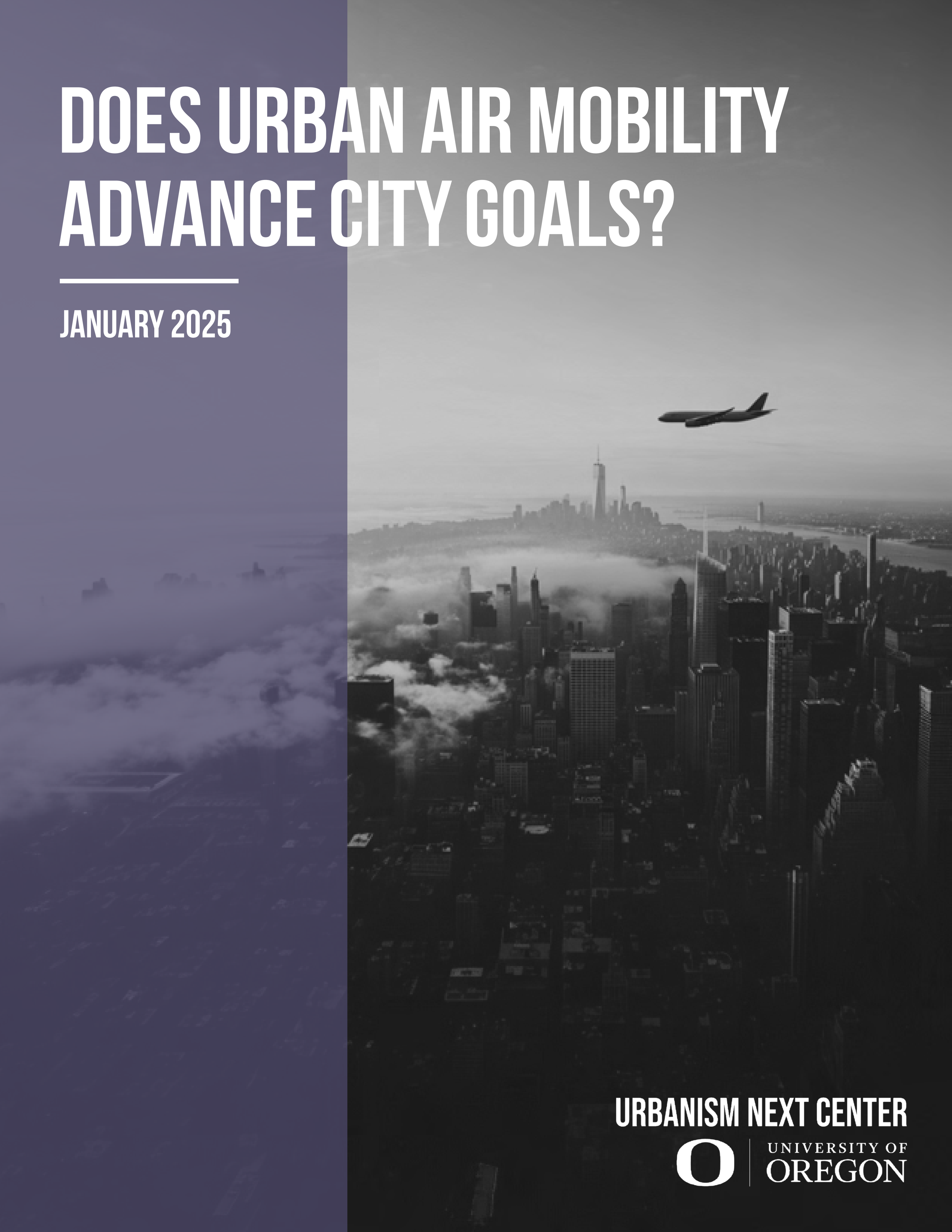
DOES URBAN AIR MOBILITY ADVANCE CITY GOALS?

JANUARY 2025



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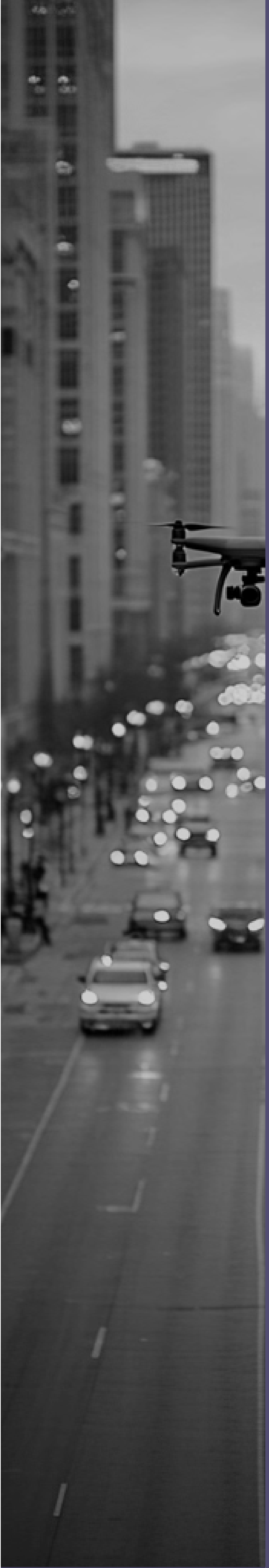

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URBANISM NEXT CENTER

The Urbanism Next Center at the University of Oregon conducts research and convenes partners from around the world to understand the impacts of new mobility, e-commerce, urban delivery, and autonomous vehicles on the built environment. Going beyond these emerging technologies, we explore the possible implications on equity, health, safety, the economy, and the environment to inform decision-making that supports community goals. Urbanism Next brings together experts from a wide range of disciplines including planning, design, development, business, and law and works with the public, private, and academic sectors to help create positive outcomes from the impending changes and challenges confronting our cities.

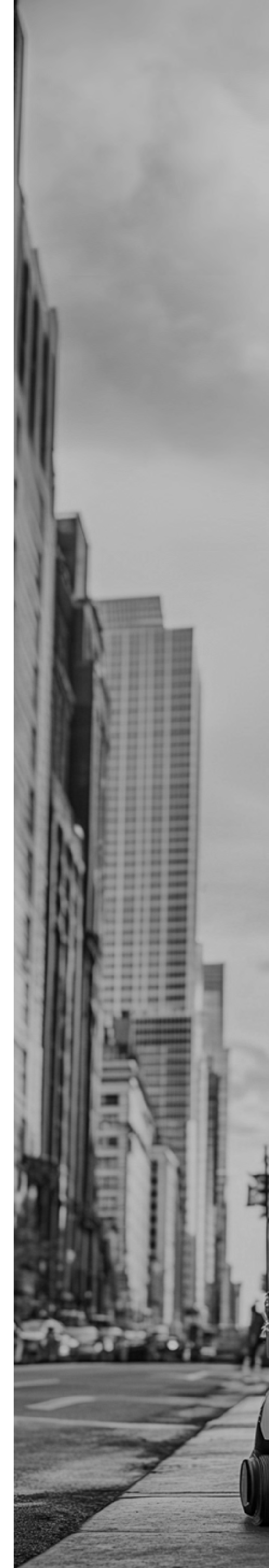

TABLE OF CONTENTS

INTRODUCTION

Urban Air Mobility (UAM) includes an emerging suite of highly or fully automated passenger or cargo air transportation services using vehicles that take-off and land vertically (eVTOL); it goes by several monikers including Advanced Air Mobility (AAM) and Unpiloted Aircraft Systems (UAS)[1] and currently represent a $5b industry globally (Summers, 2023). While many reports are bullish on the industry's projected growth, predicted market sizes range enormously from $2.5 to $641 billion by 2035 (Booz Allen Hamilton, 2018; Cohen et al., 2021; Summers, 2023). Varied market size predictions reflect divergent scenarios and assumptions, including UAM geographic spread, timelines, and prediction methodologies. Others note that current UAM operations only represent about 0.5% of its full market potential due to constraints including infrastructure, regulatory, public perception, and certification (Booz Allen Hamilton, 2018).

While helicopters have enabled air travel in urban settings for decades, they have proven too loud, expensive, and dangerous for everyday travel at scale (Silva, 2023). Companies herald quieter electric-powered motors and reduced costs via automation enabling UAM to "democratize flight by offering affordable and environmentally sustainable transportation" (Ravich et al., 2023, p. 3). Yet cities and policymakers are approaching these new technologies with caution; aware that "if unregulated and unplanned for, UAM could simply become a luxury flying taxi service" (Gomez, 2021). While some cities seek to be early adopters of the new services, others approach UAM as "no way in heck are we going to pursue this" or "maybe down the road, but not now" (Zukowski, 2024).

Local officials and planners should leverage emerging technologies to minimize failed deployments, maximize public benefits (Gomez, 2021), and focus energies on achieving broad goals. UAM offers a futuristic vision of travel. But is it the best tool for cities seeking to achieve broad goals like reducing emissions, mitigating traffic congestion, increasing accessibility, and delivering equitable travel options? Or could it reflect either excitement over new possibilities or the political challenges that have stymied current—and proven—tools like dedicated transit lanes, higher costs of parking, and congestion pricing in a quagmire of litigation, public backlash, and politics?

