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FRAZER-NASH CONSULTANCY
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Scaling Advanced Air Mobility in the UK

A feasibility assessment for an eVTOL airport shuttle transport system

November 2023

Abstract

Advanced Air Mobility presents an opportunity to revolutionise public transportation, offering significant travel-time savings with improved connectivity, resulting in potential socioeconomic benefits valued at £2.1 billion annually for the UK[1]. The building blocks for this future aviation revolution will be centred around automation, autonomy, and electrification, with benefits including reduced road congestion, load alleviation on existing surface transport modes, and new multi-modal trip options — all while maintaining the course for net-zero emissions.

This publication assesses how the GKN Aerospace Skybus concept can play a major role in our UK future air transport system, focusing the analysis on an a shuttle service for Manchester Airport; this use case is very similar to the existing park-and-ride concept already in use around many towns and cities, and which this analysis will call a “park-and-fly” capability.

An assessment of the benefits to Skybus passengers over existing transport options has identified the significant sensitivities that exist around the location of a Vertiport (a future eVTOL airport). To unlock the benefits, investment will be required to develop solutions to the key challenges, particularly around Skybus integration with the existing air transport system. Collaboration between industry, Government and the Civil Aviation Authority (CAA) will be required to bring this capability to life, using a ‘systems thinking’ approach to achieve it effectively.

This analysis has engaged industry and Government stakeholders, including Urban-Air Port Ltd, Department for Transport, Connected Places Catapult, and a large UK airport, all of whom have informed the potential of the Skybus concept and the key next steps along the journey to routine airport shuttle services.

This publication was delivered by:

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The growing potential of the AAM market

Market Definition

The vision for the Advanced Air Mobility (AAM) sector is to create a safe, affordable and complementary air transportation system for both people and cargo. AAM for passenger transport can generally be categorised into Urban Air Mobility (UAM) and Regional Air Mobility (RAM) with each segment having multiple use cases. These include offering transportation to complex urban areas and hard-to-reach rural locations where existing forms of surface transportation are limited due to location or low customer demand.

The AAM market should be considered as a 'system of systems', which includes the air vehicles, supporting infrastructure, controlled airspace, and the policy & regulation that will underpin safe operations.

A key element of AAM is the electric-powered vertical take-off and landing (eVTOL) aircraft. Often referred to as 'air taxis', eVTOL aircraft utilise electric propulsion systems that enable zero emissions, lower operating costs and reduced noise pollution.

This combination of transformative technologies can help unlock the transport of people and cargo in a more sustainable way; Using air corridors to transit passengers around quickly, safely, and efficiently between and within cities and towns.

Market Outlook

The AAM market is a rapidly developing and growing sector.

The USA's National Aeronautics and Space Administration (NASA) predicts by 2030 globally there will be as many as 750 million flights a year for air metro services[2].

A market forecast by Morgan Stanley predicts a value of up to $1 trillion by 2040[3] for the AAM sector, demonstrating the expectations many have for significant growth in this new and developing market.

Market Enablers

To achieve AAM integration 'at scale' within the UK, both industry and government must collaboratively unleash the key market enablers (or accelerators) to stimulate change and steer the market in the desired direction. The key enablers to accelerate the growth of the sector include:

> **Regulation & Policy.** The Civil Aviation Authority (CAA) are actively involved with the development of UAM and RAM; CAP2539 was developed in July 2023 to provide guidance to manufacturers, operators, and infrastructure providers on the key consumer principles from the regulator's perspective[4], helping to align pathways between industry and the regulator during early-stage development. The CAA has also identified a series of key workstreams in the development of eVTOL regulations, which include aircraft certification, pilot training & licensing, and operational certifications, amongst others[5]. The Future Flight Challenge (FFC), which aims to fund future technology demonstrations in 2024, promotes CAA engagement[6], enabling a collaborative environment to help maximise regulatory readiness and accelerate the pace of disruptive technologies entering the market.

> **Capability Integration.** Air vehicles should be developed collaboratively and concurrently with regulatory and policy development, airspace design change, and infrastructure planning. Organisations such as Urban-Air Port Ltd work closely with AAM developers to provide infrastructure solutions that support the key integration considerations that underpin future operations. The Future Aerospace Industry Working Group (FAIWG-AI) published a constructive plan which identified a set of immediate actions and directed them to the relevant stakeholders. The overarching aim of these actions is to accelerate the development of an integrated airspace[7].

> **Social Acceptance.** Uncertainties relating to safety, noise and security can lead to public discomfort when introducing new technologies[8]. Phased demonstrations will help the public to observe the benefits of AAM, and help industry to identify and mitigate the risks. The FFC has recently commissioned a Future Flight Community Integration Group which aims to foster the views of a diverse community in order to help shape future aviation integration[9].

2 The Future of Mass Air Transportation

Skybus: A high capacity eVTOL

The Concept

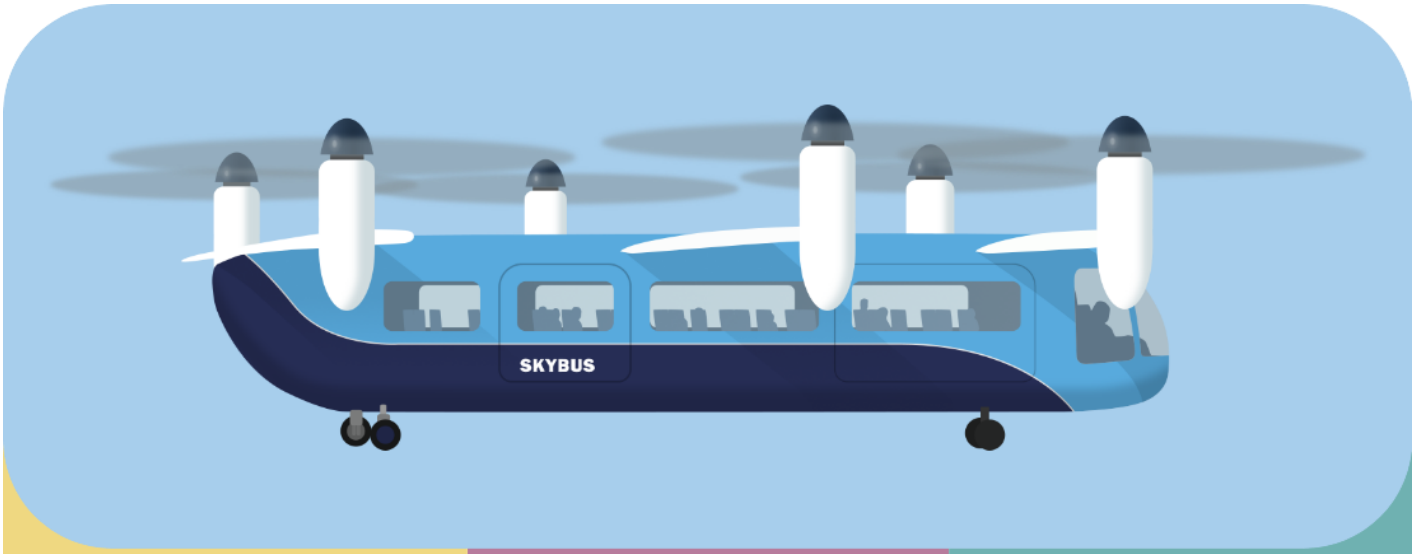
Skybus is a battery-electric, six-rotor eVTOL concept developed as part of a collaborative FFC Phase 2 project. Unlike typical eVTOL concepts designed for 1-6 passengers, Skybus accommodates up to 30 passengers. This capacity enables Skybus to support mass air-transit use cases within urban areas to supplement existing transportation services

The Value Proposition

The high capacity aims to reduce the cost-per-passenger-mile to below $1 (with a 75% load factor)[10], creating a service which is both affordable and accessible to the general public.

