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# AAM-ROADMAP – FROM GERMANY, FOR GERMANY

A CAMPAIGN OF THE BDLI ADVANCED AIR MOBILITY WORKING GROUP



**BDLI**



German Aerospace Industries  
Association



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## 1. GLOSSARY

AAM	Advanced Air Mobility
ATC	Air traffic control
AzB	Anleitung zur Berechnung von Lärmschutzbereichen [Instructions for the calculation of noise abatement areas]
BMDV	Federal Ministry for Digital and Transport
BMI	Federal Ministry of the Interior and Community
CONOPS	Concept of operations
DFS	Deutsche Flugsicherung [German air traffic control]
EASA	European Aviation Safety Agency
eVTOL	Electric Vertical Take-Off and Landing
IAM	Innovative Air Mobility
ICAO	International Civil Aviation Organization
IFR	Instrument flight rules
LuftVG	Luftverkehrsgesetz [Aviation Act]
PBN	Performance-based navigation
PTS-VPT-DSN	Prototype Technical Design Specifications for Vertiports
VFR	Visual flight rules

## 2. INTRODUCTION

In recent years, Germany has become the global technology leader in the field of Advanced or Innovative Air Mobility (AAM/IAM) for electrical Vertical Take-Off and Landing (eVTOL) aircraft. eVTOL aircraft will make it possible to connect both metropolitan and rural regions quickly, safely, sustainably and affordably, independently of existing ground-based traffic infrastructures.

The Federal Ministry for Digital and Transport presented the Federal Government of Germany's action plan for unmanned aircraft systems and innovative aviation strategies on May 13, 2020. Objectives have been defined for eVTOLs in line with this action plan:

### « 5. Air taxis for passenger transport and as a possible means of transport for emergency physicians in air ambulances

- The Federal Government is collaborating with the European Union Aviation Safety Agency (EASA), who is developing air taxi certification regulations.
- The German government will also support the development of requirements for aerodromes at the ICAO and EU levels. Areas of focus: Aerodromes should be interoperable for a wide range of air taxis. Where possible, existing aerodromes should be usable by air taxis as well.
- At the national level, the development of approach and departure procedures to and from airports is being promoted.
- A regulatory framework is being created for combining mobility services together. The objective is a multimodal transportation chain into which air taxis are integrated. »

We embrace and expressly support this, but see the need to push for the required infrastructure as well as the necessary new flight procedures and airspace integration procedures, including at controlled commercial airports under certain framework conditions, for a joint prompt realization by 2025.

The first operational eVTOL use in the European Union is currently planned for the Olympic Games in Paris in 2024. Therefore, France has implemented initial regulatory initiatives and made adjustments in the helicopter regulatory framework for the use of eVTOLs as well. In Germany, the major commercial airports in particular, but also private companies and regional aerodromes, are showing great interest in investing in the AAM sector. The foundation for this will be regulatory guiding principles, requirements and an implementation strategy at the national level, which must be jointly developed and put into action in a timely manner in order to create the necessary awareness among all stakeholders.

In addition to the infrastructure, the development of suitable approach and departure procedures and, under certain circumstances, slot regulations for eVTOLs, especially at controlled aerodromes, is of particular importance for the realization of sustainable advanced air mobility services. Capacities in airspace and on the ground as well as at German air traffic control (DFS) are already limiting factors today. Managing a not-insignificant volume of additional traffic, dependent or independent, is hardly feasible with the existing setup.

### 3. AAM ROADMAP OBJECTIVES

- Define the strategic vision for AAM in Germany until 2030
- Coordinate various initiatives/test routes
- Develop a common understanding of the AAM ecosystem and its key players, applications and interdependencies/interrelationships
- Assess trends, drivers, opportunities and challenges in AAM
- Define key milestones (in areas such as regulation and airspace integration) to achieve the vision and objective of AAM in Germany by 2030
- Identify key requirements for AAM products, systems and services
- Identify priority areas for AAM capability development in Germany
- Establish demonstrators/pioneer routes that serve as critical milestones to achieving a national AAM strategy
- Provide guidance for engaging new, interested players
- Define a clear timetable with milestones analogous to, e.g., Italy (6 months)