This report first overviews the current state of UAM services in the United States. It then reviews anticipated timelines for UAM operations and use cases including geographic deployment, anticipated scale, price, and required infrastructure. Next, we consider the goals that UAM seeks to advance and how feasible meeting these goals may be, given the anticipated scope and scale of UAM in the coming decades. We conclude with a discussion of the role of local, state, and federal government in navigating UAM services, and the role of UAM as one tool among many for policymakers seeking to achieve concrete objectives.

1 AAM and UAM are sometimes used interchangeably. UAM was coined first and is used by the Federal Aviation Administration (FAA) (Federal Aviation Administration, 2023c), which will regulate UAM services federally; some prefer AAM, however, as it suggests a range of applications beyond urban settings. While most writings to date include both cargo and passenger transport under the UAM umbrella, some agencies prefer to distinguish passenger travel as UAM and air cargo delivery as UAS (LADOT, 2021).

CURRENT STATE

CURRENT STATE OF UAM SERVICES IN THE US

UAM testing and regulatory approvals are currently being overseen by the FAA, which has partnered with NASA to research and test the new technologies to maximize safety and efficiencies (Harper et al., 2022). Federal regulators are also working to create a new operating framework, an Uncrewed Traffic Management (UTM) system, to relieve anticipated strain UAM would place on the existing centralized air traffic control structure. The UTM system would engage local jurisdictions as active participants, who would provide data and information sharing to communicate to operators.

UAM services in the US are currently in nascent forms, with cargo delivery systems arguably more advanced, albeit still quite limited, relative to passenger services. Small, planned demonstrations and pilot cargo programs have been conducted by a number of companies in the US including Amazon, DHL, Flytrex, Uber Eats, Firtey, and Wing (Cohen et al., 2021). Passenger UAM, by contrast, have yet to be launched in pilot demonstrations, although operator projections say they could begin as early as the end of 2025 (Archer, 2024).

While both cargo and passenger services are expected to share similarities in their launch process—such as needing FAA approvals and scaling following small-scale operations to refine operations and business cases (Harper et al., 2022)—the current state of cargo versus passenger UAM in the US is quite distinct. In the following subsections, we first review the state of cargo UAM services followed by passenger.

Cargo UAM in the US

From 2017 through 2020, the FAA's Unmanned Aircraft Systems (UAS) Integration Pilot Program (IPP) testing and evaluated the integration of civil and public drone operations operating in national airspace systems (Federal Aviation Administration, 2023b). After the IPP program concluded in 2020, FAA launched BEYOND, which focuses on continued challenges of cargo UAM delivery, including beyond visual line of sight (BVLOS) operations, community engagement, and societal and economic benefits of UAS operations (Federal Aviation Administration, 2023b). BEYOND is slated to run from October 2020 through 2024 with eight lead participants, listed along with primary activities to date in Table 1 (Federal Aviation Administration, 2023a). These programs represent a mixture of surveillance and inspection activities, as well as cargo delivery most commonly discussed within UAM. Long-range drone delivery requires visual observers stationed on the ground to monitor airspace along the route; exceptions include companies who receive FAA Beyond Visual Line of Sight (BVLOS) waivers to allow drones to be flown beyond a pilot's line of sight.

Table 1. FAA BEYOND Participants

Participant	Primary Activities
Choctaw Nation of Oklahoma	Received BVLOS waiver in 2023; has conducted BVLOS flights up to 28 miles and have plans to expand operational corridor. Use case is for medical package delivery moving test samples between Nation's clinics
Kansas Department of Transportation	BVLOS waivers in 2022 and 2023 select conditions including Class G (uncontrolled) airspace lower than 300 ft for utility inspection along transmission line easements
Memphis-Shelby County Airport Authority, Tennessee	Partnered with FedEx to receive BVLOS waiver beginning in 2022; between 2022 and 2023, FedEx has increased capabilities and as of August 2023 had permissions to fly across the entire airport without visual observers. Goals include airport surveillance and payload delivery.
Mid-Atlantic Aviation Partnership (MAAP), Virginia	In partnership with Virginia Tech, first drones to with the FAA's 2021 rule on operations over people (2022). Dominion Energy received BVLOS waiver to conduct full-remote fixed site inspections in 2023, to perform critical infrastructure inspections at facilities in six states.
North Carolina Department of Transportation	Zipline, NCDOT partner, received its part 135 certification in June 2022 authorizing it to complete the longest-range on-demand commercial drone deliveries in the U.S. In July 2023, NCDOT was issued a statewide BVLOS waiver, used for construction sites with the Skydio X2 platform in class G (uncontrolled) airspace.
North Dakota Department of Transportation	Along with industry partners, is testing statewide networks that supports UAS operations beyond visual line of sight. In 2023, North Dakota received an FAA (44803(c)) waiver on to enable flight testing in furtherance of UAS certification and integration into the National Airspace. Also in 2023, received BVLOS approval enabling operations up to 9,000' MSL with the Meteomatics Meteodrone. Weather data collected will yield more accurate and precise forecasts and a better understanding of current weather conditions
The City of Reno, Nevada	Has three BVLOS waivers to support test operations in areas surrounding Reno; anticipated use cases include search and rescue, first responder, patrolling pipeline, and infrastructure inspections.
University of Alaska Fairbanks (UAF)	In February 2023, Alaska received FAA approval (44083C waiver) for civil operations within a test area to prove drone safety for certification in the national airspace system.

Source: Federal Aviation Administration (2023a)

A number of cargo demonstration programs have received FAA exemptions including approvals for beyond visual line-of-sight operations and the ability to operate small, unmanned aircraft systems (drone airlines) (Cohen et al., 2021). The FAA authorized four types of certifications to delivery drone operations:

- "A part 135 Single-Pilot operator is a certificate holder that is limited to using only one pilot for all part 135 operations.
- A Single Pilot in Command certificate is a limited part 135 certificate. It includes one pilot in command certificate holder and three second pilots in command. There are also limitations on the size of the aircraft and the scope of the operations.
- A Basic operator certificate is limited in the size and scope of their operations: A maximum of five pilots, including second in command, and a maximum of five aircraft can be used in their operation.
- A Standard operator holds a certificate with no limits on the size or scope of operations. However, the operator must be granted authorization for each type of operation they want to conduct." (Federal Aviation Administration, 2023b)[2]

Table 2. US Drone Delivery Companies, 2023

Company	FAA Part 135 Certification	Operating Timeline, Scale, and Area
Zipline	Part	June 2022; authorized to operate as an air carrier and conduct common carriage operations; first fixed-wing part 135 UAS operator to be certified.
Prime Air	Standard	First company to operate a drone larger than 55lbs; Amazon began commercial operations in August 2020. Delivers cargo and prescriptions in College Station, TX and Lockeford, CA with planned expansions by the end of 2024.
US Flight Forward	Standard	September 2019, completed first package delivery when it flew medical supplies at WakeMed hospital campus in Raleigh, NC.
Wing	Standard	A subsidiary of Alphabet, Wing was the first company to receive FAA approval in April 2019. Delivers food and pharmaceuticals to homes in Christiansburg, VA
Causey Aviation Unmanned	Standard	Granted certification by FAA in January 2023 to operate and complete long-range on-demand commercial drone deliveries in the U.S.

Source: Federal Aviation Administration (2023b), Streitfeld (2023)

[2] FAA provides Part 135 certification to companies to approve package delivery by drone (Federal Aviation Administration, 2023b).

Drone package deliveries across permitted companies operate in a number of test cities or facilities. A number deliver medical supplies or prescriptions (see Table 2). For example, the Cleveland Clinic announced it will partner with Zipline to delivery certain medications to patients' home starting in 2025; to operationalize this plan, the Clinic will add drone docking and loading stations to several facilities in northeastern Ohio. Technicians will load the drones, which will deploy autonomously, fly 300 feet above the ground, and drop off packages at patients' homes using a delivery droid attached to a tether that enables precise delivery locations (Cleveland Clinic, 2023; Daleo, 2023). But not all technological hurdles have been cleared with cargo-delivering drones. Critics of Amazon's drone delivery services in College Station, TX and Lockeford, CA say that the "the venture as it currently exists is so underwhelming… drone delivery does not approach the scale or simplicity of Amazon's original promotional videos." Instead, customers experience a "gap between dazzling claims and mundane reality" including technological mishaps and limitations. Drones are limited in how much they can carry and how far—up to 5lbs for Amazon drones and 8lb for Zipline (Daleo, 2023; Streitfeld, 2023). Amazon drones are limited to delivering one item at a time, items cannot be breakable as drones sometime drop items from 12ft, cannot fly when it's too hot, windy, or rainy; drop-offs can also be stymied by mundane obstacles on target drop-off locations, like cars parked in the driveway or trees in the backyard (Streitfeld, 2023).

While cargo delivery represents the most advanced branch of UAM services, the remainder of this report focuses largely on passenger UAM and its implications for achieving city goals.