The Skybus concept has significant potential, with early estimates from GKN Aerospace predicting competitive ticket prices of between $20-30[10].

Figure 1: Key Benefits of Skybus[10]



Increased Passenger Capacity (in comparison with other eVTOLs)

Skybus is being developed to carry up to 30 passengers, to create a mass transportation solution with a lower cost per passenger than smaller air taxis.

Rapid Burst Charge

A burst charging capability between flights will maximise Skybus' availability for a regular and reliable revenue passenger service.

High Speed Transportation

Skybus will cruise at up to 180mph in future integrated airspace, giving passengers the benefit of reduced journey times.

2 The Future of Mass Air Transportation

eVTOL Infrastructure

Establishing the infrastructure required for air vehicles like Skybus is a key enabler for future eVTOL operations. The design of Skybus will impact the design of the Vertiports that service it, and vice versa.

The European Union Aviation Safety Agency (EASA) define a Vertiport as "*an area of land, water, or structure used or intended to be used for the landing and take-off of VTOL aircraft*"[11]. Vertiport designs differ significantly from those of conventional airports.

Vertiport designs need to include essential systems that are important for eVTOL airport shuttle services, including battery charging infrastructure, maintenance facilities, and passenger processing facilities/amenities.

The outputs of the FFC Phase 2 Skybus project included an extensive design study of a Skybus Vertiport, resulting in a conceptual layout with a focus on the 'passenger journey' to improve the experience of the travelling public. This concept is illustrated in Figure 2.

It is assumed that the Air Traffic Management (ATM) systems of the Vertiport are largely automated and managed remotely from a central off-site location.

Figure 2: Skybus Vertiport concept on the River Thames in London, UK.

[Image Copyright Pascall+Watson Architects. Used with permission]

2 The Future of Mass Air Transportation

Location Considerations for a Vertiport

There are a range of complex and interlinked considerations that will inform the location of any Vertiport. Extensive research and modelling will be required to compare Vertiport location options, to identify the most appropriate locations that balance local environmental benefits and concerns, alongside the requirements for the Skybus network. The key considerations for a Vertiport location include:

Integration with Existing Transport Networks

Vertiports need multiple robust interchanges with other transport networks to provide an integrated, convenient and cost effective transportation solution for the travelling public.

Traffic Impact

A Vertiport will increase traffic volume on the local roads connecting to it. Consideration needs to be given to the ability of these roads to handle increased traffic (or be upgraded), along with the associated positive and negative effects for local businesses and residents. Significant parking infrastructure will also be required.

Noise

The effects of eVTOL noise and annoyance on public health and wellbeing require consideration. It is likely that Vertiports will not be located adjacent to noise-sensitive areas.

Energy Requirements

A Vertiport will have significant energy demands for eVTOL operations, with increasing pressure for this power to come from renewable sources. Alongside the power generation options, requirements for any infrastructure upgrades for high capacity electricity transmission also need to be considered.

Airspace

Future airspace design will focus on integration of airspace users, rather than segregated blocks of airspace, but the details of these new designs are still in development. In time, regulation will be drafted detailing how eVTOL operations in congested airspace above large populations can be conducted safety and securely. However, for now, the unknowns around airspace regulation are a key risk when selecting Vertiport locations.

Future Exploitation

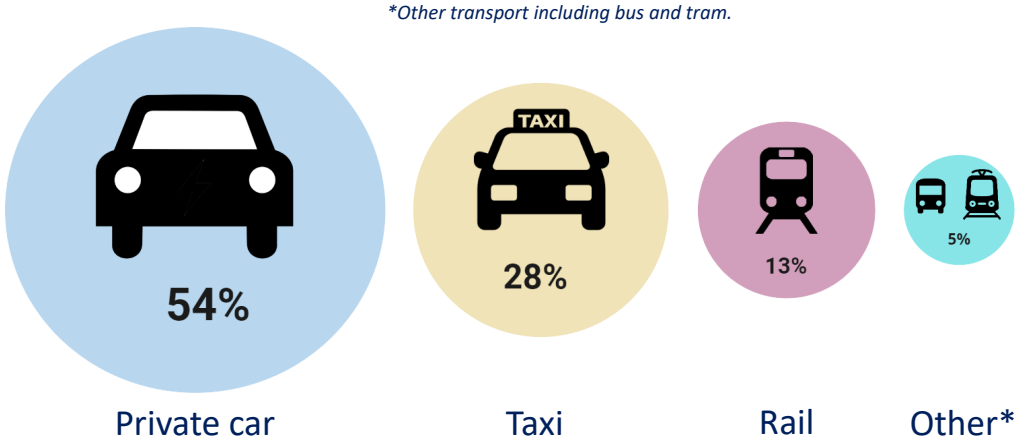
An airport shuttle service is one of many potential use cases for Skybus and it will be useful to consider other functions for Skybus—such as inter-city and intra-city travel—when deciding on a Vertiport location.

3 A Skybus Operation for Manchester Airport

Manchester Airport (MAN) is the busiest airport in the UK outside of London, with over 23 million passengers in 2022 (28 million in 2019)[12]. Manchester Airport's significant passenger numbers have been used to illustrate how a Skybus park-and-fly service could work to support passenger transfer to and from the airport.

Figure 3: Travel modes to/from Manchester Airport (data from DfT[12])

**Other transport including bus and tram.*



Parking Problems at Manchester Airport

BBC News reported in 2023 that many Manchester Airport passengers have been refusing to pay the perceived high costs of parking at the airport, and instead looking for more cost-effective options to support the convenience of travelling by private car[13]. Many have been looking for cheaper alternative parking arrangements, which has led to security issues including vehicle damage, car seizures and key loss.

Whilst using alternative transport methods is an option, Department for Transport (DfT) data shows that travel by private car is the significantly preferred form of travel for passengers travelling to Manchester Airport, despite the dissatisfaction with parking charges.

Greater Manchester Airport Transfer

The airport has excellent public transport links with Manchester city centre, but many passengers have limited public transport options when traveling from elsewhere. Private car is often not the quickest transport mode for travel to the airport with journey times often increased by traffic congestion on the main routes heading to the airport (M56, M60 and M6).

