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Paris Air Show

Introduction

After years of false starts and pilots, advanced air mobility (AAM) is finally emerging as a viable mode of transportation to carry people and goods in new, community-friendly, and cost-effective ways.

2021 and 2022 were milestone years for the Future Air Mobility industry with respective investments of €6.3bn21 and €2.7bn21 invested worldwide. This remains well above previous years when disclosed funding never exceeded €1bn21. Many AAM players advanced from early-stage concepts to more tangible prototypes (e.g., Lilium or Volocopter) while the infrastructure is also improving

AAM is emerging as a significant shift in mobility, offering fundamentally new capabilities and applications that were previously not feasible.

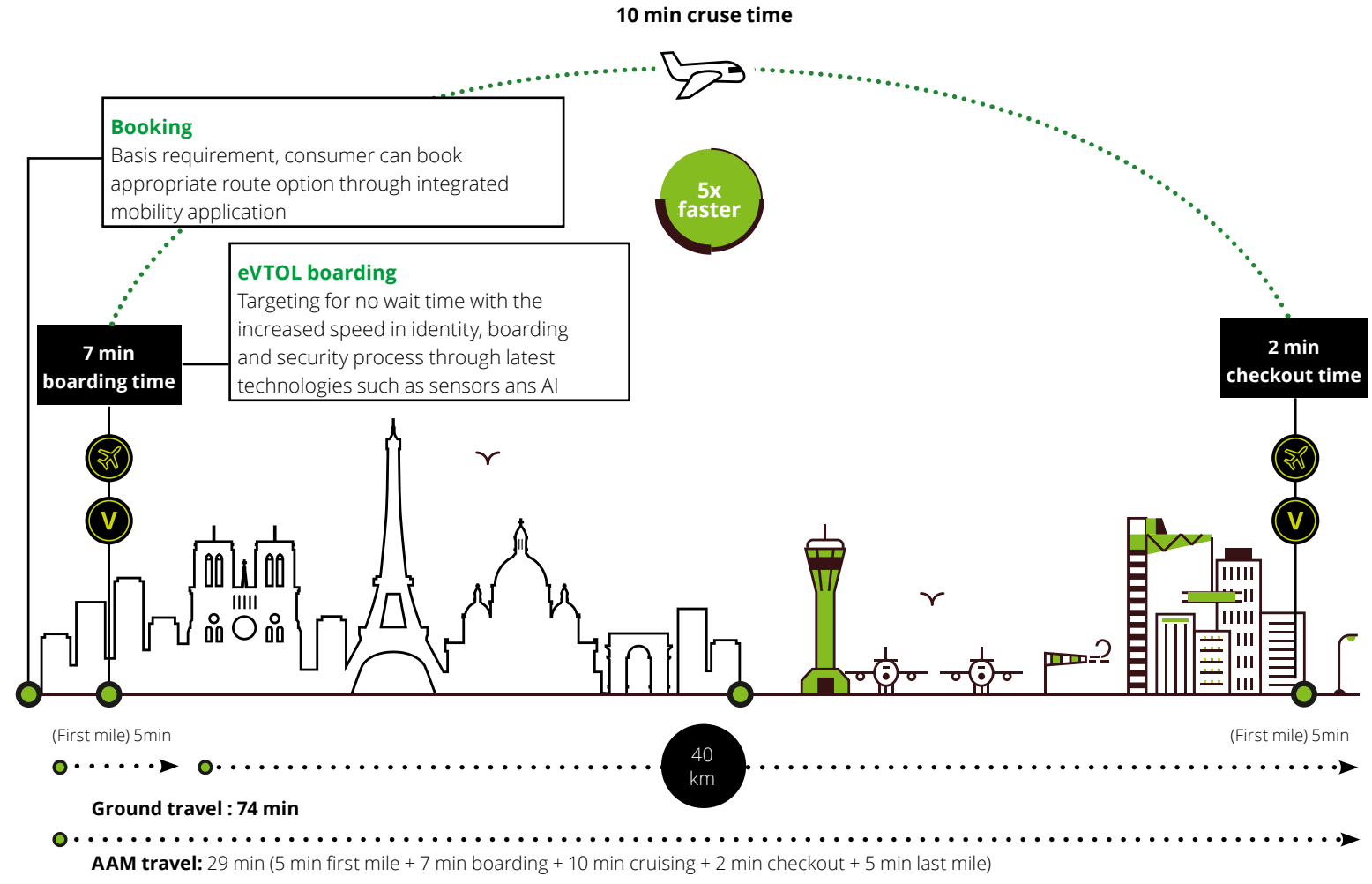
With urbanization and population growth driving congestion in cities, AAM promises to save passengers time, improve productivity and quality of life, increase accessibility for rural and disadvantaged communities, and expand access to goods and services. Trips using AAM could take minutes instead of hours as in the past.

Manufacturers aim to see eVTOL flying by 2024, and the AAM industry could become mainstream in the 2030s as companies strive to make it a commercial success. According to Vertical Flight Society, approximately 600 eVTOL aircraft concepts and designs are being developed by about 350 companies worldwide. At the same time, the healthy competition between eVTOL companies could help evolve the AAM ecosystem more efficiently and rapidly.