## 4. GENERAL REGULATORY CONSIDERATIONS

In addition to general political support, concrete actions by the responsible bodies are crucial to meeting this challenge. Therefore, we propose the following regulatory measures:

### **Adaptation and clarification of existing European and national laws, rules and regulations for applicability to eVTOLs**

eVTOLs are certified as a new and distinct aircraft category by EASA in the Special Condition (SC) VTOL. For eVTOL operation and eVTOL infrastructure approval, eVTOLs must also be redefined as an aircraft category in national laws and regulations or added to an existing category if they are to be operated or to use either airspace or infrastructure. To make the procedure efficient, existing regulations should be supplemented where necessary and possible. This includes definition and clarification of the use and application of current national and international (European) laws, rules and regulations for airspace use during a transition period until full alignment has taken place and, if valid, beyond. Here, the following points should serve as a guideline:

- The regulatory framework for safe, efficient and sustainable eVTOL operation in the Federal Republic of Germany should serve as a model for the European vision and its ambitions as much as possible – and should be in alignment with the regulations from EU countries that have already documented these as guidelines. The Basic EASA Regulation<sup>1</sup>, which is built on a risk-based and operations-centered approach, should be used as the foundation for this new regulatory framework for eVTOL operations in Germany. A clear, harmonized regulatory framework covering all responsibilities should be developed from this and should include rules on safety, danger prevention and data protection in accordance with the EU regulations.<sup>2</sup> It is also recommended here that Germany adopts the EU's three 2020 regulations for implementing U-space<sup>3</sup>, and that the EU initiate the development of a harmonized drone taxonomy (classification).
- To enable eVTOL flight operation as quickly and safely as possible, real-world flight tests and flight trials should be facilitated to advance the adoption of innovative technologies. Framework conditions for vertiports and ground infrastructure are required and should be developed in parallel. In addition, competencies and capacities must be built up and promoted to support operating licensing, certification and safety oversight at the national and local levels.

In this context, it is also necessary to clarify which administrative contact partners are responsible for approving vertiports and integrating them into the local transport infrastructure. This is to ensure that the infrastructure is developed in an efficient and targeted manner.

1 Regulation (EU) 1139/2018

2 Regulation (EU) 945/2019, Regulation (EU) 947/2019

3 Regulation (EU) 664/2021, Regulation (EU) 665/2021, Regulation (EU) 666/2021

## 5. AIRSPACE INTEGRATION

Regarding the complex of issues related to airspace integration, the following considerations should be taken into account:

### **Independent procedures for integrating eVTOLs at commercial airports**

Looking at the required airspace and infrastructure capacities at airports with control zones, it is already clear that hardly any additional infrastructural, operational or personnel capacity is currently available for VFR-eVTOL traffic. Thus, establishing new, independent infrastructures, flight procedures and airspace solutions for eVTOLs is crucial. However, for an economical and safe eVTOL transport system, it is essential to be able to increase the number of movements per hour to the maximum supported by the existing infrastructure. This must take place independently of and in parallel to existing air traffic and, if possible, without setting up additional ATC structures.

Therefore, new autonomous approach and departure procedures for eVTOLs to and from controlled airports must be developed and advanced in a way that does not affect the number of current and planned arrivals and departures. For example, DFS has developed an eVTOL sector in connection with a German commercial airport, which could serve as a template for other airports. This can be set up on the basis of existing regulations and procedures, such as those for helicopters, with prior joint determination that the regulations and procedures are suitable.<sup>4</sup> The specific local situations of the airports must be taken into account. In addition to eVTOL airspace integration, this is also conceivable on the ground side. Benchmark projects at three to four different airports, at minimum, are to be strived for. Existing agreements and projects initiated by DFS with airports, for example Stuttgart and Munich, are to be taken into account.

### **A mandate for DFS to actively develop and implement solutions for eVTOL operation, together with the industry**

German commercial airports in particular have recognized the added value and the opportunity for sustainable aviation through the pioneering role of the eVTOL as an electric passenger aircraft on short-haul and regional routes, and have pushed ahead with initial plans for the necessary ground infrastructure. Due to the challenges they will face, commercial airports predeveloped initial approaches for airspace integration in this process, together with manufacturers and DFS. It is imperative to continue this initiative, by commissioning and supporting DFS to actively develop and implement independent and innovative solutions for safe and economical eVTOL operations in Germany together with the industry. This applies both for VFR and later for IFR and, if necessary, in basically all airspace classes.

