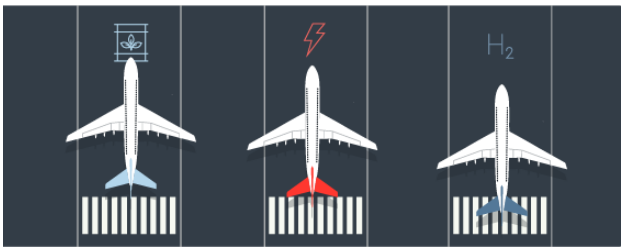
GREENING FUTURE FLIGHT

Planning holistically for electric aircraft, hydrogen aviation, and greater use of sustainable aviation fuel—to reduce aviation's carbon footprint

Technology continues to advance decarbonization efforts in aviation. Research and development toward low-emission and zero-emission flight includes battery electric and hydrogen-fuel-cell technologies. Together with sustainable aviation fuel (SAF), these technologies hold promise to deliver enduring solutions that address carbon-emissions reduction.

In the following Q&A, WSP's Mattias Frithiof, Director, Advisory, Sweden, and Gaël Le Bris, C.M., P.E., Senior Aviation Planner & Senior Technical Principal, United States, explore the challenges that the sector must address to turn these fossil-free fuel alternatives into viable options; they also consider the potential for wider positive impact.



How do you see fossil-free fuel alternatives shaping aviation for future flight?

Mattias Frithiof: Generally speaking, air transport provides fast transport over large distances, which increases accessibility and connectivity. This is a cornerstone component in the processes that create societal and economic development in a globalized world. So, there are tangible values and benefits from this form of transportation. Of course, though, there are negative impacts as well. The introduction of alternative fuels and propulsion techniques should be seen as a way to further improve the balance between the costs and benefits of aviation.

As with any technology shift, change will come gradually; implementation will start small, and the scale will then increase. Already today, the deployment of SAFs is increasing and improving aviation's environmental performance. SAFs will most likely be the main focus in the short and medium term—with a more disruptive technology shift on the horizon, as the sector moves towards electrified aircraft. Here too, change will likely be gradual, as tests are increasingly carried out in small- and medium-sized aircraft on short and medium distances.

While disruptive technology itself is interesting and exciting, there is real potential for multifaceted positive impact, enabled by gradual development. Current fleets, systems and infrastructure will not be obsolete overnight. This situation is good for the economy from both public and private perspectives; it facilitates well-considered collaboration and innovative initiatives. With the gradual introduction of new technologies, small aerial vehicles over shorter distances will first change the landscape for regional accessibility. New possibilities will arise for more connections and thus improved economic relations and business activity as well as better accessibility in new directions. Formerly "disconnected" areas may be revitalized as they can structurally compete with more accessible geographies. A more geographically distributed and less monocentric economic development may be one very positive outcome of this process.

Gaël Le Bris: Improved accessibility and economic outcomes would certainly reinforce aviation's established role around the world. In the fight against climate change, the aviation community has been at the forefront of research for change. The 1999 special report on Aviation and Global Atmosphere of the Intergovernmental Panel on Climate Change (IPCC) was extensively discussed at the ICAO[1] level. The first national and regional research and development initiatives specifically targeting carbon emissions started in 2001, resulting in lower-emission aviation policies, practices, and technologies. They have been implemented since the mid-2000s with effective results.

Today, aviation accounts for about 2 percent of carbon emissions and 3.5 percent of the drivers of climate change.[2] As a sector, we have a plan to go farther and significantly reduce our carbon footprint. The goal is to continue taking steps to reduce emissions and achieve carbon neutrality by 2060, with individual airports and air carriers taking a pledge to reach net-zero emissions as soon as 2030. SAFs are already a reality. These fuels are made using a variety of waste products and renewable and sustainable feedstocks in order to prevent deforestation and competition with food production. They can reduce the lifecycle emissions of commercial flights by up to 80 percent.[3] The good news is that technologies and standards exist for producing affordable SAFs meeting the criteria of existing jet fuels. This means that they can be blended with conventionally sourced Jet A-1. Furthermore, aircraft and engine manufacturers are now certifying their aircraft to fly with 100 percent SAF.

The next step is electric aviation. Prototypes have been flying for a few years. The first electric commuter aircraft with batteries are on track to be certified in 2022 or 2023. They might open a new era of zero-emission regional air mobility. Regional aircraft may follow at the 2025-2030 horizon, potentially powered with fuel cells converting hydrogen into electricity. Based on current technologies, it is unclear if all-electric larger commercial service aircraft are feasible. However, hybrid propulsion systems—using an electric engine for most of the cruise and a conventional thermal engine to deliver more thrust during takeoff and landing—hold promise. Regarding the potential of electric propulsion, though electric technologies are evolving rapidly and breakthroughs are happening regularly, we have so far barely explored the tip of the iceberg.

