

ENABLING ADVANCED AIR MOBILITY IN SAUDI ARABIA

ROADMAP DEVELOPMENT

2024

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Foreword from the Minister

Under the leadership of the Custodian of the Two Holy Mosques, King Salman bin Abdulaziz Al-Saud, and His Royal Highness, the Crown Prince, Mohammed bin Salman Al-Saud, may Allah bless them, Saudi Arabia is on an ambitious journey to develop a diverse, sustainable, and thriving economy through our Vision 2030.

The Kingdom's National Transport and Logistics Strategy and the Aviation Sector Strategy demonstrate our leadership's commitment to transforming Saudi Arabia into a global aviation sector leader.

Advanced Air Mobility represents a revolution in the way we envision transportation and mobility but also a magnificent opportunity to reshape our lives, economies, and the design of our cities.

Advanced Air Mobility will improve safety, enhance passenger experience, empower our tourism sector's growth, and promote long-term environmental sustainability.

As we embark on this journey, we seek collaboration, innovation, and thoughtful policymaking. Through the work of the General Authority of Civil Aviation (GACA) and the entire aviation ecosystem, the sector offers unprecedented opportunities for the Saudi people. Together, we can harness the full potential of this exciting frontier and ensure that it serves not just a select few but benefits all.

Forging the path toward a brighter, more connected, and sustainable future, I look forward to sharing these opportunities with you as we work together to build the region's leading aviation sector.



**HE Saleh bin
Nasser Al-Jasser**

Minister of Transport,
Chairman of the Board of
the General Authority of
Civil Aviation



Foreword from the President

Welcome to the Advanced Air Mobility Roadmap for Saudi Arabia, an ambitious plan to transform our aviation sector into the most developed in the Middle East.

Advanced Air Mobility is not merely a concept. Advanced Air Mobility represents a paradigm shift in how we move, commute, and ultimately, how we live. Advanced Air Mobility encompasses a range of innovative solutions, from small Unmanned Aircraft Systems (sUAS) to larger Vertical Take-off and Landing aircrafts (VTOLs). These technologies promise to provide faster and safer means of moving goods and people, holding the potential to alleviate congestion on our roads and enable more accessible access to remote areas, unlocking many unprecedented economic and societal benefits.

Furthermore, transitioning to cleaner solutions such as electric-powered aviation is essential as we battle climate change. Advanced Air Mobility pioneers are leading the change in developing electric and hybrid-electric aircraft, marking a significant step toward achieving a sustainable and green future.

For these reasons, GACA is working on several areas to ensure that Advanced Air Mobility will be a reality in Saudi Arabia as soon as possible, from implementing a pioneering test bed with NEOM to developing the required regulatory framework.

Saudi Arabia's Advanced Air Mobility Strategy and Roadmap will delve into the underpinning technologies, identifying use cases, the regulatory framework required to ensure safety, the economic opportunities it presents, and its potential to revolutionize passenger mobility, cargo delivery, emergency response, medical transport, and disaster relief. All this will be achieved through collaborative work with essential partners in the sector, from national authorities to international industry leaders.

I am honored to share insights into this exciting frontier one that promises to redefine the way we think about mobility and transportation in the 21st century.



**HE Abdulaziz bin
Abdullah Al-Duailej**

President of General
Authority of Civil Aviation



What is Advanced Air Mobility (AAM)

Advanced Air Mobility (AAM) is a developing form of aviation, eventually operating within a highly automated and collaborative environment, which will be enabled by various innovative technologies. This novel air transport system aims to move passengers and cargo and provide aerial services, improving intermodal transportation accessibility, safety, efficiency, sustainability, and **quality of life**. Since the launch of Vision 2030, the Kingdom has taken significant steps towards its future and society development, where the transport sector has been an essential element. Now, recent technology advancements can propel Saudi transport to new heights, fostering economic growth **and resulting in multiple applications**, including:



Passenger transportation to arrive faster at an airport or other destinations avoiding heavy traffic, transport urgent patients to a hospital, visit vibrant historical places and natural reserves, and much more



Cargo transportation, including the delivery of parcels and packages in shorter times, especially those for emergency uses like medical supplies



Utility services, including area mapping and imaging, agriculture, advertising and entertainment, infrastructure and construction site inspections, security uses, and fire fighting



How the Kingdom can benefit from AAM

Saudi Arabia is **strongly positioned to benefit from AAM** and to accelerate achievement of Vision 2030



