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Aviation in the new European Alternative Fuel Observatory (EAFO): Open data for market development and prevalence of alternative technologies

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Summary

The following article overviews the current availability of alternative fuels in European aviation, focusing the market development and prevalence of new technologies, a key content of the upcoming new version of the European Alternative Fuel Observatory (EAFO) [1] initiative, which is the main, central reference portal for publicly available information on alternative fuels (AF) vehicles and AF-infrastructure in the EU, supporting policy-decision making in an adequate manner. The article presents the current status of various low emission power trains in aviation and explains the evolution of the market by presenting the open data collection efforts of the EAFO portal.

Keywords: alternative fuel, aviation, BEV (battery electric vehicle), policy, infrastructure, market development

1 Introduction

Well-functioning aviation is indispensable for the European citizen's mobility, also for the European Economy as a whole. It connects people, boost businesses and affects the economy in a positive way. Although it contributes to the GDP of the European Union by 2,1% and employs around 0,5 million people EU-wide market distortions can occur, which also affects competitiveness and connectivity of people and businesses.[2] That's why it is especially important to ensure equal conditions for the participants of the whole industry and precisely for the use of fuel.

Policy actions and the efforts of industry have led to improvements in fuel efficiency over recent years. For instance, the amount of fuel burned per passenger dropped by 24% between 2005 and 2017. However, these environmental benefits have been outpaced by a sustained growth in air traffic, with passengers in 2017 flying on average 60% further than in 2005[3].

In the EU in 2017, direct emissions from aviation accounted for 3.8% of total CO2 emissions. The aviation sector creates 13.9% of the emissions from transport, making it the second biggest source of transport GHG emissions after road transport. Before the COVID-19 crisis, the International Civil Aviation Organization (ICAO) forecasted that by 2050 international aviation emissions could triple compared with 2015. [4]

A market-ready, zero-emission aircraft by 2035, carbon-neutral scheduled collective transport for journeys under 500km by 2030, and possible quotas on low-carbon fuels are among the goals set by the European Commission in its Sustainable and Smart Mobility Strategy. The strategy, which was published on 9 December 2020, is aimed at delivering a 90% reduction in emissions from the European Union's transport sector by 2050. Targets outlined in the Green Deal that relate to aviation include a "zero-emission large aircraft" that "will become ready for market" by 2035. The goal for 2030 is that "scheduled collective travel of under 500km should be carbon neutral within the EU".

1.1 GHG reduction strategies in aviation

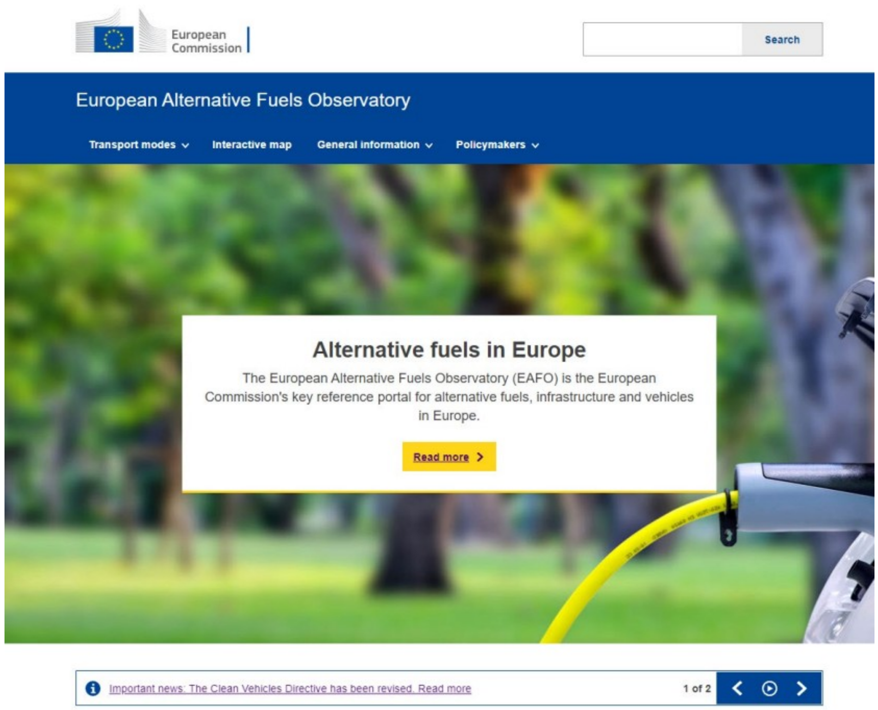
Energy efficiency and energy reduction of stationary and taxiing planes at airports. Aircraft have auxiliary power units (APUs) to supply them with electricity and conditioned air on the ground. When the main engine is shut down, these units are turned on to provide a supply and use kerosene. At airports, stationary planes at terminal hubs can use landside mains electricity connections and preconditioned air (PCA) systems, rather than the aircraft's own APUs or Ground Power Units (GPUs). As part of measures to reduce noise at airports and achieve the operators' climate change and environmental targets, ground power supply has already been significantly developed in recent years. Two different versions are usually used here. At the gate stands, ground power is supplied by the airport grid. At the remote stands, on the other hand, ground power units (GPUs) tend to be used, which use diesel generators to produce the electricity, the latter could also be replaced by battery or hydrogen fuel cell powered units. For the push-back of planes tugs are used which could be electrified. For taxiing planes, (zero or low emission) ground vehicles could be used reducing the need to use the engine of the plane. Other ground vehicles and operations at airports can be electrified as well similar to road vehicles. It will be investigated to what extent it will be possible to track the use of the infrastructure, for example in hours connection, kerosine saved or by emissions reduced.

