FAIR PROMOTES ELECTRIC AVIATION

INFOSHEET #2

ELECTRIC AIRCRAFT - ENERGY CARRIERS

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 electrifying aircraft. In this infosheet you will get a brief introduction and overview of the energy carriers used in the development of electric aviation.

There are mainly two different kind of energy carriers in the development of electric aviation: batteries and hydrogen. Both can be used solely or in combination with other energy carriers such as jet fuel and is then called hybrid electric. The two most important factors affecting the development of the battery technology is battery capacity and cost.

BATTERY LIFE

Battery life will be determined by both the capacity and ability to deliver full power. Today, there are no regulation regaring batteries for electric aviation, but it will probably be stricter compared with the car industry, where batteries are considered end of life at 75% to 80% reduced capacity. The Swedish company Heart Aerospace is counting on between 1000–3000 recharging cycles for a battery before it will be replaced. This is an interval between one to three years, depending on how many times a day the batteries are recharged.

MINERAL DEMAND

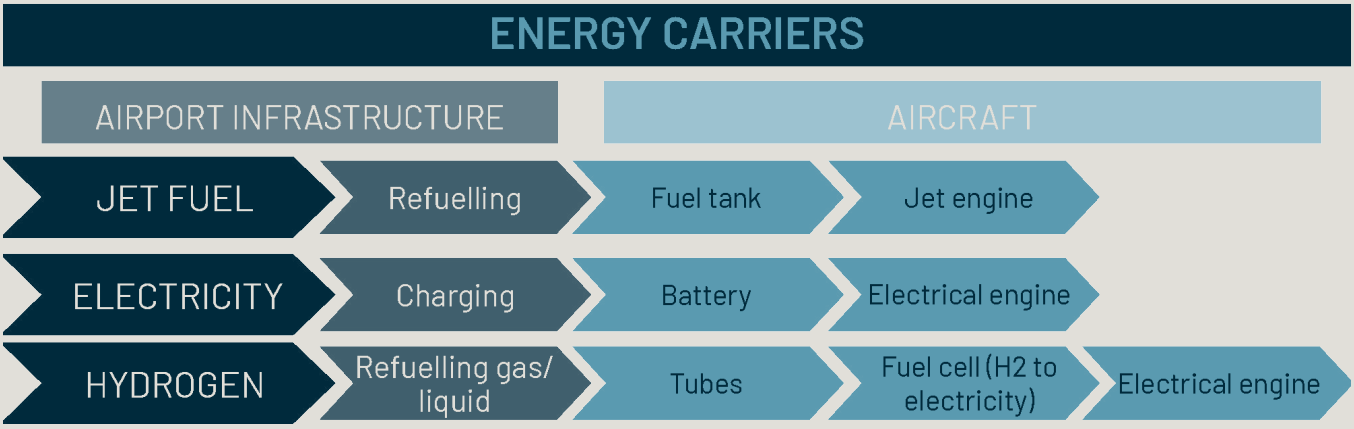
Mineral demand for key materials, such as cobalt and lithium, is often pointed to as a problem for expanding the use of electrical cars. These minerals often come from politically and economically instable countries. This is assumed to be a bottleneck for the expansion of the electric car industry in the next 15 years. In an effort to address some of these problems, the European Commission has proposed modernised EU legislation aimed at steering the production of batteries to more sustainable solutions as part of a circular and climate-neutral economy. This is part of the new Circular Economy Action Plan. Batteries that are more sustainable throughout their life cycle are key for the goals of the European Green Deal.

RE-CYCLING

In terms of reuse and recycling of batteries, the trend in the car industry is on reusing old batteries as grid storage. This could perhaps be a new sector. Batteries which are not suitable for cars and aircraft any longer, but nonetheless able to store relatively large amounts of energy, can yet be suitable to use in other solutions. Another area for more sustainable batteries and extending the life of scarce minerals is recycling, something that Northvolt in Skellefteå is researching and developing.

SAFETY AND DOWN-SIDES WITH ION-BATTERIES

There are drawbacks with Li-ion batteries. They have a tendency to overheat, which in some



Type	Specific Energy, Cell level, Wh/kg	Specific Energy, Pack level, Wh/kg	Number of passengers	Range, km
Fully electric	250	150-170	2-3	330
	400	300	30	490
	600	400-500	50-70	490
Hybrid electric	400	300	50-70	490
	600	400-500	100-150	490
	1000	>750	180	1 450

cases can cause fires. Li-ion batteries require safety mechanisms to prevent high voltages and internal pressure. Another drawback is when the batteries age, they can lose capacity and frequently stop working. Moreover, Li-ion batteries are about 40% more expensive than Ni-Cd batteries.

HYDROGEN FUEL CELLS

A fuel cell generates electrical energy through an electrochemical reaction. The process is similar to a battery, but with the difference that a battery needs to be recharged when the electrodes are consumed. A fuel cell produces electrical energy as long as it is fuelled by hydrogen and oxygen. Water is the only emission from a fuel cell, but at high altitudes this can impact the climate since it contributes to increased cloud formation. The carbon footprint for fuel cell technology depends, however, on the manufacturing process used to make the hydrogen.

