



WHITE PAPER

Leading in Advanced Air Mobility

The Market Opportunity for Massachusetts

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Prelude:

Advanced Air Mobility: MassAutonomy's inaugural “deep dive” into mobility technology

This market study was created in partnership with MassAutonomy (a Massachusetts-focused, industry-created Non-Profit Organization focused on addressing complex transportation issues through disruptive technologies). It is the first in a series of “deep dives” MassAutonomy plans to define the future of mobility in Massachusetts. These studies are intended to build compelling business cases, both for the Commonwealth of Massachusetts and private investors, to initiate and accelerate commitments and partnerships between the public and private sectors to unlock the future of mobility.

The MassAutonomy and BCG joint study, “Leading in Advanced Air Mobility”, aims to provide a value assessment of the economic and environmental impacts possible through the increased movement of people and goods via air vehicles powered by sustainable energy sources. This study provides an initial view of the potential of Advanced Air Mobility (AAM) - it is highly likely that unpredicted innovations and shifting consumer sentiment will create new opportunities and use cases. The study is intended to give the Commonwealth and its citizens an understanding of such future possibilities based on current technology and development trajectories.

Introduction

Advanced Air Mobility: Part of a larger mobility technology market for Massachusetts

Advanced Air Mobility is one segment in a broader market composed of technologies with the capacity to improve mobility, and the delivery of mobility services, through innovation and automation. The broader mobility technology market supports all modes of transportation and the connections between modes of transportation – whether by air, land, sea, or subsea. As well as including technologies that enable new modes of transportation, the market also includes technologies that improve access to existing modes; improve the efficiency, safety, or speed of these modes; allow different modes to coexist with less friction; or reimagine the ways that consumers interact with mobility providers.

This market study focuses on Advanced Air Mobility and explores in detail the ways in which technological innovation and increased autonomy are expected to expand consumer demand for this particular type of mobility service. The study aims to size specific forecast expansions of the AAM market - those that seem most likely to occur. However, the study also examines the competitive advantages that Massachusetts would have, not just in the AAM market but, more significantly, in the broader mobility technology market. The study's focus on AAM should not obscure the importance of this larger potential advantage for Massachusetts. While some technology innovations in AAM will drive opportunity in other applications (e.g., autonomy software, battery technology, etc.) this study specifically focuses on the impact directly attributable to AAM.

What is mobility technology?

The mobility sector is made up of all those industries that come together to move people via train, automobiles, or planes. Mobility technology includes all of the technologies and systems that support, empower, and improve industries within the mobility sector. It is a broad term that describes the ecosystem of companies and industries that are working to address global transportation-related issues.

Nations, states, and cities worldwide are facing a massive challenge to improve transportation systems so that people waste less time and emit less carbon – all while reducing costs so that mobility is more accessible. Governments must achieve these goals in the face of growing populations, less space and capital to build roads, and by relying on technology that is under development and so is not currently available.

The transportation challenge is real and growing: According to a 2019 World Health Organization (WHO) study, about 150 hours of productivity are lost every year per person in 20 of the world's most congested cities; over 90% of urban populations live in environments below WHO health standards due to vehicle emissions; and 1.3 million people die each year because of traffic crashes. With an additional 20% of the world's population expected to migrate to cities by 2050, these problems will only get worse.

Over the past few years, mobility technology has seen huge growth in investment and interest. Across the globe, governments and companies are developing technology, running land and air-based pilots, and creating partnerships to transform mobility for their citizens. For countries and states that are early adopters, there are huge secondary benefits from nurturing mobility-related industries. The companies they attract will drive employment and tax revenues as their technology is licensed across the globe.

