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EVTOL: БУДУЩЕЕ АВИАЦИОННЫХ ИННОВАЦИЙ — ПРОБЛЕМЫ И ПЕРСПЕКТИВЫ

Обакеми Чойс Нунанйон,
студент кафедры «Проектирование и сертификация авиационной техники», Московский авиационный институт, г. Москва

Белло Фархан Идрис,
студент кафедры «Проектирование и сертификация авиационной техники», Московский авиационный институт г. Москва

Кану Мелоди Чимела,
студент кафедры «Проектирование и сертификация авиационной техники», Московский авиационный институт г. Москва

Аннотация

Электрические летательные аппараты вертикального взлёта и посадки (eVTOL) обещают низкоэмиссионную «точка—точка» городскую мобильность, но сталкиваются с техническими, нормативными и социальными барьерами. В статье кратко рассмотрены ключевые концепции и сравнены разработки Joby Aviation, Wisk Aero и «Эколибри», а также проанализированы главные ограничения: энергетическая плотность аккумуляторов, реальная дальность, шум, автономность и инфраструктура вертипортов. Обсуждаются регуляторные подходы и вопросы общественного принятия; при целевом развитии технологий и стандартизации возможен ограниченный запуск eVTOL-услуг в течение следующего десятилетия.

Ключевые слова: eVTOL, городская воздушная мобильность, электрическая авиация, распределенная тяга, сертификация авиационной техники, авиационная инфраструктура, аккумуляторные технологии.

EVTOLS: THE FUTURE OF AVIATION INNOVATION — CHALLENGES AND PROSPECTS

Obakemi Choice Nunanyon,
student, Department of "Design and certification of aviation equipment", Moscow Aviation Institute, Moscow
e-mail: choiceobakemi@gmail.com
Bello Farhan Idris,
student, Department of "Design and certification of aviation equipment", Moscow Aviation Institute, Moscow
e-mail: farhanbello03@gmail.com

Kanu Melody Chiemela,
student, Department of "Design and certification of aviation equipment", Moscow Aviation Institute, Moscow
e-mail: kanumelodyhb@gmail.com

ABSTRACT

Electric Vertical Takeoff and Landing (eVTOL) aircraft promise low-emission, point-to-point urban mobility but face interconnected technical, regulatory and social barriers. This paper reviews core aircraft concepts and compares three developers — Joby Aviation, Wisk Aero and Ecolibri — then examines the main constraints: battery energy density and degradation, limited operational range, acoustic impacts, autonomy and vertiport/charging infrastructure. Regulatory frameworks (Federal Aviation Administration, European Union Aviation Safety Agency, and Rosaviatsia) and public acceptance are discussed; despite significant hurdles, targeted R&D and clear standards could enable limited eVTOL services within a decade.

Keywords: eVTOL; Urban Air Mobility (UAM); Advanced Air Mobility (AAM); electric propulsion; battery energy density; noise; certification; public acceptance.

1. Introduction

Electric vertical takeoff and landing (eVTOL) vehicles have rapidly emerged as a disruptive concept in aviation. Enabled by advances in electric propulsion, composite materials, and increasingly capable flight-control systems, eVTOL aircraft are widely discussed as a possible solution for short-range urban and regional mobility. At the same time, researchers and regulators note that public concerns about safety, noise and infrastructure remain central to adoption. [1][12]

In an era of increasing urban congestion and climate concerns, proponents argue that eVTOLs can provide "urban air mobility" (UAM) or "advanced air mobility" (AAM) – effectively treating urban airspace as a new transportation layer. The vision is that eVTOL air taxis will offer door-to-door transport at speeds much higher than cars, reducing commute times and traffic stress.

Interest in eVTOL has been fueled by substantial investments and partnerships. Investors poured billions into the sector during the 2020-2021 boom, while major industrial partners such as Uber, Boeing and Toyota helped validate the market narrative and accelerate development programs. [2][3][4]

2. Leading eVTOL Developments: Case Studies

Three prominent eVTOL developers were examined, highlighting their aircraft concepts, business status, and development progress. Two of which are US-founded global players (Joby, Wisk) and one a Russian startup (Эколибри/Ecolibri).

2.1 eVTOL Technology and Design Concepts

eVTOL aircraft exploit electric propulsion to achieve vertical takeoff/landing and horizontal flight. Unlike conventional airplanes, they need not use long runways, making them suitable for urban environments [1]. They also promise lower direct emissions and reduced local noise compared with helicopters, although those benefits depend heavily on configuration and operating conditions.