This article examines where and how AAM can compete with the existing modes of transportation and focuses primarily on the consumer perspective given the available options.

Can AAM enhance the transportation ecosystem?

AAM promises to enhance the existing transportation ecosystem by addressing congestion and pollution. AAM offers the potential to increase the efficiency of current transportation networks by reducing travel time, improving sustainability, and expanding access to goods and services. AAM will be closely integrated with existing transportation networks and infrastructure for first and last-mile connections. It would be critical for operators to integrate AAM into the existing transportation system to create an integrated mobility solution in urban areas (figure 1). This new mobility solution can help determine the clear pathways for passengers, which could be essential to tracking routes and planning vehicle deployment



First-mile ans last-mile mobility

- **Ground-sharing**
- **walking**
- **E-bike/cycle**
- **Train/subway**

Notes:
Based on the assumption that eVTOL cruises at 240km/h, the average ground speed is 40 km/h, and the air route is shorter than the ground
Transit time for departing passengers at vertiport is assumed at 7 minutes and will vary based on the route frequency – initially might take more time for scheduled operations and will reduce as the market matures
Assumed 2 minutes quick checkout at vertiport as there will be no procedures
Ground time includes booking time

Source : Deloitte analysis.

Can AAM compete with the existing modes of urban transportation effectively?

AAM operators can compete with existing urban transport but must improve the economics to capture the market, as the demand will likely be directly proportional to the service price. A lower price per seat over time would likely create more demand, resulting in a high load factor because consumer willingness to pay for faster transportation is expected to be one of the primary factors driving AAM adoption. As the demand increases, higher production volumes could lead to economies of scale.

AAM economics depend to a large extent on the type of fleet, seating capacity, load factor, and length of flight routes. AAM operators should also establish a business model for pilot-operated eVTOL as the scaled commercial launch of autonomous eVTOL operations will at least be 10 years beyond the commercial launch of piloted eVTOL operations.

Besides economics, safety, trip duration, and carbon footprint also play significant roles in driving the AAM market. In 2022, transportation activities were responsible for approximately 25% of EU CO2 emissions, and a major portion is attributed to passenger cars, around 64%. Manufacturers of eVTOLs claim zero operating emissions, and this new mobility system could achieve net-zero if being powered by either low carbon grid (e.g., in France, Nordic Countries, ...) and / or by cutting carbon from the related modes of transport during flight operations.

Standard taxi and ride-hailing services hold different fee structures—ride-hailing companies are priced less for passengers compared to traditional standard taxis. Hence, we have analyzed and compared AAM transportation with ground ride-hailing companies and taxis (figure 2). The standard taxi price in Paris averages €1 (ranging from €0.95 per km to €1.3) per vehicle km, and the premium taxi (incl. moto taxis) price averages €2 (ranging from €1.6 to €2.1) per vehicle km. The AAM transportation mode could present an alternative to the premium taxi market for some trips due to passengers willingness to pay for the time and that it can be positioned as a luxury mode of transport. However, compared with the price-per-taxi vehicle per km, AAM ridesharing can compete with both standard and premium taxis as the anticipated price is almost equal. AAM seat per km price is estimated to be around €1.6 for a 4-seater eVTOL aircraft (figure 3). Ground transportation costs equate to more kilometers since the air distance between origin and destination (O&D) is shorter than on the road. On average, ground distance will likely be about 10% more than the air for a typical trip in a European city.