A Vibrant Society

- Reduction of traffic congestion
- More connected communities
- Reduction of traffic accidents
- Contribution to the national target of Net Zero 2060 by **saving hundreds of thousands of tonnes of CO₂**
- Wider capacity to welcome more pilgrims and offer them better experience



A Thriving Economy

- Attraction of foreign direct investments
- Technology and manufacturing localization
- Boost growth of key sectors, such as Tourism, Transportation, Manufacturing
- Contribution of **tens of billions of Saudi riyals to the GDP** and creation of **thousands of jobs** by 2040



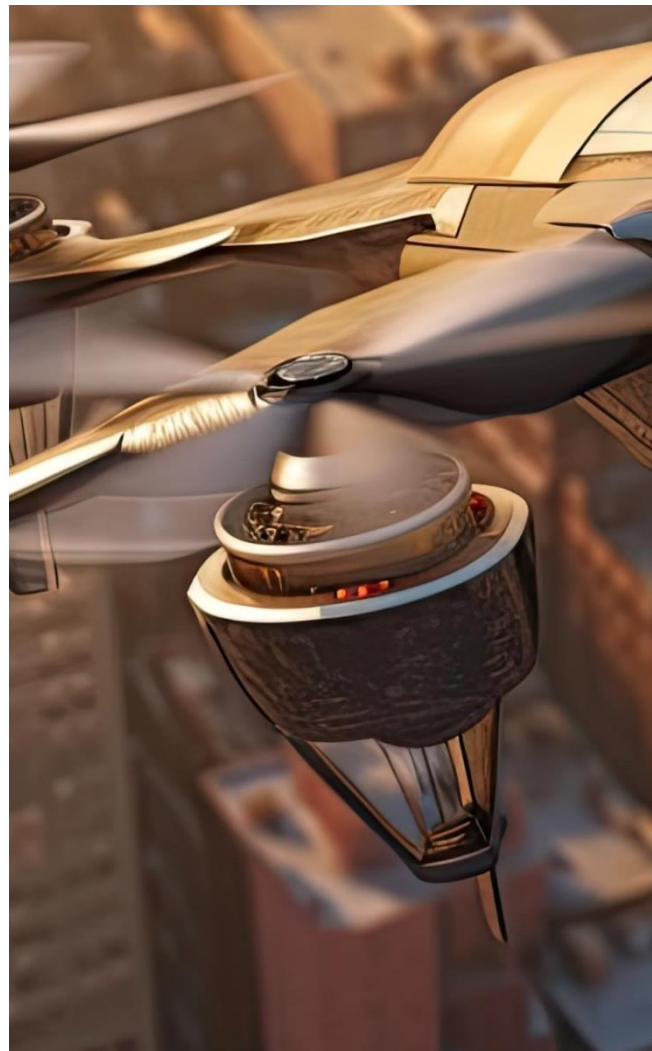
An Ambitious Nation

- Enhanced economic sustainability of public entities through new revenue streams from AAM services

Focus areas to build an AAM ecosystem

To develop a successful AAM ecosystem, some challenges must be addressed in the short- and long-term:

- **Technology:** Recent improvements in battery technology have enabled electric Vertical Take-Off and Landing (eVTOL) flights over 200 km, yet **further energy density** is needed to connect distant cities with a reasonable payload. OEMs are also working on **reducing rotor noise**, which stands at around 65 dB at a 75 m distance, however, further improvements are required to allow a dense flow of VTOLs in urban areas in smooth and convenient ways. Finally, **manufacturing and operating costs must be optimized** to improve affordability, resulting in scaled production and autonomous operations.
- **Regulation:** Multiple AAM elements need regulatory frameworks that have still not been developed anywhere in the world. Prominent Civil Aviation Authorities (CAAs) have issued proposed guidance materials. Yet, there is still considerable progress required on **regulatory framework for the airworthiness, maintenance, repairs, and operations (MRO), vertiport development, air operations, airspace and traffic management and advanced communications, among other**. Furthermore, as the International Civil Aviation Organization (ICAO) Assembly stated in its 41st session in 2022, such frameworks need to be **globally harmonized**, for which international cooperation is critical.
- **Infrastructure:** Widespread AAM operations will only be possible if supported by a **dense network of vertipads**, as the need for first- and last-mile ground transportation would defeat the purpose of AAM. Even if these will not be very different from helipads, unique requirements such as **electrification and integration in urban landscape** require close consideration and planning.
- **Airspace and Traffic Managements:** Development of air traffic management solutions for AAM aircrafts are essential, considering that UAS and VTOLs will fly at **low altitudes** (below 1,000 m) and at high **expected**



traffic volumes (first piloted, then unmanned), which can only be managed by **automated systems**.