The typical travel times for Manchester Airport passengers from surrounding locations are as follows[14].

Manchester Piccadilly: 25 mins (train), 35 mins (car)

Northern Quarter: 40 mins (public transport, including tram and bus); 40 mins (car via inner ring road)

Preston: 75 mins (train); 80 mins (car)

Blackburn: 90 mins (train); 80 mins (car)

These figures are based on peak travel times and have been used later in this report to illustrate the comparative benefits of Skybus.

Taxi Cost Comparisons

For the purpose of comparison with Skybus journey costs, shown on pages 11-14, the cost of a taxi to Manchester Airport from various locations is shown in Table 1. Skybus may be a more cost effective option than a taxi for passengers travelling to the airport from areas further afield.

Table 1: Cost of taxis from various locations to MAN[15]

Location	Cost
Manchester (10 miles)	£20
Preston (40 miles)	£95
Blackpool (60 miles)	£120
Leeds (60 miles)	£120
York (90 miles)	£200

3 A Skybus Operation for Manchester Airport

Skybus Passenger Demand

It is important to understand the expected number of passengers that would travel using a Skybus service, to assess the economic viability of Skybus. Estimates of Skybus utilisation can be derived by comparing various percentages of the current throughput of Manchester Airport passengers (using passenger numbers from 2019[12]), to indicate a range of the number of daily flights required, and the number of Skybus aircraft required to undertake these flights.

The analysis is based on assumed operational hours of 06:00-22:00, with each Skybus aircraft flying a 30 mile each way return journey (based on the Vertiport locations considered on page 9) every hour, with burst charging between each flight, and then requiring a 45 minute full recharge every 8 hours[10]. Figures are based on a passenger load factor of 75% and include a 10% margin on Skybus fleet size to account for aircraft downtime (e.g. maintenance).

There are 2 key requirements to unlocking the Skybus capability and realising these levels of demand:

> **A fully operational Flight Information Service (FIS)**[7] that allows air traffic control to effectively coordinate all airspace users in a future integrated airspace. This must be prioritised to safely and effectively integrate Skybus and other eVTOLs into the airspace network in the volumes required to satisfy future demand, without disrupting existing airspace users.

> **Multi-modality for Vertiport access** to support the predicted passenger numbers, including increases due to potential flight delays. This involves connecting the Vertiport to surrounding population centres via a multitude of transport options, such as road, rail, and other public or private transport.

Figure 4: Estimates of Skybus flights required for a Manchester Airport service

Airport passengers using Skybus daily (% of MAN passengers*)	**15,400** (20%)	**7,700** (10%)	**3,900** (5%)
Required daily Skybus flights	**686** (~43 per hour)	**343** (~22 per hour)	**172** (~11 per hour)
Number of Skybus aircraft required	**25**	**14**	**8**

* Includes both arriving and departing passengers, excluding passengers connecting to other flights (based on 2019 DfT data, numbers rounded to nearest 100)

A Vision of the Skybus Passenger Experience

The Skybus passenger experience, alongside the operational advantages and complexities of delivering a Skybus service, has been illustrated in an 'operating concept vignette' on the following page. The passenger journey is shown in 12 consecutive key operational steps, from arrival at the Vertiport, to entering the international airport. The vignette outlines the benefits to passengers using a Skybus service compared to other transport options, including low-key and unobtrusive processing, plus high levels of automation, which reduce waiting times. The numbers of flights/passengers in the vignette are taken from the 10% example of MAN passengers from Figure 4.

SKYBUS
Operating Concept Overview

Estimate of Skybus Demand
Manchester Airport had 28 million passengers in 2019. If **10%** of these were to use a Skybus service, there would be **7,700 daily Skybus passengers**, requiring **~170 flights each way**. This means an average of 1 flight **every ~5 minutes** (over 16 operating hours daily).

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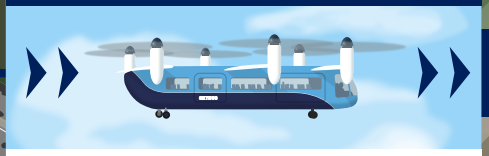
Departing Terminal

1 Arrival

This terminal illustration is based on the Vertiport concept design by **Pascall+Watson Architects**

Returning passengers

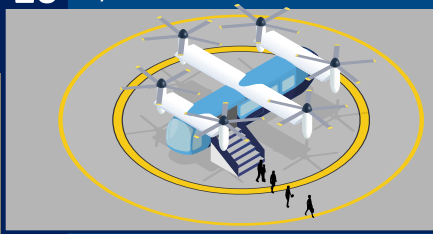
9 During Flight



Skybus travels to the destination using **pre-approved flight corridors**. A Flight Information Service (FIS) will **assure safe flight** through an integrated airspace.

Arrival at International Airport

10 Skybus lands at destination > disembark



11 Leave through Skybus terminal

12 Head straight into main airport

Passengers

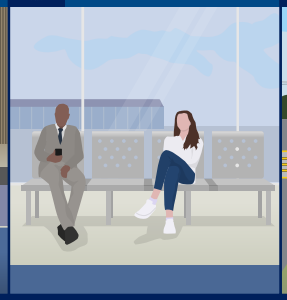
1 Arrive at Skybus Vertiport terminal.

2 e-Gates / ticket check.

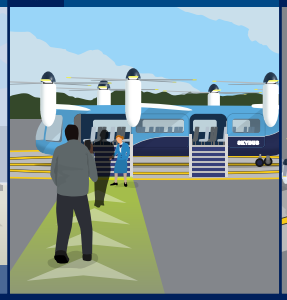
3 Drop off luggage and head through security.

4 Variety of retail options available in main lobby.

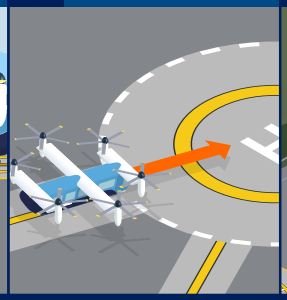
5 Go to boarding gate.



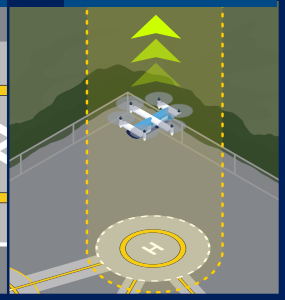
6 Board Skybus at the eVTOL aircraft stand.



7 Skybus taxies to take-off position.



8 Skybus takes-off vertically.



3 A Skybus Operation for Manchester Airport

Selecting Vertiport Locations

Two potential park-and-fly Vertiport locations—Ainley Top and Samlesbury disused Aerodrome (see Figure 5)—have been identified based on the location considerations outlined in page 4 of this report. Both are located near a region with significant population centres, with Samlesbury serving Lancashire and Ainley Top serving Leeds, Bradford, and environs. These should not be viewed as the only options and, more widely, multiple Vertiports (park-and-fly as well as other use cases) creating a network of eVTOL routes is likely to be the best way to fully realise the benefits of AAM.