Figure 2. Major existing transportation options on the ground

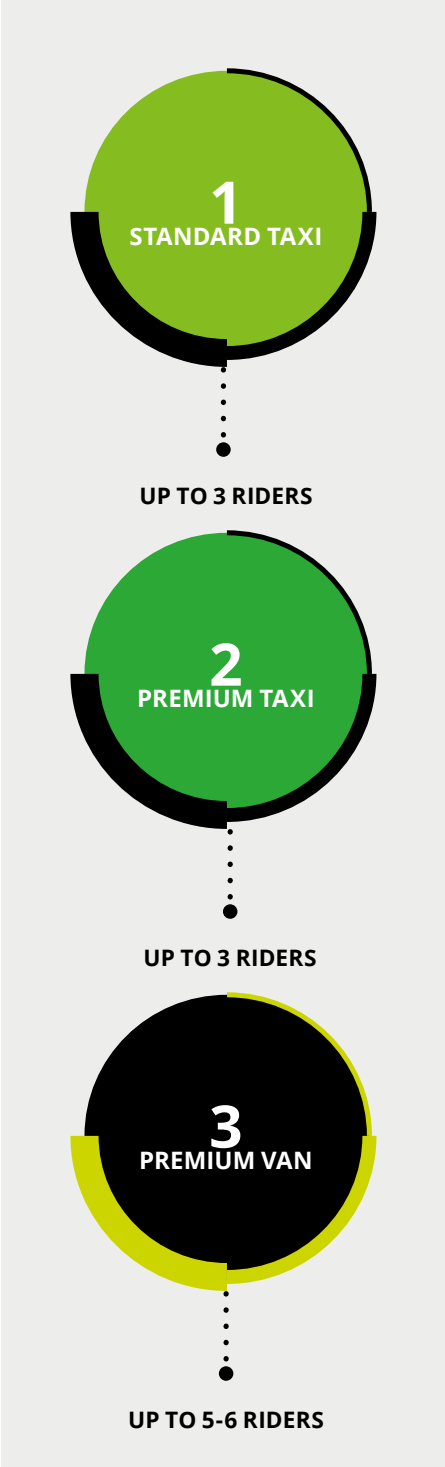
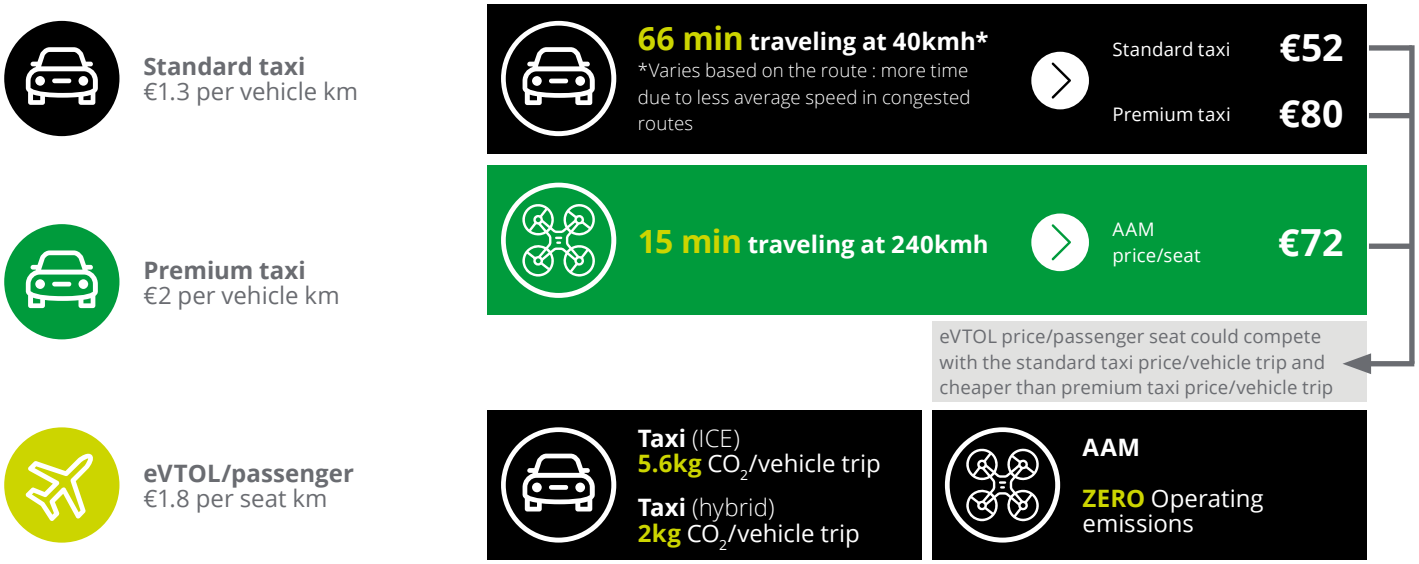


Figure 3. AAM ride-sharing competes with a ground taxi for a 40km trip



Note: AAM trip includes the vertiport transit time. The price for eVTOL seat mile will be based on the operator business model. Assumed the same price for the seat km (€1.8) irrespective of PLF. The price-per-seat km can vary based on the total number of fleets operated on a specific route