Passenger UAM in the US

Current UAM operations are limited to on-demand helicopter rides (e.g., BLADE, Voom) in select US markets including New York City and the San Francisco Bay Area. In sum, nearly 300 aircraft concepts are under development by both established manufacturers including Airbus, Bell, and Embraer, as well as new market entrants including as Archer, Ehang, EVE, Joby, Lilium, Vertical Aerospace, and Wisk (Cohen & Shaheen, 2024). Just four currently plan to launch on-demand UAM services in the next decade in various countries worldwide: Lilium, EHang, Vertical Aerospace, and Lilium. Additional auto manufacturers have also announced investments in UAM technologies including Aston Martin, Audi, Daimler, Geely, General Motors, Hyundai, Porsche, Stellantis, and Toyota (Cohen & Shaheen, 2024).

While some eVTOL vehicles have been approved and are being manufactured as of 2023, no commercial tests or operations have yet begun in the US. Industry and researchers anticipate UAM services to be rolled out in phased operations, akin to stages of technological development and adoption of autonomous vehicles (see for example Bansal & Kockelman (2017)). Current passenger use cases remain limited to replacing existing helicopter passenger services with eVTOL flights to reduce pollution between JFK Airport and Manhattan in New York, proposed services in Orlando between the airport and conference center (author communication with city staff, June 2024). Operators project launching additional operations in the San Francisco Bay Area by the end of 2025 (Archer, 2024).

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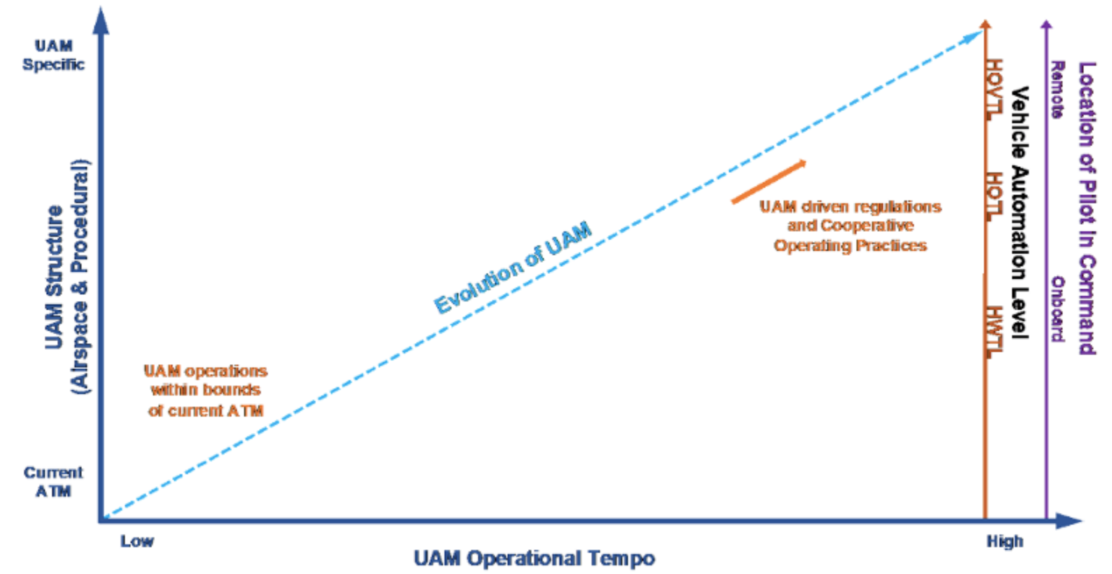
LOOKING AHEAD: POTENTIAL UAM DEPLOYMENT SCENARIOS

Due to stringent manufacturing certification and regulatory process, plus the need to develop new logistical operations to oversee widescale UAM operations, researchers do not forecast UAM services to crop up overnight in cities as previous technology-enabled modes like e-scooters did in 2017 (Harper et al., 2022). Instead, current expectations are for a phased introduction of UAM operations over time. Estimates currently expect the launch of commercialized UAM passenger services between 2025 and 2026 (Harper et al., 2022), with scaled operations and profitability arriving in the late 2020s and early 2030s (Cohen et al., 2021).

Figure 1 shows the FAA's anticipated evolution of UAM systems over time, with a gradual increase in UAM operational tempo (the density, frequency, and complexity of operations), automation with less direct human control over time, and movement from current air traffic monitoring systems to ones specific to UAM.

Figure 1. FAA Anticipated Evolution of UAM, 2023.



Source: Federal Aviation Administration (2023c)

Note: Human-Within-the-Loop (HWTL), human is always in direct control of the systems; Human-on-the-Loop (HOTL), human has supervisory control of the systems; Human-Over-the-Loop (HOVTL), human passively monitors the systems and is informed by automation if, and what, action is required

Phased deployment will require overcoming a range of technological and regulatory hurdles. While scenarios described to date describe differing numbers of phases or stages, most agree that immediate, midterm, and long-range predicted operations and challenges exist.

Initial UAM Operations

Initial UAM passenger operations are expected to use eVTOL aircraft in limited capacities within existing regulatory frameworks, local rules and agreements, and air traffic control systems. Aircraft will be crewed, fixed-wing, and have low-levels of automation limited to existing helicopter technologies such as autopilot and auto-landing. The aircraft pilot will be onboard (i.e., not operated remotely) (World Economic Forum, 2020). Operations will be limited to corridor-based travel, likely along existing helicopter routes; FAA-published helicopter routes currently exist for eight US metropolitan areas (LADOT, 2021). Initial operations are anticipated to be scheduled rather than on-demand (Cohen et al., 2021). Ravich et al. (2023) raise a number of immediate challenges including:

1. TECHNICAL FEASIBILITY

eVTOL vehicles are still in development and will need to undergo performance, safety, and reliability tests and approvals prior to launch.

2. SAFETY REGULATIONS

Safety standards and regulations for low-altitude air spaces must be established by regulatory bodies like the FAA; this will entail either creating new rules or adapting existing ones to low-level operations.

3. PUBLIC ACCEPTANCE

Current skepticism from the public around safety, noise, and privacy issues. Yedavalli & Mooberry find (2019) that safety issues are a dominant concern among the American public, with just 42% currently believing that UAM is either safe or very safe. Initial introduction of UAM on routes, rather than ad hoc, may help to increase public acceptance (SXSW, 2023).

Midterm UAM Operations

In the intermediate term, UAM may then evolve from corridor to hub-and-spoke systems between dense commercial areas and lower-density residential areas (Cohen et al., 2021). The frequency of UAM travel will increase and cooperative operating practices (COPs) will be developed; COPs will be FAA-approved and address how operators will collectively manage operations within a UAM corridor including conflict management and airspace use. New technologies and capabilities will be needed to support data-sharing between regulators and operators to manage a more complex systems. While some expect the operational tempo—the number of flights—to remain low overall, increases over initial stage operations may necessitate changes to existing regulatory frameworks and procedures. Aircraft will continue to evolve, although pilots will remain on-board with the introduction of complementary, but still limited, remote pilot operations (World Economic Forum, 2020).

Intermediate challenges include:

1. INFRASTRUCTURE DEVELOPMENT

Infrastructure development including UAM landing platforms and stations—commonly termed as "vertiports"—charging stations, and air traffic control infrastructure to support low-altitude operations. Such infrastructure would require substantial investment.

2. NEW MANAGEMENT SYSTEMS

New air traffic management systems will be needed to accommodate increased aircraft in the sky and ensure safety.

3. WORKFORCE DEVELOPMENT

Workforce development around operations, vehicle design, engineering, maintenance, and air traffic control will be needed to support more widespread operations (Ravich et al., 2023).

Long-term UAM Operations

Mature UAM services will represent high-frequency service, although predictions are divided about if eventual UAM services will continue to operate within increasingly complex corridor systems (World Economic Forum, 2020), or could culminate in point-to-point and on-demand services akin to air taxi services (Cohen et al., 2021); the eventual configuration of routes vs. an on-demand and ad hoc system will depend on state and FAA regulations (SXSW, 2023). Mature UAM systems would require a complex and UAM-specific regulatory regime that enable cooperative operations within UAM corridors alongside FAA-established guidelines and approvals. Aircraft operated in mature UAM systems will frequently be piloted remotely or automated (World Economic Forum, 2020).
A range of challenges to envisioned mature UAM services exist. Skepticism also exists, however, that this envisioned final stage may not be truly feasible due to infrastructure and capacity limitations, weather-related limitations, and public perceptions and acceptance around noise, safety, and air traffic at scale (Cohen et al., 2021). For example, Reiche et al. (2021) note that climatology analyses find favorable weather conditions in select locations such as Los Angeles and San Francisco, but less favorable conditions in New York City, Washington, DC, and Denver. Future UAM vehicles may require meteorological sensors alongside machine learning to reduce weather-related delays and cancellations (Reiche et al., 2021). Varied weather across the US may also result in UAM deployed in some but not all markets and/or aircraft manufacturers to produce a range of aircraft styles suited to different weather conditions or climates (Cohen et al., 2021).

Ravich et al. (2023) outline additional challenges to long-term UAM success including:

1. SUSTAINABILITY & EFFICIENCY

Sustainable and efficient operations to ensure UAM helps to reduce—rather than contribute to—emissions and energy efficiency. This would include integrating with renewable energy grids.