Introduction of energy efficient propulsion technologies using electrification & hybridization. Evolutionary technology will continue to be developed, bringing with them around a 20% improvement in fuel efficiency to each generation of aircraft. But in the next 30 years, the industry will likely see even more radical shifts. Introduction of zero-emission solutions at plane level: use of batteries and/or hydrogen fuel cells providing power for electric engines (propellors). By 2050, it is expected that electric- and hydrogen-powered propulsion will have the potential to serve regional, short-haul and perhaps medium-haul markets.

Fuel transition to sustainable fuels like biofuels and e-fuels. Traditional liquid fuels are expected to remain necessary for long-haul aircraft and for the remaining short and medium haul aircraft that have not shifted to electric or hydrogen, but with a transition to 100% sustainable and low carbon sources.

1.2 The new revamped EAFO 3.0

With the third version, EAFO became the European Commission's key reference portal for alternative fuels, infrastructure and vehicles in Europe. The vision of EAFO, is to provide openly accessible data at the highest of quality, in an easily accessible way on Alternative Fuels in Europe to Public Authorities, Consumers and the EU. The overall objective of EAFO is to further expand this vision, by additional development of the portal: (1) providing reliable data, information, and relevant news items, based on the needs of key target groups; (2) built with user-friendliness and functionality in mind; (3) provide expert advisory services and analysis to the European Commission.



1. Figure: Front page of the revamped EAFO 3.0 portal

In EAFO 3.0, with the move to the ec.europa.eu domain (www.alternative-fuels-observatory.ec.europa.eu), the portal is further enhanced to serve as the official European Commission's knowledge provider of alternative fuels vehicles & infrastructure. The vision for the knowledge centre, is that it must be leading in providing the most reliable information for policy makers, consumers, and other stakeholder groups. The knowledge centre has a role in supporting strategies, policies, investment decisions, and consumer behaviour, by providing insights into the current situation and trends, latest news on solutions and innovations, best practices, potential bottlenecks, tools with practical information, and in-depth research results.

1.3 Alternative Fuels Alternative fuels for zero-emission aviation

Policy actions and the efforts of industry have led to improvements in fuel efficiency over recent years. For instance, the amount of fuel burned per passenger dropped by 24% between 2005 and 2017. However, these environmental benefits have been outpaced by a sustained growth in air traffic, with passengers in 2017 flying on average 60% further than in 2005 (DG MOVE, 2022).

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1.3.1 Electricity

Battery electric aircrafts are rapidly growing in terms of technology and market development. Energy density is widely recognized to be the bottleneck for the zero-emission electric powertrains. With the growing efficiency rates, Li-ion batteries became sufficient in 2019 for small aircrafts. These vehicles are mostly used for short distances in smaller airports and flight schools. Direct electricity can be used in aviation. It requires electric engines and electricity storage onboard. Batteries and ultracapacitors are the most common types of electricity storage options but needs further R&D efforts. Current electricity generation is emissions-intensive in many regions but increasing trends in the use of renewables for energy production will help reduce emissions from this sector in the future, where for example wind and solar are expected to be cost-competitive due to current mass production.

1.3.2 Hydrogen

H_2 is seen as an attractive alternative aviation fuel both in recent and past research as it has a great supply potential, contains three times the energy content per weight of traditional jet kerosene (43.2 MJ/kg vs 120 MJ/kg respectively) and does not produce CO2 from combustion [8].

Hydrogen can become in the longer term an option to decarbonise the aviation sector, through the production of liquid synthetic kerosene or other synthetic fuels. These are “drop-in” fuels that can be used with existing aircraft technology, but implications in terms of energy efficiency must be considered. In the longer-term, hydrogen-powered fuel cells, requiring adapted aircraft design, or hydrogen-based jet engines may also constitute an option for aviation.

