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Transformation

The “low-altitude” economy is taking off

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Key takeaways

- The "low-altitude" economy refers to the emerging economic sector centered around activities, businesses, and services conducted in the airspace below 3,280 feet above the ground. It's growing largely due to the rise in electric vehicle take-off and landing (eVTOL), and, according to BofA Global Research, the global civil adoption of eVTOL could grow by 62% in 2025-30E.
- Somewhere between a helicopter and a drone, eVTOL has higher safety; is more environmentally friendly; creates less noise; and has a lower selling price than that of a helicopter, according to BofA Global Research. An eVTOL typically consists of five major systems: power, avionics, structural, energy and thermal management, and assembly parts.
- According to BofA Global Research, there are six end-applications for eVTOLs, namely public security, logistics distribution, medical & fire fighting, tourism, urban commuting, and intercity/intracity transportation.

What is the “low-altitude” economy?

The “low-altitude” economy (LAE) refers to the emerging economic sector centered around activities, businesses, and services conducted in the airspace below 3,280 feet (1,000 meters) above the ground. In the United States, the Federal Aviation Administration (FAA) has issued numerous policies for accommodating wide-scale advanced air mobility operations in the LAE.[1]

Pushing the low-altitude economy forward: Electric Vertical Take-Off and Landing (eVTOL)

Electric vertical take-off and landing (eVTOL) is an emerging type of electric aircraft that combines the advantages of helicopters with fixed-wing aircraft. Powered by electricity, it can take off and land vertically.

Exhibit 1: There are four types of eVTOL structure designs
Classification of eVTOL

Category	Form
Overall structure	Single rotor Multiple rotor (Multicopter) Hybrid (lift + cruise) Vector thrust (tilt rotor/duct/wing)
Design payload	Light (100kg) Medium (300-500kg) Heavy (≥1000kg)
Operation mode	Autonomous Piloted
Transportation	Passenger Cargo Passenger & cargo
Power	Pure electric Hybrid (lithium battery + hydrogen, lithium battery + aviation fuel)

Source: BofA Global Research

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These aircraft usually use multiple rotors or propellers, and different configurations like tilt rotors, tilt ducted fans and tilt-wing technology, to achieve vertical flight with the ability to transition to horizontal flight. The eVTOLs can be classified into several

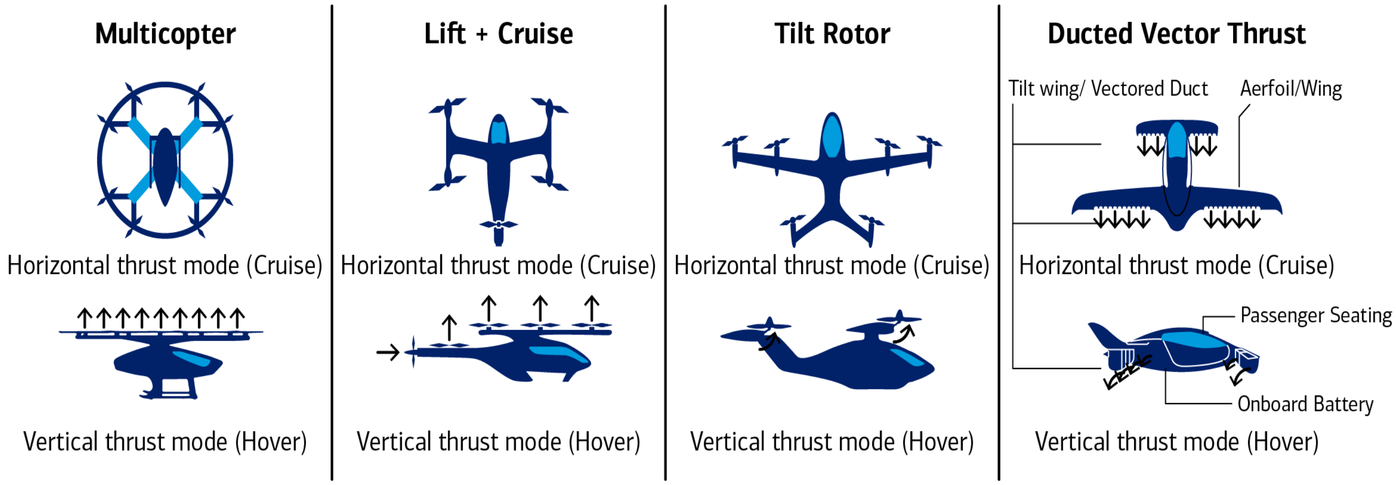
[1] Federal Aviation Administration. (2024). With New Rule, FAA is Ready for Air Travel of the Future, https://www.faa.gov/newsroom/new-rule-faa-ready-air-travel-future

types depending on their design, power source, and operation mode (Exhibit 1). In theory, the heavier the payload an eVTOL can carry, the more power it needs, and hence requires more sophisticated designs.