Source: Deloitte analysis,

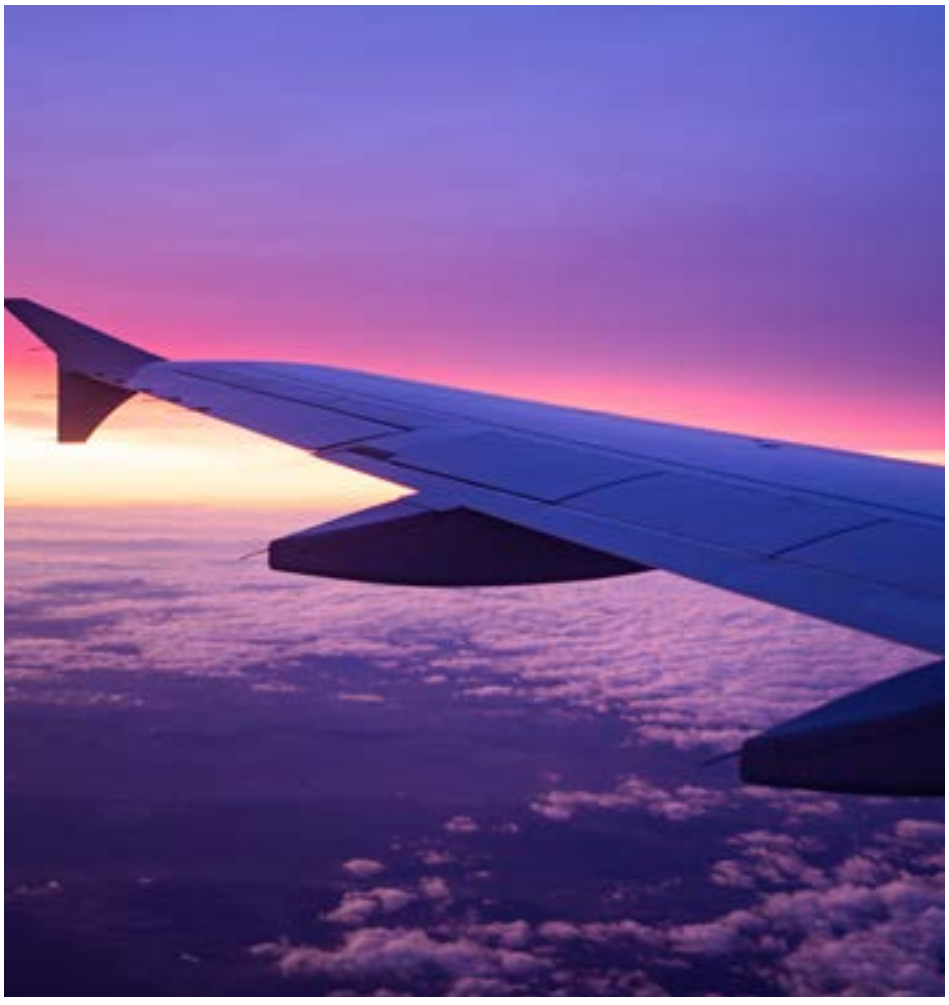
Note: AAM trip time includes the vertiport transit time. The price for eVTOL seat km will be based on the operator business model. Assumed the same price for the seat km (€1.8) irrespective of PLF. The price-per-seat per km can vary based on the total number of fleets operated on a specific route.

Source: Deloitte analysis, Paris taxis fares, eVTOL company websites.

The AAM industry is expected to mature rapidly toward high route frequency to provide quick and economical air travel for short distances. Unlike commercial aviation, limited seats in the eVTOL means operators' need to achieve a 100% passenger load factor (PLF) will likely be crucial for staying competitive.

Also, the average cost per passenger could decrease as PLFs increase, driving eVTOL operators to provide AAM service at more competitive pricing. Deloitte's analysis suggests that average gasoline and diesel passenger vehicles used as taxis emit about 140 (varies mainly between 120-200) grams of CO2 per km and hybrid passenger vehicles emit about 50 (varies mainly between 30-120) grams of CO2 per passenger km.

The eVTOL aircraft deliver greener trip options with zero operating emissions and could help in reducing carbon levels from the related modes of transport for the respective trip (if we take the assumption that the grid is decarbonized). The AAM transportation can perform significantly better on time and carbon footprint and could eventually compete with price by accessing the mass market.



AAM as a ride-hailing and ride-sharing service

Transporting people between and within cities, either scheduled or on-demand, could become a crucial application for AAM, where the most significant market is likely to exist. This is primarily because the AAM's ultimate objective is to become a transportation system for mass transit, operating between urban, suburban, and rural areas. Among these two applications, intra-city transportation (transporting people and goods within cities) offers more value and is projected to fuel long-term growth. This is because they are shorter trips and address the burning issue of congestion. AAM ridesharing services could drive the market for intra-city movement as the turnaround time could be as little as six to seven minutes for a 40 km trip, and this time would be enough to charge the electric aircraft for the next trip. There is also expected to be the potential to reduce the price per passenger seat by about 8% in five years from inception with increased demand, larger fleet size, higher aircraft utilization, and PLF.

For instance, a passenger may be able to travel three times faster at the same price in a short 30km trip and assist in reducing about 7 to 8 kilograms of CO2, for example, from Roissy airport to Paris center (figure 4).

For longer routes (inter-city), the alternatives are different. Few customers use taxis to connect between different cities: the two main alternatives are the personal car and the train.

For instance, for a 600km trip between Paris and Bordeaux, the passenger may be able to travel up to 2.6 times faster and cut about 115 kilograms of CO2 (vs. doing it by car). The aircraft turnaround time could be higher as the demand might not be high to fly back, and it could take about 60 minutes to charge the vehicle. As a result, the overall cost of the trip (around €750) is high if we compare it to doing this trip with a personal car which would cost approximately €145 (€55 for the toll charges and €90 for diesel/gasoline expenses for a medium size car). This could still provide a convenient alternative for some trips where the customer doesn't want to use its personal car (e.g., wants to take another transportation after, doesn't have a car etc.) and wants to travel faster. However, it doesn't hold true if we consider the main inter-cities transport alternative in France: the train. For such a trip, a train would cost approximately €65 for 2nd class and €80 for first class, and the trip would take 130min, connecting city-centers to city-centers with close to zero CO2 emissions.

