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Electrification in aviation: Identifying opportunities and challenges

By Justin G. Fisch, Esq., Dustin C. Elliott, Esq., and William F. Tarantino, Esq., *Morrison & Foerster*

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Eliminating greenhouse gas emissions from air travel is one of the most difficult challenges in the emission reduction puzzle. Air travel accounts for just above 2% of global carbon dioxide emissions, and it is one of the fastest-growing sources of greenhouse-gas pollution.[1] Today, a flight from London to New York generates roughly the same level of emissions as it takes to heat the average European household for an entire year.[2]

The aviation industry is facing a sustainability challenge that involves much more than just mitigating climate impacts. Reducing noise impacts and managing local air quality issues stemming from noxious gas emissions will also continue to drive environmental decision-making for airports and airlines around the globe — especially as aircraft operations surge alongside population growth.

> Electrification of the flying experience adds a layer of complexity to infrastructural growth requirements.

In tackling these challenges over the next decade or two, the aviation industry can capitalize on a growing trend that is already beginning to shift regulatory and policy landscapes around the globe: aircraft electrification.

The concept of electrifying aircraft is nothing new. The past few decades have seen electric flights around the globe, major policy announcements by national governments, and significant investments by startups and industry stalwarts alike.

More than a dozen companies, including Airbus and Boeing, are currently exploring the potential to electrify small aircraft, creating the equivalent of flying taxis that can cover around 100 miles on a charge.[3]

Zunum, a research and manufacturing firm that designs electric aircraft, has received its first orders from California charter operator JetSuite for a 12-seater hybrid electric aircraft, due to enter service in 2022, and a stretched 50-seater to enter service by about 2030 — even though it has never even flown a test aircraft.[4]

Aircraft electrification presents a number of difficult technical, regulatory and policy challenges, but it also points toward critical solutions. Airports and airlines are also constantly responding to noise complaints regarding their operations, one of the principal operating constraints and limits to growth in the industry.

Whereas recent aircraft models have reduced noise levels and generally improved air quality in comparison to their predecessors,[5] internal combustion aircraft will likely experience significant limits to growth in the decades to come around issues of environment, climate, noise and air quality, among other issues. Electrification is a way to bridge the gap between increased demand and enhanced environmental mitigation requirements.

With this industry change on the horizon, we explore some of the pressing regulatory, policy and infrastructure issues influencing the transition to commercial electric aircraft deployment.

INFRASTRUCTURE

Barring unforeseen changes, the aviation industry is slated for momentous growth — electrification aside. This growth will necessitate infrastructural investments on a global scale, with airports capable of sending and receiving commercial flights throughout the largest world markets.

BATTERIES AND CHARGING

Electrification of the flying experience adds a layer of complexity to these infrastructural growth requirements. For instance, airlines using electric aircraft will require battery charging infrastructure at airports. In financing and developing charging infrastructure projects, airports and airlines will likely participate in administrative proceedings before public utility commissions.

Charging the batteries on-site may also require additional gate time. With gate slots at a premium at airports worldwide, developing and regulating the use of airport gates for charging will be a key political and regulatory challenge for airlines and airports alike.

In lieu of gate charging, airlines and airports may also swap batteries. Plane batteries could be charged and stored as needed. Careful development of the regulations implementing the use, handling and storage of these grid resources will be key to the efficient and timely development of the infrastructure necessary for electrification.

Industry stakeholders should also consider the role that airports may play as energy storage facilities for local utilities and the grid at large. As regulators continue to remove barriers to the participation of energy storage resources in wholesale and retail electricity markets, the degree of regulatory certainty for gauging the trajectory of energy storage resources is just now coming into focus.

Regulators are beginning to recognize, for example, that electric storage resources can and should be able to participate in power markets as both load (i.e., demand) and generation, thereby allowing storage projects to be financed with the expectation of generating multiple revenue streams.

In other words, large-scale storage projects are uniquely valuable because of their ability to both provide energy to the electrical grid and take excess energy from it, thereby providing two distinct services for which the storage projects could be compensated.

Key to the development of electrified aviation will be a focus on enabling common standards, regulatory frameworks and infrastructure across states, municipalities and continents.

Airports and airlines should factor in the potential to capitalize on these valuable characteristics as they develop onsite charging infrastructure.

RANGE

As with electric automobile deployment, range anxiety presents another regulatory and technological hurdle for proponents of increased aircraft electrification to overcome. While batteries have improved, they still cannot get aircraft as far as fuel can, and they currently take longer to recharge than their fuel-based counterparts.

With current technology, an hour of flight time requires at least an hour of charging time.[6] This metric would pose serious challenges for the industry's usual focus on overall aircraft utilization hours, which prioritizes flight hours in the utility of an aircraft making profit. Today's planes make money in the sky — not at the gate.

As noted above, however, finding a way to capitalize on the e-storage resource capabilities of large-scale battery and charging infrastructure facilities may create new economic opportunities for airlines. Understanding range limitations and the likely timeline of technological advances on battery range will be vital in shaping policy strategies for effective deployment of electric aircraft.

Range limitation of electric aircraft may present difficulties with existing regulatory frameworks; the features of internal combustion engines are baked into the regulations themselves in some instances. Take the Federal Aviation Administration's fuel "reserve" requirement, for example. For safety purposes, certain aircraft are required to carry enough fuel to land at an airport 200 miles (322 kilometers) from the intended destination. On a normal flight, planes do not tap into that fuel, as it is for emergency purposes only.[7]

It is an open question as to how regulators would treat "reserve" requirements for electric airplanes. One can imagine a potential regulatory structure where electric aircraft prototypes would be required to have hybrid capabilities, meaning they would be equipped with both an electric motor and a combustion engine (the latter for emergency reserve purposes).