According to BofA Global Research, the end-markets of eVTOL include tourism, air taxi, public services (e.g., firefighting, EMS (emergency medical services), police security, etc.), and cargo transportation. As of March 2025, there were more than 1,100 eVTOL models globally under Vertical Flight Society's (VFS) directory, with vectored thrust and multicopter the most-popular structure designs (Exhibit 2).

Exhibit 2: Structure of different types of eVTOL

Ducted vector thrust is the most complex type of eVTOL



Source: BofA Global Research

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Somewhere between a helicopter and a drone

An eVTOL's flight altitude, driving range, payload, and speed fall in between that of a helicopter and a drone. On one hand, since eVTOLs typically leverage a distributed power system with multiple small-size electric rotors, they are safer, more environmentally friendly, creates less noise and have a lower selling price than that of helicopter, according to BofA Global Research. On the other hand, drones have limitations on payload, and hence are not allowed for large-weight cargoes or carrying passengers. In sum, eVTOLs are more suitable for carrying passengers/cargoes and carrying out sophisticated maneuvers at lower costs.

Breaking down the supply chain of eVTOLs

An eVTOL typically consists of five major systems: power, avionics, structural, energy and thermal management, and assembly parts (passenger cabin, safety, etc.), of which, power, energy, and avionics systems account for over 70% of the bill of materials (BoM) costs.

Power system

The power system of an eVTOL is comprised of electric motor/drives, a charging system and interface, electronic speed controller (ESC), propellers or rotors, cooling system, and power transmission components; of which, the electric motor and battery system are the biggest cost components.

- **Electric motor/drive**: The core of the power source that drives the rotors or propellers to achieve vertical takeoff and landing, as well as horizontal flight. In general, each electric motor corresponds to one rotor, enabling stable flight even when some motors fail. Permanent magnet synchronous motors are preferred due to high efficiency and power density.

- **Charging system and interface:** Fast charging or wireless charging technology is considered efficient, and safe charging solutions are necessary to meet the high-frequency demand of urban air traffic.

- **ESC (electronic speed controller)**: Used to control the rotational speed and output power of the electric motor. It can precisely adjust the operating status of the electric motor to ensure the stability and reliability of the power system.

- **Propellers & rotors**: Direct components that generate lift and thrust. The blade materials of the propellers or rotors use high-strength and lightweight materials such as carbon fiber composites.

- **Cooling system**: Ensures all components, especially electric motors and batteries, will not malfunction due to overheating. Liquid cooling is the common cooling method.

- **Power transmission components**: Includes drive shaft, couplings etc., which transmit the power of the electric motor to the propellers or rotors, ensuring the efficient transmission of power. They need to have high reliability and good fatigue resistance.

Avionics

The avionics system is the sum of all electronics systems in an eVTOL and oversees information processing, communication, navigation, and control of the aircraft. It provides various necessary information support for the flight of the eVTOL and realizes information interaction with external parties. According to BofA Global Research, the avionics system accounts for 20% of the BOM cost of eVTOL.

The avionics system of an eVTOL includes: 1) the control system, including a flight control system, which is the "brain" of the eVTOL, and engine control system; 2) a communication system, such as VHF (very high frequency) radios, satellite communication equipment, and a data link system; 3) a navigation system, such as a global navigation satellite system (GNSS) and integrated navigation system (INS); 4) an instrument display system, including altitude indicator, altimeter, air speed indicator, etc.; 5) the supervision system, including anti-collision warning system, camera perception system, etc.; and 6) a power management system, which is in charge of the monitoring and management of the battery/batteries and other power sources. All systems or modules are linked to the flight management system (FMS), which is in charge of overall flight management and schedule.

It's worth noting, however, that while the avionics system of eVTOLs and conventional civil airliners do share some similarities, their differences are stronger, according to BofA Global Research (Exhibit 3).