The future of medium- and long-haul commercial aviation using hydrogen burnt as an aviation fuel in lieu of kerosene in jet engines is achievable. Airbus is committed to fly a demonstrator of hydrogen aircraft by 2035. However, going from technical feasibility to introducing a brand-new fuel in commercial aviation and making it widely available is a long journey. In parallel with the effort to develop aircraft technologies, a viable aviation hydrogen supply chain should be established, and airports need to adapt, to store and deliver large quantities of hydrogen at the gate.

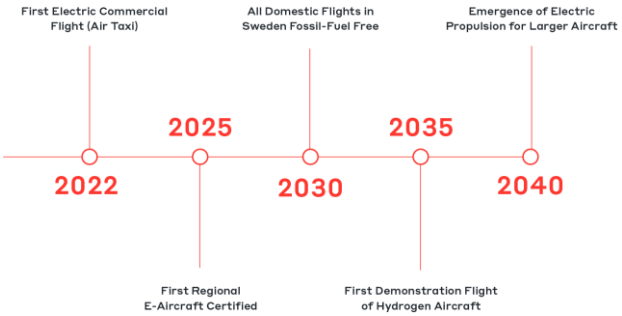


Figure 1 - Potential timeline for greener aircraft technologies

[1] International Civil Aviation Organization

[2] Intergovernmental Panel on Climate Change, World Meteorological Organization, United Nations Environment Programme; in addition, according to a Manchester Metropolitan University-led international study: when the non-CO_2 impacts were factored in, aviation's part was calculated to be 3.5 per cent of all human activities that drive climate change.

[3] IATA, Developing Sustainable Aviation Fuel

In addition to supply chain development, what are the current challenges that the sector must address to turn these fossil-free fuel alternatives into viable options?

Gaël Le Bris: There are many issues to be addressed, and both aerospace and airport standards will need to evolve to account for these new energy sectors. For example, there are National Fire Protection Association (NFPA) standards in the U.S. applying to hydrogen and aircraft fueling, but they are completely separate documents.

There is also the infrastructure challenge. Making electric aviation viable implies that airports can accommodate these aircraft. Today, around the world, there is no charging or hydrogen infrastructure to ensure access to the airport and to support ground operations. Electric chargers are not eligible for existing national or local funding mechanisms. At commercial service airports, operators and air carriers might find it beneficial to invest together to develop this infrastructure. Small airports may need to think out of the box and consider innovative approaches to funding. Similar to what we have seen with Tesla for electric vehicles, original equipment manufacturers (OEMs) could invest in the deployment of chargers.

With the advent of advanced air mobility powered by zero-emission quieter electric aerial vehicles, many in-between general aviation airports might be turned into mobility centers providing point-to-point regular and on-demand services to rural communities. While this is great news, that flying will become greener and more accessible to everyone, these airports could face a financial conundrum to accommodate the new demand. Future planning and policies should anticipate these emerging issues.

Laws and regulations will need to be reviewed as well. For instance, regulations on aviation services and those on utilities might conflict, potentially raising legal questions and preventing viable business models from emerging. Also, the long-term impact of new energy types on the aviation-fuel revenues of governments and stakeholders should not be underestimated. So far, the effort has been focused on fundraising and developing aerospace technologies. It is now the time for the sector to come together to holistically prepare for low-emission flight—advocate for greener aviation, educate policy makers and legislators on these issues, and work on removing obstacles to greater progress.

Figure 2 – Use cases for advanced air mobility with electric aircraft

Mattias Frithiof: The Nordic countries have ambitious agendas for the transfer away from fossil-based aviation fuels. Sweden aims for all domestic flights to be 100 percent fossil-fuel free by 2030 and for all international flights departing from Swedish airports to be fossil free by 2045.[4]

SAF is a key part of continuous efforts to improve the climate impact of the aviation sector, and electrified aviation will further enhance performance.

A number of initiatives, both public and private, are striving to realize the necessary development of regulation, infrastructure and aircraft technologies.

[4] Fossil-Free Aviation 2045

As mentioned earlier, the development of alternative aviation fuels and technologies will be gradual and first deployed on a smaller scale. Ground infrastructure, airport systems, airline fleets and business models will take time, and funding, to readjust. However, herein also lies a possibility.