The European Commission addresses the use of hydrogen in the transport sector in the Sustainable and Smart Mobility Strategy, published afterwards the European Green Deal and presented in 2021. The key limiting factor for the use of hydrogen in industrial applications and transport is often the higher costs, including additional investments into hydrogen-based equipment, storage, and bunkering facilities. Furthermore, the potential impact of supply chain risks and market uncertainty is amplified by the tight margins for final industrial products due to international competition.

Demand-side support policies are needed. The Commission considers assorted options for incentives at EU level, including the possibility of minimum shares or quotas of renewable hydrogen or its derivatives in specific end-use sectors (for instance certain industries as the chemical sector, or transport applications), allowing demand to be driven in a targeted way. In this context, the concept of virtual blending could be explored.

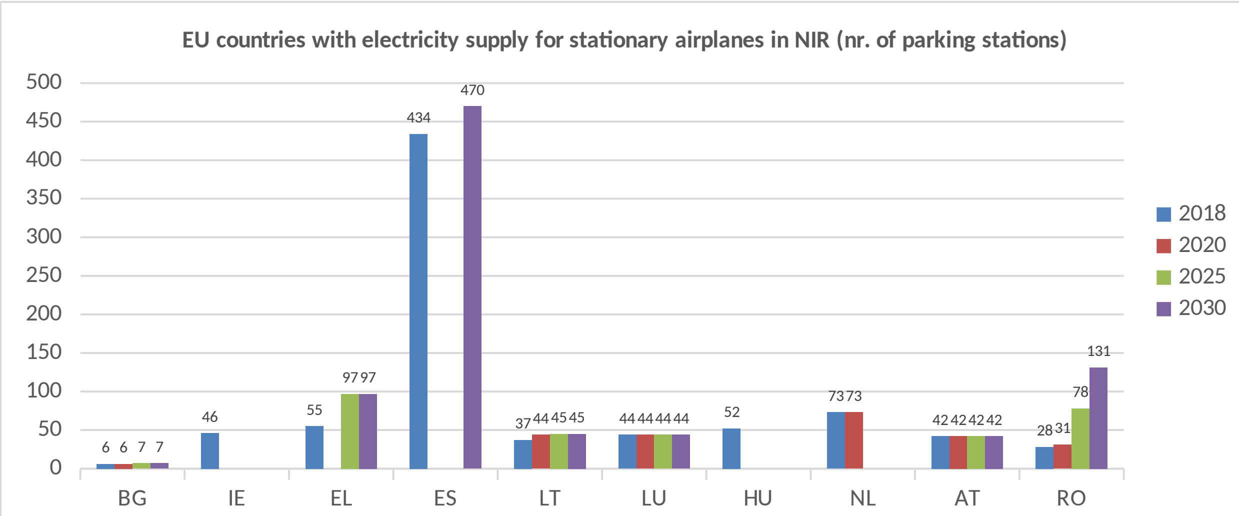
1.3.3 Biofuels

For aviation, advanced biofuels are the only low-CO2 option for substituting kerosene. The compatibility of bio-kerosene with today's planes has been proven. Cost, however, must become competitive. The 'Flightpath 2050' initiative aims at 75% reduction in CO2 emissions and 90% reduction in nitrogen oxide (NOx) emissions.