An overview of the factors that informed the selection of these locations is presented below:

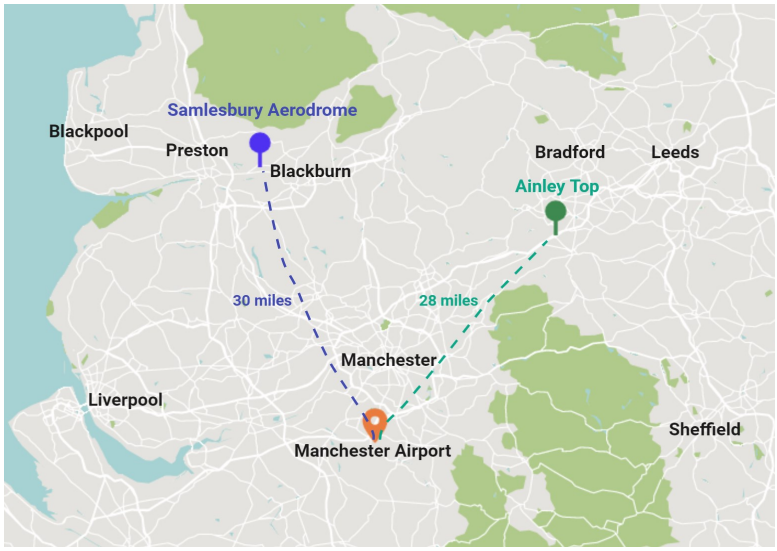


Figure 5: Potential park-and-fly Vertiport locations

[Map data © Google 2023]

Integration (Road)

Samlesbury: The site benefits from direct access to the A59 and A677, and is only 1 mile from the intersection with the M6.

Ainley Top: Located just off the M62 north of Huddersfield, the site offers great connectivity to the road network.

Integration (Public Transport)

The Skybus park-and-fly use case focuses on travel to the Vertiport by private car, therefore suitable road access to potential sites has been prioritised as a consideration. It is difficult to find a site in the region that is well connected with both rail and road links. This is because most train stations are located in town centres where the small capacity roads, congestion, and lack of low-cost land for parking spaces would make road access to the Vertiport difficult. However, this issue would not exclude future Vertiports in these urban locations, connecting areas that do not already have fast public transportation links to nearby cities and fulfilling the goal of Skybus being a complementary transport system.

Passengers without private car access could still use the park-and-fly Vertiport through the introduction of EV shuttle buses linking residential areas and public transport hubs to the Vertiport. These links would be as follows:

Samlesbury: A shuttle connecting to Preston and/or Blackburn train stations in around 20 minutes.

Ainley Top: A shuttle connecting Huddersfield station in around 10 minutes.

3 A Skybus Operation for Manchester Airport

Traffic impact

Samlesbury: Whilst well connected by road, increased traffic due to the Vertiport may cause congestion in the local area. The M6 connection would likely be able to cope with the additional demand, but further analysis would be required to assess the impact on smaller adjacent roads such as the A59 and A677.

Ainley Top: Similar to Samlesbury, the M62 connection is likely to cope well with the additional demand, but further analysis would be required to determine if the A629 access road would require further development.

For both sites the impact on these roads should be assessed in conjunction with the expected reductions in congestion at Manchester Airport for a holistic view of the Vertiport's impact.

Noise

Samlesbury: Being an active industrial site on a disused airfield, noise pollution in the immediate area may not be a primary concern. Nearby small villages may however require further consideration.

Ainley Top: Adjacent to the busy M62 and with no residential areas directly nearby, noise pollution is unlikely to be a concern.

Energy

Samlesbury: Not far from the West coast, installations such as Walney Offshore Wind Farms[16] would make excellent sources of renewable power, to be joined by projects such as the Mersey River Tidal Power Project[17] in the future.

Ainley Top: Onshore windfarms such as the Blackstone Edge wind farm[18] would be a potential source of renewable power.

Airspace

Skybus will operate within a future integrated airspace, utilising a fully operational FIS. This will allow air traffic control to effectively coordinate all airspace users, and support the safe operation of the Skybus service from both locations.

Future Exploitation

Samlesbury: This location is well-suited to act as a Vertiport hub between Lancashire and Greater Manchester, with potential to act as a link to Manchester and Liverpool city centres.

Ainley Top: This location is well-suited to act as a Vertiport hub between the metro areas of Leeds, Bradford, Greater Manchester and Sheffield.

3 A Skybus Operation for Manchester Airport

Comparing Skybus to the Alternatives

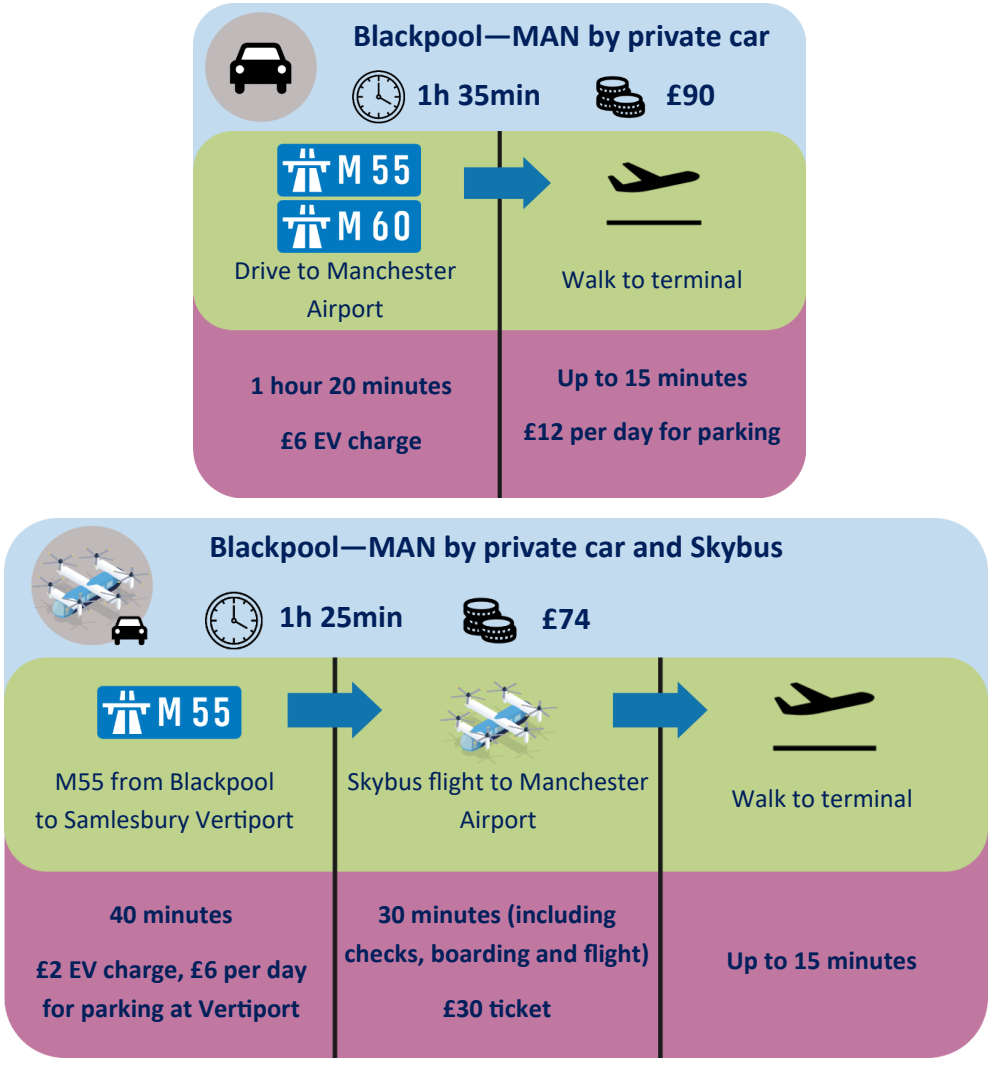
When Skybus enters service, passengers travelling to Manchester Airport will have a range of competing transport options to consider, each varying in price, travel time and convenience. A comparison of these transport options with Skybus has been conducted to identify the differences in the customer journey between each method of transport, outlining the potential benefits and challenges of each.

