Delivered by Innovate UK and ESRC

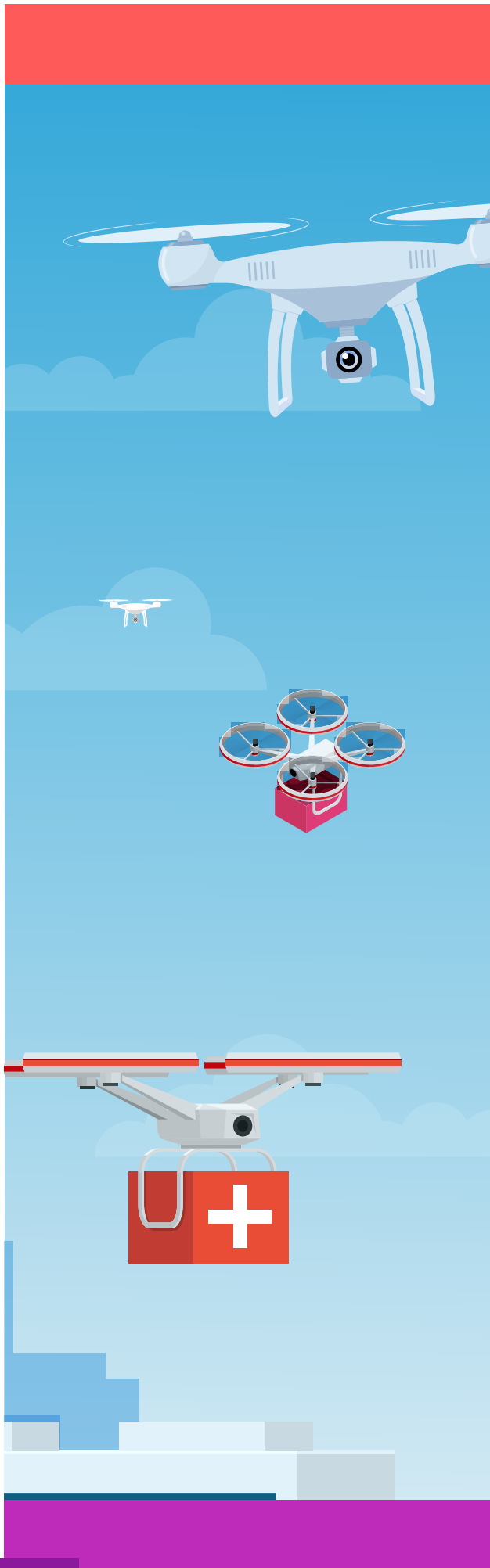
# Future Flight Use Cases

## 9 ways Future Flight will transform aviation

July 2024

# Contents





# Introduction

**The UKRI Future Flight Challenge, delivered by Innovate UK and the Economic and Social Research Council, is a £300 million programme co-funded by industry and the UK government to help build the ecosystem needed to accelerate the introduction of advance air mobility, drones, and zero-emission regional aircraft in the UK.**

Working with industry, academia, government and regulators, and stakeholders across the country, the Future Flight Challenge is transforming how we connect people, transport goods and deliver services in a sustainable way that delivers socio-economic benefits across the UK.

The global market for drones, advanced air mobility (AAM) and supporting services is projected to be approximately $74 billion by 2035, with a predicted 1.8% increase in UK GBP and £16 billion in cost savings to the UK economy by 2030 through drone services alone.

To support the widespread adoption and commercialisation of these new aviation technologies and services, the UKRI Future Flight Challenge wants to demonstrate a range of possible use cases to potential end users.

## Purpose

UK Research and Innovation commissioned 3Mile to develop several use cases that clearly demonstrate the benefits that advanced air mobility, drones and zero-emission regional aircraft can deliver to those already involved in the industry and those not yet involved, as well as with the general public and businesses that may use or be impacted by future flight services.

The use cases were developed by a team of experts with experience across the future flight domain and working with key stakeholders across the aviation sector. Taking this approach will help to develop a joined-up and shared understanding of real-world operations across the total ecosystem.

Each of these use cases presents a simple and easy to follow story of how different services are performed today, how this will change in future, the potential scale of the operation and market, and the implications on what is needed to support and deliver the service.

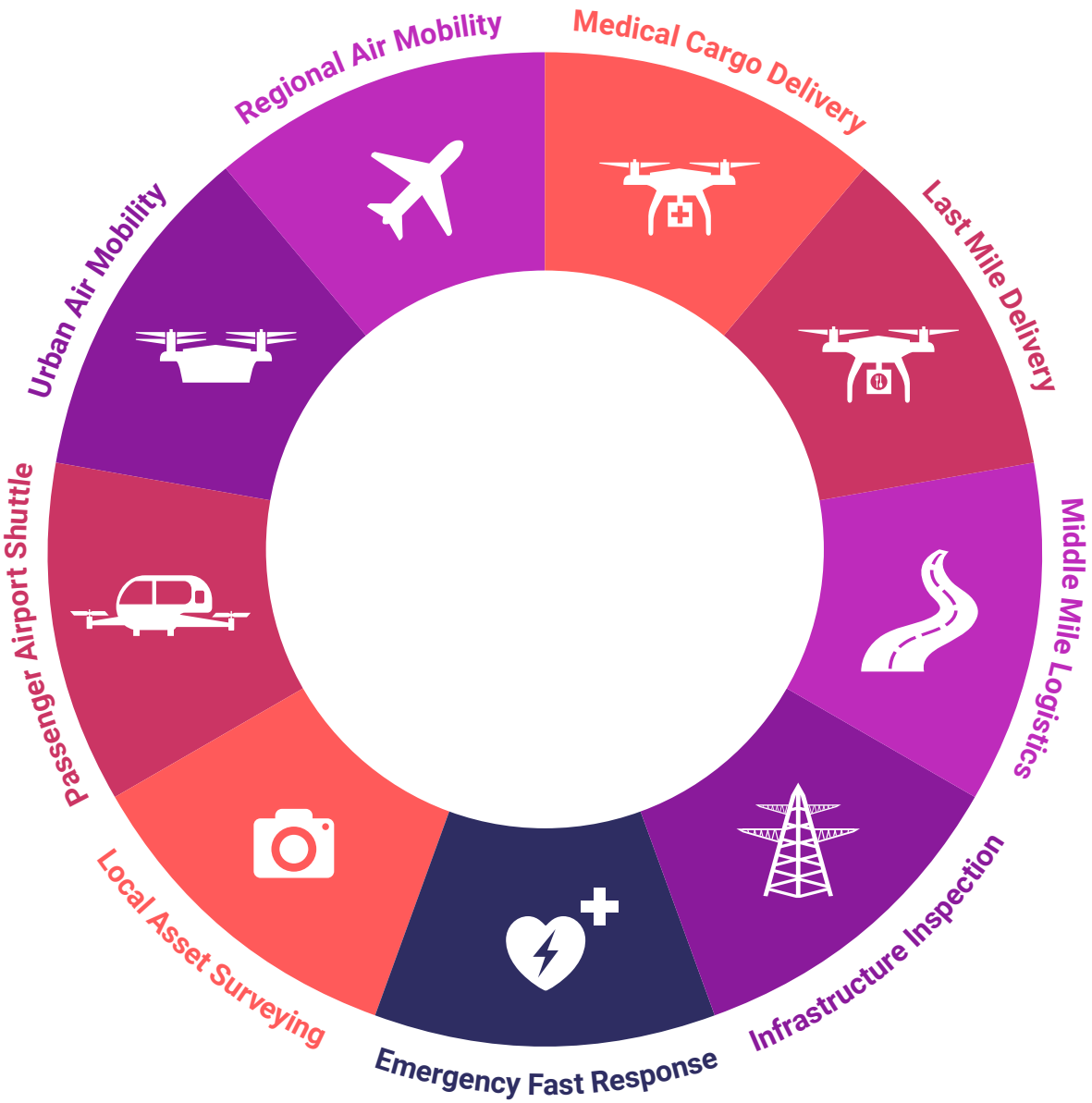
**Visit our website to find out more.**

# An Expose into Future Flight Use Cases

**The Future Flight Challenge (FFC) is driving innovation across the aviation ecosystem to position the UK as a global leader in advanced solutions. This publication opens a window into a series of future of flight use cases through story telling. Each story explains the significant opportunity that new innovative aircraft technology can provide to the industry and wider society. Each story is standalone. You can read only the use cases that interest you.**