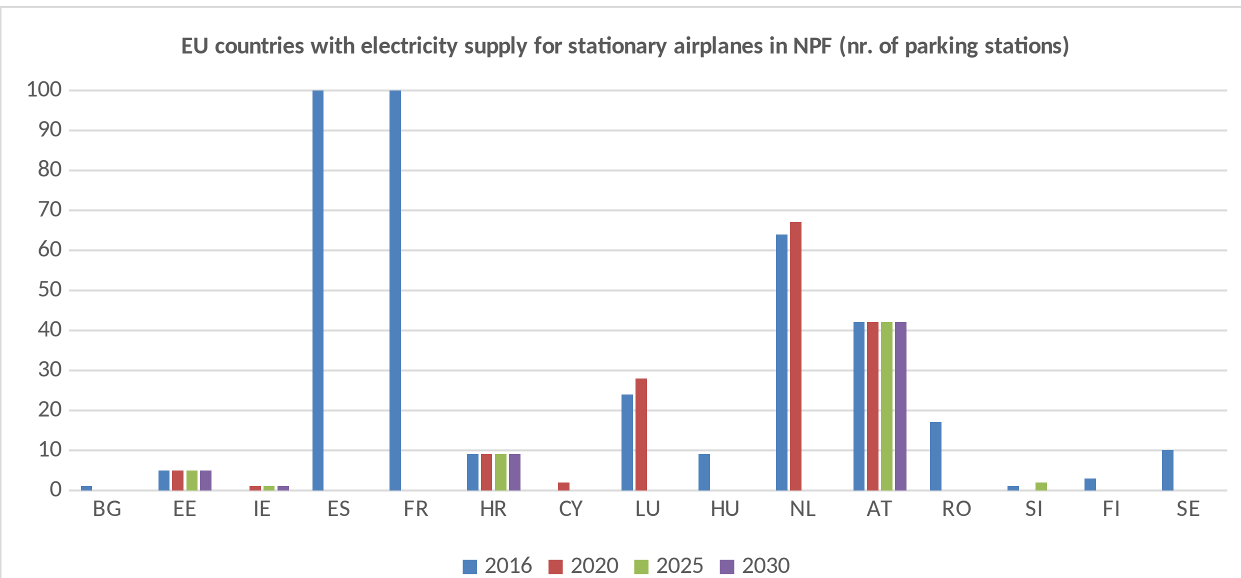
2 Open data on the new EAFO 3.0 portal

2.1 Electricity for European aviation

In order to provide a general overview of the current trends and status quo about the electrification of European aviation, the portal presents generic information in the context of the European airports and aircraft traffic. This will present data from EAFO partners such as Eurostat (for example on infrastructure, passengers, freight), energy use or other information, deemed relevant for the audience of the portal. There will be a novel dataset setup, about electricity supply infrastructure at airport terminals for stationary planes. EU Member States are already have set targets on this in their NPF and report on the progress of this in the NPF IR.

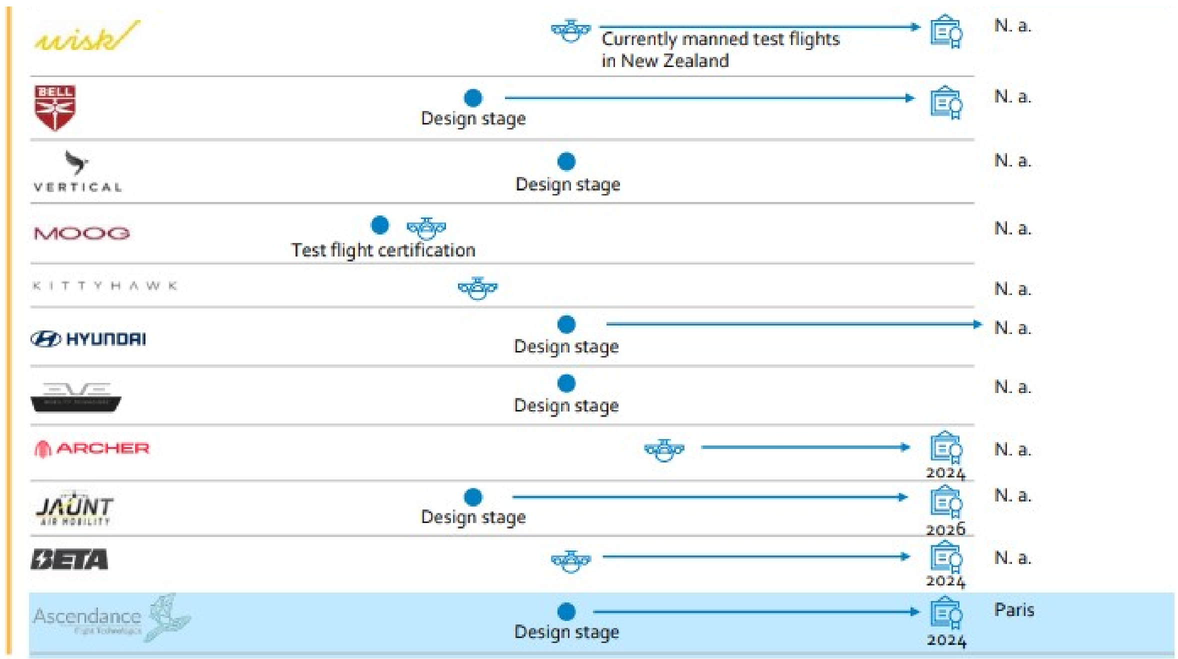


2. Figure: EU countries with electricity supply for stationary airplanes in NIR (nr. of parking stations)



3. Figure: EU countries with electricity supply for stationary airplanes in NPF (nr. of parking stations)

Developments on airports related to the use of AFs for ground vehicles, this will mainly be based on pilot and demonstration projects. Examples are taxiing of planes using ground vehicles, development of special purpose zero emission vehicles for airport use.