- Quadrotor (Multirotor) – Several vertical rotors fixed to the airframe with no wing providing lift and control solely by varying rotor speeds (e.g., Joby Aviation's prototype is a large tilting-rotor multirotor).
- Lift-plus-Cruise – Separate rotors for vertical lift and dedicated propellers for forward cruise.
- Tiltrotor/Tiltwing – Rotors (or the wing) pivot between vertical and horizontal orientation, similar to the military V-22 Osprey.
- Hybrid - Some eVTOL proposals incorporate combustion engines or hybrid-electric power. For example, the Russian Ecolibri concept has been described in trade sources as a hybrid-electric design intended to extend range beyond that of purely battery-powered competitors. [5]

In practice, many companies have adopted multirotor or tiltrotor approaches for small passenger models.

2.2 Background and Funding:

Joby Aviation (founded 2009) is one of the longest-standing eVTOL developers and has secured major strategic investors - notably Toyota, alongside earlier support linked to Uber. Wisk, by contrast, developed with strong Boeing backing. Russian activity around Ecolibri remains much earlier-stage and is described mainly in specialist trade reporting. [3][4][5][6]

2.3 Aircraft Concept:

Joby's aircraft is a piloted, winged tilt-rotor eVTOL carrying one pilot and four passengers; it uses six tilting electric rotors for vertical lift and wing-borne cruise, claims ~200 mph (≈322 km/h) cruise and up to ~150 miles (≈240 km) range on a single charge, and has reported very low measured noise levels in FAA tests. The vehicle relies on lithium-ion batteries and is designed for daily operations with relatively short ground turnaround.

Figure 1 — eVTOL aircraft developed by Joby Aviation.
Source: Joby Aviation media kit, https://www.jobyaviation.com/news (accessed: 15.03.2026).
Courtesy of Joby Aviation. (c) Joby Aero, Inc.

Wisk's Model-6 (Cora) is a 5-seat, fully autonomous tilt-rotor design with 12 distributed rotors and no cockpit; it targets ~120 kts (≈222 km/h) cruise and ~90 miles (≈145 km) range, prioritizing autonomy and sense-and-avoid systems over piloted operations.

Figure 2 — Wisk Aero Gen 6 aircraft.
Source: Wisk Aero media kit, https://brandfolder.com/wiskaero/media-kit-2025 (accessed: 15.03.2026).

Ecolibri is presented in trade coverage as a hybrid-electric VTOL concept with a tilt-wing / tilt-rotor style layout and distributed propulsion. Unlike pure-electric peers, it is promoted on the basis of longer projected range through the use of a hybrid powertrain; however, publicly available technical detail remains limited compared with Joby and Wisk. [5]

Figure 3 — Ecolibri eVTOL aircraft.
Source: Ecolibri official website, https://эколибри.рф/evtol (accessed: 15.03.2026).

2.4 Certification Progress:

Joby has led the U.S. certification push: company filings describe continued progress with the FAA certification pathway, while the broader U.S. regulatory environment has also advanced through powered-lift rulemaking. [6][8]

Wisk is pursuing an autonomy-first certification path. Its Generation 6 prototype completed a first autonomous flight in 2025, and the company continues to position the aircraft for FAA certification as an autonomous passenger-carrying platform. [4][7]

In Russia, regulatory activity remains nascent. Trade reporting on Ecolibri indicates early prototype and development work, while Russian aviation authorities have only recently begun issuing eVTOL-related airworthiness approvals in adjacent VTOL categories. [5][9]

2.5 Partnerships:

Joby has secured strategic industrial and commercial partners to de-risk manufacturing and market entry - notably Toyota for production support and Uber through the earlier Elevate transaction and partnership structure. [3][6]

Wisk benefits from Boeing's engineering, certification and scale capabilities after Boeing's major investment and program consolidation, while also using its Generation 6 program to demonstrate market readiness. [4][7]

Ecolibri's partnerships appear primarily domestic and developmental in character, with publicly available information still limited compared with Western eVTOL programs. [5]

2.6 Current Status:

Joby is in advanced flight testing and production planning as it proceeds through certification and scales toward initial commercial operations; company filings describe continued testing activity and manufacturing preparation. [6][8]

Wisk has accumulated extensive prototype flight experience across multiple generations and has now demonstrated a Generation 6 autonomous flight. The company remains focused on autonomy validation, airspace integration and certification preparation. [4][7]

Ecolibri remains at the conceptual / prototyping stage in publicly available reporting and appears earlier in the development cycle than leading U.S. competitors. [5]

Table 1. Summary of key eVTOL developer characteristics (sources as cited).