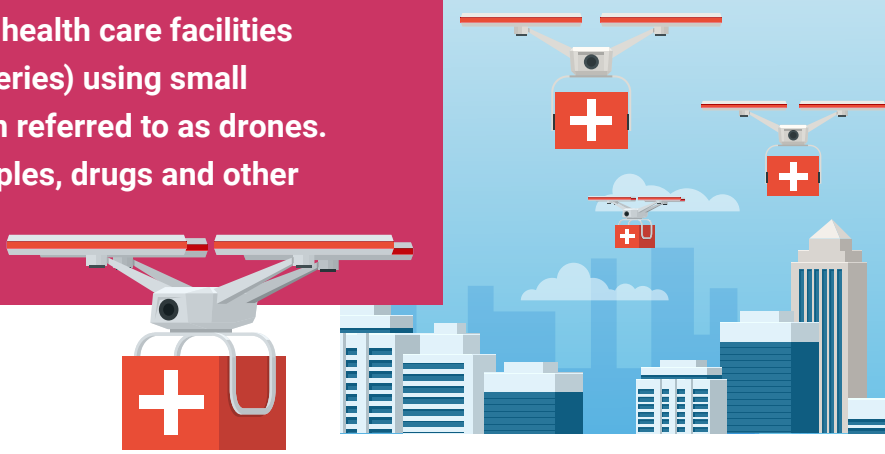
## What Use Cases are included?

We have selected nine use cases, spanning a range of aircraft technologies and operating environments. These represent only a sample of the opportunities that future flight will provide.



# Medical Cargo Delivery

**The transit of medical supplies between health care facilities (e.g. hospitals, laboratories and GP surgeries) using small electric uncrewed aircraft systems, often referred to as drones. Medical supplies include pathology samples, drugs and other medical related products.**



## How is this performed today?

Medical supplies are transported via **ground vehicles** including vans, cars and motorbikes. Couriers provide services either **on-demand** or within **scheduled** slots. **Hospitals and laboratories align resources** to fit with pathology transport availability.

## How will this change in the future?

Drones will be available **on-demand** to transfer medical cargo between health care facilities. Networks of facilities will be connected via aircraft using **local landing and take-off infrastructure.** Medical staff deliver payloads to the aircraft and then the payload is transported to the receiving centre where medical staff would confirm delivery, remove the payload and enter the payload into the local logistics. **Pathology services and hospital resource schedules will be improved as a result of drone delivery.**

## What are the benefits?

### Better Patient Outcomes

Quicker test results, treatment earlier, discharged quicker, less travel time and supporting home care

### Reduced Product Wastage

Specialist equipment and key personnel shared by many – smoothing peaks in demand

### Optimised Staff Rostering

"Just in Time" delivery allows reduced inventory

## What are the current limitations?

- Drones can't operate in all weather conditions
- Limited flying distance restricts size of hospital networks
- Size, shape and weight of the payload box (limited by aircraft capability)

## What is the Operating Environment?

- A network of hospitals and laboratories and other sites such as care homes
- Medical staff are trained to operate the system
- Permanent and pop-up landing sites
- Drones operate using rotor craft capability only or including fixed wing capability for cruising
- Flight routes designed to balance capability of drones and community needs
- Shared airspace with close co-ordination with emergency services
- Centralised command and control of aircraft operations
- Possible carriage of dangerous goods
- Flights are as short as 1 mile and can fly regionally up to 50 miles (only limited by aircraft capability)
- Urban environments overflying communities and built-up areas

## Case Study NHS

Northumbria Healthcare is trialling a scheme which will see drones take to the skies. The aircraft will transport clinical supplies, prescriptions, blood packs and mail between hospitals, care homes and GP surgeries.

**27 Healthcare Facilities**

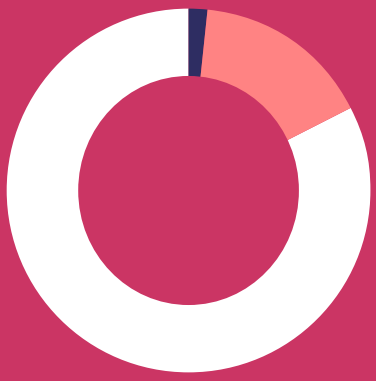
**Up to 80 flights per day**

**70 mph electric aircraft**

## How big is the opportunity?

**6000+**
GP Surgeries

**1,148**
UK Hospitals (930 NHS, 218 Private)



**105**
Medical centres providing pathology services

**300,000**
Tests are performed every working day in the UK

**95%** of clinical pathways rely on patients having access to pathology services

## How does this support sustainability?

This use case applies innovative green technology to improve access to healthcare and create better outcomes for patients by optimising hospital and laboratory procedures.

**Reduced inequalities**

**Good health and well-being**

### 1. Short

10s of hospitals in network. Operations supported by trained operators from service providers

### 2. Medium

Multi-aircraft operations providing high-value cargo delivery applications

### 3. Long

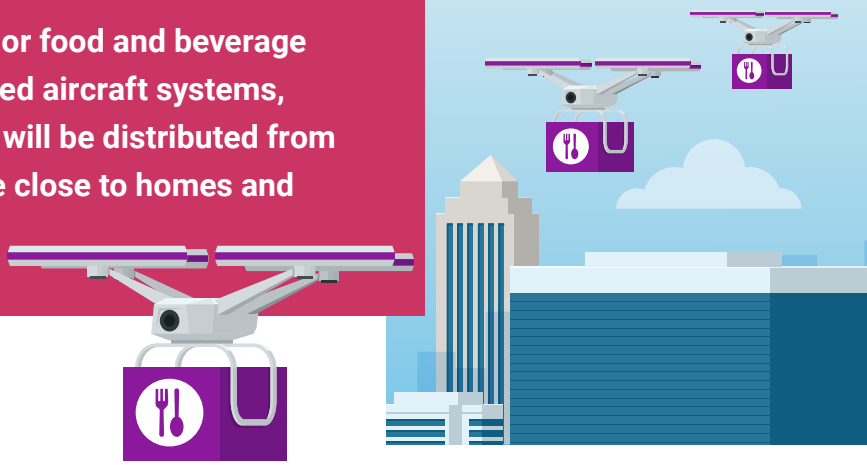
Large scale, autonomous operations, centralised pathology services with transformative hospital experiences

## What are the Challenges?

| Sector | What is the challenge? | What needs to happen? | Who needs to help? |
|---|---|---|---|
| **Business Integration** | Integrating drone operations within the operating procedures of hospitals and laboratories to assure the chain of custody. | Public service trials to test and evaluate operating rules for medical cargo logistics. Assessment of benefits to hospital and laboratories as a result of on-demand logistics. | • Central Government<br>• Health Care Providers<br>• Medical Drone Service Providers |
| **Product Quality** | The safety, quality, and efficacy of medicines, blood products and medical devices are assured through the flight operations. | Rules and guidance for the quality control of pathology services using drones, guaranteeing chain of custody and integrity of medical products. | • Medical and Healthcare Regulatory Agency<br>• Medical Drone Service Providers |
| **Community Integration** | Designing operations to minimise the impacts on the general public and wildlife in terms of safety, noise, privacy. | Rules and guidance for national flight path routing to support safety, noise and privacy. Roles and responsibilities of authorities in managing airspace permission of airspace routes and location of ground sites. | • Local Authorities,<br>• Civil Aviation Authority<br>• Community Groups |
| **Carriage of Dangerous Goods** | Safe transfer of dangerous goods between health care facilities. | Rules and guidance for carriage of dangerous goods including dangerous good containers and associated manual handling. | • Civil Aviation Authority<br>• Medical and Health care Regulatory Agency<br>• Standards Bodies |
| **Airspace Integration** | The safe and efficient integration of uncrewed and piloted airspace users in urban airspace. | National standardisation of operational coordination with emergency air vehicles. Strategies for co-ordination and deconfliction with VLOS drone operations. | • Government<br>• Civil Aviation Authority<br>• Emergency Service Providers<br>• Airspace Managers<br>• Local Authorities |