- **Human Capability:** Several AAM-related professions (e.g., inspectors, mechanics, ground operators) must be **planned, trained, certified, and employed**. Pilot requirements also represent a significant challenge: the expected **pilot shortage** in commercial aviation adds to the future **transition to autonomous operations**, which calls for the design of **flexible career paths** that embed the required transitions.
- **Public Trust:** As a novel transportation system, acceptance and adoption of AAM by local communities will require **public engagement and information campaigns** to convince people of AAM's safety and convenience and overcome opposition such as “**not-in-my-backyard**”.

Progress towards enabling AAM

GACA, as well as many other authorities in the Kingdom, is already making **significant progress in different fields** towards AAM enablement

Ongoing support to the industry

- In 2020, Saudi Jameel Investment and Management Company (JIMCO) participated in a funding round for Joby Aviation.
- In 2021, NEOM and Volocopter formed a joint venture to develop the first operating AAM ecosystem in KSA.
- In 2022, The Helicopter Company and Airbus signed a collaboration agreement to introduce Urban Air Mobility services in Saudi Arabia.
- In 2022, Saudia Airlines signed a pre-agreement for 100 eVTOLs to be supplied by Lilium to establish commercial transportation services at main airports in the country.
- In 2023, Flynas and Eve Air Mobility have signed to explore the possibility of starting eVTOL operations in Riyadh and Jeddah in 2026.

Testing of the AAM operations

- In 2023, a series of successful test flights were conducted at NEOM with Volocopter in a close collaboration with GACA.

Conducting Research & Development cooperation

- Several Saudi research institutions are performing relevant studies and tests with the support of GACA on Unmanned Aircraft Systems (UAS).
- Various agreements have been established between leading national and foreign universities to collaborate on AAM research.

Regulatory framework

- GACA has already developed regulations for light and heavy UAS operations.
- GACA is participating in multiple AAM working groups to support and accelerate the development of harmonized standards, including ICAO AAM Study Group.
- GACA is collaborating with international authorities to foster the development of comprehensive AAM regulatory frameworks, including with EASA, FAA, DGAC, and others.

International cooperation

- Saudi Arabia, through the Ministry of Transport and Logistics Services (MOTLS) and GACA, has signed several memoranda with different countries, such as USA, UK, Singapore, South Korea, France, and China, to foster cooperation on future mobility.
- GACA is establishing joint working groups with leading international OEMs to ensure the country is prepared to embrace AAM as soon as its safety is appropriately proved, and key sector players can participate in the Saudi AAM ecosystem.



AAM activities in the Kingdom

Saudi Arabia has made considerable progress in enabling AAM activities in different spheres, where GACA has supported many of these developments



Medical products transportation

- The Ministry of Health and SPL with the support of GACA, have successfully carried out trials in July 2022 to transport blood units using UAS during the Hajj season 1444H.



Research and Development advancements

- Several Saudi universities are testing UAS in coordination with GACA, enriching local knowledge base and enabling industry localization.



eVTOL testbed

- In May 2023, as a result of collaboration of NEOM, Volocopter, and GACA, a first successful flight test of air taxi eVTOL was conducted in NEOM region.



UAS type certification acceptance

- GACA has accepted the type certificate issued by the FAA to the commercial delivery UAS named "M2" manufactured by Matternet.



Industrial applications

- GACA has granted multiple flight authorizations to various types of use cases. E.g., Saudi Aramco is utilizing UAS for aerial inspection of their flares and tanks, mapping, and security surveillance.



AAM Roadmap

- Under the aegis of AAM Roadmap Project, the AAM Roadmap for the Kingdom has been developed to enable a thriving national AAM ecosystem.

