On-Demand Electric VTOL

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Uber’s Perspective: Market Accelerator

Fast forwarding to a future of on-demand urban air transportation

“Rather than manufacture VTOL hardware ourselves, we instead look to collaborate with vehicle developers, regulators, city and national governments, and other community stakeholders, while bringing to the table a very fertile market of excited consumers and a clear vehicle and operations use case.”

Uber Elevate White Paper

“The vision portrayed above is ambitious, but we believe it is achievable in the coming decade if all the key actors in the VTOL ecosystem—regulators, vehicle designers, communities, cities, and network operators—collaborate effectively.”
Barriers and Enabling Technologies

Regulatory
FAA Certification
Airspace

Technology
Battery Energy Storage/ Rapid Chargers

Community Acceptance
Noise
Safety
Emissions

Market
Efficiency -> Low Energy Use/Cost
Maintenance -> Elimination of Cyclic
Reliability -> Utilization
Performance -> Productivity
= Affordability

Operations
Infrastructure
Pilot Training
Weather
Barriers and Enabling Technologies

Aerodynamic Efficiency (L/D)

Ease of Use (training time/cost)

Propulsive Efficiency

Safety (auto-like, 1.5 vs 7.5 accidents/100M miles)

Energy Used (mpg/pax)

Ride Quality NVH

Normalized Energy Cost ($/lb/mile)

Noise (dBA)

Current

Technology Enabled

<5

<30%

<15

>85

<60

<25%

100%
Community Noise Differences

No advancing-retreating blade issues at cruise, so these aircraft can use very low propeller tip speeds.

~400 ft/sec vs ~800 ft/sec (helicopters)

Noise varies (tip speed)\(^5\)

Potential to achieve ~70 dB noise certification levels, or ~15 dB lower than existing helicopters

Opportunity to map into background noise levels of portions of urban areas.
Affordability Differences

Energy Cost Reduction Basis

Aerodynamic Efficiency
Lift/Drag increases from 4.5 to 14 (3.1x improvement)

Propulsion Efficiency
increases from 28% to 92% (3.3x improvement)

Energy cost decreases from ~$5.00 per gallon to ~$2.65 electricity-based equivalency (1.9x improvement)

Energy Use: 10.2x lower

Energy Cost: 19.4x lower

Electricity-based energy and reduced maintenance yields ~70% lower total operating cost at 150 to 200 mph speeds with 2080 hrs/year utilization (with ~10x less energy use).
Basis for Improvement from Current Helicopter Safety Rates

- Highest contribution of accidents is pilot error (~70%)
- Stabilization, autonomy pilot-aids, and digital fly-by-wire systems are technologies that are coming up from below (unmanned to manned aircraft)
- Next highest contribution is propulsion system failure (~15%), these new electric VTOL aircraft have propulsion system redundancy (no single part failure issues)
- Complex gearboxes and multi-engine inefficiency/high cost are avoided through the Distributed Electric Propulsion (DEP) technologies
- DEP eliminates Dead-man’s curve (not just reduced as in multi-engine heli’s)
- Ballistic Recovery System (BRS) is possible with DEP fixed wing concepts as a back-up solution which isn’t possible with rotorcraft
Infrastructure Differences

Additional Requirements:
- Min: 45 deg. crosswind
- 500 ft. private ground clearance
Sunnyvale, CA
Hwy 237 & Lawrence Expy
Courtesy of Google Maps

Approach 15
Approach 07
Approach 23
Hover Area
Approach 33

8:1 Surface Limit
Opportunities for Engagement

- AHS/AIAA: Transformative Vertical Flight Workshops (3rd annual in June/Denver)
- NASA: Flight demonstrators (X-57), System Studies (MIT VTOL Airspace Study)
- GAMA: EPIC (Electric Propulsion and Innovation) Sub-Committee
- Uber: Elevate Ecosystem Summit (Dallas-Fort Worth, late April)