New mobility technologies can create seamless and sustainable urban transportation systems. A wide range of solutions are emerging, of which Advanced Air Mobility is just one part. They include shared and autonomous vehicles, and micromobility options such as e-scooters. (See Exhibits below). At MassAutonomy, we view the mobility technology industry as consisting of three primary categories:

- **Modal providers – The set of companies and technologies that focus on a single mode of travel (whether air travel, personal cars, or public transportation), including:**
 - Vehicle manufacturers
 - Vehicle maintenance and training providers
 - Mode-specific software and technologies (e.g., air traffic management)
- **Technology enablers – The set of technologies cutting across transport modes that will enable seamless multi-modal, low-carbon, and cost-effective travel for citizens, including:**
 - Autonomous driving software
 - Ride hailing / booking platforms

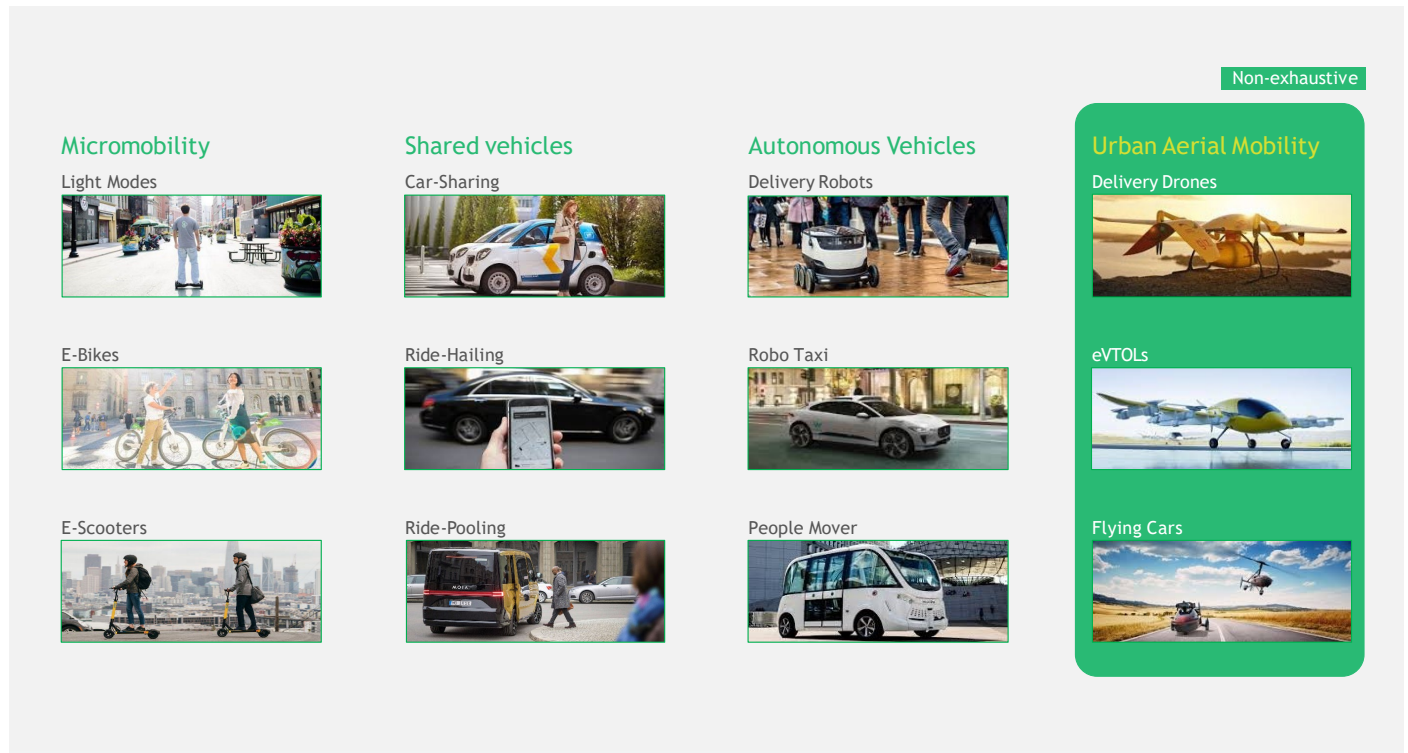
- Battery technologies and electrification
- **Infrastructure enablers – The infrastructure required to sustain multi-modal transportation and ensure the safe operation of vehicles, including:**
 - Vertiport operators
 - 5G cellular networks
 - Renewable energy for vehicle charging
 - Academic institutions

Image 1 - In this context, cities push for AV mobility concepts



BCG estimates the total global market for new mobility could be worth over \$1 trillion. This represents a massive opportunity for the Commonwealth of Massachusetts. A 2017 study by Boston Consulting Group (BCG), the City of Boston, and the World Economic Forum predicted broad benefits for Boston from city plans to introduce autonomous mobility, including greater productivity, more space, and lower emissions (See Exhibit).