AAM development phases

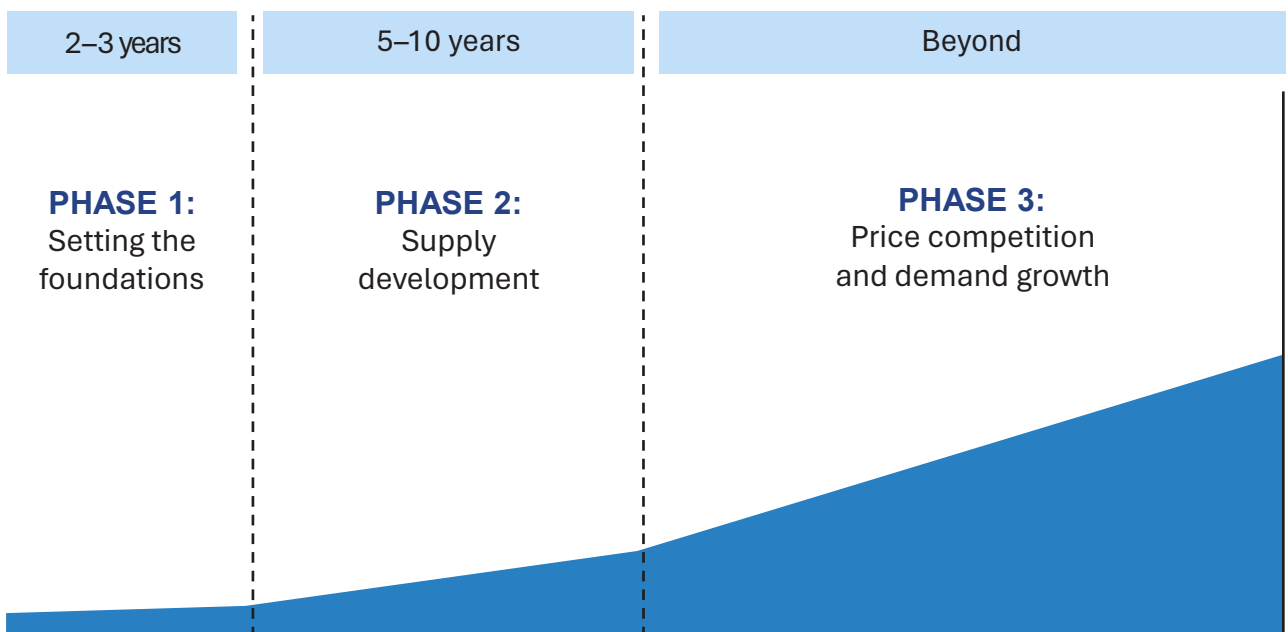
AAM development will follow **three main phases**, each with different challenges and sector dynamics:

Phase 1: During the early development of AAM, key limitation factors are a lack of ground and digital infrastructure, the ongoing development of a regulatory framework, and pending certification for different elements of AAM. Flights consist of demonstrations in a controlled environment and tests.

Phase 2: Commercial operations become feasible thanks to the development of different enablers. The scale of operations and public awareness and acceptance increase. The main limitation is the short supply of the AAM fleet, driven by small-scale manufacturing capacity and competing orders from multiple countries and regions. Fares are relatively high, and routes are limited due to incipient vertical networks. Primary use cases include cargo, airport shuttles, and tourism.

Phase 3: As supply develops, prices decrease. Connectivity improves with the development of denser vertipad networks. AAM popularity grows and drives higher levels of embracement. Demand flourishes as prices become closer to those of ground transportation alternatives, thanks to operations automation and manufacturing scale.

AAM market evolution



Key limitation factors



¹ Aircraft and infrastructure

AAM roadmap for the Kingdom

To enable AAM sector development and plan early phase activities (Phase 1 on previous page), **GACA has developed the AAM Roadmap.**

Objectives of the roadmap

- **Assessment of** global, regional and national **AAM market** potential across different use cases.
- **Definition of AAM strategy** for the Kingdom, setting targets for development of the sector.
- **Establishment of a governance structure** for the AAM sector, including necessary stakeholder coordination and engagement mechanisms.
- **Elaboration of AAM Roadmap for short and long term**, including all key initiatives for timely AAM implementation.

In this initiative GACA has been supported by a consortium of consultants and industry experts as well as a wide circle of 40+ stakeholders including authorities, OEMs, infrastructure developers, R&D institutions, potential operators and others.

STAGE 1

- 1.1 Assess **AAM market potential** across different use cases

STAGE 2

- 2.1 Define **AAM strategy for the Kingdom** and set targets
- 2.2 Define an **AAM sector governance** with clear engagement mechanisms

STAGE 3

- 3.1 Elaborate **AAM Roadmap** for short and long-term including detailed implementation initiatives