2. EQUITY

Equity challenges including both access to UAM services by historically disadvantaged and marginalized groups, as well as ensuring that UAM does not create the latest environmental justice issue, imposing a disproportionate share of noise or other impacts on some communities.

3. INTEGRATION

Integration with other transportation modes to create a fully multimodal transportation network; a multimodal network would require long-term strategic planning and coordination across diverse community, private sector, and governmental groups.

Some cities echo these skepticisms of the long-term, high-frequency service predicted by industry, with transportation nonprofits such as Urban Movements Labs and cities including Los Angeles having chilled to UAM after early engagement (Shalby, 2024). Professionals question UAM's ability to meaningfully advance city goals, and the role that cities—and public dollars—should therefore play in its advancement. This paper discusses such long-term challenges—particularly sustainability and equity—further in later sections.

Use Cases

Existing literature identifies five primary use cases for UAM:

1. Cargo delivery including from manufacturer to warehouse or for moving time-sensitive, high-value items in highly congested areas (e.g., medical deliveries)
2. Infrastructure inspections
3. Emergency management such as search and rescue, evacuation, wildfire management, and surveying
4. Air taxis to transport existing transit services within urban areas
5. Regional air mobility at existing airports to connect urban centers with one another and suburban areas (Gomez, 2021; Harper et al., 2022; Summers, 2023)

Of these use cases, only cargo delivery and infrastructure inspections have been piloted, and conversations with city staff suggest that these remain practical, viable, and important use cases. Yet it is often the human-centered travel cases—air taxis and regional air mobility—that are often espoused as an end stage goal and that some predict as the use case with most rapid growth potential (Summers, 2023). Others suggest that cities may use UAM to support mobility-limited populations to counteract existing infrastructure that perpetuates economic or racial segregation in US cities (Gomez, 2021). Yet regulation, technologies, and public perceptions would need to shift markedly from their current state before either air taxis or regional air mobility could, quite literally, take off.

Current public perceptions of potential UAM services are quite mixed, with less than half (45%) of people surveyed across five counties—United States, New Zealand, Mexico, and Switzerland—currently supportive of UAM services (Yedavalli & Mooberry, 2019). Younger (<34 years) and older (85+ years) adults, men, as well as people earning higher-incomes are more receptive to UAM services, both perceiving them as safer and more likely to report that they would likely use UAM (Booz Allen Hamilton, 2018; Yedavalli & Mooberry, 2019). Others would feel safer under select conditions, such as traveling to the airport or on long-distance recreational trips, compared to scenarios such as commuting. People report, for example, being more willing to take UAM for longer recreational trips or trips to connect to airports than shorter trips or for commute travel (Booz Allen Hamilton, 2018). Similarly, people express apprehension about flying either with other passengers that they do not know or flying solo, particularly in either automated or remote-piloted contexts (Shaheen et al., 2018). Travel time, safety, service reliability trip cost, and trip purpose may all influence travelers' willingness to adopt automated UAM (Al Haddad et al., 2020; Fu et al., 2019).

Decades of research has documented that people want frequent transportation options that minimize travel time (see for example Yoh et al. (2011)). Counter to these well-documented transportation tenets, Yedavalli & Mooberry (2019) find that people perceive UAM less positively when it flies frequently, in the middle of the night, or lands near home. People also prefer when vehicles fly at high altitudes to reduce UAM vehicle sounds; reducing sound noise is a decades-long effort in transportation, with research concluding that noise from transportation is an environmental justice issue (Schweitzer & Valenzuela Jr, 2004) and that greater noise levels can reduce home values (Ozdenerol et al., 2015).

Geographic Deployment

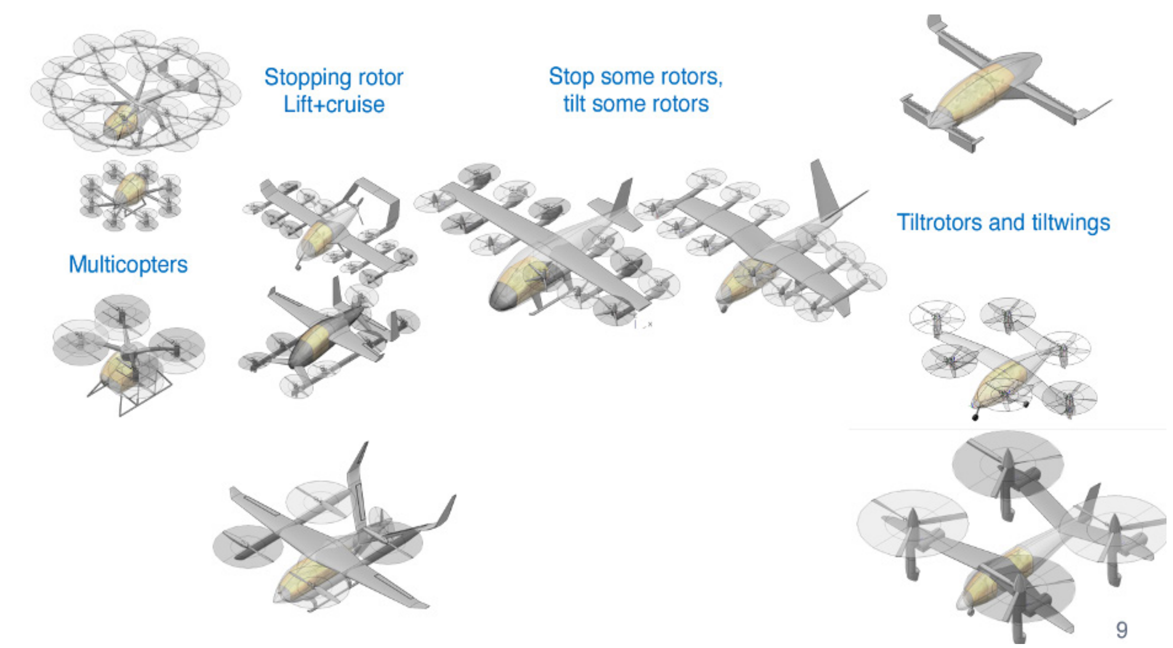
Climate or weather conditions may limit geographical deployment. In a climatology analysis, Reiche et al. (2021) found favorable deployment conditions in temperate cities such as Los Angeles and San Francisco, with less favorable conditions in less temperate cities such as Denver, New York City, and Washington, D.C. Some of these limitations could be addressed through technological innovations (e.g., meteorological sensors, machine learning, mixed vehicle fleets), but could also result in UAM being deployed in select, but not all, markets.

UAM service geographies will likely depend on service structure, such as corridor-based routes, hub and spoke systems, or point-to-point services (Cohen et al., 2021). While some argue that UAM stations (i.e., vertiports) can be placed close to residences and office centers because they are quiet relative to existing aviation technologies (Summers, 2023), others foresee a range of restrictions that would limit both geographic deployment and temporal availability. Under current regulatory limitations and anticipated limitations of both voice-based communications and human cognitive capacity, UAM services may only be accessible to between 24% and 65% of US city populations (Vascik, 2020). Cities may also limit time-of-day access, flight paths, or restrictions over sensitive biological areas (LADOT, 2021). Availability could change under special flight rules areas that, for example, allow UAM to operate in underutilized airspace that separate from conventional airport operations (Vascik, 2020).

Number of Vehicles in a Region

Vehicle design continues to evolve, with some resembling traditional winged aircraft and others anticipated to support vertical takeoff and landing (see for example Figure 2) (Federal Aviation Administration, 2023c). Currently, researchers anticipate between two and nine person capacity per UAM vehicle (Silva, 2023; Summers, 2023).

Figure 2. Possible UAM vehicle designs.



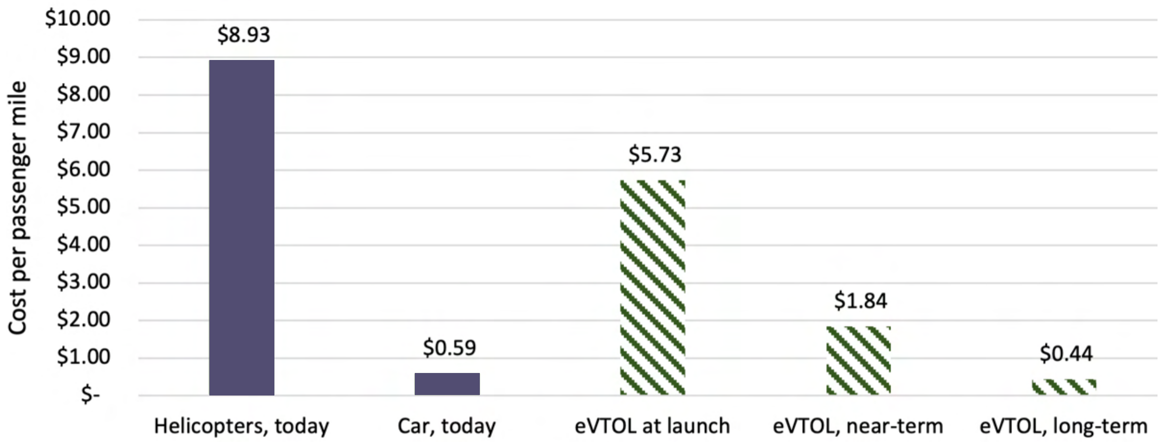
Source: Silva (2023)

Fleet size represents a critical variable for trip price and traveler wait time, both of which are most impactful for short-distance trips (Ploetner et al., 2020). The number of vehicles in a region will depend on infrastructure capacity and traveler demand. Forecasts from Bavaria, Germany, anticipate 123,449 UAM trips per day, or 0.8% of total daily trips in the region; its share is projected to be even smaller (0.5%) of short-distance (<10km) trips where demand is concentrated (55% of UAM demand is for trips under 10km) (Ploetner et al., 2020). Fleet size projections are far smaller in other regions. For example, Eve Air Mobility projects 200 UAM vehicles serving 90 routes and 30 stations in Miami (SXSW, 2023); by comparison, Miami-Dade Transportation and Public Works operates 1,339 transit vehicles, each of which can accommodate several dozen passengers (Federal Transit Administration, 2022).