Another way to do this would be by defining eVTOL approach/departure and cruise procedures in a general CONOPS<sup>5</sup> as a DFS sovereign task. Along with commissioning DFS, the cost assumption for the development and implementation of the processes in operation is to be clarified.

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4 For example, application of required minimum distances from VFR FATO to IFR runway in accordance with CS-HPT-DSN.B.100 or SERA.8012, or use of an ATZ/TMZ as a stand-alone eVTOL sector within a control zone.

5 A concept of operations (CONOPS) is a document describing the characteristics of a proposed system from the viewpoint of an individual who will use that system. It is used to communicate the quantitative and qualitative system characteristics to all stakeholders..

### **Creation by DFS of a regulatory framework for the introduction in Germany of new IFR flight procedures for VTOLs, which have already been tested in Europe and in the industry**

To leverage the infrastructure as efficiently as possible and to enable safe and reliable operations, IFR-based approach and departure procedures will play a key role in the future. Solutions for vertiports (e.g., PBN) that do not result in any changes to existing plans for VFR-certified infrastructure or installation of cost-intensive IFR infrastructure are to be developed and implemented based on existing procedures for helicopters and airplanes.<sup>6</sup>

### **Enabling of unlimited test flights and real-world laboratory operations at existing aerodromes and airports, based on current helicopter regulations**

German commercial airports see the development, implementation and operation of vertiports as a new market segment with economic potential. However, implementation is currently very difficult due to an unclear regulatory situation as well as a lack of capacity among mandatory project partners.

Permission for individual demonstration projects has so far been very restrictive. Facilitating that permission, coupled with the clear willingness to apply and interpret existing regulations<sup>7</sup>, gives airports as well as manufacturers and operators the opportunity and security to gain important technological and operational insights at an early stage, minimizing risk. Initial funding from the Federal Government or the respective state can provide important incentives for private investment and thus promote AAM in the long term.

For reasons of resource availability, the necessary development of new airspace integration solutions at controlled airports is to be carried out as part of a pioneer project on one or two exemplary routes that will be operated commercially in the future. The main content is to be the possible independent AAM integration into regular operations at two to four airports of different sizes and designs. This will also make a significant positive contribution to public acceptance. Therefore, support from politicians at the federal level for precommercial demonstrator projects is essential as a basis for developing economically self-sustaining connections and for creating social acceptance, as well as supporting awareness campaigns to identify potential vertiport sites at airports and at suitable urban and regional locations.

### **Support DFS to provide the resources needed to swiftly implement the necessary adjustments and developments**

The commissioning of the first eVTOL routes and infrastructures is currently planned for 2024 in other European countries. To ensure that Germany does not fall behind, it is essential to support DFS in providing the resources required to rapidly implement the necessary adaptations and developments. Regarding airspace integration, this will provide an essential milestone for the timely establishment of a broad network in Germany as well.

<sup>6</sup> For this purpose, the requirement for a planning approval procedure when establishing a restricted area in the context of establishing instrument flight operations may need to be revised.

<sup>7</sup> EASA EAR for SERA, EASA EAR for ATM-ANS, EAR for Air Operations, General Administrative Regulation for the Approval of the Installation and Operation of Heliports, and EASA PTS-VPT-DSN



**Establish a longer-term task force for collaborative development of appropriate practices with relevant system partners**

By means of a task force consisting of relevant stakeholders such as airports, DFS and eVTOL manufacturers, the framework conditions and steps required for prompt implementation are to be discussed and jointly adopted under the leadership and moderation of the Federal Ministry for Digital and Transport (possibly with the involvement of EASA). Challenges and questions arising in the process should be solved jointly and as quickly as possible.