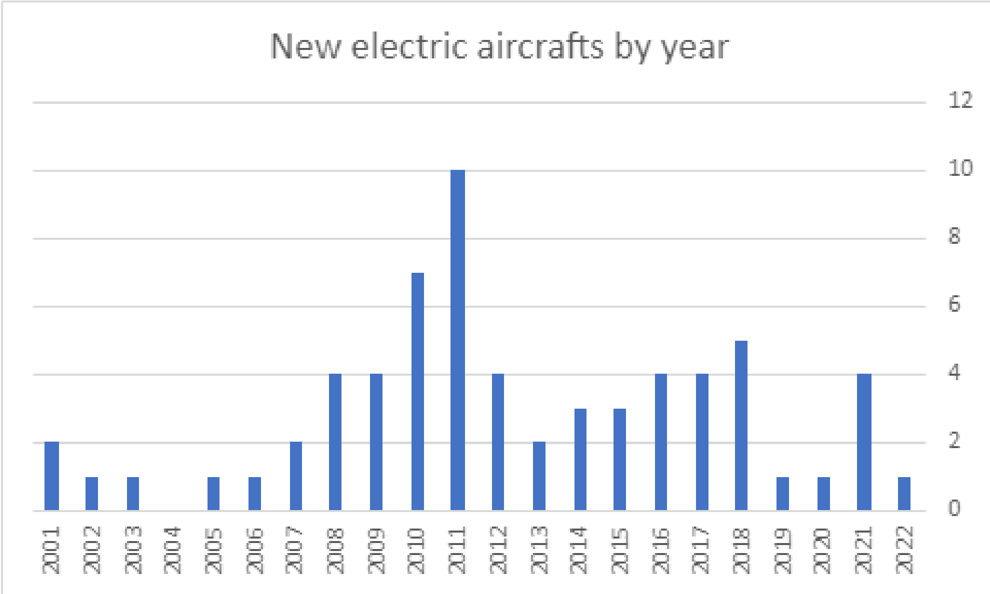
4. Figure: Urban Alternative Fuelled Aviation (passenger) pilot projects roadmap in EU, announced by industry [6]

EAFO 3.0 will cover the number of terminal hub positions which covered per MS and if possible other countries in EAFO scope (e.g., EFTA countries), and as % of the terminal positions at TEN-T core airports. Information will be supplied on additional measures taken by countries for example for airports outside the scope or installations for mobile applications.

Information on the availability or development of zero emission airplanes, including VTOL (virtual take-off and landing or "drones") for passenger taxi-like transport. Examples of these are the product development of Airbus (see figure below) or the recently announced BALIS project. The aim of the BALIS project is to develop and test a fuel cell powertrain with an output of approximately 1.5 megawatts. This would be enough to allow the development of a regional aircraft with 40 to 60 seats and a range of 1000 kilometres. Countries will be requested to provide information on the number of AF planes registered. As this will most likely not include planes using biofuels or e-fuels are the use of these in blends is allowed in planes the number of AF planes will be very low if indeed registered separately. As examples, pilot projects and start-ups include Volocopter, Ampaire, Zero Avia, Lilium Aircraft. Lilium is creating a sustainable and accessible mode of high-speed, regional transportation for people and goods. Using the 7-Seater Lilium Jet, an all-electric vertical take-off and landing jet, offering leading capacity, low noise, and high performance with zero operating emissions, Lilium is accelerating the decarbonization of air travel.