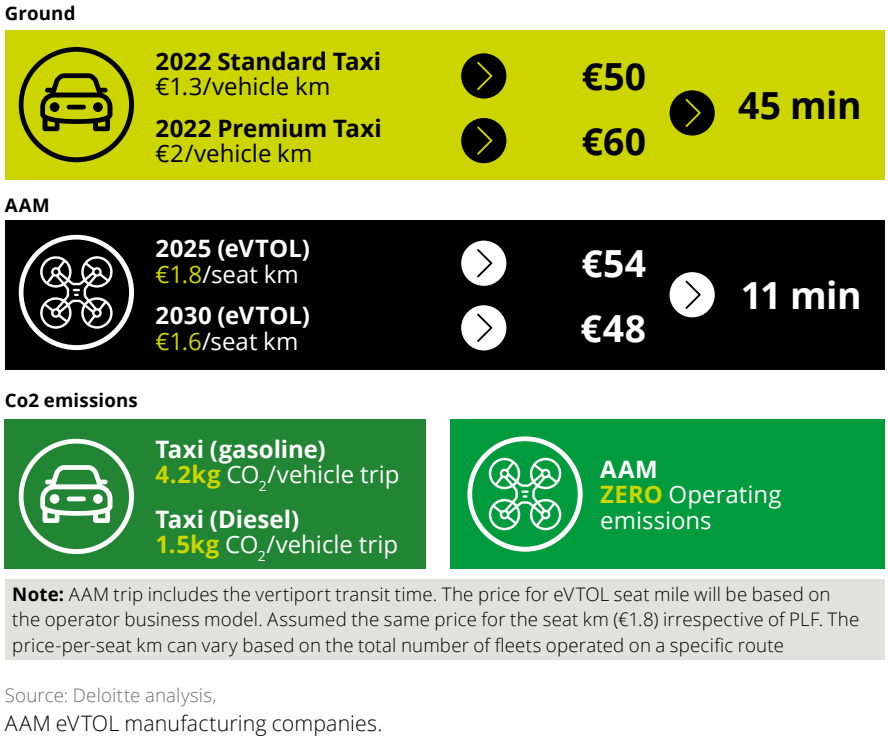
While AAM inter-city travel can be useful in the US because of the lack of alternatives (and the distance), the train alternative in France (and in many other European countries) makes it virtually impossible for AAMs to compete. A good train network offers to customers a cheaper, faster, and more convenient service (sending them directly in city-centers).

AAM's ultimate objective is to become a transportation system for mass transit, operating between urban, suburban, and rural areas but not for longer trips between cities

Figure 4.
AAM could cut intra-city travel time by more than:

75% with zero emissions from flight operations

30km trip: Roissy airport to Paris center



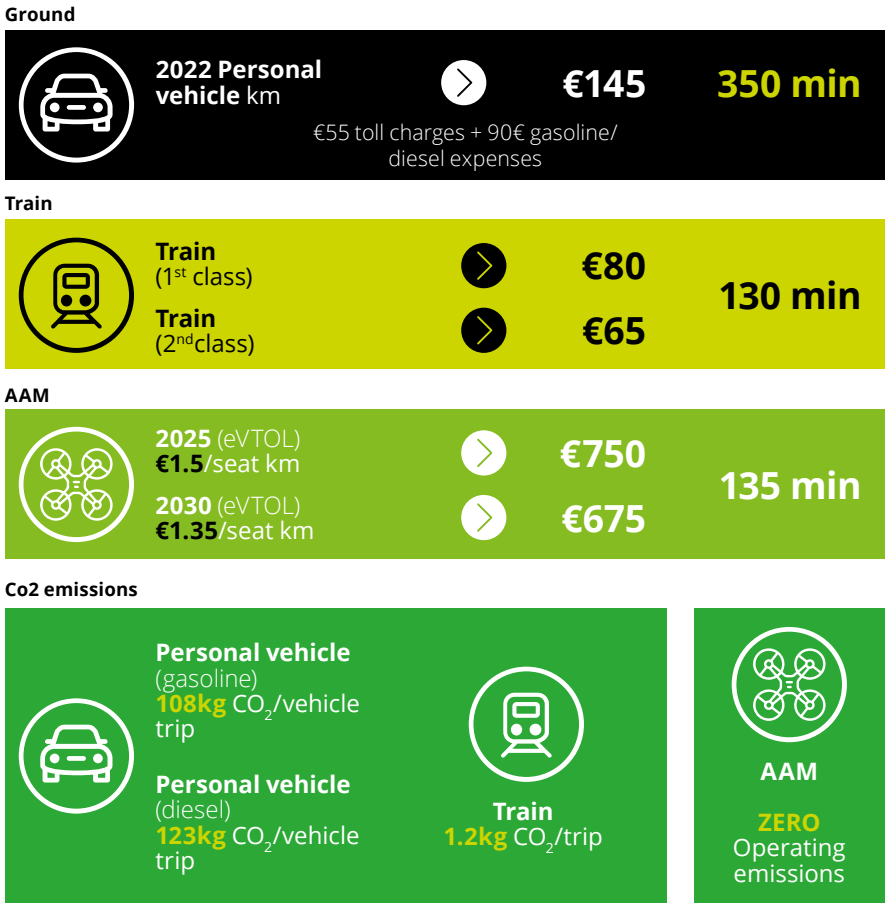
Note: AAM trip includes the vertiport transit time. The price for eVTOL seat mile will be based on the operator business model. Assumed the same price for the seat km (€1.8) irrespective of PLF. The price-per-seat km can vary based on the total number of fleets operated on a specific route

Source: Deloitte analysis,
AAM eVTOL manufacturing companies.