Image 2 - Hence, new transportation solutions evolve to supplement and replace existing ones, UAM being one of many solutions



Why Massachusetts?

In addition to the pressing need to transform mobility to ensure a sustainable and equitable future for the Commonwealth, Massachusetts has a demonstrated capability in leading the world in innovative industries. Massachusetts is a world-renowned center for the life sciences, fintech, and biotech industries. All these industries were in a similar stage of development to mobility technology when the Commonwealth sought to build a winning position in them. How has Massachusetts been successful? The Commonwealth has several notable characteristics which are well suited to these and the nascent mobility technology and Advance Air Mobility industries:

Support for new businesses: Massachusetts has a history of acting as an incubator for high-potential technology industries and companies, is home to world-leading educational institutions (primarily in areas - technology and engineering – that are critical to mobility technology) and provides a supportive environment for businesses at an early growth stage.

Agile policy making: With state and local leaders dedicated to progress and innovation, Massachusetts has the policymaking ability to make mobility technology work. It also has one of the lowest corporate tax rates in the US, ranking in 39th place among all states. Time and time again, the Commonwealth has shown a willingness to organize and move quickly when faced with a substantive opportunity, driven by the entrepreneurial spirit of the state's political leaders.

The Commonwealth also has the potential to reap significant and compelling benefits by developing a mobility technology ecosystem that connects its more rural and less developed parts with the greater Boston and Worcester areas. By focusing on Massachusetts' "gateway" cities and other communities that are less well connected, mobility technology providers can build transportation corridors that provide mobility at a reasonable cost – creating opportunities for citizens and companies located across the state.

Massachusetts already enjoys a tremendous starting point for establishing itself as a world leader in mobility technology through early partnerships with NASA, the World Economic Forum, and private companies. By combining these partnerships with the cutting-edge research in enabling technologies being carried out in the state's leading institutions - such as MIT and Endicott College, among others – Massachusetts has already taken significant steps in the right direction.

Introducing Advanced Air Mobility

Advanced Air Mobility involves the development of air transportation systems that move people and cargo between places previously not served or underserved by aviation – local, regional, intraregional, urban – using revolutionary new aircraft that are only just now becoming possible. Over the next few decades, AAM-enabled vertical-take-off-and-landing (VTOL) vehicles and last-mile delivery drones will transform the way that people and cargo are transported.

AAM offers an exciting opportunity for Massachusetts. We estimate that if the Commonwealth were to take an innovative approach to leading in the development of AAM, the industry could generate annual revenues (from passenger tickets and per-delivery cargo fees) of up to \$1.1 billion by 2040, create up to 9,000 jobs, and deliver an annual reduction in CO2 emissions of at least 21,000 tons.

The full economic opportunity for Massachusetts exceeds this figure after taking into account how the technological expertise developed for Advanced Air Mobility would enable the Commonwealth to serve other areas of the mobility technology market, such as self-driving cars and software-based automotive design.

In addition to economic and job creation benefits, a thriving AAM market would allow Massachusetts to provide new transport connections, making access to transportation more equitable. Such a market would also permit residents to access goods and services faster and provide a congestion-free alternative to road travel.

Since AAM vehicles would be powered by electricity, sustainable aviation fuel, or hydrogen, users would benefit from green modes of transportation. By taking the lead in this important area, the Commonwealth would also have a head start in integrating new mobility technologies into existing transportation systems.