There are approximately 120 regional airports in the Nordic region with small-scale traffic, often feeding to the major hubs in a traditional hub-and-spoke system. Over the long term, in part due to initial limitations of new technologies, opportunity will arise to establish new connections and economic relations—in essence, a more distributed and decentralized system. This evolving situation offers an opportunity to better "manage the asset" among the 100-plus regional airports and within the surrounding support structures in the Nordic region—to generate greater value from the airport asset itself and enhance economic activity throughout the region.

What steps can airports take now to enable greener flight?

Gaël Le Bris: SAF is available at some airports in Western Europe and North America, including Los Angeles International Airport, Oslo Airport, and Stockholm Arlanda. Smaller airports such as Clermont-Ferrand Auvergne (CFE) in France and Ängelholm-Helsingborg in Sweden are joining the movement to transition to SAF. The main obstacle to wider implementation is the supply chain, as production must be further developed. Airport operators, such as San Francisco International Airport and Amsterdam Airport Schiphol, have been proactively advocating for these alternative fuels. For instance, SFO has a SAF Stakeholder Working Group bringing together the aviation stakeholders and the fuel industry.

Advanced air mobility (AAM)[5] has yet to become a commercial reality. There is still uncertainty on the timeline for the emergence of these new ways to fly. However, airport practitioners should start exploring high-level planning scenarios. They need to consult their air carriers and other flight operators as well as their fixed-base operators—with supporting guidance and tools.[6]

While power sharing and smart power management can provide a short-term solution, onsite power generation and storage should be on the table to increase resilience. Regarding hydrogen, there is a whole supply chain to develop. Ultimately, the emergence of a hydrogen economy will create a large-scale supply chain that will benefit aviation. In the meantime, we need to develop a cost-efficient, aviation-specific framework that can address the small demand of the first hydrogen-powered aircraft operators, especially at smaller, remote airports. Groningen Airport Eelde in the Netherlands is seeking to implement a hydrogen-unit production powered by an on-site 22 MW solar farm.

Earlier, you mentioned the potential wider impacts from electric flight. Can you expand upon how electric flight can positively affect accessibility and economic vitality?

[5] Advanced air mobility (AAM) includes urban air mobility (UAM) and regional air mobility (RAM). It encompasses a wide variety of vehicles with different capabilities: vertical takeoff and landing (VTOL), short takeoff and landing (STOL) operating on runway shorter than 1,500m, and conventional takeoff and landing (CTOL).

[6] WSP is developing for the U.S. Transportation Research Board a guidebook for planning for the emergence of electric aviation at airports. Along with the research report, an assessment tool will be available, to estimate the long-term electricity demand of the entire airport ecosystem considering the "electrification of everything"—from the curbside to the runway.

Mattias Frithiof: Connectivity and accessibility are key concepts in what is commonly called the “new economic geography,” a concept coined by the economist and Nobel laureate Paul Krugman. Rapid technological advances, more cost-effective ways of transporting people and goods, and innovative communications reduce geographical barriers. This creates the conditions for spreading the competitiveness of individuals and companies beyond the local horizon. While originally a theory to explain international trade relations and macroeconomics, the concept provides a way to understand regional and local development. Increased accessibility will, according to the new economic geography theory, improve the performance of regional economies.

Aviation is provided where demand is high and where connectivity is crucial, whether it is on an international, a national or a regional scale. Surely, major economic centers will still be vital destinations. But, to what extent can aviation, initially constrained by technological limitations, generate new economic relations? Can shorter travel times and higher frequencies open up medium-haul commuting to additional groups of travellers? A shift to greener flight can bring greater connectivity and wider benefits.

What are the main takeaways regarding planning for greener flight?

Gaël Le Bris: Greener flight must embrace greener solutions from the curbside to the airspace. So, holistic planning is essential. It requires increased collaboration among stakeholders to remove all obstacles to develop greener flight and ground infrastructure. Ground handling is just one example. The conversion of ground support equipment (GSE) to electricity is gaining traction. Individual airlines and ground handlers have been progressively transitioning to electric GSE. Airports are also enacting policies for expediting this process. Virtually all airport vehicles can be electrified, from the buses to the aircraft de-icing trucks; models are already available commercially, and manufacturers are working on expanding capabilities to add to the list high-performance specialized vehicles, such as firefighting and winter operations apparatus.

Mattias Frithiof: Greener flight is essential to supporting the health of the environment and people, and it also brings greater opportunity to advance more distributed and decentralized economic activity and social sustainability. Pushing forward to implement new technologies is necessary in the broad effort to reduce carbon emissions and provide enduring solutions that preserve aviation’s critical role around the world.

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