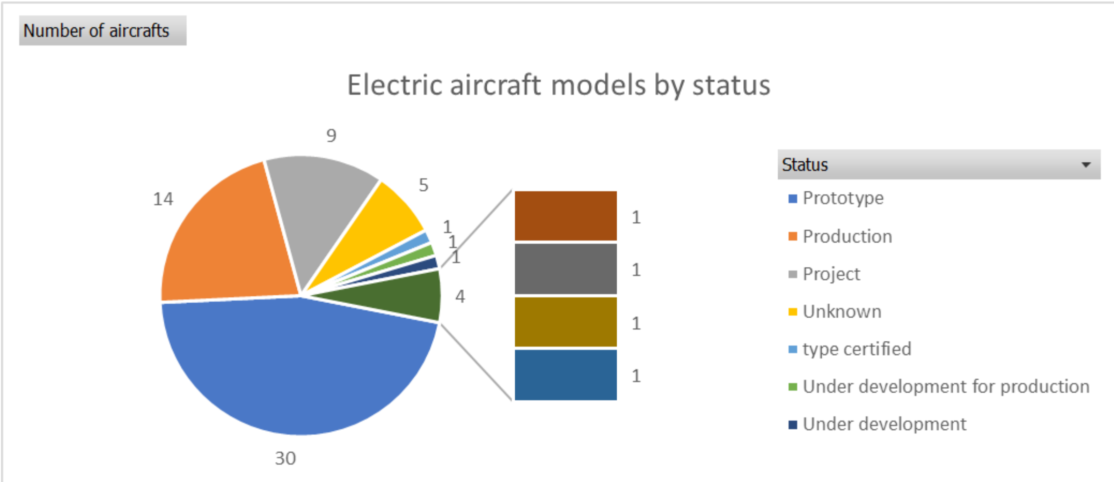
2.1.1 Electric aircrafts in development

An electric aircraft is an aircraft powered by electricity, almost always via one or more electric motors which drive propellers. Electricity may be supplied by a variety of methods, the most common being batteries. The number of new types of electric aircrafts, including pilot and experimental projects grew steadily in the past.



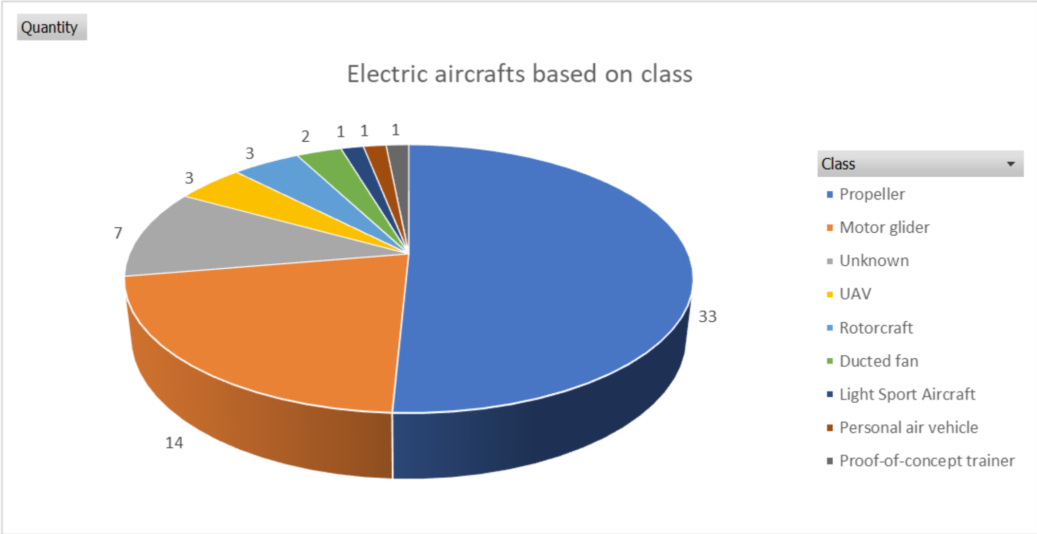
5. Figure: New electric aircraft models by year

The status of the electric aircraft models is differing, most of them are only prototypes and not available in commercial production. There are also many demonstrations, project-based activities and some are under development for production. There is currently one type of certified electric aircraft, the Pipistrel Velis Electro from Slovenia, which is a trainer aircraft.



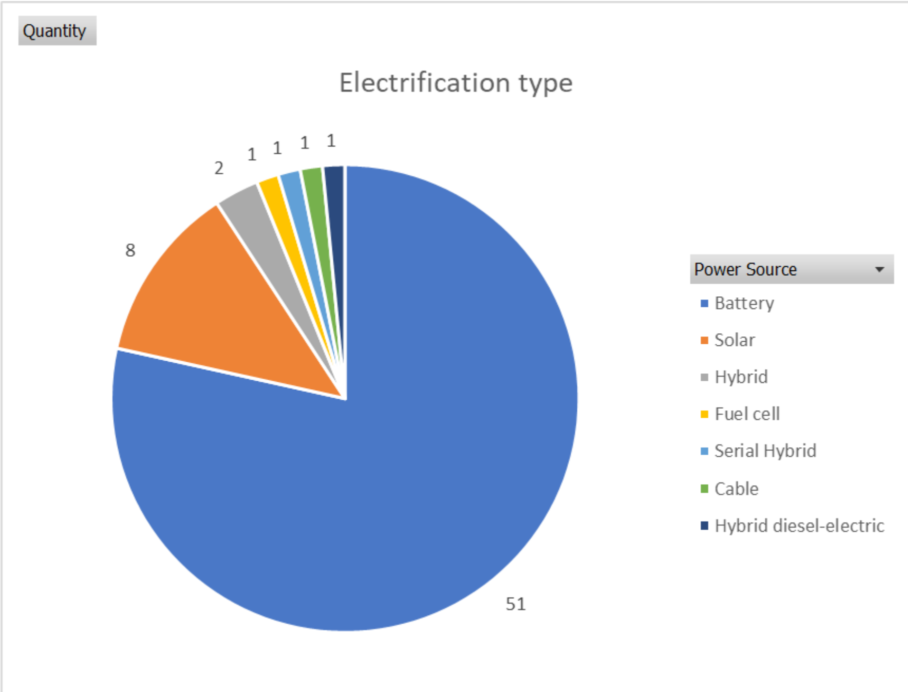
6. Figure: Electric aircraft models by status

More than half of electric aircrafts has propeller shaft engines, some are motor gliders and there are other types in smaller quantities, such as rotorcrafts, ducted fans and personal air vehicles.