Figure 5.
AAM is not competitive vs train for inter-city travel

Inter-city (Paris – Bordeaux)

600km trip



Note: Airline and AAM includes airport and vertiport transit time, and taxi price is estimated from Uber and Taxis websites. eVTOL claims zero operating emissions, and CO2 emitted from the electricity production to charge the battery is not considered. The price for eVTOL seat will be based on the operator business model. Assumed the same price for the seat km (€1.5) irrespective of PLF. The price is calculated on flight distance rather than road distance which in this case amounts to 500kmX

Source: Deloitte analysis,

What should AAM companies do to drive faster adoption?

Cities' growing need for new mobility options due to congestion, environmental challenges, and expanding access to communities, goods, and services could accelerate eVTOL aircraft use. However, unlike other rapid technological advancements—such as the swift adoption of smartphones—the advances in eVTOL use could gradually progress toward scale and mass adoption. AAM companies should choose the right aircraft, route, and business model to facilitate faster adoption based on the anticipated demand in different markets and regions.

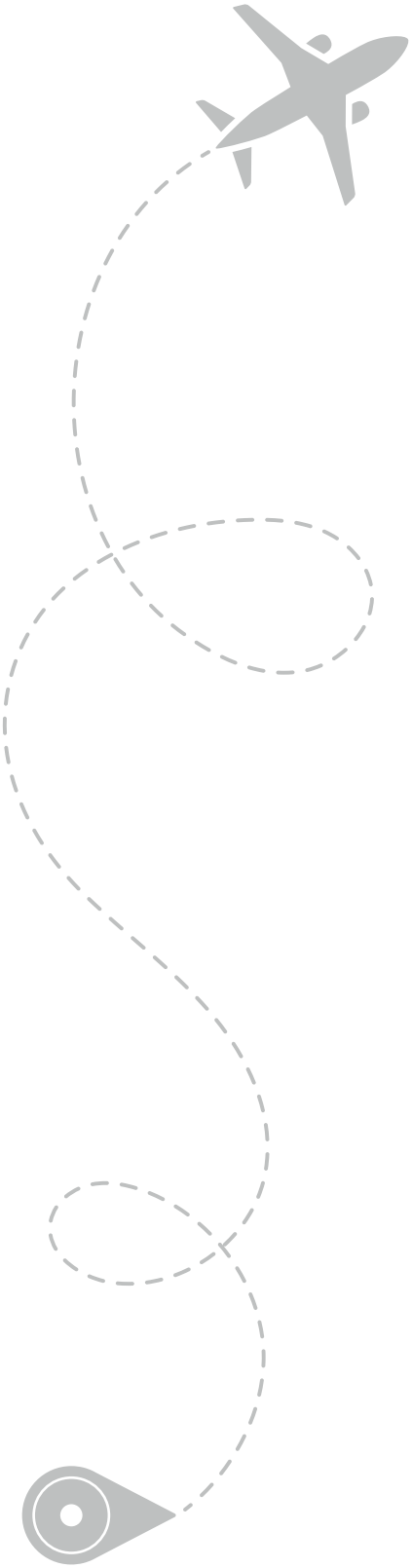
Due to less turnaround time, short to medium-length routes could likely have higher traction for eVTOL operations in the initial stages. The development of integrated mobility applications that help consumers review all trip options, including first and last mile, could play a crucial role in the faster adoption of eVTOL aircraft. The existing sophisticated ground network could tie into an air mobility system to create a new transportation network, and consumers can access this network through an integrated mobility application. Such applications would provide the information to help customers compare and select the appropriate mode of transport or a combination based on the requirements. Furthermore, comparison across price, time, accessibility, and sustainability in the integrated mobility application could be critical in empowering people to make decisions.

The shared information between different parts of the transportation ecosystem will likely help determine the clear pathways for consumers and could be essential to track passengers or cargo and plan the vehicle deployment for the upcoming transportation leg.

Advances in eVTOL use could gradually progress toward scale and mass adoption.

Though every business model that AAM companies adopt should have a mix of aircraft configurations, higher aircraft utilization can be achieved by selecting appropriate aircraft configurations—more 4-to-6-seater aircraft mix for intra-city and lesser seat configuration for inter-city trips. To differentiate trips, operators should also ensure seamless, integrated transport options and less transit time between each mode to drive positive consumer perception around time and distance. Furthermore, AAM companies should identify routes where eVTOL operations can significantly impact timesaving during the initial launch phase.

Finally, optimal placement of ground infrastructure considering prime locations such as dense locations, business areas, airports, and areas with poor access or limited transportation options will likely be critical in driving demand for eVTOL operations. This means AAM companies should identify and focus on strategic locations for placing takeoff and landing infrastructure, such as vertiports.