Exhibit 3: eVTOLs undertake tasks for short distances and low altitudes, and focus on obstacle avoidance and interaction with urban air traffic
Difference between eVTOL and civil airliners' avionics systems

	eVTOL	**Civil airliners**
Function	Undertake tasks in cities with short distances, and hence pay more attention to precise control during low-altitude flights, obstacle avoidance, and interaction with urban traffic management systems to ensure safe flights in complex low-altitude environments	Undertake tasks with long distance and high-altitudes, higher requirement on precise navigation, efficient communication with ground-based air traffic control systems, and dealing with complex weather conditions
Flight control system	Adopt FbW (Fly-by-Wire) or more advanced distributed systems, which can quickly respond and precisely control multiple rotors or tilting mechanisms to achieve vertical take-off and landing and flexible flight	Adopt hydraulic-mechanical or FbW systems. Its control logic is mainly aimed at the flight attitude and power control of fixed-wing aircraft, and the control methods are quite different from eVTOLs
Navigation system	In addition to the traditional satellite navigation system, it relies on high-precision indoor positioning technology and low-altitude obstacle-avoidance sensors to achieve precise navigation and obstacle avoidance in urban environments	Rely on global satellite navigation systems, INS, and ground-based navigation facilities for navigation. During high-altitude flights, the requirement for navigation accuracy is relatively low, while that of reliability and redundancy are extremely high
Communication system	Communicate frequently and in real-time with the urban air traffic management system to obtain flight permits, traffic information, etc., and need to communicate over short distances with ground-based stations or other aircraft	Communicate with ground-based air traffic control departments over long distances through high-frequency and very-high-frequency communication systems to ensure flight safety and coordination in the vast airspace
Display system	Emphasize simplicity and intuitiveness, mainly showing key parameters such as flight attitude, battery power, and obstacle-avoidance information to meet the pilot's need for quick decision-making in complex low-altitude environments	Cockpit is equipped with multiple large-screen displays showing rich flight information, including flight instrument, navigation maps, engine parameter, etc. to support the pilot in comprehensive flight management and monitoring during long-distance flights

Source: BofA Global Research

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Airframe structure

The structural system of an eVTOL includes the fuselage, wings, rotor and propulsion system mounts, and landing gear system.

- **Fuselage**: The main structure of the aircraft and is usually made of lightweight and high-strength materials such as composites and carbon fiber reinforced composite (CFRP).

- **Wings**: Used to effectively increase lift, reduce the workload of the motor, and improve flight efficiency**.** CFRP is the main material and glass fiber reinforced materials are also used as protective films.

- **Rotor and propulsion system brackets:** Rotors are the key components for eVTOLs to achieve vertical take-off and landing, and usually use carbon-fiber-composite rotor blades to withstand the huge stress caused by high-speed rotation. The propulsion system brackets are used to install rotors, motors, and other equipment. They are usually designed to be streamlined to increase the structural stability and aerodynamic performance of the eVTOL and reduce air resistance.

- **Landing gear system**: Responsible for the vertical take-off and landing, as well as ground operations. High-strength aluminum alloys or titanium alloys are usually used to produce the main structure components of the landing gear.

- **Passenger cabin and safety system control and operation interface**: The cockpit layout needs to meet aviation-grade standards as well as be equipped with emergency lighting, luggage storage areas, air filtration and purification system.

- **Safety equipment and emergency system**: Includes emergency exits and escape routes, overall parachute, and a fault detection and early warning system.

Energy

Compared with batteries for EVs (electric vehicles) or industrials, eVTOL batteries have higher requirements on energy density, power density, charging speed, and safety. Fast charging and discharging are also necessary due to large currents released instantaneously during take-off and landing.

However, a solid-state battery is considered to be the battery for eVTOL aircraft in the future given their higher energy density and greater safety guarantee (non-flammable and less likely to leak, leading to lower risks of fire or overheating compared with lithium batteries).

- **Battery energy density**: An eVTOL consumes a large amount of energy and releases a large current instantaneously during take-off and landing. Comparatively, EVs have lower requirements for instantaneous high-power output during normal driving conditions such as acceleration and climbing. In general, the battery mass cannot be over one-third of the total mass of the aircraft. The larger energy density results in lighter battery and hence longer cruising time and more space for passengers.

- **Power density**: As an eVTOL requires a large amount of power for vertical take-off and landing, the power needed for vertical takeoff is usually 10-15 times more than that for a vehicle driving on the ground.

- **Charging speed**: Given eVTOLs' high requirement for power density, they need to have fast-charging abilities (i.e., 80% of the battery to be charged in 15 minutes).

- **Safety standards**: No battery failure is allowed when the eVTOL is flying and hence there is a strict requirement on the thermal management system and operation under extreme environmental conditions. For EVs, potential harm caused by accidents is lower compared with eVTOLs.