# Last Mile Delivery

**The immediate delivery of retail products or food and beverage to consumers using small electric uncrewed aircraft systems, often referred to as drones. The products will be distributed from a central warehouse or mobile pop-up site close to homes and businesses in urban locations.**



## How is this performed today?

Consumers have access to a range of **within the hour, same-day or next-day delivery** of products by couriers using **vans, cars, motorbikes and bicycles.** Services offer convenience of delivery and deliver **straight to the door** of the consumer. Size of parcels is only limited by the means of travel.

## How will this change in the future?

Drones will provide new capability to last mile delivery providing **on-demand options** for consumers. The new capability will directly support **consumers immediacy needs** delivering products required **within minutes** rather than hours. The aircraft will either land to drop products or lower the package using a sling.

## What are the benefits?

### Customer Experience

Immediacy of products, ease of access to products

### Cheaper Products

Driving cost of products down for consumers by reducing cost of delivery

### Improved Commerce

New paths to market for product providers

### Health and Environment Outcomes

Removing carbon emitting traffic from the roads, delivering environmental, health, and well-being improvements.

**350k Deliveries Completed**

**One Flight Every 17 Seconds**

## Wing Case study

A large shopping centre has partnered with a last mile cargo delivery operator to expand its home delivery operations in Brisbane, Australia. Working on behalf of local merchants, deliveries are completed with 15 minutes. Customers who order via air delivery are asked to specify a delivery spot where their package can be safely lowered from the drone once it arrives.

## What are the current limitations?

- Consumer landing sites require space to deliver products
- Distribution centres required in strategic locations
- Limited maximum payload and range

## What is the Operating Environment?

- Customers order products using online platforms
- Drones flown from fixed locations such as supermarkets or delivery lockers or from mobile pop-up sites
- Significant number of individually controlled take-off and landing pads within each site.
- Drones land or drop packages via a sling
- Urban environments with flights over populated areas
- Drones are operated by a remote pilot initially with transition autonomous operations
- Multiple service delivery operators serve the same locations / regions
- Drones are operating in airspace with other aircraft
- Air traffic management services provide situational awareness and safety related services

## How big is the opportunity?

**3.6bn** parcels delivered in UK FY22/23, **3.2bn** of which were under 2kg (Ofcom)

**Under 2kg**

Two thirds of consumers have experienced issues with parcel deliveries (Ofcom)

UK e-commerce market worth

**£223bn** in 2024, reaching **£595bn** by 2029 **(22% growth)**

## How does this support sustainability?

This use case applies innovative technology to provide vendors with a cheaper, faster, and more environmentally friendly delivery option when compared to traditional road-based methods.

**Decent work and economic growth**

**Industry, innovation and infrastructure**

**Climate action**

### 1. Short

Services provided in semirural locations by single service operator

### 2. Medium

Urban networks are operating with multiple service operators in same airspace

### 3. Long

Large scale operations using aircraft operated autonomously

## What are the Challenges?

| Sector | What is the challenge? | What needs to happen? | Who needs to help? |
|---|---|---|---|
| **Community Integration** | Engage public on introduction of drone operations in communities balancing societal value with societal impact. | Local community engagement pathways in place to support operational approvals of drone operations. Rules and guidance on role of communities in flight approvals in urban areas. Roles and responsibilities for distribution of drone flight information to public e.g. purpose / intent. | • Central Government<br>• Information Commissioner<br>• Local Authorities<br>• Airspace Managers |
| **Carriage of Goods** | Controlling the carriage of goods (and lowering packages to the ground). | Rules and guidance for carriage of goods / commercial air transport. Standardisation of technical capability for carriage of goods and lowering of goods to the ground. | • Aircraft Manufacturers<br>• Civil Aviation Authority<br>• British Standards Institute |
| **Airspace Management** | Co-ordinating a significant number of flights in single airspace to ensure safety, efficiency and mitigate societal impact. | Rules and responsibilities for delivery of airspace management services including network management services that balance capacity, efficiency and safety risk. | • Central Government<br>• Civil Aviation Authority<br>• Local Authorities |
| **Standards** | Developing UK strategy for standardisation to support industrialisation and regulatory. | Roles and responsibilities for implementation of UK standards framework. | • Central Government<br>• British Standards Institute<br>• Civil Aviation Authority<br>• Market Surveillance<br>• Authority |
| **Automation** | Introduction of high levels of automation to support business case. | Rules and guidance for implementation of high-levels of Automation (and Artificial Intelligence). | • Central Government<br>• Civil Aviation Authority<br>• Aircraft Manufacturers<br>• Airspace Managers |

# Middle Mile Logistics

**The transfer of large cargo up to 500kg (as much cargo as can fit in a car) using uncrewed aircraft systems, often referred to as drones. The aircraft transport goods from a warehouse or central facility to a distribution hub. The range of the aircraft is 1000 miles and beyond. The aircraft use traditional combustion engines with limited electric propulsion in the short-term and hydrogen fuel cell propulsion in the long-term to support range needs.**

## How is this performed today?

Long distance cargo delivery uses traditional ground transport methods including **trains, trucks, shipping, and short-haul airborne services** by commercial and private aircraft. **Airborne services rely on pilots** where there is a significant resource shortage.

## How will this change in the future?

Drones will provide new cost-effective solutions to middle mile logistics focussing on **time-critical services** and **improving logistics access** to under-served regions and communities. They will also provide international delivery capabilities. They will operate increasingly from small aerodromes. Overall, these services will **alleviate skills shortages** in the logistics market.

## Did you know?

Airlines rely on expensive private jets and crews to support transport of critical aircraft parts to support fast return to service of passenger aircraft. This function could be completed by uncrewed aircraft systems reducing cost.

## What are the benefits?

### Just-in-Time Delivery

Enabling on-demand cargo movements for time critical organisations

### Supply Chain Reliability

Unaffected by road traffic leading to predictable delivery times

### Enabling Cargo Market Growth

Alleviate skills shortages in cargo aviation

### Distributed Logistic Networks

New trade routes, increased commerce and growth in communities

## What are the current limitations?

- New airport security infrastructure services required to handle increase
- Limited range & payload compared to road vehicles
- New airfield and energy infrastructure required

## What is the Operating Environment?

- Drones capable of transporting up to 500 kilograms
- Drones can fly up to and beyond 1000 miles including across international borders
- Drones are predominantly fixed wing aircraft and have capability for short take off and landing
- Drone operated using a system including a remote pilot based at a central control centre
- Operating from existing airports and aerodromes with runways
- New energy infrastructure at airports and aerodromes to support charging requirements
- Existing airspace management and aerodrome rules

## Case Study

Northumbria Healthcare is trialling a scheme which will see drones take to the skies. The aircraft will transport clinical supplies, prescriptions, blood packs and mail between hospitals, care homes and GP surgeries.

## Did you know?

FedEx in the USA own 235 small aircraft for middle mile logistics all capable of being replaced by drones.