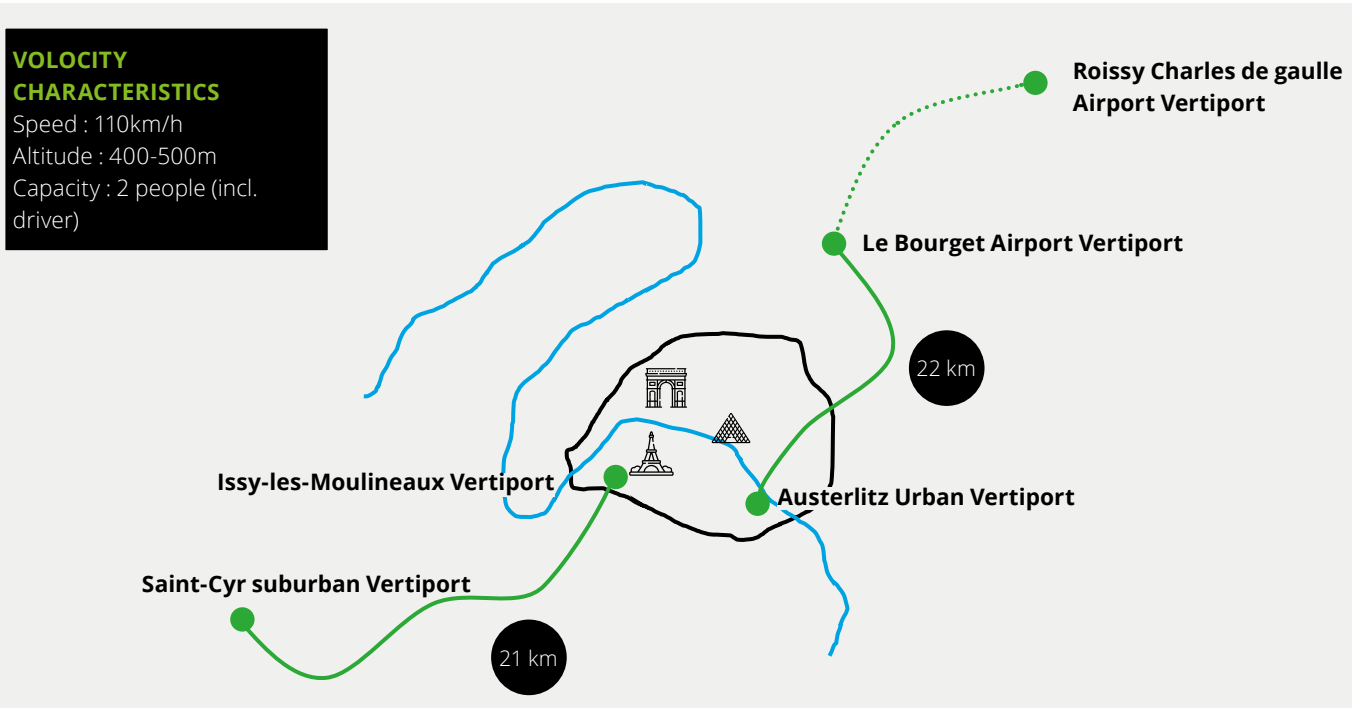


Will eVTOL be ready for the Paris Olympics games?

The upcoming 2024 Olympics games in Paris are expected to be a great testing field for eVTOLs. The ADP Group (Paris Airports Operator) announced that they were going to open the first urban air mobility commercial routes in 2024 (fig. 6) and a test center already opened in Cergy-Pontoise in November. Volocopter will be the partner for these first tests and the Olympics games. According to the AAM reality Index they have a high likelihood of being certified in time for 2024, so there should be no problem on this side. ADP group plans to use existing helicopter routes, and they are currently talking with aviation safety regulators on how these routes will be supported by additional mid-point landing facilities. These routes will be useful for tourists traveling for Olympics as they connect Charles de Gaulle Airport to Paris, but it will not be possible to access Paris city center directly as the vertiports are still in the periphery: this is probably a big downside for many tourists. Other major drawbacks with the earlier displayed figures are the speed (110kmh) and the capacity (1 passenger) of the Volocity, which will considerably rise prices. As a result, this means of transport will be reserved to VIP customers able to pay a high price (ADP estimates the average price of a trip at €110). In the long-term, the company is forecasting 4 seats aircrafts being available without the need to be driven by a human onboard, but it is hard to tell when such commitments will become a reality. One thing is certain: the 2024 Olympics should really be considered as a POC (before further developments) which will offer an (expensive) experience to the passengers willing to try it. In the long run, the ambition is also to have vertiports for Parisian hospitals and offer the most streamlined passenger experience possible.

Paris Olympics games will be a first test for the Volocopters eVTOL and the Parisian AAM infrastructure

Figure 6.
ADP Group will open 2 commercial routes connecting Paris to airports in 2024



What are the current barriers to eVTOL development?