- **Cycle life**: The battery of eVTOLs has low usage frequency but a significant amount of consumption per flight. What's more, it is costly and complex to replace batteries and hence the cycle life should reach 1,000 times or more. For EVs, frequent cycle charging and discharging is more convenient as they travel longer every day. As such, EVs require cycle life of up to 10,000 times.

- **Shape and size**: The batteries in eVTOLs are often required to be irregular shapes due to compact internal aircraft space and aerodynamics, while the battery module of EVs is usually installed at the bottom of a vehicle or trunk which is more spacious.

Six end-applications on the eVTOL runway

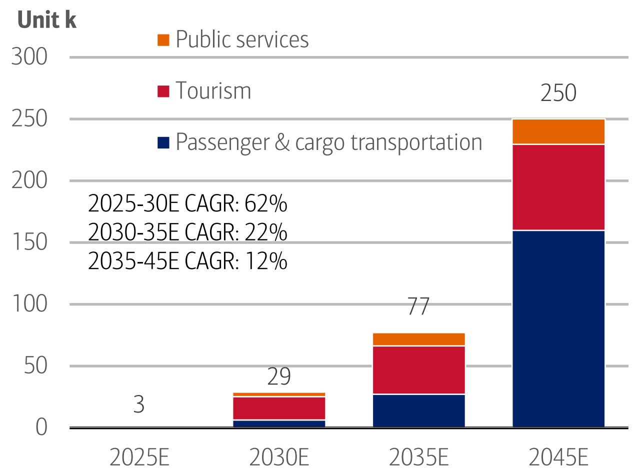
According to BofA Global Research, there are six end-applications for eVTOLs, namely public security, logistics distribution, medical and firefighting, tourism, urban commuting, and intercity/intracity transportation and the global eVTOL industry will experience three phases of development:

1) During 2025-30, global eVTOL manufacturers should gradually obtain the production certificates for their eVTOLs as well as operator certificates. In the meantime, governments that would like to promote the industry will need to procure eVTOLs to use in public service and tourism attraction sites, testing the safety and stability of eVTOLs in limited scenarios.

2) During 2030-35, governments and public services operators will likely still be the main buyers of eVTOLs, while demand in passenger and cargo transportation will pick up. Compared with other transportation tools (vehicles, trains, airliners, etc.), eVTOLs offer differentiated experiences – however, due to the high production and operation costs of eVTOLs, the scale of sales remains modest.

3) After 2035, with the economies of scale and tech advancement in battery and electric motors, BofA Global Research expects the production cost and operation cost of eVTOLs to be greatly reduced. As such, the competitiveness of the eVTOL market will likely be greatly enhanced and eVTOLs for passenger and cargo transportation will likely play a more important role in the transportation industry.

Exhibit 4: BofA Global Research expects 62% CAGR in 2025-30
Global civil eVTOL UIO growth in 2025-2045E



Source: BofA Global Research estimates

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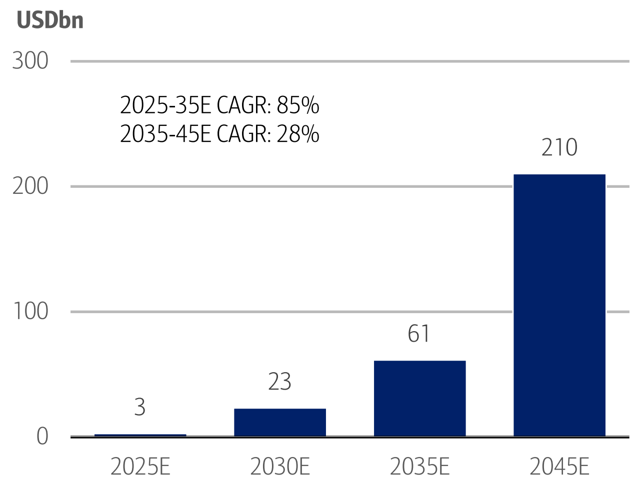
Exhibit 5: BofA Global Research expects 85% CAGR in 2025-35
Global UAM market size (USD billion) in 2025-45E



Source: BofA Global Research estimates

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With the above assumptions, the global civil eVTOL UIO (units in operation) will reach up to 77k/250k units by 2035/45E, according to BofA Global Research (Exhibit 4).