Price of Trips

On-demand aviation services today typically range between $149 to $300 per seat, although some are far more expensive (Cohen et al., 2021). As a result, travel at these price points primarily serve high-income and business travelers. While projections anticipate UAM costs falling (see Binder et al. (2018)), researchers note a high degree of uncertainty on both the degree to which they will (if ever) become affordable to the wider public and on what timeline. Cohen et al. (2021) observe that commercial aviation took decades reached widespread affordability, and that future prices will likely hinge on both technological advancements and policy (Cohen et al., 2021). For example, improved battery capacity, reduced charging times, and improved algorithms could reduce trip costs. Other changes, however, could increase costs; continued sprawl, for instance, could increase trip distances and therefore costs and dead-heading, where vehicles fly without goods or people either upon completing a trip or to start a new trip. The public's strong preference for piloted operations would also increase costs over automated or remote piloted services (Shaheen et al., 2018).

Figure 3. Costs per mile estimates across different modes and timelines.



Source: Binder et al. (2018)

Estimates of future UAM travel fall below current prices with some in industry projecting initial ticket prices akin to premium ride-hail products (Summers, 2023), with other estimates suggest that it will remain a costly mode of transportation. Estimates for fixed route "air metros" project about $30 per trip; air taxis could range from $131 to $1,912 per trip, with others putting these costs in terms of minutes of service and projecting services ranging between $8 to $18 per minute. Estimates suggest that more than quadrupling forecast trips from 130 million to 740 million would be associated with a 40% reduction in trip costs; even at 740 million trips per year, however, estimates predict each trip costing $30 (World Economic Forum, 2020). Such prices are unlikely to achieve industry's stated objectives to achieve a "price per passenger mile that is accessible for a wide percentage of the population", at least as a daily travel mode (Wisk, 2024).

As an intercity mode, industry projects UAM providing faster service than either high-speed trains or taxis, with prices falling above trains and below taxis; Lilium (2024), for example, projects a 1 hour 10-minute trip between Manhattan and Philadelphia costing $200.

Trip price is important from both a financial access point of view as well as passenger demand. While some research finds that some consumers are willing to pay more for autonomous flying taxis—up to about 45€ ($49) per hour (Fu et al., 2019)—experiments using Swiss data suggest that many travelers are quite price sensitive to price. For example, doubling UAM base fare from 6 to 12 CHF ($7 to $14) reduces the demand threefold (Balac et al., 2019).

IS UAM POISED TO ADVANCE CITY GOALS?

UAM proponents outline a wide array of city goals that UAM could help address. Yet history suggests that variable economic, organizational, and political perspectives can create multiple objectives that diffuse objectives to limit desired outcomes (see for example Taylor & Morris (2015), Yoh et al. (2015)).

To date, several cities and regional organizations have generated UAM frameworks and principles. For example, LADOT (2021) published an Urban Air Mobility policy brief to document policy considerations raised through three of its existing policy frameworks: 1) Strategic Plan (LADOT, 2021); 2) Urban Mobility in a Digital Age Strategic Plan (Hand, 2016); and 3) Principles of the Urban Sky (developed jointly with the World Economic Forum (2020)). Some of these represent early public explorations into UAM, although interest has chilled among some of these early actors (Shalby, 2024). More recently, Miami-Dade Transportation Planning Organization published an Urban Air Mobility Policy Framework and Strategic Roadmap in 2023. Such efforts represent some of the most advanced efforts to consider how UAM may fit into existing transportation services, although staff across multiple cities acknowledge the breadth and depth of remaining unknowns (author communication with city staff, June 2024).

Core to considerations, cities must weigh if the benefits introducing, scaling, and integrating UAM with existing transportation services will outweigh its costs (Harper et al., 2022). In this section, we outline potential opportunities and primary limitations to address seven widespread city goals while considering elements such as scalability, price, regulatory environment, and existing alternatives:

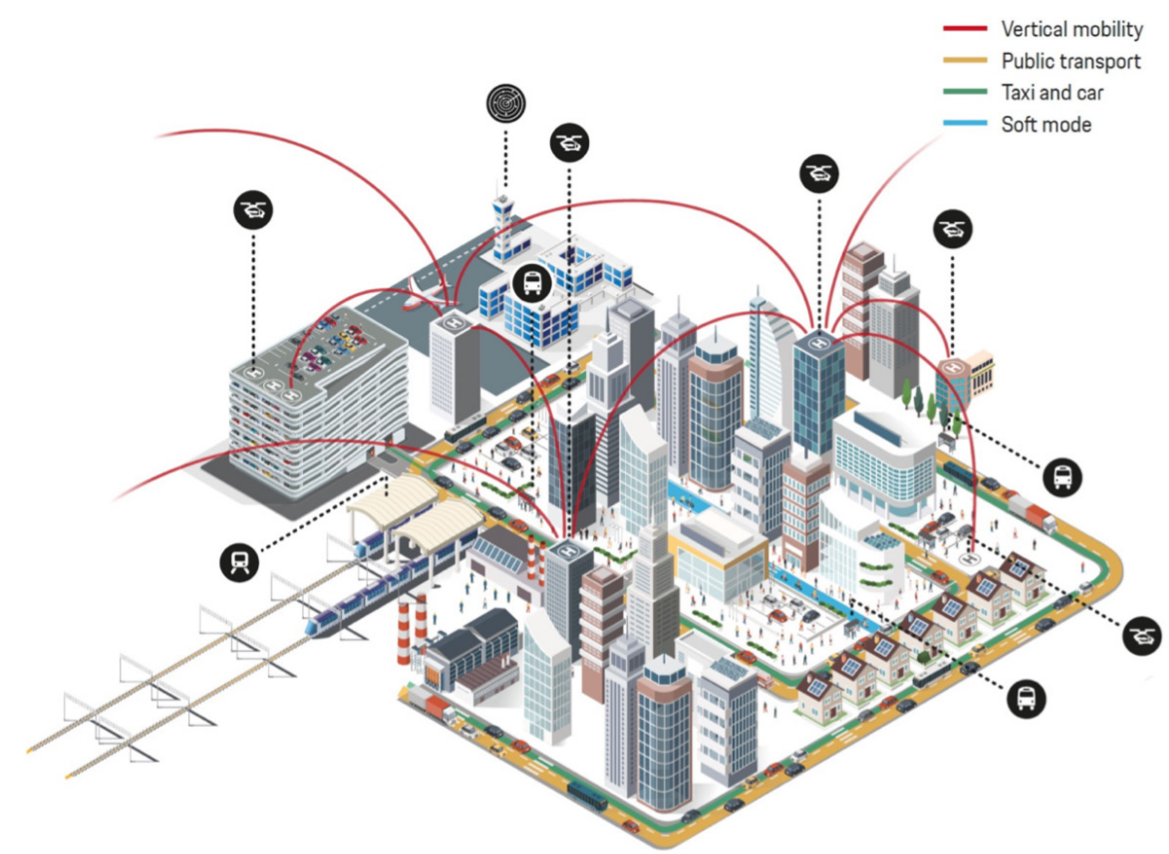
1. Minimize environmental impact and reduce greenhouse gas emissions
2. Reduce traffic congestion
3. Ensure equitable access for all travelers
4. Increase accessibility to destinations
5. Minimize nuisance and noise
6. Maintain personal and data privacy
7. Improve safe transportation options

For each of goal consideration, many of the stated advantages of UAM remain relatively limited in large part due to its anticipated scale, which—even under a range of pricing scenarios—is expected to be quite low. Ploetner et al. (2020) calculate that UAM trips will capture about 1% of total trips, with about 0.5% for trips under 10km (6.2 miles), the distance with the majority (55%) of travel demand; even at farther distances of 30km (18.6 miles) or more, UAM is not expected to comprise more than 4% of total mode split—less than the share of people who take transit to work across the US (5%) (Wang & Renne, 2023). Additionally, UAM goals may conflict with one another. For example, reducing prices could increase demand (and vice versa), which could make services more affordable to a broader population; yet more UAM services will also increase noise pollution and emissions. Similarly, UAM applied to urban—rather than suburban, exurban, or rural contexts (see for example Figure 4)—is touted as relieving congested city street and offers the density of demand to produce the lowest trip costs. Yet it is these locations where public opposition is likely highest due to greater proximity to noise (Yedavalli & Mooberry, 2019), construction costs are higher, and it will compete against far more transportation alternatives such as public transit. The following sections consider each of the seven goals in more detail and the implications of scalar limitations on goal achievement.