An Overview of Advanced Air Mobility Technology

AAM vehicles will fall into two broad groups. Small AAM drones with a combined weight and payload of under 55lbs will be used for last-mile package deliveries, while larger AAM vehicles will transport passengers or carry bigger cargo consignments.

These larger aircraft will take off and land vertically. They will have the capacity to carry two to eight people and fly distances of up to 300 miles. Many will be electrically propelled, making them quieter and more energy efficient than conventional aircraft. In addition, they will occupy the airspace in the earth's atmosphere below commercial airliners.

In the near term, vehicles carrying passengers or larger cargo consignments will be guided by an on-board pilot. But over time, they will become more autonomous. Initially, a single vehicle will be remotely controlled by one individual, although technological improvements should eventually allow several vehicles to be guided by just one person.

There are many other potential AAM use cases that would benefit society. These include aerial infrastructure inspections, adoption by the emergency services or military, and even mundane tasks such as window-washing or de-icing buildings.

Using AAM to transport passengers or make last-mile package deliveries is rapidly gaining the attention of investors and early adopters. In recent months, high-tech, traditional retailers and logistics players, including Amazon, Walmart, Google, Uber, FedEx and UPS, have announced plans to use remotely guided drones for parcel and air cargo deliveries. Meanwhile, aerospace companies including Boeing are testing autonomous passenger vehicles.

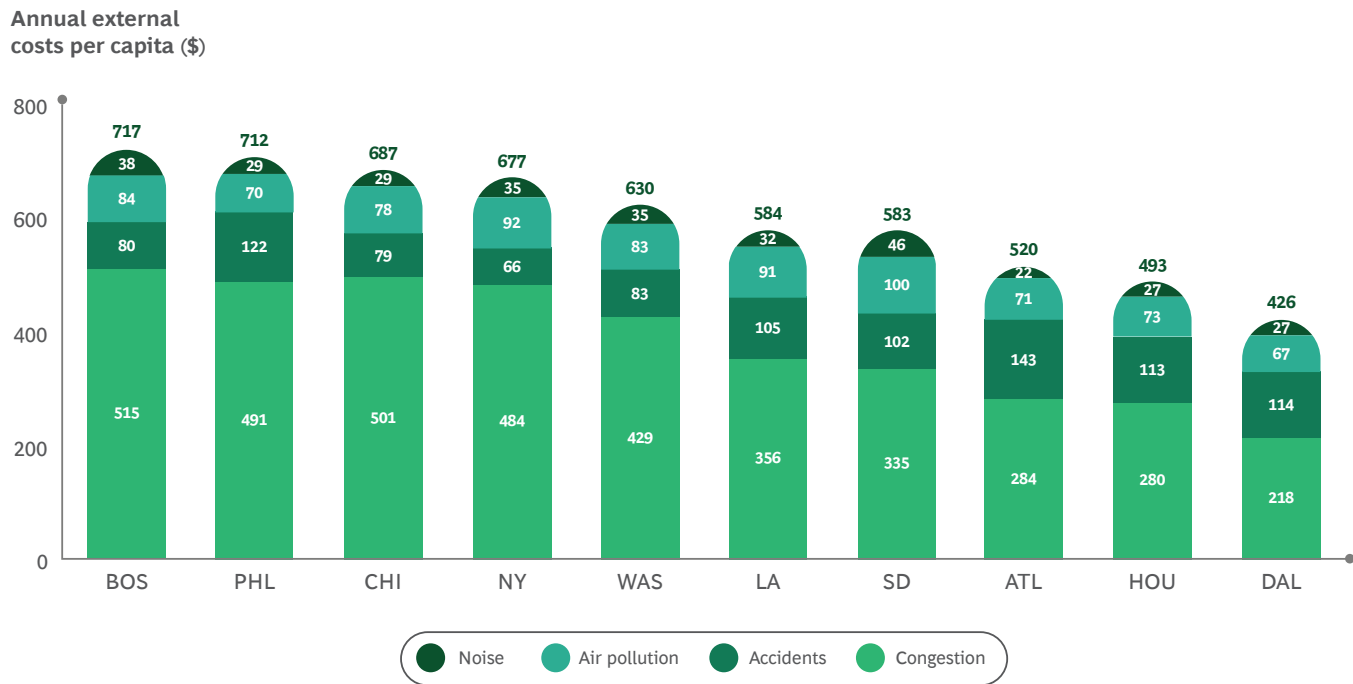
The Market Opportunity

Several transportation challenges are creating the momentum for a shift towards AAM

