | City of Vaasa | FAB Kronoby Flyghangar | Into Seinäjoki Oy | Lycksele Flygplats AB
MidtSkandia | Ostrobothnia Chamber of Commerce | RISE Research Institutes of Sweden
Skellefteå City Airport AB | Skellefteå Kraft AB | South Ostrobothnia Chamber of Commerce
Storumans Kommunföretag AB | Swedavia Umeå Airport
Umeå Municipality | Umeå University | University of Vaasa
Vaasan Sähkö Oy | Vaasa Region Development Company, VASEK
Västerbotten Chamber of Commerce | Örnsköldsvik Airport AB

SUPPORTING PARTNERS

Air Traffic Network | BSR ACCESS | ELISE | Finavia
Funktionshinderrådet Umeå | Future Cleantech Solutions
Green Flyway | Grön Flygplats | Heart Aerospace
Helsinki Electric Aviation Association ry
Jonair | Luftfartsverket
NEA – Nordic Network for Electric Aviation
Umeå kommunföretag AB
Umeå Institute of Design
The Swedish 2030-secretariat
Transportföretagen



FAIR PROMOTES ELECTRIC AVIATION

KVARKENRÅDET
MERENKURKUN
NEUVOSTO

EUROPEAN UNION

Interreg
Botnia-Atlantica
European Regional Development Fund