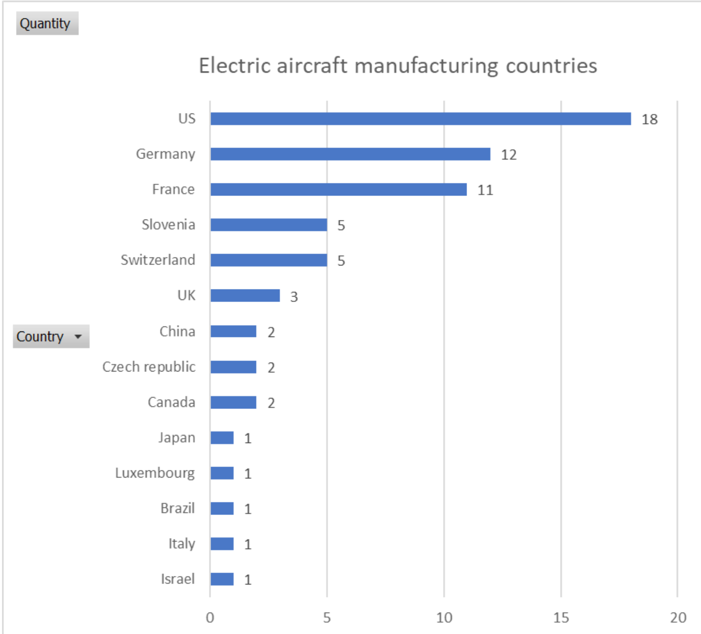
7. Figure: Electric aircraft models based on class

If we look at the electrification type, there are mostly battery electric aircrafts developed, with some examples of solar and hybrid models.

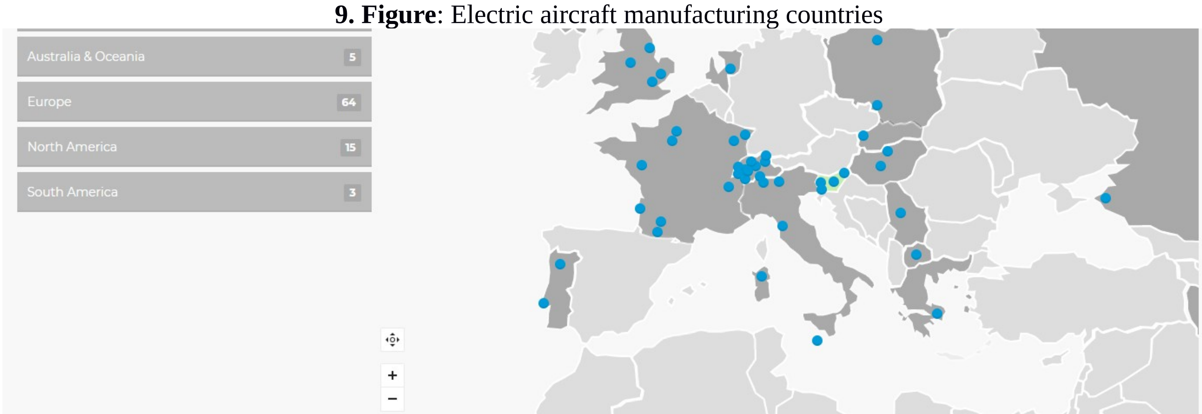


8. Figure: Electric aircrafts based on electrification type

Considering the country of origin for the aircrafts, Germany, France and Slovenia are the most prominent countries in the European Union. There is also Switzerland in Europe with several experimental and pilot projects developed.