- Growing urbanization and higher population densities in cities are exacerbating pollution and congestion caused by passenger vehicles and the increasing number of freight trucks.
- The transportation sector worldwide is under greater pressure than ever to decarbonize and transition to greener modes.
- The rise in e-commerce, and consumer expectations for ever faster delivery times, are creating a need for more efficient delivery methods. These can't come soon enough: the number of packages delivered worldwide is set to climb to 200 billion, up from fewer than 90 billion in 2018.

AAM can help address these challenges. Take the costs to cities from last-mile delivery vans. A BCG study which examined the external costs of last-mile delivery in US cities in 2021, ‘Only an Ecosystem Can Solve Last-Mile Gridlock in Package Delivery,’ found that these costs worked out at \$717 per capita in Boston, higher than any other urban center. (See Exhibit 1). However, by operating above congested city areas, AAM technologies could mitigate these negative impacts and additional costs while also meeting consumers’ delivery needs.

Exhibit 1 - The External Costs of Last-Mile Delivery Are High



Source: European Commission, Directorate-General for Mobility and Transport; BCG analysis,

Note: Each type of external cost is calculated differently. Accidents and air pollution costs are determined in terms of healthcare costs; congestion costs are determined in terms of the value of lost time

In this report, we have set out to gauge the potential future size of the AAM market in 2040 in Massachusetts. Market size projections for AAM can vary widely depending on assumptions about regulations and technological progress. For instance, the application of military VTOL technologies to commercial vehicles, and the use of drones to carry packages, are still under development. How AAM vehicles will be regulated is also yet to be determined but will impact the market’s trajectory.

Consequently, for the purpose of our study, we have concentrated on the number of passenger and cargo trips that we expect to be handled by AAM vehicles in 2040. By this time, a mature market should be in place. We have focused on use cases that will interface directly with consumers, are the most viable, and will make up the bulk of AAM trips, while recognizing that new use cases may yet emerge that significantly disrupt the market.

We have included in our modeling three ‘archetypal’ passenger trips and three cargo trips, as follows:

Passenger journeys:

Shuttle trips to Boston-Logan International Airport: AAM vehicles could operate regular shuttle routes between vertiports (airports for VTOL aircraft) located across Massachusetts and Logan airport in the state capital. AAM would offer greater range and more connections than existing travel options such as ride-hailing services, rental limousines, and dedicated airport bus operations. For example, it would provide fast, reliable travel for executives flying into Boston to attend a business conference in nearby Worcester.

On-demand air taxis: AAM could provide a congestion-free alternative to conventional taxis, rented limousines, and ride-hailing services for point-to-point travel on demand. For example, a couple visiting the Boston area might choose to try out a new restaurant in Lawrence because of the ease of travelling by air from a vertiport near their hotel to a vertiport close to the restaurant.

Regional airline replacements: AAM could act as a replacement for scheduled short-haul flights (i.e., less than 200 miles) currently served by regional airlines, either within the Commonwealth of Massachusetts or into and out of the state. Because AAM vehicles would use dedicated vertiports, they would not have to rely on one of Massachusetts' eight airports. For example, a caterer from Dorchester who wanted to expand her service area would have far greater freedom to travel to clients in Cape Code and Martha's Vineyard, or even further afield.

Cargo journeys:

Courier services: In future, AAM vehicles could provide point-to-point courier services for businesses and public-sector organizations that wanted to eliminate delays and extra costs caused by road traffic congestion. For example, AAM could be used to carry medical test samples from Springfield in the west of the state to a laboratory at Massachusetts General Hospital in Boston via a hired courier.