This assessment considers journeys from both Blackpool and York using the potential Vertiport locations—Samlesbury Aerodrome and Ainley Top—to compare Skybus against other transport options. All estimated costs are Net Present Value; train costs from Trainline[19], bus costs from local transport companies[20] [21], parking costs obtained from Manchester Airport's website[22], and EV charging costs from EDF[23]. The overall cost of parking at the airport is based on the total cost of a 7-day parking stay, with the parking charge shown as a daily rate. The cost of parking at the Vertiport is taken as £6 per day, based on parking rates from a public car park in Preston[24].

Passengers Using a Private Car from Blackpool or York

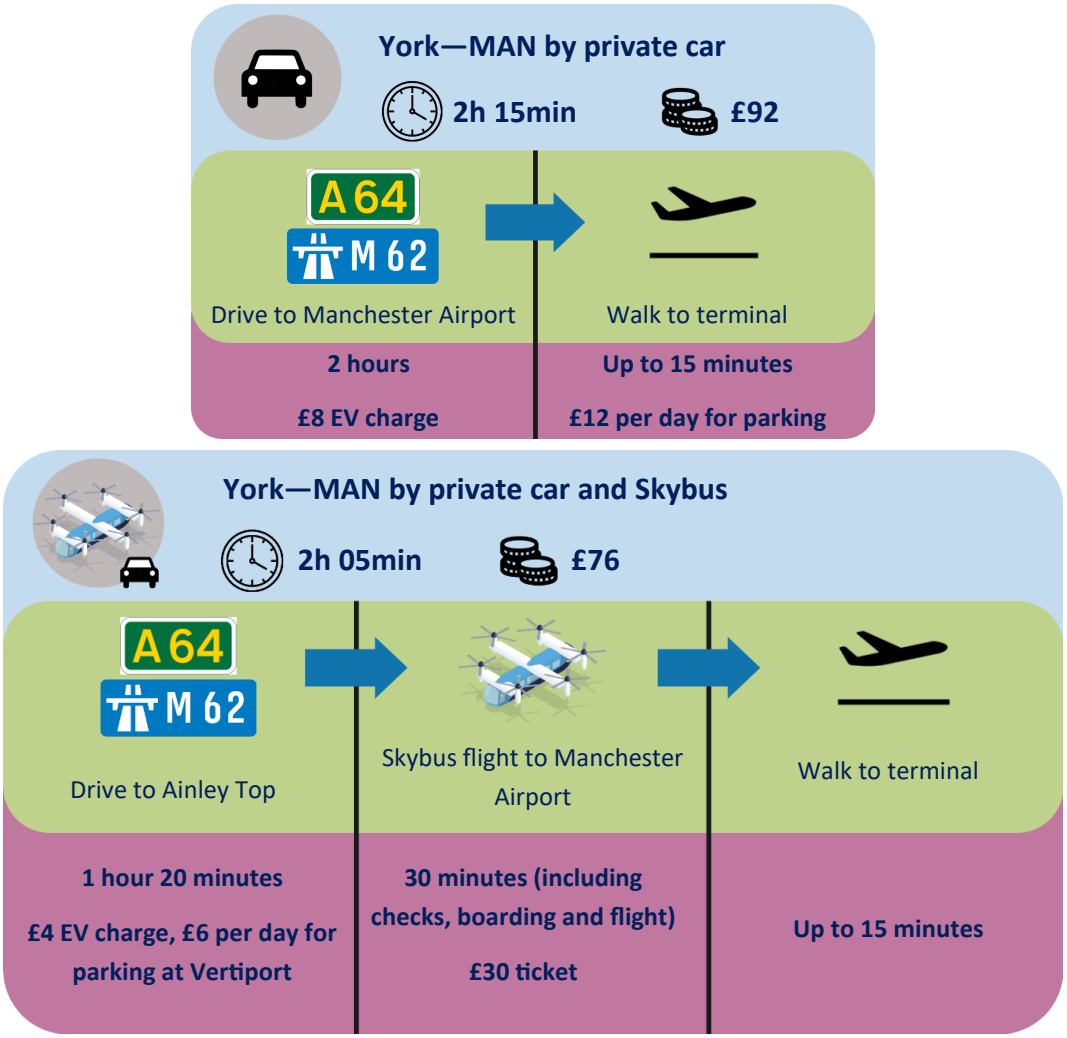
This analysis compares use of a private car for the full journey to Manchester Airport, with the use of a private car to the Vertiport at either Samlesbury or Ainley Top. The journey is assumed to take place at the busiest times of day. The car is assumed to be an EV. The Skybus journey time includes the time required for parking, entering the Vertiport and boarding the Skybus.

Figure 6: Comparison of journey from Blackpool to Manchester Airport by car, with and without Skybus



3 A Skybus Operation for Manchester Airport

Figure 7: Comparison of journey from York to Manchester Airport by car, with and without Skybus



The journeys from Blackpool and York to the airport using Skybus allow passengers to cut out a significant portion of the drive, including the busy M60. However, they still require driving to the Vertiport which may add time to the journey due to traffic. Those living in towns nearest to a Vertiport will benefit from further time savings, as their time on the road is minimised on the way to the Vertiport. For the two Vertiport options considered, total travel times to the airport from nearby towns, assuming the passengers drive to the Vertiport, are shown in Table 2 (these include up to 15 minutes for walking to the terminal, as in Figures 6 and 7). The first two locations are closest to Samlesbury, whilst the last two are closer to Ainley Top.

Table 2: Travel times to MAN from the nearest towns to the Vertiports

Location	By Car	By Skybus
Preston	1h 30min	1h 05min
Blackburn	1h 30min	1h 00min
Huddersfield	1h 45min	55min
Brighouse	1h 45min	55min

The key comparison points between using Skybus and using a private car for the full journey are:

> **Time:** The Skybus journey time is shorter by up to 50 minutes than when a private car is used for the full journey (depending on starting location and traffic conditions). In addition, there is more variability in private car full journey times due to the likelihood of traffic delays.