Company	Country	Aircraft Type	Seats	Range (km)	Speed (km/h)	Certification Status	Key Partners
Joby	USA	6-rotor tilt-rotor winged quadcopter	5 (1+4)	~240	322 (200 mph)	FAA certification in progress [8]	Toyota, Uber, Delta, ANA, RTA Dubai
Wisk	USA/NZ	12-rotor fixed-tilt multicopter	5	~145	222 (120 kts)	Autonomous flight tested; certification path in development [7]	Boeing, Kitty Hawk, Groome Trans.
Ecolibri	Russia	5-rotor hybrid-electric tilt-wing	4–5	up to ~1200	~270	Conceptual stage; prototyping [5]	Rostec

3. Challenges

3.1 Technical Challenges

The eVTOL concept faces several formidable technical hurdles. Analysis on the most critical ones were carried out including: energy storage (batteries), practical flight range, acoustic noise, autonomy level, and supporting infrastructure.

a. Battery Energy Density and Degradation

Battery energy density is the central constraint for eVTOLs: today's lithium-ion cells deliver far less usable specific energy than liquid aviation fuels, and even optimistic next-generation chemistries still leave tight mass and thermal-management limits for VTOL missions. [1]

Because batteries are heavy, VTOL designs face a weight-range vicious circle: hover sizing increases cruise dead weight, so adding range demands more battery mass, which further increases required lift. This is one reason why commercially promoted ranges for leading aircraft remain modest rather than helicopter-like across all missions. [1][3][4]

High C-rate daily cycling accelerates capacity fade, and end-of-life performance margins force designers to oversize packs, reducing useful payload and range. [1]

Thermal runaway and cell safety demand robust battery-management systems, shielding and suppression measures, which add weight and certification complexity. [1]

Mitigation strategies include hybrid / range-extender architectures, rapid-charging or swappable packs for high-utilization fleets, and careful mission design; each option eases one constraint while introducing cost, infrastructure or complexity trade-offs. [1][5]

In short, battery energy density - and its lifecycle and safety realities - remains the single greatest technical bottleneck for eVTOL commercialization. [1]

b. Flight Range and Mission Profiles

Practical eVTOL range is constrained by battery energy density, so most designs target short urban or short-intercity missions rather than long-haul transport. Corporate disclosures for Joby and Wisk align with that pattern, and the broader battery literature explains why. [1][3][4]

c. Acoustic Noise

Urban noise is a key constraint for eVTOL adoption. Even where developers expect clear improvements relative to helicopters, public-acceptance studies consistently show that noise remains one of the most important concerns for future urban air-mobility operations. [12]

d. Autonomy and Human Factors

Most current eVTOLs combine high automation with a human pilot onboard (Joby's approach), while a few - notably Wisk - pursue fully pilotless operations. Full autonomy for passenger service is not yet certified and raises major questions about human factors, supervision, safety assurance and public trust. [6][7][10]

Networked ground control and fleet-management systems are essential for routing, separation and dispatch, but they require highly reliable communications, redundancy and cybersecurity. Regulators are still formalizing how powered-lift and autonomous capabilities should be certified and integrated into the wider airspace system. [8][9][11]

Trust depends on demonstrable safety and transparency: staged demonstrations, visible redundancy and credible regulatory oversight are critical to public acceptance and certification progress. [7][8][10]

e. Infrastructure (Vertiports, Charging, Airspace Integration)

eVTOL operations require dedicated vertiports in urban areas (rooftops, parking structures or adapted helipads) with safe approach paths, passenger handling space and energy infrastructure; suitable locations are limited, and local planning constraints may slow deployment. [12]

3.2. Business and Financing Challenges

Capital: eVTOL development requires extremely high upfront investment - certification, testing and manufacturing infrastructure can each cost hundreds of millions of dollars. Leading developers such as Joby and Wisk have depended on large industrial partnerships and funding rounds to sustain progress. [2][3][4]

Market and valuations: Many eVTOL firms went public through SPAC mergers during the sector's financing boom, but investor enthusiasm cooled as timelines lengthened and commercialization risks became clearer. [2]

Revenue risk: The commercial model assumes strong demand for premium urban flights (often estimated around $200–$250 per trip on routes like airport transfers), yet true operating costs per seat-mile remain uncertain until fleets operate at scale. Profitability likely depends on high daily aircraft utilization, which also increases infrastructure and maintenance demands.