On-demand rapid deliveries: Drones and other AAM vehicles could be used to make rapid business-to-consumer deliveries of groceries or medicines from a distribution center or retailer to an individual consumer. Currently, retailers such as Walmart offer road-based delivery services, within a given time slot, for customers who order on-line. However, by using drones rather than road vehicles, they could deliver far more quickly. To give a local example: a care home in Brockton could meet a resident's urgent need for a specific medicine by using a remotely controlled drone to pick up the prescription from a specialty pharmacy in Milford.

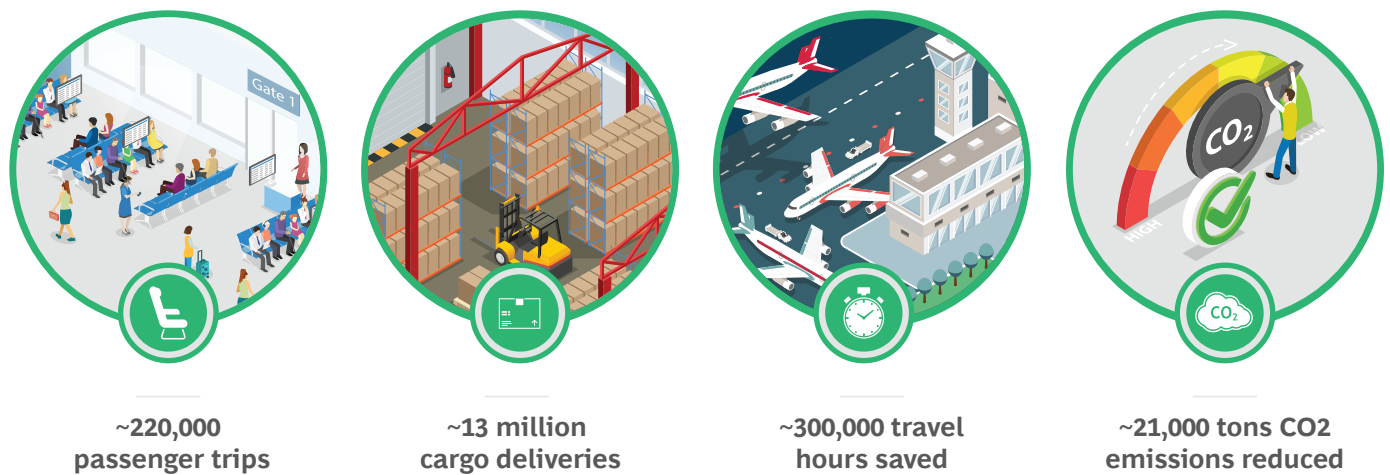
Last-mile express deliveries: Parcel delivery companies that currently use vans for last-mile express deliveries could enhance their offering by deploying drones to take parcels from road vehicles to the purchaser's doorstep. Several drones could potentially operate from the roof of a single van, enabling companies to cover a bigger area and serve neighborhoods more efficiently.

Our Findings

Using these six journey types as the basis for our analysis, we estimate that the AAM market in Massachusetts could be worth up to \$1.1B in revenues in 2040 based on constant 2022 dollars.

A Massachusetts AAM market of this size would translate into around 220,000 passenger flights and 13 million cargo deliveries a year. It would also deliver a 21,000-ton reduction in annual CO₂ emissions and cut the amount of time residents spend on travel each year by 300,000 hours (See Exhibit 2).

Exhibit 2 - Modeled annual AAM impact in Massachusetts



Source: BCG AAM market model

These annual figures would be equivalent to 600 daily passenger trips and 36,000 daily cargo deliveries in Massachusetts alone.