## How big is the opportunity?

Over **406,000 HGVs** in the UK carrying freight by road

**175 billion tonne-kilometres** of goods moved by HGVs in the UK

**3%** of inter-modal journeys involving HGVs began or ended at an airport in 2022

## How does this support sustainability?

The use case provides industry with a flexible, efficient alternative to existing options for middle mile logistics, leading to the potential for increased productivity and economic growth.

**Decent work and economic growth**

**Industry, innovation and infrastructure**

### 1. Short
Creation of “Air-Bridges” between rural and remote cities and towns up to 100 miles

### 2. Medium
Expanded operations to urban networks and supporting long-range operations up to 500 miles

### 3. Long
Creation of new trade routes and links across international borders up to 1000 miles

## What are the Challenges?

| Sector | What is the challenge? | What needs to happen? | Who needs to help? |
|---|---|---|---|
| **Operational Cargo Network** | Set strategic direction for UK Cargo Drone Operations. | UK Master Plan for UK Cargo Network using Drones. | • Central Government<br>• Logistics Companies |
| **Aerodromes and Airports Operations** | Enable airports and aerodromes to introduce new cargo services by drones. | Infrastructure and supporting services support cargo market growth. | • Airport Associations<br>• Airports<br>• Logistic Companies |
| **Communication and Control** | Command and control infrastructure to support extra long-range drone operation. | Scalable solutions for Network Command and Control Solutions. | • Aircraft Manufacturers<br>• Telecommunication Providers<br>• Civil Aviation Authority<br>• Standards Bodies |
| **Certification Basis for Operations** | Enable cross-border international operations. | Rules and guidance for international certification basis for aircraft Multi-organisation approvals for international cross-border drone operations. | • Central Government<br>• Civil Aviation Authority<br>• International and Regional Aviation Bodies |

# Infrastructure Inspection

**The aerial inspection of large network ground infrastructure using small electric uncrewed aircraft systems, often referred to as drones. The aircraft using on-board cameras and sensors for real-time and post operation analysis. The aircraft can fly large distances, beyond visual line of sight of the operator, and quickly and efficiently inspect, monitor, survey and support rapid response action.**

## How is this performed today?

**Helicopters**, locally piloted **drones** (operated in **visual line of sight**) and **manual labour** survey teams provide the capability for large infrastructure inspection requirements.

## How will this change in the future?

The **uncrewed aircraft** system will be flown **beyond visual light of sight** and be the primary means of inspection, monitoring, surveying and other support capability. **Better data**, captured more efficiently, with **no potential risk to individuals** and using green technology will transform aerial inspection, monitoring and survey.

## Did you know?

Electricity System Operator (ESO) released a report in March 2024 proposing a £58 billion investment is required in the electricity grid to meet the growing and decarbonising demand for electricity in Great Britain by 2035.

## What are the benefits?

### Energy Security

Ensuring infrastructure can deliver uninterrupted energy at an affordable price

### Asset performance

Improve asset lifetime performance of existing infrastructure

### Health & Safety

Reducing high-risk activity for workers

### Safety Compliance

Improved inspection regimes leading to better safety compliance outcomes

## What are the current limitations?

- Technical capability of drone to fly close to assets given positional accuracy required
- The ability to efficiently and effectively extract insight from captured data

## What is the Operating Environment?

- Drones are deployed on pre-determined routes set by the layout of infrastructure
- Drones navigate using onboard autonomous capability
- Drones are monitored by a ‘remote pilot’ from a central command centre
- Drones use high fidelity onboard technology to capture data
- Drones operate near (within metres) to buildings and other obstacles where other airspaces unlikely to fly
- Drones are either located coincident with the infrastructure or have to travel to and from a central base

## How big is the opportunity?

**71,000 road bridges** maintained by local councils in the UK, with a maintenance backlog of **£5.4bn** (RAC, 2022)

**4,500 miles** of overhead lines inthe UK electricity grid, with **£112m** spent on inspection (NGET, 2021)

**20,000 miles** of track in the UK rail network, with visual inspection on a 4-weekly cycle across **950 annual shifts** (Network Rail, 2019)

## How does this support sustainability?

This use case supports the maintenance, development, and efficiency of critical infrastructure, in particular national power grids and related infrastructure required to ensure affordable and clean energy for all.

**Affordable and clean energy**

**Industry, innovation and infrastructure**

**Climate action**

nationalgrid

Since 2021 National Grid has been exploring the use of beyond visual line of sight UAS operations to replace helicopters for close inspection. Operations will expand to walking overview (public safety), fast flyover (hot spots), steelwork inspection (rust), component inspection (failures), vegetation encroachment.

### 1. Short

Aircraft supporting key close inspection and monitoring tasks over limited range.

### 2. Medium

Multiple operations being performed in parallel replacing helicopter operations.

### 3. Long

Fleets of aircraft operating autonomously across wide scale network infrastructure.

## What are the Challenges?

| Sector | What is the challenge? | What needs to happen? | Who needs to help? |
|---|---|---|---|
| **Business Integration** | Adoption of drone services in the infrastructure inspection market. | Market promotion of the use of drones to support large scale aerial infrastructure inspection. | • Central Government<br>• Infrastructure Owners and Operators<br>• Aerial Inspection<br>• Service Providers<br>• Drone Manufacturers |
| **Airspace Integration** | Opening the airspace to support large scale beyond visual line of sight operations within close proximity to infrastructure. | Air risk policies and technical aircraft capabilities to optimise operations in Atypical Air Environment. Operations in legacy airspace and at aerodromes including unlicensed airfields accommodate drone operations. | • Civil Aviation Authority<br>• Aircraft Manufacturers<br>• Infrastructure<br>• Inspection Drone<br>• Service Providers |
| **Airspace Management** | Introduction of high capability automation functions to support navigation. | Rules and guidance to develop and assure automated navigation capability for aircraft. | • Aircraft Manufacturers<br>• Navigation and traffic management solution providers |
| **Command Control** | Ensure Command and Control System is resilient to support wide area operations. | Telecommunication networks provide resilient command and control services. Aircraft systems have technical capability to operate over long distances. | • Aircraft Manufacturers<br>• Central Government Office of Communications (OFCOM)<br>• Civil Aviation Authority |

# Emergency Fast Response

**The provision of first responder capability to support emergency services using electric uncrewed aircraft systems, often referred to as drones. The aircraft size varies from under 25kg to as large as 300kg which is half the size of a helicopter. This capability provides value to ambulance, police, fire, and search and rescue.**

## How is this performed today?

Emergency response is through normal emergency services such as ambulance, police, fire, search and rescue. **Access and response times of these services is dependent on the distance you are from the dispatch facility** and the vehicles available. Helicopters provide the primary airborne capability today. There is a capability gap for ultra-fast response action i.e. within minutes.

## How will this change in the future?

Drones provide **fast access response** to emergencies arriving within minutes to support first response action such as **delivering products, locating survivors or victims** or provide **situational awareness** of accidents or events. Emergency services will assess the type of event, its location and if beneficial, will **deploy the aircraft to arrive within minutes.** This capability provides additional situational awareness to first responders and command and control oversight.

## What are the benefits?

### Patient Outcomes

Saving lives. Every minute counts for heart attack victims

### Rapid Deployment

Improving outcomes for missing persons and long-term patient outcomes by providing support sooner

### Better Decision Making

Transmission of patient data and situational awareness on scale and impact of emergencies

### Enhanced Safety

Avoids placing humans in dangerous situations such as fires, radiation, presence of infectious agents etc

## What are the current limitations?

- Drones can't operate in all weather conditions.
- Access to onscene data and video feeds may be lost in the event of technical failure.
- Capability of onboard sensors limited due to limit on weight.

## What is the Operating Environment?

- The aircraft are located at emergency hubs located to best service the local community
- The public access emergency response through emergency response phone number
- Initial triage determines viability of flights operations through interaction with other agencies / airspace managers
- Aircraft fly a time-critical direct route to location
- Aircraft has the ability to hover at scene and broadcast messages
- Aircraft returns to its base using a community friendly route avoiding built-up areas
- Aircraft uses onboard sensors and cameras to capture real-time activity
- Aircraft can drop equipment to the ground using a parachute or a sling

## Did you know?

In Sweden in January 2022, the first life was saved using a fast response drone delivering a defibrillator. It arrived within 3 minutes, well before paramedics, and was used by a member of the public to restart the patient's heart.