Publications to date anticipate that take-off and landing infrastructure will be most limited in dense, urban areas due to footprint restrictions, integration with air traffic control, and community acceptance (Vascik, 2020); these limitations present challenges as the greatest space limitations and barriers to implementation are likely to occur in the same places where demand (or at least potential market share) is highest. Take-off and landing infrastructure located at existing airports and less populated areas are likely to face fewer barriers to implementation (Vascik, 2020). In addition to a location to land, local governments will need to ensure that airspace in and around all vertiports is likewise protected (Federal Aviation Administration, 2023c).

Space and location considerations are just one element of infrastructure needs. Infrastructure developments must also consider paving materials, markings, refueling and charging locations, fire protection (hoses and water hookups), lighting, and wind cones, among others (LADOT, 2021). Unlike electric vehicles, eVTOLs require high-voltage charging sites with customized cables, integrated cooling systems, and the ability to store power on site; such electrical systems are still under development and many current electrical grids may not be capable of supporting projected UAM energy needs (Huber, 2022). Varied eVTOL power sources—battery, high-speed charging, etc.—likewise presents challenges to interoperability. Additional safety and design considerations may be necessary in contingency situations and FAA is expected to provide guidance that will inform state and local efforts to provide infrastructure (Harper et al., 2022). For example, ensuring both infrastructure safety of charging stations exposed to heat and elements, as well as contingency planning for service disruptions to airspace (e.g., fireworks) are needed to ensure safety operation of UAM services and infrastructure.

Figure 5. Envisioned Integration of UAM with existing transportation options.



Source: World Economic Forum (2020)

Goal 1: Minimize environmental impact and reduce greenhouse gas emissions

UAM services are forecasted to reduce environmental impacts and associated greenhouse gas (GHG) emissions relative to gas-powered vehicles. However, such optimistic forecasts are far from certain. Arguments of UAM reducing overall environmental impacts rest on three interrelated factors: 1) UAM services will be fully-electrified using power generated from renewable sources, 2) infrastructure will be sustainable, and 3) UAM will replace internal combustion engine vehicle travel.

Research suggests that all-electric UAM services are both feasible (Afonso et al., 2021) and, when they replace short-haul regional air traffic, can reduce GHG emissions (Summers, 2023), although others predict that on-demand UAM will produce more GHG and air pollutants relative to ground transportation modes (Zhao et al., 2022). If UAM are hybrid—as expected in at least in the short- and medium-term (Cohen et al., 2021)—predicted environmental benefits fall sharply. UAM may also remain hybrid powered in order to extend range, with electric operations but use of internal combustion engines during takeoff and landing when energy needs are highest; this would result in localized emission impacts (Harper et al., 2022). Agencies or cities could incentivize or regulate fuel types through fleet size limitations by fuel type, limiting fossil fuel recharging, or incentivizing electric recharging.

Transition to fully electric UAM systems would require tandem investment in power grids, most of which today would require substantial investment to fully transition to clean energy (LADOT). While some argue that biofuels would pave the most sustainable path forward (Afonso et al., 2021), many assume UAM vehicles will be equipped with batteries, raising additional questions around long-term sustainability and environmental justice of battery production and disposal (see for example Hawkins et al. (2012)).

In addition to questions around energy and battery sustainability, questions around the environmental impact of supportive infrastructure abound. UAM in a fully-developed system would require new or adapted reuse of airports, helipads, and parking garages. With many US airports at capacity, however, adapting airports to UAM services would require individual airlines to forgo conventional, high-capacity passenger air travel for low-volume eVTOL services, including self-financing all infrastructure retrofits. Cities are unlikely to invest public dollars into UAM infrastructure due to uncertainty in their ability to deliver on a more sustainable and equitable future, which limits infrastructure development to private sector actors (author communication with city staff, June 2024). For example, the UAM operator Archer signed a memorandum of understanding with Kilroy Realty Corporation—a large US developer—to create a five-hub UAM system around the San Francisco Bay Area (Archer, 2024). Constructing new infrastructure could be associated with substantial environmental impacts, with cement production currently representing 8% of total global CO_2 emissions (Lehne & Preston, 2018). Relatively few studies consider life cycle emissions of UAM services (Cohen et al., 2021).

Assuming UAM successfully transitions to clean electric operations, its environmental benefits relative to alternatives remain uncertain. Kasiwal (2019) estimated that an eVTOL with one occupant (pilot or single passenger in a fully-automated vehicle) would produce about one-third (35%) lower greenhouse gas emissions than a gas-powered vehicle, but 28% more emissions than a battery electric vehicle with the same occupancy; similarly, a Booz Allen Hamilton (2018) report estimates that eVTOLs would produce twice as much CO_2 emissions compared to an all-electric car. Is introducing UAM the most efficient or expedient way for cities to reduce GHG emissions? Even at scale, UAM are predicted to be less than 1% of total daily trips in studied regions (Ploetner et al., 2020). Under the most optimistic emissions reductions forecast, UAM would reduce daily total emissions in a region by 0.3% (35% reduction per trip * 1% of daily trips). By comparison, transitioning all internal combustion engine vehicles to electric vehicles could reduce total emissions by 20% (assuming 87% of personal trips are made in vehicles (Bureau of Transportation Statistics, 2017) and emissions reductions of 23% between ICE and EV (Farzaneh & Jung, 2023)); transitioning the overall energy grid from fossil fuels to renewable sources and encouraging people out of vehicles altogether and on to modes such as transit, walking, and biking, could reduce emissions far below these estimates. Shifting 20% of current vehicle trips to zero-emissions modes like walking or biking, for example, could generate the same emissions reductions as transitioning the entire vehicle fleet to electric and 67 times fewer emissions compared to forecast UAM emissions reductions. Cities largely already know how to encourage people to walk and bike more: provide supportive infrastructure, increase density to bring destinations closer together, and make driving more difficult through fees or tolls; what cities currently largely lack is the political will or public support to implement the changes needed to catalyze such mode shift (Thigpen et al., 2023).

Goal 2: Reduce traffic congestion

While UAM companies previously marketed themselves as a way to relieve rush-hour congestion, many agree that will neither reduce surface traffic volumes nor congestion due to its limited capture of daily trips as well as induced demand (Federal Aviation Administration, 2023c; Harper et al., 2022). Cities are divided as either skeptical of UAM's ability to reduce traffic congestion or are reserving judgment until after UAM routes can be included in regional traffic models (author communication with city staff, June and July 2024).

With UAM capturing at most about 4% of daily trips (Ploetner et al., 2020), "the number of daily users of this new mode of transportation will not be of a level great enough to result in a substantial, or even noticeable, change in surface traffic congestion" (Harper et al., 2022, p. 26). Should ridership numbers rise, surface congestion is unlikely to abate due to induced demand, in which people adjust the times of day, modes, or routes they travel to take advantage of the new capacity and perceived time savings. The result: levels of congestion equal to what were observed prior to capacity expansion. Induced demand, raised as an issue more than 100 years ago, has been formalized and documented so thoroughly on surface streets that it's been dubbed the "fundamental rule" of road congestion (Plumer, 2016; Thigpen et al., 2023). Neither adding roadway nor transit capacity has been shown to lesson peak hour traffic congestion (Duranton & Turner, 2011; Giuliano et al., 2016) and Elon Musk's Boring Company—with a goal of tunneling under existing roads to build one's way out of congestion—was ridiculed by urban planners, engineers, and economists alike (see for example Penn (2018), Marshall (2018), and Plumer (2016)). The same would hold for seeking to build our way out of congestion by taking to the sky: we have yet to reduce long-term congestion by expanding capacity.

There is public appeal in thinking we can build our way out of congestion. This is in part because planners and engineers repeatedly tell people that we can build our way out of congestion with new infrastructure projects including road widening and transit additions (Manville & Cummins, 2015; Thigpen et al., 2023); as a result the majority the American public believes adding capacity will reduce congestion (Klein et al., 2021). Challengingly for cities seeking to actually reduce congestion, proven strategies such as road pricing prove far less popular compared to capacity expansion (Thigpen et al., 2023).

Goal 3: Ensure equitable access for all travelers

UAM frameworks highlight equitable access for travelers as a key tenet underpinning UAM strategies (see for example LADOT (2021)and Miami-Dade Transportation Planning Organization (2023)). Both trip costs and geographical accessibility are central to ensuring access to travelers, particularly those historically underserved by transportation services. Yet research to date suggests that private companies that provide technology-enabled transportation services are not immediate panaceas for existing disparities, nor do they automatically engender equitable service themselves. Research finds, for example, that ride-hail and shared e-scooters do not fill existing gaps in the public transportation network, and continue to disproportionately serve neighborhoods with higher median household incomes with greater access to personal vehicles (Barajas & Brown, 2021; Meng & Brown, 2021); these findings suggest that UAM will not automatically solve existing geographical inequities in transportation access and, without proactive policy, could perpetuate such divides. Cities have previously addressed geographical equity concerns by mandating equity zones with vehicle deployment or service thresholds as well as reduced publicly-levied fees in equity focus areas to encourage additional service (Brown & Howell, 2024).