Economic and Job Creation Benefits

Based on these findings, a significant opportunity exists for Massachusetts to create jobs and grow its economy through AAM. To realize this potential, policymakers must establish the Commonwealth as a first mover to build an industry serving the nation-wide AAM market demand as well as its own. By capitalizing on its existing technological prowess, seen already in biotech and high-tech R&D, and capturing a larger slice of the US AAM market – pri-

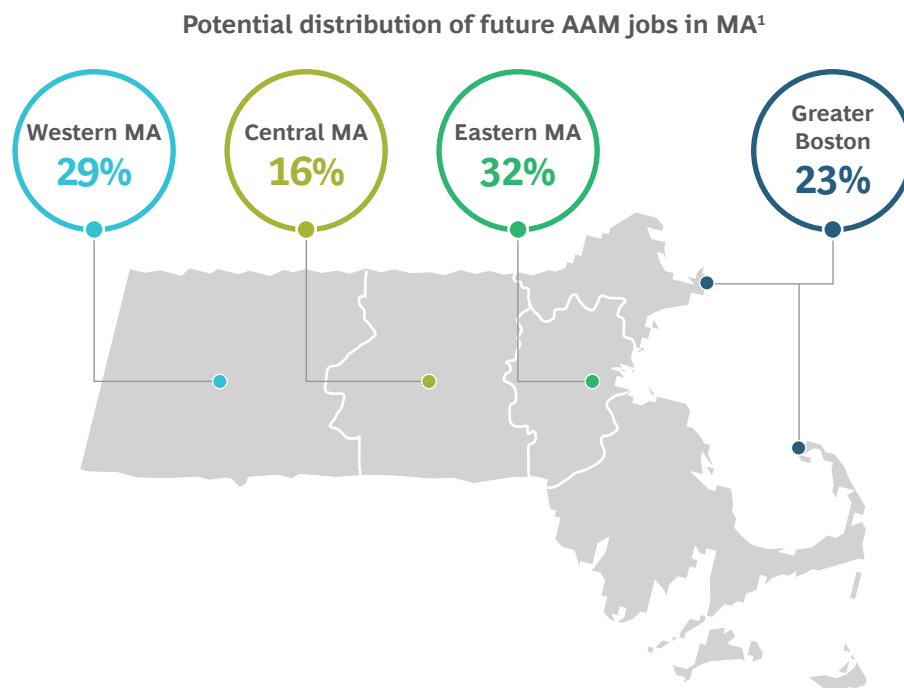
mary through software and data services – Massachusetts could create an up to 9,000 jobs falling into the following categories:

- Artificial intelligence and data service jobs: Up to 1,700
- Flight operations jobs (on-board pilots and ground-based flight operators): Up to 1,450
- Avionics manufacturing jobs: Up to 1,200
- Maintenance, repair, and overhaul (MRO) jobs: Up to 800
- Ground operations jobs (vertiport maintenance, cargo handling etc.): Up to 100
- Customer service jobs: Up to 250 jobs
- Additional AAM supporting jobs (insurance reps, utility electricians etc.): Up to 500
- Induced jobs (employment in surrounding economy due to the increased spending power of AAM created employment): Up to 2,700

Furthermore, we anticipate that AAM-related jobs would be distributed throughout the state, with 70% located outside the Greater Boston area, creating widely spread development benefits in line with policymakers' goals (See Exhibit 3).

By moving first and serving the wider US market, Massachusetts could build a significant advantage lasting decades because of the high barriers to entry faced by other states (including technology requirements and the relatively small market size in individual states). However, if Massachusetts doesn't act urgently, another state certainly will.

Exhibit 3 - Potential distribution of future AAM jobs in MA1



These 4 geographies align with the 7 workforce regions as Eastern (Berkshire & Pioneer Valley), Central (Central), Eastern (Northeast, Southeast, Cape & Islands) and Greater Boston

Sources: Dept Economic Analysis RIMS data, BCG Analysis; Regional economic development blueprints (from Mass.gov)

This more aggressive scenario may still be understating the benefits that Massachusetts could achieve since it is based on six use cases. We have not included jobs that could be generated in the state through the development of infrastructure, such as the building of vertiports, as the Massachusetts AAM market ramps up through 2040.

In addition, we have excluded synergistic jobs created as the technological expertise in data systems and artificial intelligence that Massachusetts builds for use with AAM vehicles carries over into other mobility technology areas, such as self-driving cars, leading-edge marine propulsion, and software-based automotive design. Policy makers will need to conduct a thorough economic impact assessment to evaluate the number of jobs that could exist in a mature Massachusetts AAM market due to these additional employment opportunities.