**6. INFRASTRUCTURE**

To provide the framework conditions – on the basis of the objectives formulated so far – for the timely establishment of the route network and, above all, successful eVTOL operation during the initial phase of operations and beyond, especially in Germany, we propose the following infrastructure measures:

**Clarification or adjustment of the interim regulations on infrastructure, and active introduction and application of EASA PTS-VPT-DSN<sup>8</sup> in Germany**

There is great interest in the German and European aviation industries, especially on the part of airports, aerodromes and specialized vertiport developers, to plan and build necessary infrastructure as promptly and pragmatically as possible on the basis of existing requirements. However, clear framework conditions on how to proceed in the current transition period are lacking, leading to uncertainty and reluctance.

A circular issued by the Federal Ministry for Digital and Transport in 2020 on the approval of the installation and operation of aerodromes for VTOL aircraft (vertiports) has addressed some fundamental issues. However, these were formulated and discussed (unjustifiably) restrictively and without sufficient legal certainty, so the lack of clarity persists. With operational and commercial eVTOL operation in view, to commence in the near future, it is important to formulate clear guidance and adapt it to current circumstances in order to provide planning certainty for airports and infrastructure developers and operators. Among other things, the following should be considered:

Since German eVTOL manufacturers in particular plan to start operations with various models between 2024 and 2026, the foundations must be laid at an early stage to ensure that the rollout locations include Germany. EASA published the Prototype Technical Design Specifications for Vertiports (PTS-VPT-DSN) in 2022, and EASA is working on additional binding documents for the eVTOL operation and infrastructure specifications. These must be accompanied and supported proactively and in the best possible way at the national level. Where there are no binding EU requirements, regulations based on existing requirements for helicopters<sup>9</sup> are to be established for the interim period, taking into account and including EASA PTS-VPT-DSN. If binding specifications for eVTOLs are available, they must be applied proactively and as quickly as possible at the national level.

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 8 The EASA Prototype Technical Design Specifications for Vertiports offers guidance to urban planners and local decision-makers as well as to the industry to enable the safe design of vertiports to serve these new types of vertical take-off and landing (VTOL) aircraft, which are now at an advanced stage of development.

9 General Administrative Regulation on the Approval of the Construction and Operation of Helicopter Airfields

Existing aerodromes and landing sites should, as far as possible and feasible, also be suitable for use by eVTOLs. To this end, framework conditions<sup>10</sup> must be established so that the existing permits under aviation law can be adapted accordingly and supplemented for eVTOLs, provided that the necessary technical requirements are met. In this context, existing laws and regulations, for example following the example of France, are to be supplemented and adapted as efficiently as possible for and regarding eVTOLs. This includes the regulatory framework for the construction of eVTOL infrastructure at existing aerodromes. eVTOL aerodromes should, as far as possible, be interoperable for a wide variety of eVTOLs.

### **Simplified and accelerated approval procedures for vertiports**

AAM requires the adaptation of existing (helicopter) landing sites (e.g., by means of an appropriate charging infrastructure) or even the creation of numerous new landing sites (vertiports) in urban and rural areas to enable the general public to access this new means of mobility. Current approval procedures in Germany for heliports require 10–15 years, which represents an enormous investment risk for AAM. Therefore, new ways of permitting and approving vertiports must be developed that minimize the time required for design, construction and green-lighting of vertiports to make AAM commercially competitive in view of other nations.

The approval process must also consider that integration of eVTOL landing facilities with local transportation infrastructure is a key factor in the success of AAM.

### **Development of common noise principles/noise categories for eVTOLs**

According to current knowledge, eVTOL aircraft are many times quieter than conventional aviation and are also free of emissions, which should facilitate broad public acceptance as well as accelerate the approval procedures. However, this cannot yet be adequately applied to calculation and modeling for aircraft noise and noise abatement areas, since there is no corresponding aircraft type category in the instructions for the calculation of noise abatement areas (AzB). Therefore, it is essential to include a new aircraft type category for eVTOLs in the AzB.