### 40 minutes

is the average response time for heart attacks in the UK. The NHS target is 30 minutes.

### How does this support sustainability?

This use case has the potential to significantly improve patient health outcomes and provide more equitable access to healthcare resources across the population.

Reduced inequalities

Good health and well-being

## How big is the opportunity?

**900,000** Emergency medical calls in the UK in December 2023. Nearly 29,000 per day.

**620,758** Fire and rescue services 29,742 attended incidents in 2022 (GovUK).

**100,000** Hospital admissions due to heart attack annually in UK (BHF)

**29,742** Killed or seriously injured in road traffic casualties annually in UK (2022, GovUK).

**14,123** National Police Air Service attended incidents in 2022, with 88.9% achieving a positive outcome.

### 1. Short

Small network of emergency response to support niche emergencies

### 2. Medium

Small networks of drones providing emergency response activity to large scale emergencies and increasingly replacing helicopters

### 3. Long

UK wide network of emergency response operations using range of drones and capabilities

## What are the Challenges?

| Sector | What is the challenge? | What needs to happen? | Who needs to help? |
|---|---|---|---|
| **Business Integration** | Seamless integration of drone operations within emergency response procedures. | Business processes and working arrangements with other stakeholders support use of drones in emergency response. | • Central Government<br>• Drone Service Providers<br>• Emergency Response Organisations (Fire, Police, Healthcare, Maritime etc) |
| **Airspace Integration** | The fast-time deconfliction of aircraft within the same airspace. | Rules and guidance for prioritisation of emergency flight operations over other aircraft. | • Central Government<br>• Civil Aviation Authority<br>• Airspace Managers |
| **Service Integration** | Siting of emergency hub locations, in a UK wide network, to support local communities. | National strategy for emergency response networks drive authorisation process. Rules and guidance for national and local planning permission of emergency networks sites. | • Central Government<br>• Civil Aviation Authority<br>• Emergency Response<br>• Local Authorities<br>• Airport Associations<br>• Airspace Managers |
| **Community Integration** | Design a flight route network over communities that mitigates noise, privacy, safety concerns. | Public promotion campaign and consultation strategy for emergency fast response. Rules and guidance for flight path routing for emergency response. | • Central Government<br>• Healthcare Providers<br>• Local Authorities<br>• Civil Aviation Authority |

# Local Asset Surveying

**The survey of local buildings, assets or infrastructure such as roads and lighting using small uncrewed aircraft systems, often referred to as drones. The aircraft are operated within visual line of sight and also at close proximity beyond visual line of sight i.e. behind buildings or infrastructure. The aircraft are equipped with on-board camera and sensors for real-time and post-operation analysis.**

## How is this performed today?

Traditional methods of inspection include **workers using visual scanning** and, for larger physical assets, the use of **ladders, scaffolding** and **cherry pickers**. These forms of inspection are best suited for reactive operations i.e. to resolve issues and effect repairs. Drones have been used in survey activity for over 10 years in the UK but with limited opportunity in public services.

## How will this change in the future?

Drone services will provide effective and efficient wide scale aerial asset surveying capability to **public services** and **private customers**. Drones equipped with **cameras** and other sensors can collect large amounts of data quickly to support **real-time and post operation analysis**. The frequency of inspection can increase allowing organisations to change the way they perform inspections and surveys.

## What are the current limitations?

- Drones can't operate in all weather conditions
- Societal Concerns - local residents unaware of purpose of drone operations (friend or foe)

## What are the benefits?

### Health & Safety

Falls from height are a significant cause of fatal injuries

### Cost Saving

Drone services provide value services to authorities with limited budgets

### Asset Performance

Preventative maintenance schemes improve reliability and performance of assets

### Reduced Impact

Reducing impacts on residents – inspections take minutes rather than days

## Case Study

Yorkshire Housing carried out inspections on three sites with known issues, where expensive repairs were already scheduled. Spending under £10K on drone inspections, they predicted a greater than ten-fold return on investment by substituting extensive roof repairs and replacements with well-informed targeted maintenance.

## What is the Operating Environment?

- Electric uncrewed aircraft operated by a remote pilot
- Drones are operated from pop-up locations in close proximity to the area to be surveyed
- Drones are operated in local area primarily within visual line of sight but also beyond visual line of sight ie. behind buildings or infrastructure
- Aircraft operate near (within metres) to buildings and other obstacles where other airspaces unlikely to fly
- Drones are flown in urban areas, above populated environments and in close proximity to people

## Did you know?

Aerial surveying can be used for a range of activities, such as:

- High-rise maintenance and cladding inspection, insurance checks and validation
- Thermal imaging to survey insulation and combat heat loss
- Solar-panel inspection, installation and construction monitoring
- Development land inspections and planning applications
- New or void property marketing, using 3D-modelling and video
- No-contact inspection of more vulnerable properties, or heritage sites at higher-risk of damage and disruption via intrusive physical interactions.

## How big is the opportunity?

In 2018 there were a total of **£420bn** in public property assets, with a further **£60bn under construction,** majority owned and operated by local authorities.

Total local authority operational expenditure costs relating to highways, transport, and housing was **£8.7bn** in FY22/23 (ONS)

**317** The number of local authorities in England

**20%** London's councils own one-fifth of the land in the city

## How does this support sustainability?

This use case enables local authorities and other community organisations to efficiently monitor manmade and natural assets, informing planning and development work, and improving the welfare of local people.

**Life on land**

**Industry, innovation and infrastructure**

**Sustainable cities and communities**

### 1. Short

Increasing use of drones to replace inspection and monitoring tasks within visual line of sight of operator

### 2. Medium

Multiple operations being performed in parallel, increasing the level of proactive surveying in public services

### 3. Long

Fleets of aircraft operating autonomously across wide range of surveying tasks

## What are the Challenges?

| Sector | What is the challenge? | What needs to happen? | Who needs to help? |
|---|---|---|---|
| **Business Integration** | Adoption of drones services in the asset inspection and survey market. | Wide scale promotion of benefits to central and local government on the use of drones to support local area asset survey and inspection tasks. | • Central Government<br>• Infrastructure Owners and Operators<br>• Local Authorities<br>• Aerial Inspection<br>• Service Providers |
| **Organisational Capability** | Local authorities and other small organisations lack the technical capability and organisational capability to perform complex drone operations. | Rules and guidance on technical, operational and organisational capability for delivering assured public services. | • Local Authorities<br>• Drone Service Provider Trade Bodies |
| **Insurance** | Creation of an insurance framework appropriate to risk levels to support operations and ensure premiums are cost effective. | Data architecture and information sharing agreements ensure access to information to better inform risk levels Insurance framework manages recovery of funds to support uninsured activity. | • Central Government<br>• Insurance Companies<br>• Managing General<br>• Agent (Insurance)<br>• Insurance Regulators<br>• Civil Aviation Authority |
| **Community Integration** | Engage public on introduction of drone operations in communities balancing societal value with societal impact. | Local community engagement pathways in place to support operational approvals of drone operations Roles and responsibilities for distribution of drone flight information to public e.g. purpose / intent. | • Central Government<br>• Information Commissioner<br>• Local Authorities<br>• Airspace Managers |

# Passenger Airport Shuttle

**The transfer of up to four passengers to airports for onward travel using electric aircraft capable of vertical and take off landing, often referred to as eVTOLs or Air Taxis. The aircraft use a range of technology to fly. For example, designs use multiple rotor blades or ducted fan jets for vertical take-off and landing, or a hybrid system combing rotor blades / fan jets with a fixed wing and a propeller or fan jet to enable horizontal flight. The aircraft are flown by a single pilot. They are operated from aerodromes which are often referred to as vertiports.**

## How is this performed today?

The public has access to a range of **public and private transport options** to support travel directly to the airport. The suitability of the transport operations depends on the location. Those within cities have access to a range of **train** and **bus** links. Those in rural locations often have limited transport options and have to use **private transport.**

## How will this change in the future?

Passengers will access **on-demand** or **shuttle** services to airports for onward travel The air stops will be **conveniently located** to help travellers access aircraft shuttles close to their home and provide alternative travel corridors that **improve travel times** compared to public or private transport.