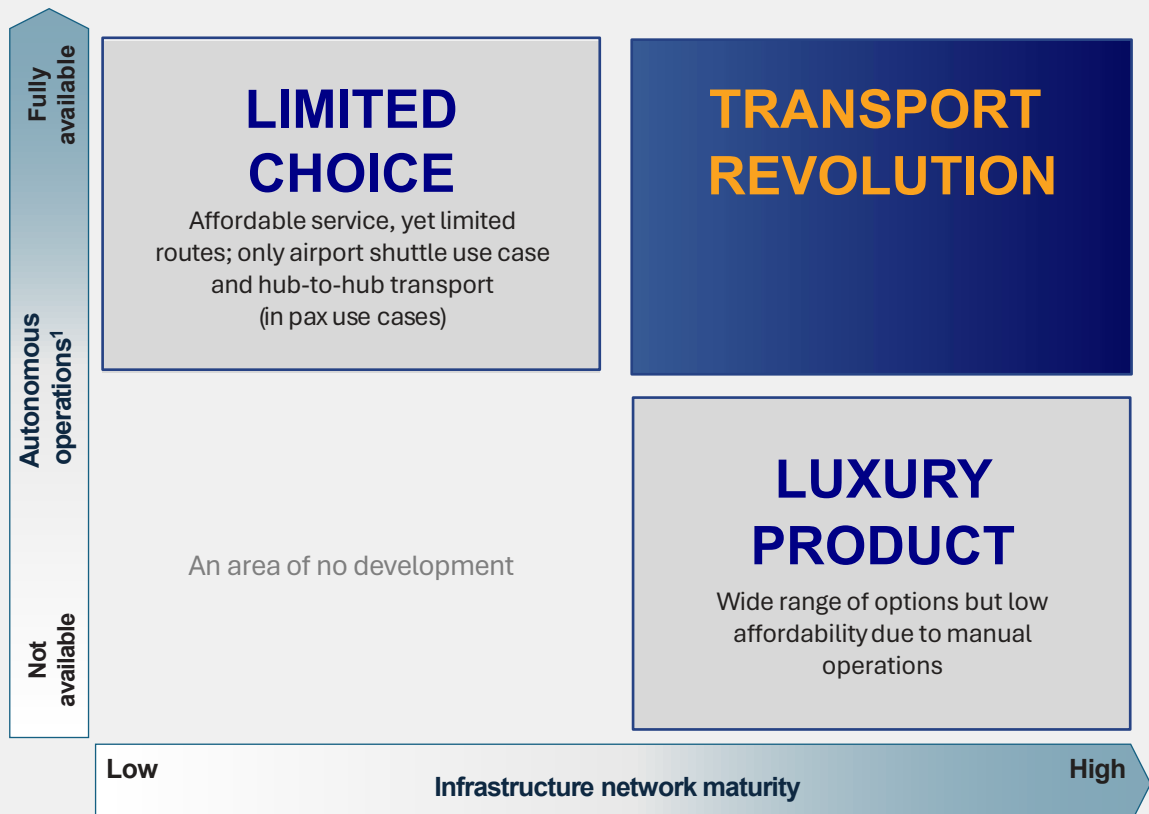


PROJECT OBJECTIVES

AAM development scenarios

Successful AAM development depends on the enablement of all its elements. Three of the most challenging elements are **ground infrastructure, autonomous operations, and traffic management of the AAM Aircrafts**. The first defines available routes, while the second and third impact volume and affordability. Thus, **three key potential scenarios** can be distinguished:

- **Luxury Product** (high infrastructure maturity but no autonomous operations): Flight fees remain high due to the need to recoup high infrastructure investment. Volume and public acceptance for high-price use cases is low, yet high net-worth customers enjoy premium mobility across various routes. AAM plays a similar role as private aviation but for urban travel.
- **Limited Choice** (low infrastructure maturity but with autonomous operations): With unmanned operations, prices decrease, while available routes are still limited due to smaller vertipad networks. Adoption grows significantly but only for specific hub-to-hub routes, including shuttles between airports and city centers.
- **Transport Revolution** (high infrastructure maturity and autonomous operations): Prices are competitive vs. ground transportation alternatives, and a wide range of use cases and routes enable large-scale operations and high aircraft utilization. AAM will thrive and play a significant role in the transport sector.



1. Flight operations, airspace management and ground handling

Next steps

In the coming months and years, GACA will continue its efforts to enable a successful AAM ecosystem in Saudi Arabia. Short term focus will be to:

- 1. Onboard relevant stakeholders to the AAM roadmap**
- 2. Mobilize necessary resources to advance the AAM ambition**
- 3. Develop the regulatory framework**
- 4. Work with the ecosystem to prepare for early operations**





Be part of the transformation!



If you have further questions about AAM developments in Saudi Arabia, please scan the QR code or write to aaminquiries@gaca.gov.sa