### **Allowing stand-alone landside eVTOL landing sites at airports without classifying them as airside infrastructure or capacity expansion**

Planning for airport vertiports primarily focuses on ground sites. This is due, on the one hand, to the very limited space available in the airside infrastructure, but also to legal issues relating to existing zoning approval decisions, operational requirements for approval under aviation law, the separate fee structure for vertiports and deviating safety requirements for vertiports. With these issues in mind, it is essential to ensure that a landside vertiport infrastructure at an airport does not represent an airside infrastructure or capacity expansion and thus does not require a new zoning approval procedure according to § 8 LuftVG.<sup>11</sup>

10 Specification and definition of eVTOLs as a separate aircraft category or integration into an existing category in existing legislation

11 For example, by supplementing or specifying § 6 Para.4 LuftVG that an independent landing site within an airport that has already received approval in accordance with § 12 does not constitute an expansion.

### **Standardization of the charging infrastructure**

Today, there are many different eVTOL concepts being developed and tested. To keep the charging infrastructure as compact as possible and simple for the operators of airports, helipads or vertiports, it is essential to standardize the charging infrastructure and to develop corresponding regulatory standards in cooperation with the eVTOL manufacturers. Consideration should be given to serving as many eVTOLs as possible at all airports, helipads and vertiports by using a standardized charging infrastructure, to take advantage of the versatility of different eVTOLs.

### **Targeted infrastructure support projects, for example regarding power supply and charging infrastructure, for the initial financing of this new means of mobility**

Despite the comparatively low space requirements for vertiports, the financing and investment requirements are relatively high, due to the large number of sites needed and the necessary charging infrastructure. The infrastructure associated with the establishment of U-space and AAM, including landing sites and charging infrastructure, should be considered eligible for funding through traditional infrastructure funding channels and included in appropriate programs. This also includes reviewing and simplifying access to funding opportunities and government support, for example existing support for public passenger transport or charging infrastructure.

## **7. PROMOTION AND BUSINESS MODELS**

The introduction of transport solutions using eVTOL aircraft is initially foreseeable in global metropolises, including in Asia and North and South America. As technology matures and market penetration increases, these markets are also expected to operate the largest fleets. Against this background, Europe, and Germany in particular, will not be the driving market for the application of these new mobility solutions. However, Germany has the opportunity to play a leading role in the technological development of eVTOL aircraft and the required systems, in particular propulsion systems. Due to its established aviation companies, top scientific and academic institutions and newly formed ventures in the field of Advanced/Innovative Air Mobility, Germany is well positioned to compete at the international level.

**However, to strengthen this position and become the technology leader in the field of new air mobility, increased investments in technology as well as demonstration projects are necessary.**

Furthermore, applicability of the solutions in the domestic market will play a major role in the future development of the industry (among others, test beds and pilot applications). If Germany cannot enable the operation of eVTOL aircraft, value creation in development, testing and production of the vehicles can also be expected to shift to other countries.

## 8. RESILIENCE, SAFETY AND SECURITY

An advantage of using eVTOLs is the potential significant time savings over ground-based transportation and the necessary simplicity of using the system, similarly to a public transportation system. It is also in the interest of mobility providers to offer a system that is both secure and affordable. To be able to guarantee this, a security concept appropriate to the traffic system, aircraft size and transport capacity is necessary. EU regulation allows deviation from airport-specific security measures under certain circumstances, and in Germany there are already concepts that build on this. Transferring and applying these existing possibilities to eVTOLs is essential for fulfilling the above-mentioned requirements for the system.

### **Security concept for vertiports – applicability of the small aerodrome concept**

In principle, eVTOLs can be operated from a variety of different infrastructures, which are currently assessed according to different parameters for approval. Both the European regulation and the national regulation based on it contain exceptions to the security measures at airports required in accordance with Regulation (EC) No. 300/2008. Due to the size of the aircraft as well as the type of infrastructure needed, to take full advantage of this transport system, an alternative or deviating security concept in accordance with Regulation (EC) No. 300/2008 must be used for operations and flights outside of airside infrastructure at airports, even if commercial passenger flights are carried out with eVTOLs in the amount required. In Germany, the Federal Ministry of the Interior and Community (BMI) and the Federal Ministry for Digital and Transport (BMDV) developed a concept for aerodromes defining deviations from and alternative security measures to the common basic standards according to Regulation (EC) No. 300/2008 (the small aerodrome concept), which must also be applied for eVTOLs and vertiports.