Challenges

Hydrogen is in gaseous phase at room temperature and consists of two hydrogen molecules. It is the lightest element in the periodic table and has a high energy content. The energy content per kilogram is three times higher compared with jet fuel. But, per volume, it is low, which makes storage and transportation of hydrogen very space-intensive, requiring about 4 times more space than jet fuel with the same energy content. This can lead to less room for passengers and cargo or to larger aircraft. As fuel cells are not able to produce enough power for lift-off, this type of solution must be complemented with a battery. There are challenges to solve for fuel cell technology and operation of 19-seat fuel cell powered airplanes may be a reality in about 10 years. Similar to battery technology, the development of fuel cells is also driven by other sectors, such as the car, steel and concrete industries.

According to a study by the consultancy Roland Berger, sustainable production of hydrogen together with distribution, storage and fuelling are the largest challenges for hydrogen technology becoming a reality for air traffic.

TECHNOLOGY DEVELOPEMENTS

Today's capacity for lithium ion batteries in aircraft will most likely put the maximum range around 400km for smaller planes, maximum 19 passengers. This is an established technology that we know what to expect from.

The next generation of batteries is lithium solid state, they will be able to hold approximately twice the amount of energy which will double the range to upwards 800km. A next generation Li-battery, a solid state, has been used for the first time in a test flight in 2021.

After this the next stage will be a lithium air battery. This solution has a potential of holding almost three times as much energy as lithium ion batteries. But development is yet at an early stage so predictions are still uncertain.

As for fuel cells the range for aircraft will be longer than battery electric aircraft but still shorter than conventional jet engines.

LITHIUM ION

Todays main battery in electrical applications from phones and power tools to bikes and cars.

LITHIUM SOLID STATE

The next generation battery that can store more power in relation to weight than lithium ion.

LITHIUM AIR

A future technolgy with a promise of up towards three times the energy density of lithium ion

CONCLUSION

The battery technology are developing fast, we are already testing the solid state variants. And new types of batteries will have an big impact on electric aviation. Higher energy density will open up for longer range and/or more passengers or cargo. What is avalible now will only make out the baseline, next generation batteries can make electric aircraft a serious competitor to traditional fossil based aircraft.

WORK PACKAKGE

WP 2 - Guidelines for implementation

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

ABOUT FAIR

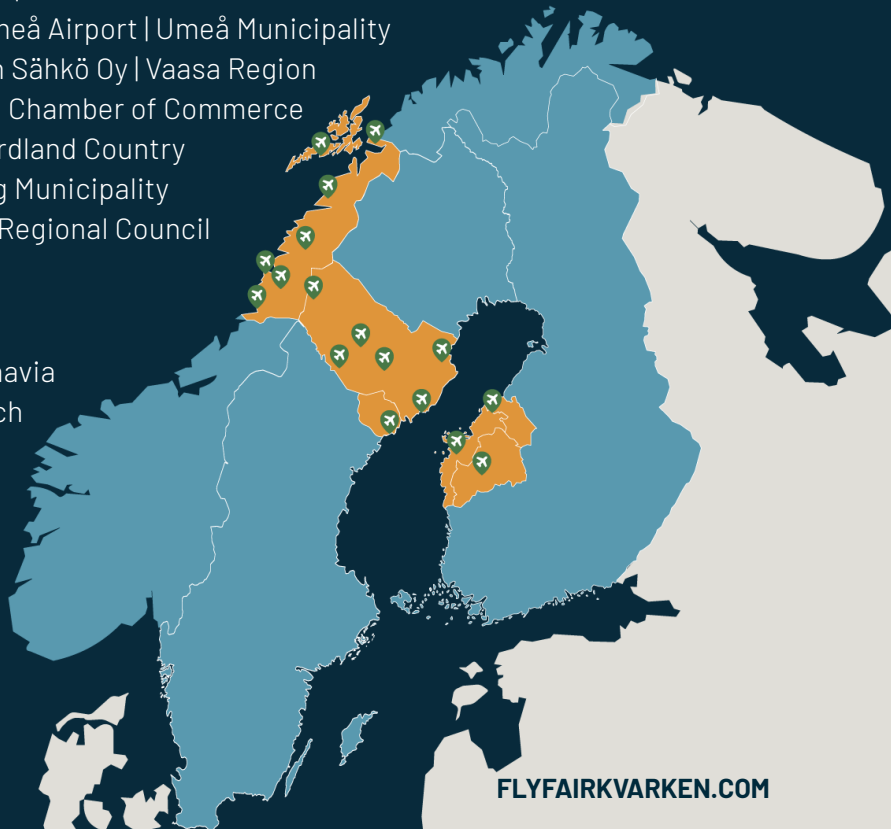
FAIR is preparing the Kvarken region for an early implementation of electric aviation. The project increases the knowledge base about electric aviation, investigates the possibilities and surveys both the needs and the required technical investments. FAIR is a first step towards a rapid introduction of sustainable aviation in the Kvarken region.

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 | Nord University | Nordland Country
Municipality | Brønnøy Municipality | Alstahaug Municipality
Helgeland Regional Council | Indre Helgeland Regional Council
Rana Utvikling

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



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