Ensuring geographical accessibility of services, however, creates tensions with an often-concurrent goal to avoid shouldering marginalized communities and environmental justice groups with a disproportionate share of UAM's negative externalities such as noise and visual pollution. A tension arises because externalities are generated with service; providing more trips to marginalized or environmental justice communities will create more access, but will also create more noise or visual or air pollution. Eliminating all externalities would, however, mean also eliminating UAM services. More pragmatic may be to pursue options where added negative externalities do not occur absent additional accessibility benefits; for example, research finds living next to a rail line (but not station) has a negative influence on home values (Clark, 2006), while both residential and commercial properties located near rail stations are typically more expensive (Debrezion et al., 2007). For UAM, this would caution against UAM routes that fly over marginalized communities without local stations to increase access. Community engagement and weighing of the relative benefits and burdens imposed by UAM services would be needed to determine the net effects on historically underserved communities.

Cities are also cautious of implementing UAM services that would complete with, rather than complement, existing public transit networks. With sizable investments in fixed route transit over the past decades, efforts to do anything but leverage UAM to extend the network may undercut efforts to provide robust transportation options to the public (author communication with city staff, June 2024).

Cost and payment represent additional, and critical, determinants in equitable access to urban mobility. Payment for UAM services must be both affordable and accessible to ensure equitable access for all travelers. Income-based discounts are well documented in transit systems as well as required by many technology-enabled transportation services such as shared micromobility (Brown & Howell, 2024). At current forecast prices—ranging from $1.84 to $5.73 per mile (Binder et al., 2018)—UAM services would need to be steeply discounted before prices were affordable for travelers earning low-incomes. Additionally, cities would need to work to ensure predictable UAM fares; research finds that ride-hail fees that vary by time of day and demand create uncertainty and often create access barriers for travelers earning low-incomes (Brown et al., 2022). Accompanying discounted fares, UAM services would need to consider lessons from other modes around fare payment systems, including previous research supporting open payment solutions, or noting that eliminating cash fares could exclude some travelers (Brakewood & Kocur, 2013; Golub et al., 2021).

Goal 4: Increase access to destinations

UAM's ability to increase access to destinations depends on both the geography and scope of operations. In urban environments, cities may seek to integrate UAM with mobility hubs to connect to existing transportation options. Added accessibility will depend on how much UAM services either complement or duplicate existing transit routes, and whether UAM operates along dedicated corridors versus on-demand air taxis. While on-demand air taxis would afford the greatest increase in accessibility, it also represents the most difficult implementation scenario as, to offer point-to-point service, UAM vertiports or stations must be nearly ubiquitous. High station saturation represents both a high-cost and a politically challenging scenario.

In contrast to urban UAM, in which UAM would compete with a range of existing transportation options and likely cover only short trip distances, suburban, exurban, or even intercity passenger UAM would cover longer distances and may be used to connect disparate hubs or suburban communities with one another or with an urban center. While more dispersed settings would present fewer logistical hurdles to both constructing new infrastructure and operating in less congested air space, it is also possible that longer travel times would create both more costly trips and longer wait times due to lower demand relative to urban settings. For example, current price estimates for UAM travel would mean a 10-mile trip could would cost about $57 ($5.73/mile) at launch, falling to about $18 ($1.84/mile) in the near term if forecasts hold (Binder et al., 2018). By contrast, current commuter rails costs fall far below these ranges (for example, $0.14 per mile for the Sounder train in the Seattle region (Sound Transit, 2024), $0.17 per mile for Accela along the Northeast Corridor (Amtrak, 2024), $0.58 per mile for Metrolink in the Los Angeles region (Metrolink, 2024). UAM would need to provide faster, more frequent, reliable, flexible, or cheaper service in order to provide viable alternatives to either driving—particularly if autonomous vehicles are introduced in the long term—or commuter rail.

Goal 5: Minimize noise pollution

Noise has long been cited as a transportation environmental justice issue (Schweitzer & Valenzuela Jr, 2004) and aircraft and rotorcraft noise are frequently cited nuisances in neighborhoods around airports and heliports (Cohen et al., 2021). Research suggests that eVTOLs would range from about 40db (cruising) to 60db (taking off); by comparison, light traffic noise is measured at around 50db and airplane cruising at 75db (World Economic Forum, 2020). While UAM noise concerns could be mitigated through aircraft designs and electrification, it is also possible that larger-scale operations would generate more noise in aggregate through the combination of more—albeit individually quieter—vehicles. UAM may either distribute noises more evenly over space or could constrain flight paths along transportation corridors already generating substantial noise such as freeways, railroads, or large arterial roadways; with many households earning lower-incomes concentrated around such facilities, constraining flight operations to around existing transportation facilities may further concentrate transportation externalities and exacerbate existing environmental justice issues.

Current public sentiment around UAM reflects considerable concerns about both noise and visual pollution. Public concerns may range over time as people become more accustomed to UAM or services are phased in, and contextual factors such as time of day or geographic location such as quiet single-family neighborhoods versus busy shopping mall. Overall impacts of noise on surrounding populations could vary by factors including: volume, duration, time of trip, frequency, number of people affected, location, UAM noise relative to other ambient noises, and/or individual versus aggregate UAM operations (Cohen & Shaheen, 2024).

Goal 6: Maintain personal and data privacy

Concerns around data privacy are not limited to UAM. Concerns around data privacy have increased over time with the rise of big data and technology-abled transportation and transit ticketing. For example, people report concerns about data privacy in transit payment systems (Golub et al., 2021). Cities have developed data standards, such as LADOT's Mobility Data Specification (MDS) to support data standardization and compliance monitoring. Adoption of standardized data collection, monitoring, and compliance across modes can both aid evaluation efforts and ensure standardized and robust individual data privacy protection across modes and operators.

Goal 7: Improve safe transportation options

UAM will introduce new safety considerations related to vehicles and operations, but they are unlikely to offer a simple solution to address the host of transportation safety issues currently present in communities and across modes. Instead, national survey and focus group findings suggest that UAM will likely face safety issues similar to those raised in existing transportation modes such as aviation, pooled ride-hail services, and autonomous vehicles. Risks that could engender safety concerns occur across a spectrum of criticality (non-essential to critical), severity (no safety effects to catastrophic failure conditions) and probability (extremely improbable to probable) (Connors, 2020). Reported safety concerns stemmed from multiple points in the journey from booking to boarding to on-board, including worries about hijacking and aircraft sabotage, unruly passengers and sexual assault, passengers visible to people on the ground, heightened risks of collisions relative to ground transportation (Booz Allen Hamilton, 2018; Cohen & Shaheen, 2024); notably, such concerns were heightened in scenarios with automated services without aircrew on board, with many people stating an unwillingness to use any form of automated mobility (Booz Allen Hamilton, 2018). Overwhelming preferences for piloted UAM services from a safety perspective clashes with desires for affordable travel given automation represents a key step in reducing operating costs, although some focus group participants were open to remote-piloted or automated services assuming lower costs (Booz Allen Hamilton, 2018).

Stated concerns around UAM echo reported public hesitancy of autonomous vehicle travel in general related to 1) technical malfunctions, 2) a lack of transparency, and 3) co-travelers (Grippenkoven et al., 2018). Technical concerns can be addressed through regulations, rigorous testing, and jurisdictional oversight; cities and departments of transportation, for example, are typically responsible for street transportation safety, while the FAA manages airspace (LADOT, 2021). Concerns around transparency—passengers' worry if vehicles take different or unknown routes, uncertainty if sensors properly identify obstacles (Grippenkoven et al., 2018)—may be allayed over time or with passenger education or experience.

Anxiety around co-travelers are more complex and not limited or allayed by the introduction of UAM; similar concerns about negative passenger interactions deter people from riding transit or pooled ride-hail services as well (Morris et al., 2020). Autonomous or remote controlled operations of autonomous vehicles and UAM, if anything, exacerbate peoples' concerns (Booz Allen Hamilton, 2018). People worry about not having a driver intercede if they are having an unsafe or uncomfortable interaction with another passenger. A host of possible safety solutions ranging from video surveillance and security guards to panic buttons have been proposed and implemented to allay safety concerns (Grippenkoven et al., 2018); travelers, however, perceive these solutions differently, creating challenges for how to efficiently and effectively address safety concerns for a wide ridership base.