## What are the benefits?

### Time Saving

Value of time drives this use case in the short-term

### Flexibility

On-demand service to suit customer need

### Reliability

Low variability in trip time compared to road transport

### Energy Efficiency

Electric propulsion is more efficient than traditional combustion transport

## Did you know?

82% of people currently travel to Manchester Airport by Car or Private Taxi.

Research by Frazer-Nash indicates that a cost and time saving can be made using a model based on park-and-ride centralised air transport.

VERTICAL · MOBILITY REIMAGINED · Joby · supernal

eVTOL passenger routes have been announced at Chicago, New York, Los Angeles and London. These will be operated by major Airlines in partnership with eVTOL manufacturers or operated by the manufacturers themselves.

## What are the current limitations?

- Central London to Heathrow initial cost estimate of £240 per person noting current helicopter landing fees at hub airports cost several thousand pounds
- Limited access to land airside at airports such that passengers have to pass through airport security zone
- Trips must start/end from existing airport or vertiport, not direct to any customer location

## What is the Operating Environment?

- Travellers can access air stops near to their home
- Flights operate from both licensed and unlicensed airfields
- Aircraft will be operated by commercial airlines, business and private aviation
- Airlines offer on-demand and scheduled flights
- The aircraft land airside within the airport
- Aircraft fly between 100 and 200 miles an hour at cruise speed
- The operating range in short-term is 10 to 100 miles
- Flights are conducted using both visual flight rules (VFR) and instrument flight rules (IFR)
- Aircraft fly over rural and urban locations typically up to altitudes of 2000ft Aircraft have pre-determined emergency / alternate landing sites
- Airports provide charging facilities with emergency systems to support operations
- Digital airspace management services will provide trusted network management and deconfliction services

## How big is the opportunity?

USA Market Study

Daily demand of **82,000 passengers** (USA-wide)

Served by approximately **4,000 four to five seat aircraft**

**100s of vertiports** required – based on new and existing infrastructure

## How does this support sustainability?

This use case will provide additional, flexible connectivity options between airports and urban / rural locations, using more energy-efficient low-emission solutions compared to road transport.

**Sustainable cities & communities**

**Industry, innovation & infrastructure**

**Climate action**

### 1. Short

Aircraft are operated with a pilot on-board from vertiports located at existing airports or purpose built vertiports

### 2. Medium

Aircraft are operated with high-levels of automation and a pilot remotely supporting flight from the ground

### 3. Long

Aircraft are operated autonomously and also have increased load carrying capability or extended range through use of new fuel capabilities such as hydrogen fuel cells in place of batteries

## What are the Challenges?

| Sector | What is the challenge? | What needs to happen? | Who needs to help? |
|---|---|---|---|
| **Open Access to Airports** | Airports provide appropriate access for eVTOL aircraft including commercial, business and private aviation actors. | Airports incentivised to provide access for electric / sustainable aircraft e.g. Passenger Duty Tax exemption Funding / tax measures to support implementation of infrastructure for recharging / energy development Rules and guidance for operations at Airports support safe and secure eVTOL Flight. | • Central Government<br>• Airports<br>• Airport Associations<br>• Airline Operators<br>• Infrastructure Providers |
| **Community Integration** | Ensuring that impacts of aircraft operations in terms of safety, noise, privacy and security are mitigated. | Aircraft are demonstrated and certified as safe for passenger transport Rules and guidance on flight operations and network of routes mitigates impact on local communities Incentivise electric and sustainable aircraft over combustion engine aircraft (e.g. A congestion zone). | • Central Government<br>• Civil Aviation Authority<br>• Local Authorities<br>• Aircraft Manufacturers<br>• Community Groups |
| **Physical Security** | Delivering appropriate security arrangements at airfields to enable efficient passenger boarding and onward seamless connections at destination airport. | Security arrangements support preboarding operations (supporting flights into secure airports flights from unlicensed airfields). | • Central Government<br>• Airport Associations<br>• Airports<br>• Airline Operators<br>• Vertiport Operators |
| **Flight Operations** | Strategies for managing emergency situations in the air and on the ground. | Standard rules for energy reserves to support flight operations are defined. Airline operators (and pilots) have agreed method for identifying appropriate alternate landing sites for operations. | • Aircraft Manufacturers<br>• Airline Operators<br>• Vertiport Operators<br>• Civil Aviation Authority |

# Urban Air Mobility

**Business, commuters and leisure users will travel across urban locations in electric aircraft capable of vertical take-off and landing, also known as eVTOLs or Air Taxi's. Aircraft will travel up to 60 miles across a network of locations within and between urban environments. Initially, the aircraft are operated by a single pilot onboard. These aircraft will transfer up to 4 passengers. Longer-term, aircraft will fly with a remote pilot and transfer up to 8 passengers. They are operated from aerodromes which are often referred to as vertiports.**


## How is this performed today?

General public use **private and public ground transport** to travel across cities, using taxis, trains, buses, water craft and bicycles. Helicopter taxi operations are available for **business and VIP customers.** They operate from a limited number of heliport locations, commercial airfields and unlicensed airfields. They are not accessible to the general public due to cost.

## How will this change in the future?

Passengers will access on-demand or shuttle services, known as vertiports, for fast and convenient travel between points of interest. Vertiports will have streamlined boarding processes equivalent to those for trains. In the longer term, vertiports will become community focal points where people can access local public services.

## What are the benefits?

### Advanced Mobility System

Improved point to point transport links to places of interest

### Community Hubs

Creating public spaces supporting delivery of local services

### Access to Public Services

For example, transporting doctors to deliver health services in underserved communities

## Did you know?

A common misconception is that eVTOLs are electric helicopters. This isn't true as performance characteristics of eVTOLs are very different. eVTOLS can use several different types of technology to fly. Some eVTOLs use multiple rotors for vertical and horizonal flight. Other eVTOLs use rotors only for vertical flight and use conventional wings with a push rotor to fly when cruising. Some eVTOL designs incorporate vectored thrust capability like the Harrier jump jet.

VERTICAL

**eVOTLs** The top 5 manufacturers building electric vehicles for urban transport have over 8000 orders. The leading UK manufacturer Vertical Aerospace has over 1500. Global trend to see entry into service as early as 2025.

**Vertiports** There are 14 recognised Vertiport infrastructure operators globally developing critical infrastructure for Air Taxis. All have predicted entry into service no later than 2026. Vehicle manufacturers have received over 61 times more funding than the vertiport companies according to SMG.

## Case Study

Dubai Roads and Transport Authority (RTA) has approved plans to develop vertiports as part of the emirate's future air mobility infrastructure network and the launch of Air Taxi services in 2026. Vertiport locations have been chosen to connect travellers with the cities Metro Network.The project is in line with the Dubai Self-driving Transport Strategy, which aims to make 25 percent of all trips in Dubai driverless by 2030.