> **Cost:** Overall Skybus is about 18% cheaper than a private car journey primarily due to the higher cost of airport parking.

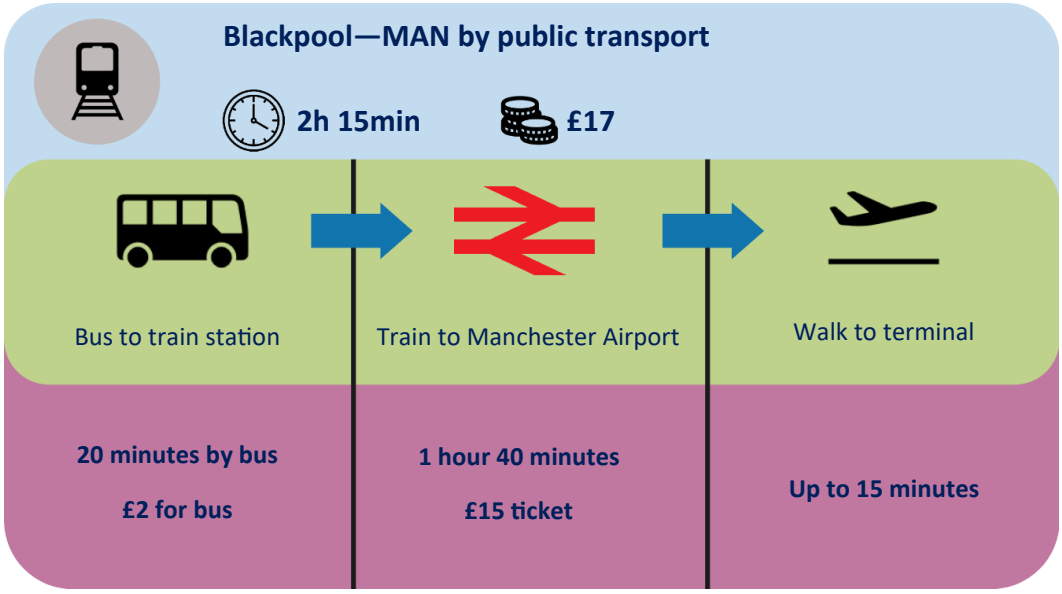
> **Convenience:** Whilst Skybus adds additional steps to the journey in comparison with the use of a private car alone, the ability of Skybus to guarantee a fast connection creates a competitive advantage over travel by road which is often affected by traffic congestion increasing journey times. In combination with the convenience of arriving directly at the airport without needing to look for parking, these factors make Skybus a convenient alternative to using a private car for the full journey.

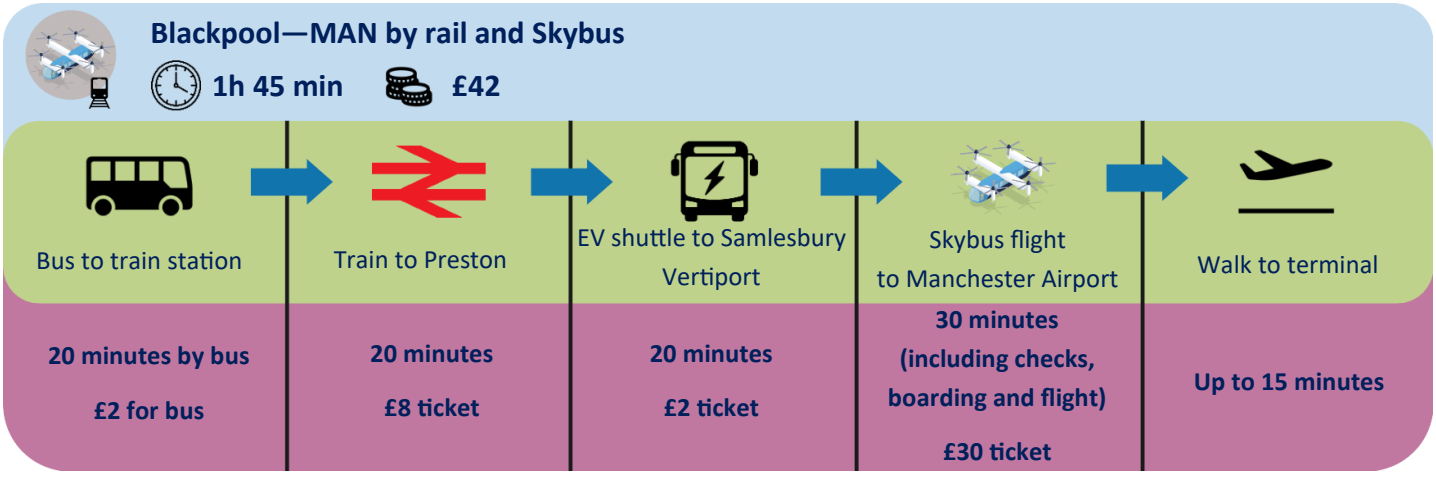
3 A Skybus Operation for Manchester Airport

Passengers Using Public Transport (Bus and Rail) from Blackpool or York

This analysis compares use of public transport services for the full journey to MAN, with the use of public transport to the Vertiport at either Samlesbury or Ainley Top and then a Skybus to the airport. The journey assumes peak time travel commencing from a home location which is a 20 minute bus ride from the local train station. Estimates for connection times between transport modes have been included in journey times (based on information from Google Maps journey planner).

Figure 8: Comparison of journey from Blackpool to Manchester Airport by public transport, with and without Skybus





The key comparison points between using Skybus and using public transport for the full journey (as presented in Figures 8 & 9) are:

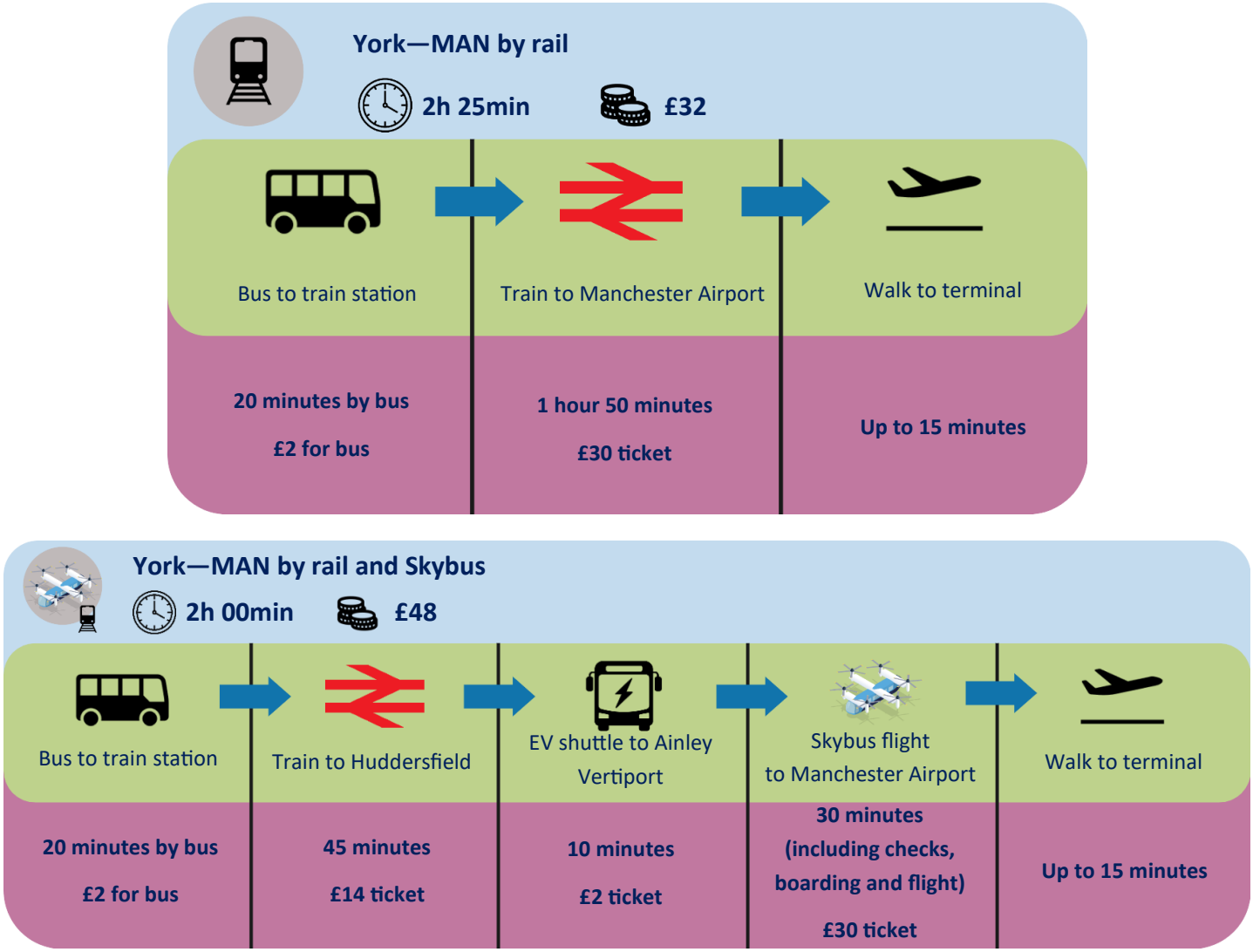
> **Time:** The Skybus journey is significantly quicker than use of public transport alone, by up to 30 minutes.

> **Cost:** The overall cost for a full journey by public transport to the airport is cheaper than for a journey including Skybus, by as much as 60%.

> **Convenience:** There are more steps in the Skybus journey than when using public transport alone, which can be less convenient and increase the chance of delays due to missed connections. Although the Skybus option still saves time on travel, these brief case studies demonstrate that use of Skybus with private cars (i.e. park-and-fly) is most likely to be the optimal setup. As only 18% of passengers currently travel to Manchester airport by public transport, this disincentive does not materially affect demand for Skybus travel.

3 A Skybus Operation for Manchester Airport

Figure 9: Comparison of journey from York to Manchester Airport by public transport, with and without Skybus



Skybus Service from Blackpool or York to Manchester Airport—Benefits and Drawbacks

A Skybus service from either Samlesbury or Ainley Top would provide an additional complementary transport option for travel to Manchester Airport, with benefits and drawbacks which depend on an individual passenger's preferences around time, cost and convenience.

The locations chosen for this analysis were based on a park-and-fly concept, which has highlighted the benefits of the Skybus to private car users, in particular those living in areas adjacent to the Vertiport. While public transport options have been considered, the benefits to these users are reduced. These benefits could be reclaimed by implementing improved public transport options around Vertiport locations, reducing the number of connections and journey times. Overall, Skybus offers a viable alternative to the different types of passengers, with unique benefits to each.

Where robust conventional public transport options to Manchester Airport already exist, such as from Manchester city centre, the benefits of a Skybus service to the airport are less significant for the individual traveller. However, these city centre locations would likely benefit from future additional use cases for Skybus, such as city-hub Vertiports delivering fast, frequent and safe inter-city flights between or within major population centres, at reasonable ticket prices. While an airport shuttle service has been selected for the analysis in this report, there are other use cases that Skybus could deliver, each with their own benefits and challenges. An example linked to the airport shuttle use case would be the use of Skybus as a link between nearby airports. In particular, linking smaller airports such as Liverpool Airport to major international ones such as Manchester is a key opportunity to be considered.

4 Stakeholder Perspectives

A Skybus or a Taxi?

Taxis can often offer passenger benefits such as convenience, comfort and privacy, but at a cost.

A taxi to Manchester Airport from York costs around £200, and about £120 from Blackpool[15].

A Skybus service will aim to offer levels of comfort beyond existing comparative public transport methods, at a significantly lower cost than taxi services.

There are a wide range of stakeholder groups who will have a range of different perspectives on a Skybus service. The following analysis highlights some of the considerations from both a passenger perspective and from an airport perspective. The analysis includes links to other interconnected stakeholder groups where appropriate, including local communities and the UK economy.

A passenger perspective

The most significant and obvious factors influencing a passenger's choice of travel mode to an airport are the passenger's perception of time, cost, and convenience. However, other factors do influence passenger decisions, both now and in a future which includes a Skybus service.

The list below summarizes some key considerations influencing a passenger perspective. Compared to the travelling public of today, it is expected that passengers in a future which includes Skybus will have more awareness and more pronounced views around the impact of technology on the environment and the economy.

Reduced Travel Time

A future integrated FIS will support quick, safe, and efficient flight operations for Skybus. A cruise speed of 180mph[10] will allow Skybus to compete with existing high-speed public services. Fast 'top up' charging can take place between each flight to increase aircraft availability, with a 45 minute full recharge only required every 8 hours (for the flight distances of 30 miles previously considered).

Increased Passenger Comfort and Convenience

Passengers will benefit from highly automated technologies that streamline their transit through the Vertiport, in areas such as baggage check and security. The Vertiport will have a user-centric design philosophy, including a modern architecture and retail amenities for passengers. The Skybus will also provide a fast connection that is more comfortable than most public transport, unaffected by road congestion and reducing driving times/distances.

Reduced Congestion and Carbon Emissions

A future Skybus service will support the UK's Jet Zero[25] strategy for net-zero aircraft carbon emissions. EV charging for cars and bicycles will be available at the Vertiport. The combination of high seating capacity and frequent flights will help to reduce road traffic congestion around airports by reducing driving distances. Vertiports will have significantly lower construction carbon footprints compared to other mass transit modes (e.g. the TfL Elizabeth Line is estimated to have created 1.7m tonnes of CO_2 during its construction)[26].