Partnerships: Strategic alliances help reduce risk - Toyota supports Joby's manufacturing development, while Boeing provides engineering and regulatory depth to Wisk; these partnerships also signal credibility to markets and regulators. [3][4][6]

Macro and competition: Broader economic conditions influence investment; since 2022, tighter capital markets have made it harder for speculative aerospace ventures to raise funding on favorable terms. [2]

Bottom line: long-term demand projections may be large, but companies must first survive the costly certification phase and prove viable operations before optimistic market scenarios become meaningful. [2]

3.3. Certification Barriers

Certification of eVTOL aircraft introduces new regulatory challenges because these vehicles combine characteristics of airplanes, helicopters and autonomous systems.

a. FAA (USA)

The FAA has created a regulatory path for eVTOLs through new powered-lift rules and pilot training standards (SFAR 117), allowing commercial operations once aircraft are certified. Guidance such as AC 21.17-4 further clarifies the certification basis for powered-lift aircraft. [8]

b. EASA (Europe)

EASA established the SC-VTOL framework, introducing additional airworthiness requirements for VTOL aircraft beyond conventional airplane or helicopter standards. The agency continues refining compliance expectations to address electric propulsion, fly-by-wire systems and distributed lift concepts. [11]

c. Rosaviatsia (Russia)

Russia has only recently begun defining VTOL certification rules; in 2024 Rosaviatsia issued its first eVTOL-related airworthiness certificate for the autonomous OG-003 UAV, indicating an emerging regulatory pathway for related aircraft categories. [9]

d. Autonomy and Classification Issues

A major unresolved issue is how to certify autonomous or pilot-optional eVTOLs and how to classify powered-lift aircraft internationally. Until standards for autonomy, redundancy and international regulatory harmonization are finalized, certification timelines remain uncertain.

3.4. Public Acceptance and Social Readiness

Beyond technology and regulation, societal acceptance will influence eVTOL deployment, particularly regarding noise, safety perception and trust in automation.

a. Noise and Environmental Impact

Surveys show noise and safety are among the most cited public concerns about urban air mobility. A major EASA study of societal acceptance in Europe found that citizens' willingness to use UAM depends strongly on trust, perceived usefulness, affordability and environmental / community impacts. [12]

b. Risk Perception and Trust

Safety perception remains the main barrier in many public-acceptance studies. Gradual automation, visible testing milestones and credible certification progress are therefore important not only technically but also socially. [10][7]

c. Regulatory Studies (EASA, NASA)

Studies from EASA and related regulatory work emphasize community engagement, transparent safety data, and careful vertiport planning to improve public acceptance. Noise management and operating procedures will likely be as important as aircraft technology itself. [12][11]

Overall, widespread adoption will depend not only on technical performance but also on demonstrated safety, controlled noise, and clear communication with the public.

4. Conclusion

Electric vertical takeoff and landing aircraft hold promise to transform aviation by enabling new urban and regional air mobility services. The technology is advancing rapidly, as evidenced by the strides of companies like Joby, Wisk, and Ecolibri. Major milestones—autonomous flight tests, partnerships with industry giants, and nascent certification efforts—are positive signs that eVTOLs could become operational within this decade.

However, as this review has shown, the path to routine eVTOL flight is laden with challenges. Battery energy density and safety impose hard limits on range and payload. Acoustic noise and urban acceptance require rigorous mitigation strategies. The certification landscape, while finally taking shape, still poses complex questions, especially for autonomy. Financially, developers face the classic "Valley of Death" where massive capital is needed before any revenue, and investors are wary.

The eVTOL future likely depends on incremental progress. Early services may be limited (e.g. short premium routes, cargo/UAM niches) while technologies mature. Government support—through grants, infrastructure funding, and sensible regulation—can help bridge gaps. Internationally, harmonizing standards will ease market entry; in Russia, aligning with global norms could open export opportunities for Ecolibri or others.

From a passenger perspective, the prospect of low-noise, zero-emission air taxis is exciting. Yet as with any radical innovation, realism is crucial. Academically, the industry would benefit from more open research on human factors, battery tech, and operations to inform all stakeholders. Collaboration between regulators (FAA, EASA, Rosaviatsia), NASA/EASA studies, and industry consortia will be key.

In conclusion, eVTOLs represent both a technical marvel and a systems challenge. Their success will hinge not just on the aircraft, but on integrated solutions spanning batteries, skies, cities, and minds. With deliberate effort addressing the issues detailed here, the vision of aerial ridesharing in cities—once science fiction—could become a sustainable reality in the not-too-distant future.

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