## What are the current limitations?

- Equitable access to mobility and personal safety concerns related to travelling with others
- No vertiports available and pre-flight security not defined
- Charging of eVTOLs will place significant strain on the grid

### 1. Short

Flights provide scheduled commuter belt travel to niche markets such as replacement to helicopter transport or tourist markets from existing airfields and airports

### 2. Medium

Flights provide affordable commuter transport to general public via a network of vertiports. Increasingly on-demand

### 3. Long

Vertiports form part of community infrastructure supporting delivery of local services and advance the overall mobility ecosystem

## What is the Operating Environment?

- Passengers access Air Taxi services for travel to other places of interest
- Flights operate from vertiports in urban environments or between urban environments
- Large cities will have 10/20/30 vertiports dependent on population
- Airlines will offer on-demand and scheduled flights
- Flights are conducted using visual flight rules (VFR) and instrument flight rules (IFR)
- Aircraft fly over rural and urban locations typically up to altitudes of 2000ft
- Aircraft have pre-determined emergency / alternate landing sites
- A network of vertiports in an urban transport mobility ecosystem
- Vertiports provide charging facilities and emergency systems

## How big is the opportunity?

London Case Study

Population of **9 million**

Metropolitan area
**14 million**

Top city worldwide for hours lost due to congestion

**156 hours**

**per year per person on average**

**1+ billion journeys**
annually on London Underground alone

Annual trips that KPMG estimate eVTOL could capture per year **14.6m**

## How does this support sustainability?

**Sustainable cities & communities**

**Climate action**

Air Taxis will provide a more energy efficient, zero-tailpipe emission alternative to comparable urban transport options at a cost that is accessible to more of the population.

## What are the Challenges?

| Sector | What is the challenge? | What needs to happen? | Who needs to help? |
|---|---|---|---|
| **International Certification of Aircraft** | Providing a global consistent certification basis for use of electric aircraft capable of vertical and take-off landing in urban settings. | Certification basis agreed with Regional and National Aviation Authorities. Certification means exist for aircraft that are certified under one scheme and 'assembled' in another area. | • Central Government<br>• Civil Aviation Authority<br>• Other National Aviation<br>• Authorities |

| | | | |
|---|---|---|---|
| **Airport Development & Licensing** | Building new vertiports in locations that are accessible to the public and connect other transport hubs. | National and local planning framework for development of new airport infrastructure. Licensing requirements for new airfields to support eVTOL operations (including rules for operations from unlicensed airfields) Viability of operations from eVTOLs high-rise buildings provides direction for infrastructure needs and public accessibility. | • Central Government<br>• Local Authorities<br>• Civil Aviation Authority<br>• Airport Associations<br>• Airports |
| **Airspace Integration** | Current Air Traffic Management systems are at capacity and need modernisation to handle flights in Urban Airspace. | A concept of operations for Urban Air Traffic Management drives development of rules and guidance for managing airspace in urban environments. Aircraft operations in visual or instrument conditions use existing flight rules and adopt new flight rules that align with performance needs of eVTOL. Data sharing agreements between all stakeholders ensure safe and efficient operations. | • Central Government<br>• Civil Aviation Authorities<br>• Local Authorities<br>• Airline Operators<br>• Aircraft Manufacturers<br>• Air Navigation Service<br>• Providers |
| **Airspace Management** | Flight routes will require tactical changes to meet customer demand and the process for approving airspace routes needs to be flexible. | Develop an Airspace Change Management Policy and Process to support dynamic introduction of routes and on-going adaption. | • Central Government<br>• Civil Aviation Authorities<br>• Local Authorities<br>• Airline Operators<br>• Air Navigation Service Providers |
| **Energy Supply Management** | Resilient and reliable power supplies from local energy hubs to satisfy demand for electric and in the future hydrogen fuel cells. | Incentivise the provision of energy to airports Airports are independent energy hubs with onsite production and storage facilities Partnerships with the national grid for storage and supply to local communities with cost recovery processes e.g. paid by the grid to store, paid to provide excess energy, no VAT on electricity costs. | • Central Government<br>• Airport Associations<br>• Energy Providers |
| **Flight Operations** | Strategies for managing emergency situations in the air and on the ground. | Standard rules for energy reserves to support normal and emergency flight operations are defined based on performance requirements of aircraft without impacting safety. | • Civil Aviation Authorities<br>• Airline Operators<br>• Aircraft Manufacturers |

# Regional Air Mobility

**The transfer of up to 19 passengers between airports using electric or hybrid hydrogen fuel cell aircraft. Aircraft fly from traditional airports and airfields. Initially, aircraft are capable of short take-off and landing (STOL) in addition to conventional landing procedures. In the longer term, aircraft capable of vertical take-off and landing (VTOL), as a result of increased battery capacity, will boost regional transport options.**

## How is this performed today?

Regional travel is primarily by **car** and **train** with some island and rural communities using air transport. Car journeys are **lengthy** and train routes have **limited networks.** Air transport is provided on a limited basis with flights only occurring once or twice a day. The aircraft are often older aircraft using combustion engines which are at the end of life. The regional network often relies on declaration of **Public Service Obligation** routes to ensure service continuity.

## How will this change in the future?

Passengers will have access to a **new route network** flying to locations previously determined unviable at a **frequency to suit public demands** and community needs including complimenting public services that they require. Services will be **on-demand** or **shuttle** services. Aircraft will use **electric** and in the long-term **hydrogen** fuels that are produced and/or stored at the airfield.

## What are the benefits?

### Jet Zero

Accelerating decarbonisation targets for aviation

### Regional Connectivity

Aircraft can serve routes and smaller airports not economically viable for larger aircraft

### Public Services

Transforming accessibility of centralised public services

### Support Business

Boosting growth and routes to market for existing enterprises and encouraging start-ups

### Tourism

Boost to regional tourism and improved local economies, revitalisation of regional airports

### Job Markets

Access to new job markets through mobility of work force

## What are the current limitations?

- Limited number of passengers for all-electric aircraft (currently up to 9 with existing batteries, up to 19 within c.20 years)
- Lack of existing charging infrastructure – will require time and financial investment

## Case Study

Birmingham Airport

Birmingham Airport has identified 39 viable routes that could be served from the airport using regional passenger aircraft. The study estimates that 58.9m passengers currently travel on these routes annually, 87.5% of these by car. Using a fleet of 61 aircraft, regional air transportation could offer passengers a roughly 2.5x quicker journey, potentially capturing 1.6m passengers annually.

**$5bn**

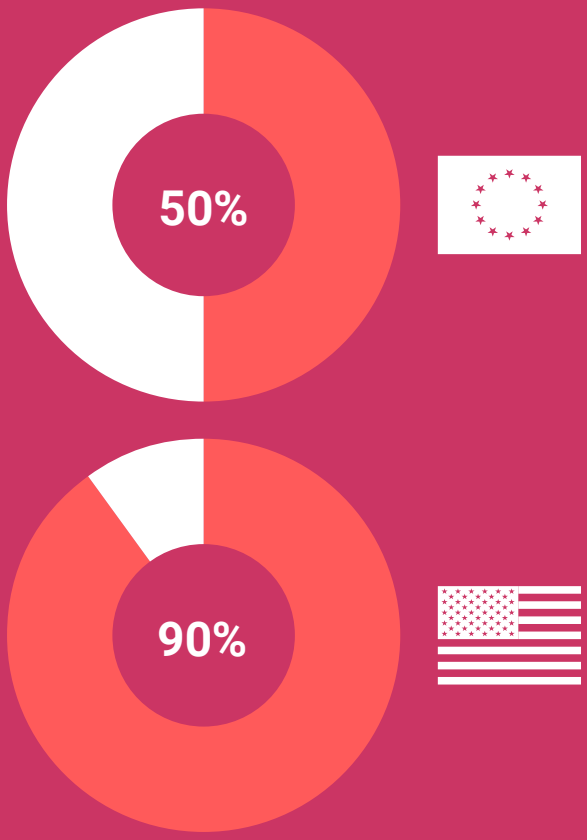
2019 passenger revenue for trips under 800km on smaller aircraft

Electric aircraft, operated from existing small airport infrastructure, could result in a global market in 2035 representing