Additionally, urban air mobility (UAM) refers to a new type of air transportation network that uses manned or unmanned aircraft to transport passengers or cargo at low altitudes in urban and suburban areas. BofA Global Research estimates the global UAM market size will reach up to $23 billion (bn) in 2035 and will further grow to around $61bn/210bn by 2035/45, with compound annual growth rate (CAGR) of 85% over 2025-35 and 28% over 2035-45 (Exhibit 5).

What is the future of these flyers?

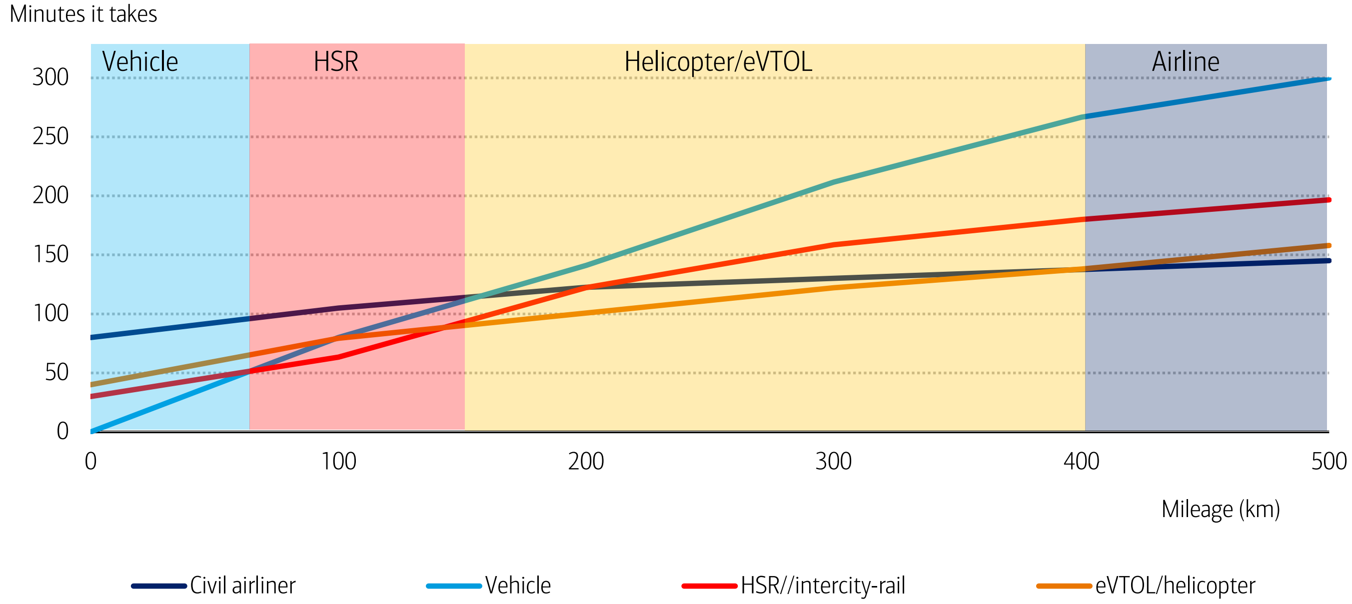
eVTOLs are considered a supplement to civil airliners and ground transportation tools such as vehicles, subways, trains and high-speed rails (HSRs), and a competitor to helicopters. In general, civil airliners cover most travel with distance of over 800 kilometers (km), HSRs 400-1,000km, and vehicles 5-200km.

Based on BofA Global Research analysis, helicopters/eVTOLs take the least travel time when the travel distances lie between 150km and 400km, compared with vehicles, HSRs, and civil airliners (Exhibit 6). For travel of 50-150km, eVTOLs have slightly more travel time than that of vehicles, rails, and subways, and charges higher fares, while they offer higher privacy and premium experience, according to BofA Global Research.

In conclusion, BofA Global Research expects eVTOLs will mainly serve as a supplement to passenger vehicles (PVs), subways/HSRs, and buses for 50-150km travel. Given industry averages, eVTOLs could take slightly more travel time than that of buses, PVs, and subways in this range of distance, and vehicles and subways may charge lower fares compared with eVTOLs.

However, eVTOLs offer better privacy and a premium experience to passengers. For travel of 150-400km, eVTOLs have similar travel times to a helicopter, and yet are safer, more environmentally friendly, create less noise, and bear lower production and operation costs.

Exhibit 6: Helicopters/eVTOLs take the least time when travel distance is around 150-400km
Travel time comparison among different transportation tools



Source: BofA Global Research estimates

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Disclosures