RUNWAYS

Airports typically implicate major land-use issues in municipalities and large metropolitan areas, where land is increasingly hard to come by. Electric aircraft stand to change airport infrastructure for the better on this front. Electric motors have the potential to allow for very short — even vertical — takeoff and landing, thus reducing the need for runway length.

AIR QUALITY

Approximately 25% of U.S. commercial service airports are in areas that violate federal air quality standards, including 40 of the top 50 airports. While aircraft noise remains the primary environmental concern, air quality has become a growing issue.[8]

Not surprisingly, airports located in air quality nonattainment or maintenance areas increasingly find that air emissions add to the complexity, length and uncertainty of the environmental review and approval of expansion projects. The potential for electrified aviation to reduce this regulatory process is promising.

But even before full electrification, industry stakeholders may consider reducing aircraft emissions by providing fixed electrical ground power. This allows aircrafts to switch off their auxiliary power units at terminal gates, reducing fuel burn and pollutants. In addressing future infrastructural investments to "green" the industry, this is one on which airports can already get ahead of the curve.

NOISE

Aircraft noise remains the most significant environmental impediment to airport expansion in the United States,

and it is the number one public complaint received by the FAA.[9] Here, too, electrification promises to ease impacts, as electric engines require less maintenance and are quieter than conventional ones.

This would be a critical development not only because it would lessen existing noise impacts, but also because it may also open up new flight paths that are currently off limits due to noise restrictions. Indeed, without the roar of big turbines to disturb residents on takeoff, more airports may be able to operate virtually around the clock and closer to urban areas.

Given its ability to reduce noise impacts, electrification has the potential to drive additional growth in the aviation industry for both airports and airlines.

POLICY

Investments in green and sustainability initiatives in the aviation industry are active and evolving. Just as countries set renewable portfolio standards or electric vehicle adoption requirements, countries are beginning to do the same for reduction of passenger carbon dioxide emissions from air travel.

The EU's Flightpath 2050 program currently calls for a 75% reduction in carbon emissions per passenger kilometer by 2050. By most metrics, electric aviation technology is key to hitting those targets.

National policies are also taking shape. Norway, for example, which is already the world's top buyer of electric cars, has mandated that all domestic flights be electric by 2040.[10]

Other existing policies affecting the electrification and sustainability of aviation include EU requirements mandating a 90% target reduction in nitrogen oxide per passenger kilometer across the aerospace sector by 2050; emission-free taxiing of aircraft; and the design and manufacture of aircraft for recyclability.[11]

The International Civil Aviation Organisation, the body responsible for global standards, has racked up a record of environmental improvements of late, and any future regulation is likely to be tied to its decision making.

Over the past decade, it has fostered adoption by the international aviation community of environmental goals in a number of areas, including:

- Noise.
- Air quality
- Climate change.
- Nitrogen oxide emissions from engines.
- Guidance on operational measures to reduce fuel burn.
- Guidance for member countries that wish to adopt emissions trading.[12]

Key to the development of electrified aviation will be a focus on enabling common standards, regulatory frameworks and infrastructure across states, municipalities and continents. Aviation is, at its core, a global industry. Consistent regulatory frameworks will be key to developing the common infrastructure necessary to sustain a transition to electrified aviation in the coming decades.

CONCLUDING THOUGHTS

As a bridge to fully electrified aviation, hybrid solutions that supplement gas turbine technology may take flight sooner.[13] These hybrid solutions may serve as a testing ground for some of the regulatory hurdles and opportunities identified, including those related to noise and air quality, as well as airports' infrastructural investments.

With the right regulatory and policy framework, the electrification of aviation has the potential to be a boon for the industry and air travelers.

NOTES

[1] See https://bit.ly/2L71pEn

[2] See https://bit.ly/2NjBSox

[3] See https://bit.ly/2Szxh5K

[4] See https://on.ft.com/2x4SOti

[5] See https://bit.ly/2NjBSox

[6] See https://bit.ly/2XkX6f0

[7] See https://bit.ly/2Szxh5K; https://bbc.in/2wijYMF

[8] See https://bit.ly/2MXwuN5

[9] See https://bit.ly/2MXwuN5; https://bit.ly/2mjr3YO

[10] See https://bit.ly/2XkX6f0; https://bbc.in/2wijYMF

[11] Targets set by the European Commission, relative to the capabilities of new aircraft in 2000. *See*: https://bit.ly/2A2UwxK; https://on.ft.com/2x4SOti

[12] See https://bit.ly/2MXwuN5

[13] See https://bit.ly/2A2UwxK

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ABOUT THE AUTHOR



Justin G. Fisch is an associate attorney at **Morrison & Foerster** in San Francisco. His practice focuses on environmental, land use, and energy law. He serves on the editorial board of the Annals of Air and Space Law at McGill University's Institute of Air and Space Law. **Dustin C. Elliott** is an associate attorney at the firm's office in Washington. His practice focuses on environmental and energy law, and he has particular experience advising clients on the intersections of natural resource, renewable energy, and climate change law and policy. **William F. Tarantino** is a litigation partner at the firm's San Francisco office. His practice focuses on environmental, infrastructure and mass tort claims.

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