As we saw with the Paris Olympics Games example, eVTOL will not be fully operational and scalable in the next 2 - 3 years. This is due to a set of limitations that will need to be overcome for the sector to grow:

1. Infrastructure

For years, most of the efforts were focused on the vehicle-end, however, considerable infrastructure investments will be required:

- **Landing & charging infrastructure:** Pre-existing heliports will have to undergo a transition to vertiports, notably because they are not equipped with charging stations. There will be some changes required to retrofit some infrastructure into vertiports (e.g., helipads, low utilization airfields) and create space for new vertiports (e.g., Reef and Archer collaboration to convert parking garages rooftops into vertiports) as multiple urban vertiports in each city will be required for the service to become attractive. Also, a dense network of reliable and rapid hydrogen and electric charging facilities will be required on top of specific charging infrastructure and skilled manpower (especially in case of battery swapping)

- **Navigation & airspace security infrastructure:** Beyond the need to build vertiports in the cities, there are also considerable challenges in augmenting the urban air traffic. The introduction and growth of eVTOL will require advanced airspace flight technologies such as detection and avoidance capabilities and assured geofencing. A NASA working group is tackling these topics to find solutions as the challenge is considerable (i.e., redesigning the future airspace)

- **Communication infrastructure:** New eVTOLs will have to integrate into the existing airspace communication system either by using existing ATC technologies or developing their own.

- **Parking facilities:** The growing number of eVTOLs envisioned (by 2027 the global eVTOL fleet should be around 5,000 units with approximately 1650 26 in EU) will need safe and convenient parking during off-peak hours. These facilities will require some specific equipment and will need to be located close to the flight routes.

2. Technologies

Some of the promises made by eVTOLs are based on forecasts of future technologies which still need to be finalized. For example, autonomous flying vehicles are not possible yet, as neither technology (some tests have been successfully done – by Wisk Aero for example – or are currently ongoing, but no standard product is available) nor regulation allow it. If we compare it to the automotive industry, autonomous eVTOLs are at least 20 years away

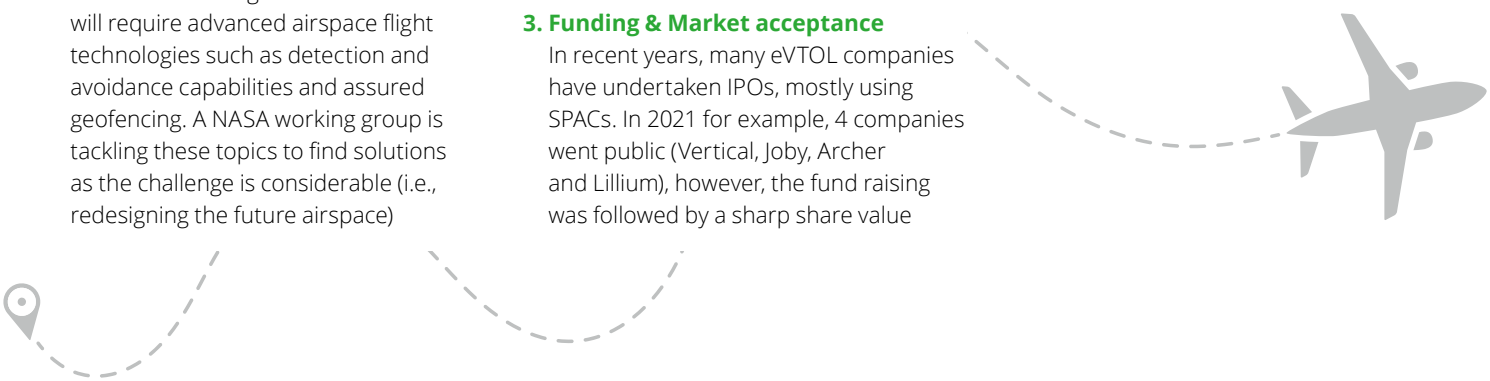
The battery technology & safety is also new to the aviation industry and will require some specific technologies as it will be used very frequently during peak hours. One example in 2022, is the experimental Aura Aerospace Guardian 1 eVTOL that caught fire during testing because of the battery.

3. Funding & Market acceptance

In recent years, many eVTOL companies have undertaken IPOs, mostly using SPACs. In 2021 for example, 4 companies went public (Vertical, Joby, Archer and Lillium), however, the fund raising was followed by a sharp share value decrease. Since their IPOs, the share price of these 4 companies has fallen by an average 78.5%. As highlighted earlier, there is still a lot of enthusiasm from private investors in this field, but eVTOL companies should be careful not to lose market trust. Future IPOs of promising actors such as Volocopter, may suffer from the historically negative returns on IPOs of eVTOLs companies.

4. Standards & Regulations

Current eVTOL status is still unclear regarding aviation standards. Among the topic which should be clarified safety is the first concern. In Europe, the EASA (European Union Aviation Safety Agency) is ahead of the FAA (Federal Aviation Agency) as they released in June 2022 a comprehensive framework for eVTOL air taxi operations in European cities. Even though the progress is fast paced, the associated operating and licensing rules are different, as they are what the EU terms “hard law” and must be approved by the European Parliament which requires public consultation (opened in September 2022)25. On top of these safety concerns, other operational standards need to be established for example: classification standards (eVTOL should not be considered as a standalone aviation class in Europe) or insurance coverage grids.



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