UAM AT THE LOCAL, STATE, AND FEDERAL LEVEL

Federal, state, and local actors would each need to lay concrete groundwork to ensure integrated UAM systems and alignment with UAM services and overarching public goals. One challenge UAM presents to each level of government is the relative levels of risk each is willing to tolerate alongside perceived benefits. UAM may yield benefits to local and regional residents and businesses, but calculating the nature and scale of potential benefits remains murky given the breadth of unknown factors such as costs, externalities, and risks. The timeline for benefits to be realized remains similarly unclear as technologies and regulatory environments continue to evolve; and it remains possible that UAM services will never be realized—at least in current imagined scope and scale—due to both known and unforeseen hurdles. Despite these unknowns, both policy frameworks and research to date suggests several potential roles for federal, state, and local governments in navigating the current and proposed UAM landscape and aligning potential UAM services with public aims. To date, the FAA has continued to advance UAM operations, rules, and regulations, while less movement has occurred at either the state or local level (Shalby, 2024).

Figure 6. Potential Roles for Government in Realizing UAM Goals in Miami-Dade Transportation Planning Organization.

This matrix presents a high-level overview of the policy framework recommendations as they relate to the key considerations. Subsequent phases of this study will utilize these recommendations in the development of an actionable timeline and an overarching Policy Framework for UAM in Miami-Dade County.

Policy Framework Recommendations	Key Considerations										
	Airspace	Charging / Fueling	Data and Network	Economy / Funding	Land Use and Zoning	Noise and Visual Pollution	Safety and Security	Social Equity	Sustainability	OEMs and Operators	Vertiport Infrastructure
Government											
State, Regional, and Local Planning	X	X		X	X	X	X	X	X		X
Public Engagement						X	X	X	X		
Incentive Program								X	X	X	X
Economic Development		X		X					X	X	X
Proof of Concept - Government Agencies	X	X	X	X	X	X	X	X	X	X	X

Source: Miami-Dade Transportation Planning Authority (2023)

Federal

Current policy frameworks and research envision the federal government establishing a regulatory framework under the Federal Aviation Administration (FAA), similar to the role it currently plays in air transportation more broadly. The FAA is currently working to establish certification and operational requirements for eVTOL aircraft, stations, airspace management, and other infrastructure and regulations needed to promote safety. The US Congress is also active in drafting and advancing legislation related to UAM; for example, the Advanced Air Mobility Coordination and Leadership Act (S. 516) directs USDOT to establish an interagency working group to coordinate efforts to bolster UAM in the US (Miami-Dade Transportation Planning Organization, 2023).

Multiple federal agencies including FAA, NASA, and the Department of Defense are currently engaged in funded research and development to support UAM including autonomous flight control, simulation advances, and electric propulsion systems. Other agencies are engaged in strategic partnerships to bring together different sectors (e.g., airspace service providers, government agencies, and aircraft manufacturers) aimed to advance UAM such as demonstrating and testing UAM vehicles (Miami-Dade Transportation Planning Organization, 2023).

State

State efforts to support UAM would need to remain consistent with federal regulations, but may refine federal guidance to meet state-specific needs or challenges. State roles may also include statewide policy and regulation to prepare institutions and infrastructure, regional infrastructure (including take-off/landing, digital infrastructure, and the energy grid), workforce development, and working with industry and community stakeholders to address negative externalities and public acceptance. States may attract UAM investments through either tax credits or other financial incentives, workforce training programs, or university partnerships to support UAM development. Workforce development programs could address training or retraining of existing labor force.

State long-range planning documents may also consider the role UAM may play in advancing state goals and, correspondingly, how many (or few) state resources should be dedicated to the issue. States can center equity in any preparatory process by examining proposed vertiports from the perspective of land use compatibility and environmental justice (Cohen & Shaheen, 2024; Miami-Dade Transportation Planning Organization, 2023).

States may serve as conveners for UAM working groups; Florida Department of Transportation (FDOT), for example, is leading a working group comprised of state, municipal, agency, and private-sector stakeholder to further analyze and explore UAM across regions and cities of a given state.

Local

Local governments, including regional and county agencies, would be central to UAM operations and must weigh the potential benefits against the potential risks that UAM may bring. Localities that seek to include UAM in the future will need to incorporate UAM proactively across a range of local agencies or departments including transportation, land use, zoning, and environmental planning; currently, cities primarily approach UAM through planning and land use rather than transportation as actions often relate to land use regulations and the allowance of private vertiports (author communication with city staff, June 2024). Figure 7 outlines how local agencies or governments may incorporate UAM considerations. Local governments would also be responsible for community engagement strategies to both educate and empower communities during planning phases. Similar to state-level roles, local governments would also need to consider workforce (re)training opportunities as well as grant-based funding and private-public partnership opportunities (Miami-Dade Transportation Planning Organization, 2023).

Figure 7. Potential Roles of Local Agencies and Departments in Preparing for UAM

Local Agency / Department	Opportunities for Incorporating UAM Considerations
Planning and Zoning	• Land use planning • Zoning codes • Code enforcement
Fire and Rescue	• Fire codes • Incident management • Emergency response • Input on location of UAM infrastructure
Police	• Enforcement • Public relations (incident management) • Security
Economic Development	• Marketing and economic incentives • Maximizing opportunities for vacant land • Redevelopment/re-use of existing assets (heliports, airports)
Legal	• Liability • Privacy and property rights • Noise ordinances
Transportation and Public Works	• Multimodal planning • Future parking facilities • Overall system integration

Source: Miami-Dade Transportation Planning Authority (2023)

While being caught flat-footed by the introduction of a new transportation technology can create planning and logistical challenges—such as when ride-hail services or e-scooters arrived in American cities—local governments should also be wary of assuming concrete timelines. Professional and industry-wide urging to construct local or regional air travel is not new; the American Planning Association in the 1950s urged cities to construct helipads to support commercial helicopter use; they justified this saying that the "Federal Government's interest in the encouragement of commercial helicopter transport" was a sign of commercial helicopter travel's "imminence", or at very least "it seems likely that helicopter passenger service will enter the short-haul market throughout the country within the next ten years -- the normal time scope of the long-range city plan." (American Planning Association, 1953, pp. 1–2). While some cities did ultimately require helipads on top of tall buildings like skyscrapers, most cite their role in rescue or disaster relief efforts rather than viability as commercial transport hubs. In Tokyo, limited use stems from strict noise regulations and local and national government rules (Cooper, 2016); in Los Angeles, critics of the city's helipad requirement stunted the city's skyline from developing iconic buildings (Reyes, 2014). Ultimately, the boom in the commercial helicopter travel portended by the American Planning Association in the 1950s did not come to pass, and construction of helicopter-related infrastructure added to building costs and created unintended consequences (Reyes, 2014). Instead of banking on a set timeline for UAM to deploy and scale, cities should consider scenario planning for how plans or regulations could be adapted based on future understandings of currently-unknown consequences or facets of UAM.

Cities are currently divided in their approach to UAM. Some are skeptical about the alignment between UAM and city goals, and are therefore content to wait to act further until or if such an alignment becomes clearer. Others view UAM as more inevitable and see the public sector's role as catching up and supporting private sector technological advancement; in this case, too, staff acknowledge the myriad outstanding uncertainties UAM presents (author communication with city staff, June 2024).

CONCLUSION

UAM is promoted as a service that could address a wide-range of city goals from reducing traffic congestion and emissions to improving access to destinations. At the forecast scale, however, trips will remain both too few and too expensive to meet broad city goals. UAM offers an exciting and futuristic technological vision; but it also can distract attention and resources from proven policies and investments that could make concrete advancements. Instituting congestion charges, for example, has been shown to reduce congestion in cities worldwide such as London and Stockholm (Börjesson et al., 2012; Transport for London, 2008). Researchers also suggest that implementing congestion charges would create a more progressive transportation system if revenues are used to fund transit services at a level that encourages easy substitution between cars and transit (Manville & Goldman, 2018). Providing high-quality alternatives to driving could encourage the modal shift needed to reduce emissions. For transit, this means providing frequent and reliable service; providing dedicated lanes to transit—such as bus rapid transit or bus only lanes—can increase ridership and reduce local emissions. A completed bus rapid transit route in San Francisco for example found that physically separated travel lanes and transit signal priority to buses reduced transit travel times by 35%; the corridor saw correspondingly impressive growth in transit ridership (McCarthy, 2023), a finding echoed in across other geographies (Kim & Ewing, 2024). Similar to transit, dedicating space to bikes and improving the pedestrian environment (such as adding street trees, furniture, and lighting) can encourage more biking and walking (Buehler & Dill, 2016; Vich et al., 2019). Walking, biking, and transit can also be encouraged through land use and zoning amendments that encourage greater densities and mixed uses to reduce travel distances as well as infrastructure construction costs.

While cities have all these tools in their toolbox, the politics of repurposing space for cars to transit, walking, or biking proves challenging. While widespread public support exist for many of the broader goals these investments would engender, such as reduced emissions, people are far less supportive of the policies themselves and often fail to see conflict inherent in promoting driving versus walking/biking (Klein et al., 2021). Rather than focus efforts on UAM, cities could invest energies and political capital in backing proven solutions to reduce emissions, mitigate congestion, increase accessibility, and promote equity. For cities that do aim to attract and adapt for scaled UAM services, they should consider scenario planning and implementing flexible regulations and plans that can be adapted and updated as understanding of UAM services' costs, risks, and benefits evolve.

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