Boosting Local Economies and Communities

A Skybus service will bring benefits to communities around Vertiport locations by improving connectivity with larger conurbations. As well as having a positive local economic impact, improved connectivity has also been shown to enhance people's overall wellbeing and satisfaction within a community[27].

Integrated with Existing Transport Networks

The Skybus airport shuttle service, as well as other Skybus use cases such as inter-city services, aims to complement existing transport systems, such as road and rail, to give more options to the public and improve general connectivity—including EV and cycle rental facilities at Vertiports.

4 Stakeholder Perspectives

An airport perspective

Airport master-planners are beginning to consider the integration of eVTOL aircraft into their existing operations, although this remains in the early stages of planning and assessment. There is significant interest in tackling the key challenges listed below, which will likely lead to an accelerated push to inform future business cases and the integration of services such as a Skybus airport shuttle service.

From an airport perspective, the key benefits and challenges of integrating a Skybus service include:

The benefits of a Skybus service:

Integration with larger airports would yield the highest benefits.

Each Skybus aircraft will have a capacity of up to 30 passengers. If a frequent and regular Skybus service is implemented, there is likely to be a reduction in passengers travelling to the airport using other saturated transport modes, providing a positive impact on the airport's roads and rail services.

The Skybus service will help airports achieve their 2050 net-zero objectives.

The battery powered eVTOL technology in Skybus, along with EV facilities at Vertiports, would contribute to a reduction in greenhouse gas emissions (assuming electricity is generated from renewable sources).

The key challenges to address:

Airport real estate is at a premium.

Major airports have already maximised the use of space within the airport and often in the surrounding areas, largely with air operations facilities, car parks and hotels. The addition of a Vertiport which is convenient for Skybus passengers may require some difficult infrastructure decisions to be made.

Investment appraisal is required for integrating eVTOL services.

The implications of establishing an eVTOL service such as Skybus at an airport are relatively unknown, which makes private investment a difficult challenge. Effective Government initiatives, policy, and regulation would help to unlock the required investment funds.

Deconflicting Skybus flights and airport flights.

There may be some challenges around airspace integration for Skybus aircraft operating in close proximity to existing flight paths for conventional aircraft. Future regulation to allow the safe and assured use of highly automated air traffic management technology will be key, with a focus on integrating the airspace and not segregating it.

Airside or landside.

Airside is the area beyond security checkpoints, in which a Vertiport could make passenger journeys more convenient if their security checks and luggage check-in were conducted at the embarkation Vertiport. However these checks would add complexity to Vertiports, and impact the smoothness of the Skybus journey. A landside Vertiport location has been assumed throughout the report, as this is likely to be the case at major airports due to the limited airside capacity.

5 Recommendations: Bringing Park-and-Fly to the skies

Conclusion & Recommendations

Skybus and other eVTOL developers face an ambitious and worthwhile set of challenges, which will bring rewards and benefits if the technology can be implemented in such a way to unleash the full potential of AAM. The Skybus service is a complex use case, which requires cooperation from a range of stakeholders, from eVTOL developers, to local and national governments/ authorities. If enabled successfully, the so-called "third aviation revolution" will be a step-change in urban transportation. The following key recommendations (listed by each key stakeholder or 'challenge owner') detail the activity required to enable Skybus services:

Local Council/Authority Engagement

Collaboration with local councils and authorities will be needed to allow Vertiports to be built and managed sustainably, and to bring benefit to the local community. Such discussions should include the following recommendations:

> **Social acceptance:** Whilst eVTOL vehicles such as Skybus will be significantly quieter than similarly sized traditional helicopters, adequate separation from noise sensitive areas may still be required. Engagements with the community through means such as surveys and presentations/ demonstrations should be carried out to better understand where a Vertiport can maximise its benefits of increased connectivity whilst minimising any disturbances due to congestion or noise.

> **Green energy generation:** Vertiports will have significant power requirements which will add pressure to local power grids. To enable Vertiports, and as a result Skybus and other AAM vehicles, to be powered sustainably, plans must involve the provision of green energy installations. It is recommended that DfT and companies in the AAM sector collaborate with local authorities, the National Grid Electricity System Operator, and the Department for Energy Security and Net Zero to enable alignment with the wider national energy net-zero strategy.

> **Infrastructure development:** Engagement with local and national authorities should be made with the specific aim of informing and considering long-term plans for infrastructure developments (including both road and rail/ public transportation). This will enable the demand for transportation to and from the Vertiport to be satisfied without causing additional congestion. This should feed into (and if needed, direct) the authority's long-term infrastructure plan.

Flight Information Service Operators

An interconnected, highly automated Flight Information Service will be essential for wide scale, efficient eVTOL operations. Industry working groups such as the Future Aviation Industry Working Group–Airspace Integration (FAIWG-AI) are focussing on outlining the next steps to achieve this.

> **Short-term, incremental implementation should be prioritised** by the relevant stakeholders, led by the CAA, and in line with the UK-wide integrated airspace vision for the future.

5 Recommendations: Bringing Park-and-Fly to the skies

Airline and Airport Engagement

Major airlines and airports have started showing significant interest in AAM, with United Airlines having signed orders for several hundred air taxis[28]. Airlines have begun to see the competitive advantage that these vehicles can offer. For example, a customer travelling in first/business class could benefit from a 'complete experience' door-to-door, involving pick-up at their house/hotel with an eVTOL taxi, and straight to the airport with minimal hassle and maximum travel efficiency.

> **Whilst Skybus is more aimed at a mass transit** and less "premium" market, generating buy-in from airlines should be seen as a key opportunity for Skybus. Airlines that become operators in the future and use this service for their economy passengers or for transiting between nearby airports will gain an advantage over their nearest competitors, and encourage further Skybus/AAM buy in from the airline industry.

> **Airports need guidance from government and industry** to better understand the benefits of eVTOL aircraft to support future investment, which should be achieved by consultations and Vertiport design case-studies.

Airport Integration

For the airport shuttle use case to succeed, integration between the Vertiport and airport is needed to assure safe operations. The airport and Vertiport must complement each other and augment the functionality of both without compromising or interfering in each other's operations.

> **To facilitate effective integration with existing airport infrastructure,** further development of the Vertiport requirements should be conducted, including structural and power requirements.

> **It is recommended that key stakeholders participate in design case-study exercises** for Vertiports around major UK airports (such as Heathrow or Manchester), highlighting key integration considerations that will be greatly valuable to the wider industry, and help accelerate their development.

Transport Authorities

Engagement with public transport operators and authorities will be needed to support the integration of Skybus, and other eVTOLs, with existing public transport routes. It is also possible that operators such as Transport for Greater Manchester and Transport for London may become operators of Skybus (and similar vehicles) on certain routes, fully integrating them into their transport networks.

> **Discussions with transport operators should focus on the city-based long-term transport infrastructure** strategy, in particular looking into the commercial aspect of integrating Skybus and similar vehicles into the network.

> **Generating buy-in through public transport operators** should be a focus to help promote a complementary service, avoiding direct competition with existing transport, as well as facilitate passenger uptake.

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