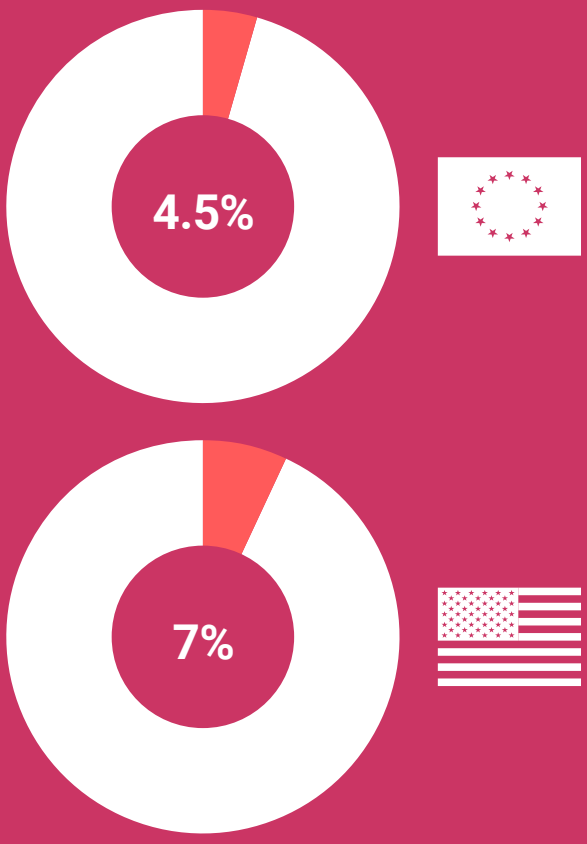
**300 to 700 million passengers**

## How big is the opportunity?

People living within **30 minutes** of an airport




Trips **under 800km** taken by aircraft



## What is the Operating Environment?

- Airlines operate aircraft from traditional airports and airfields
- Flights operate across international borders
- The aircraft are capable of trips up to approximately 500 miles
- New airport infrastructure developed based on community needs
- Aircraft capabilities meet the same technical requirements for commercial transport
- Energy production systems are local and support onsite charging / fuelling infrastructure
- Passengers have fast pre-boarding process like train travel
- Air traffic management services provide strategic and tactical support to operations

## Did you know?

Israeli founded aircraft manufacturer Eviation has developed Alice, an all electric commuter aircraft.

EVIATION

- **September 2022** Maiden Flight
- **2027** Expected In Service
- **200 Miles** Expected Range
- **9** Passenger Capacity

## How does this support sustainability?

Regional passenger transport by aircraft will provide improved, low emission connectivity enabling wider access to public services, tourism, and employment opportunities.

**Decent work & economic growth**

**Reduced inequalities**

**Climate action**

### 1. Short

Flights up to 60 miles from existing airfields using aircraft capable of short and conventional taking off and landing

### 2. Medium

Expanding to new airfields supporting aircraft capable of vertical take-off and landing (VTOLs) as battery performance improves range

### 3. Long

Flights are up to 400 miles and hydrogen fuel cell propulsion systems are being used increasingly

## What are the Challenges?

| Sector | What is the challenge? | What needs to happen? | Who needs to help? |
|---|---|---|---|
| **Airline Business Models** | Incentivising airlines to purchase The adoption of new sustainable aircraft to support flight operations. | Incentivise use of sustainable aircraft in regional transport e.g. on routes already defined by Public Service Obligation routes. Access to grant funding to support purchase of electric and hydrogen fuelcell aircraft. UK Master Plans support design of intermodal mobility networks that align air and ground transport. | • Central Government<br>• Airports<br>• Airport Associations<br>• Airline Operators<br>• Infrastructure Providers |
| **Aircraft Capability** | Developing aircraft electric and hydrogen propulsion systems capable of journeys up to 300-500 miles. | Research programmes continue to develop large scale electric and hydrogen use. Large scale operational flights trials to demonstrate capability and support regulatory developments. | • Central Government<br>• Civil Aviation Authority<br>• Local Authorities<br>• Aircraft Manufacturers<br>• Community Groups |
| **Energy Infrastructure** | Access to electric and hydrogen energy infrastructure at regional airports to support the growth of new vehicle types in the short-term. | Deployment of Smart Grids to support regional aviation. Research and development ensure safe, certified and sufficient energy infrastructure available at airports. | • Central Government<br>• Airport Associations<br>• Airports<br>• Airline Operators<br>• Vertiport Operators |
| **Skills & Training** | Creating a sustainable pathway for resources for flight operations and support roles. | Aviation Skills and Training Promotion Programme. Flight training schools use of electric and hydrogen aircraft in training to support flight operations and supply chain. | • Aircraft Manufacturers<br>• Airline Operators<br>• Vertiport Operators<br>• Civil Aviation Authority |

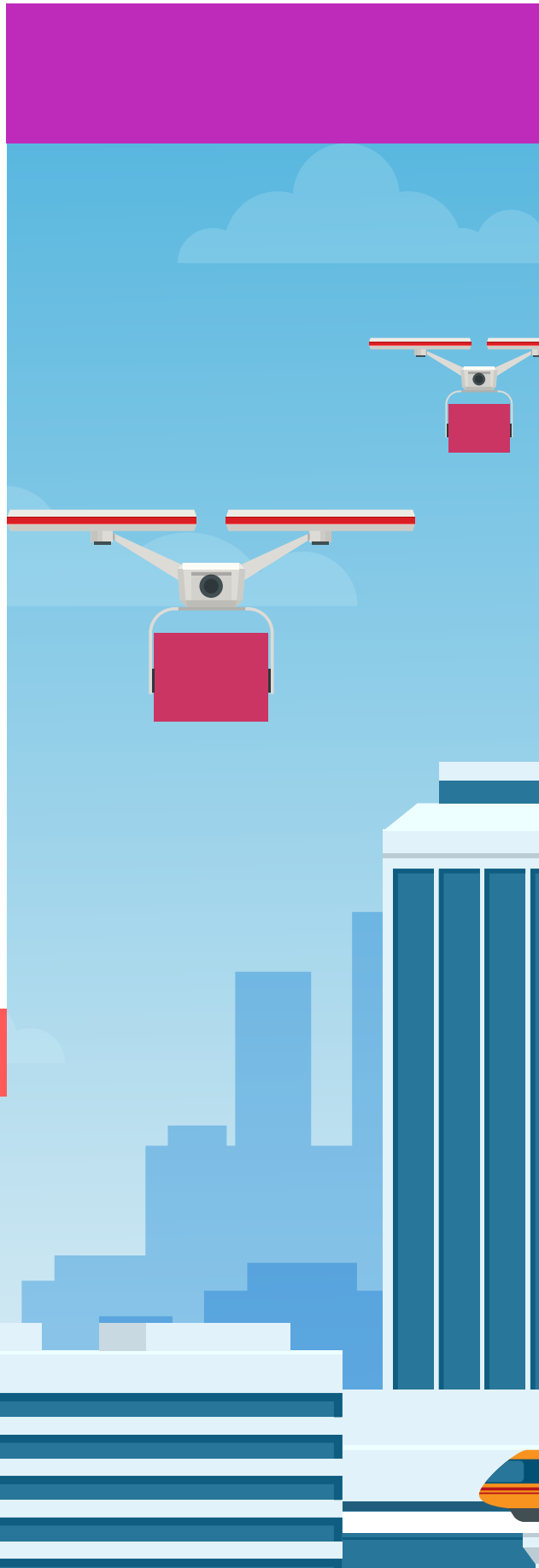
Delivered by Innovate UK and ESRC

## About Innovate UK

Innovate UK, part of the UK Research and Innovation (UKRI), is the UK's innovation agency.

It works to create a better future by inspiring, involving and investing in business developing life-changing innovations.

Its mission is to help companies to grow through their development and commercialisation of new products, processes and services, supported by an outstanding innovation ecosystem that is agile, inclusive and easy to navigate.



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