## 9. SOCIAL ACCEPTANCE

Achieving a high level of social acceptance is of great importance for the successful introduction of AAM. Rejection and resistance from the population can pause new concepts or block them altogether.

### **What are the concerns of the population**

- Concern about unauthorized and unwanted access to systems (hackers)
- Concern about safety risks on the ground and in the air (fire, weather, system failures, crashes, collisions, “exploding” batteries, risk of injury to people on board and on the ground)
- Concern about legal uncertainty in the event of an accident or violation
- Concern for animals and nature
- Concern about data or privacy protection
- Concern about noise or sound pollution
- Concern about “visual” pollution (aircraft spoiling the view of the sky)

### **How can social acceptance be promoted?**

#### **1/ Trust in technology and security**

Germany’s positive image as a country with great aviation and engineering know-how is a good starting point for basic confidence in new transport technologies.

Germany is perceived by its own population as a reputable center for technological innovation with experience in certification and approval processes, and its security standards are internationally viewed as reliable and elevated.

To help the lay population take a leap of faith in this technology, security systems (e.g., rescue systems) could be implemented or at least offered, especially in the early phases.

## 2/ Usefulness of the services offered

Meaningful areas of application facilitate the acceptance of new things. People with reservations are more easily convinced with examples of the usefulness of the technology. What are useful or meaningful applications here?

- Emergency services (transport of patients, emergency personnel, organs, medicines, supplies)
- Police operations
- Disaster operations
- Traffic monitoring
- Monitoring of critical infrastructure, big events, etc. ...

## 3/ Possible measures

Measures that engage the public and demonstrate the use of AAM as safe and beneficial can help reduce prejudice and build habituation to new sounds, objects and movement in the air.

### Which measures make sense?

- Building real-world laboratories to familiarize people with operations (habituation)
- Involving the public as potential users/beneficiaries, not just as affected parties (people who live or work in the areas of flight routes or vertiports)
- Engaging administrators/agencies/policymakers as potential users and as approvers/enablers: Transport companies, for example, should not perceive AAM as competition to their own products but as a useful addition to make their products more attractive. The mobility transition is currently being pushed very differently at the political and official levels, and the players often slow each other down. AAM must be perceived as a positive factor for the mobility transition, not as a disruptive factor.
- Highlighting new job opportunities, e.g., at job fairs and other events: The development of AAM promotes new business areas, creating job prospects and opportunities.
- Later in air taxi services, ensuring integration into existing transport systems, easy booking and combined offers of means of transport.
- Creating AAM awareness in the population through an AAM communication campaign in (social) media:
  - What is an eVTOL/UAV and what concepts are available in Germany and worldwide?
  - What are the purposes of use (transportation of goods and passengers/emergency physicians)?
  - Noise emissions compared to other means of transport (car/bus/train traffic in the city)
  - Concepts for integration into the existing transport infrastructure

## 10. PERSONNEL, QUALIFICATIONS

### **Adapted training concepts for eVTOL pilots**

With the introduction of eVTOLs, the demands on the pilot will also change abruptly. eVTOLs are designed for short flights with precise routes over sometimes densely populated areas and therefore require intensive training by the pilots. At the same time, the need for eVTOL pilots will increase significantly. Therefore, it is necessary to use efficient digital training methods to ensure safe operation. Since some of the requirements differ considerably from the current requirements for airplane and helicopter pilots, it is important to create the necessary framework conditions promptly so that appropriate training programs for eVTOL pilots can begin.

### **Adapted training concepts and provision of personnel at ANSP**

Regarding German air traffic control, it is of great interest that new training concepts are already being worked out to provide sufficient personnel in the medium term, especially for eVTOL operations.

Based on the AAM/IAM requirements for the integration of eVTOLs into airspace, it is essential to make sufficient personnel available at DSF to be able to begin working on the necessary concepts promptly.

### **Provision of guidance and personnel on the part of the approving authorities**

In the relevant authorities, sufficient staff must be available to provide appropriate guidance on the various aspects of AAM/IAM and to avoid delay, particularly in the longer-term infrastructure investments. The authority structures must grow in line with the increasing requirements of AAM/IAM. This should ensure that the authority can also adequately support longer-term growth in this area of mobility.

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