9. Figure: Electric aircraft manufacturing countries

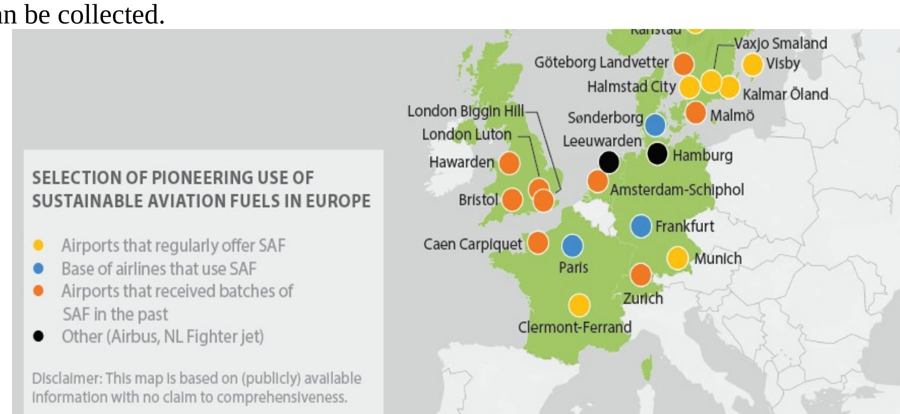


10. Figure: Distribution of electric aircrafts of Pipistrel company in European airports, flight schools. [5]

2.2 Sustainable Aviation Fuels (SAF) in Europe

Sustainable aviation fuel (SAF) is a large, perhaps the largest, opportunity to meet the 2050 goals. It is likely that aviation will need around 450-500 million tonnes of SAF per annum by 2050 (source: enviro.aero). Analysis shows that this is achievable, with rigorous sustainability criteria ensuring a transition that does not impact food or water use. There are a range of feedstock available, from non-food crops to waste sources and eventually a shift to power-to-liquid fuels made from recycled or directly captured CO2 and low-carbon electricity. All 290 airline members of the International Air Transport Association (IATA) agreed a resolution in 2017 supporting sustainability standards which "conserve an ecological balance by avoiding the depletion of natural resources". In addition, 27 airlines representing a third of global jet fuel demand are members of the Sustainable Aviation Fuel Users Group and pledge to high sustainability standards for any SAF they will use.

Sustainability is the most important aspect of SAF deployment, and the industry works closely with organisations such as the Roundtable on Sustainable Biomaterials to implement global standards. EAFO 3.0 will provide information concerning the (approval of) types of different SAFs and the actual production capacities (and, if possible, use) of SAF. The figures below illustrate the type of information which can be provided. To produce SAF in 2020 this is less than 0.01% of the quantity mentioned above as required by 2050. This chart does not include existing facilities for so-called 'HEFA+' SAF: when this fuel source is certified (expected 2020), production volume will increase significantly. For the use of SAF it is expected that this information can be collected.



11. Figure: The current use of Sustainable Aviation Fuels in European airports (2021) [7]

3 Aviation section on the new EAFO portal

3.1 The structure of aviation section on the new EAFO portal

The new portal plans to structure the different topics to eight sections. The recharging points dynamic map shows the public recharging infrastructure, available at airport premises. The airports section withholds various quantitative data on recharging points for aircrafts and ground handling vehicles, percentage of electrification of equipment for cargo and passenger. Other data includes the number of airports in EAFO countries that provide electricity to stationary aircrafts per mode: FEGP, GPUs, eGPUs. The airlines section show data on the companies' commitment to alternative fuels – i.e., Airline's alternative fuel orders at airports or roadmaps with concrete targets. The alternative fuels section is a general overview of the state-of-the-art available fuel types and their practical implications. The pilot projects and startups continuously collect and reports the latest news in innovation. The aircrafts section quantitatively shows the registration of alternative fueled aircrafts across EU countries, and the available AF aircrafts on the market, focusing on electricity and hydrogen, not biofuel.

12. Figure: The upcoming structure of aviation section on the EAFO portal.

3.2 Data collection approach

The EAFO 3.0 conducts an extensive desk-top study on the topic and in parallel approach stakeholders from the EU Commission, countries, industry (for example Airbus, Rolls-Royce), research institutes and (industry) associations. The data collection will use both primary and secondary sources. Existing contacts and new ones of the Sustainable Transport Forum will be collected, and the stakeholders (Airlines for Europe, ERA, EBAA, GAMA, Fuels Europe, Eurocontrol, etc.) will be introduced to the new expectations and common grounds will be discussed for the data collection, based on the structure mentioned above. Snowballing technique is used to approach new stakeholders in certain topics of interest. An iterative process will follow, until no new contacts or new data is available, a certain type of saturation is reached. Secondary data is also leveraged. Existing databases (e.g., Eurostat, Eurocontrol, OurAirports, EEDB, TRIMIS, CORDIS) are assessed, and their exploitation is explored. Other data sources include. Company, airport, airline, national authorities, associations etc., websites, reports, news) EU projects, research (e.g., LAirA project) and university research groups (e.g., Chalmers University).

Acknowledgments

European Alternative Fuels Observatory (www.eafo.eu) THE European reference point for information about alternative fuels, where all interested stakeholders and interested organisations access reliable data, information, and relevant news items.

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