Environmental and Energy Efficiency Benefits

Among our passenger transport use cases, using VTOL vehicles powered by electricity or sustainable fuels in place of regional aircraft that run on jet fuel will be especially advantageous for the environment, saving 5,800 tons of CO₂ emissions each year (assuming a \$200 million market size) and providing additional air quality benefits.

AAM cargo transportation will deliver the greatest environmental benefits overall. Drones that are powered by electricity and take the most direct route to their destination will be more energy efficient, and generate less CO₂, than delivery trucks (even assuming the emissions of road vehicles improve). In addition, trucks that use multiple AAM drones to make last-mile parcel deliveries will be more efficient than existing single-vehicle delivery services. According to our analysis, the emissions savings from on-demand rapid deliveries of groceries and similar items will be especially significant because of the high frequency of this category.

AAM Will Bring Other Benefits to the Commonwealth

As well as the economic and employment benefits outlined above, there are several other advantages that Massachusetts could gain by facilitating a thriving AAM market.

Regional Economic Development

Equitable access to AAM jobs is as important as access to the technology itself. In their current regional economic development plans, all seven Massachusetts regions already highlight mobility technology sectors which will form an important part of the AAM value chain, including vehicle operations, manufacturing, and AI/data-based systems. These sectors will be the largest employers of AAM workers. Economic development regions within Massachusetts should start now to formulate plans on how best to attract companies in these sectors if they want to be first movers in these areas. Furthermore, the state government should consider regional job development when weighing how to use its purchasing power, tax policies, and regulations to encourage AAM.

Many Gateway Cities are already well placed to host AAM jobs and industries. Here are a few examples:

- **Taunton:** Semiconductor and electronics manufacturing firms located in the city could transition easily to AAM manufacturing.
- **Holyoke:** The city hosts the Massachusetts Green High Performance Computing Center, providing state-of-the-art infrastructure for computationally intensive research.
- **New Bedford:** The Bridgewater State University Flight Center has the potential to train AAM vehicle operators.
- **Pittsfield:** The headquarters of the missions system division of General Dynamics are located here. Expertise in missions systems could support the development of MRO, avionics manufacturing, and Unmanned Traffic Management (UTM) systems for AAM vehicles.
- **Salem:** The city is a leader in supporting vehicle electrification and was one of the first to introduce EV charging stations.
- **Barnstable:** Both Cape Cod airfield and Barnstable municipal airport are located close to the city, making it an ideal location to develop AAM-enabled tourism.
- **Quincy:** Multiple professional services firms, insurers, and aviation operations, including Icelandair's North American headquarters, are located in Quincy.

Artificial intelligence (AI) and data-based services

AI and data-based services form critical parts of the AAM value chain and are also key enablers for the broader mobility technology market. For example, using AI to guide trucks and other road vehicles will reduce emissions in cities around the world. By establishing thriving AAM-focused industries in AI and data-based services within the Commonwealth, Massachusetts would have the potential to also serve the needs of this broader market. At the same time, insights gained from applying AI and data-based systems to non-AAM travel modes would enhance the AAM value proposition.

Other AAM use cases

While our market sizing analysis is based on six use cases (the largest by revenues and most viable ones), other use cases could emerge that were also profitable. In the area of middle-mile logistics (the transporting of goods from a warehouse to a store or fulfillment facility), distribution companies could use AAM rather than a road vehicle or cargo plane provided the technology overcomes weight and range constraints. If successful, these use cases would increase the size of the AAM market in Massachusetts and bring additional emissions reduction benefits.

As mentioned above, emergency services, including the police, firefighters, and medical responders, could use AAM vehicles to enhance response times. These public-sector use cases would probably not have a significant economic impact, as they are unlikely to represent a big source of demand. But they would improve the public services that the Commonwealth provides for its citizens. As a purchaser of AAM equipment, the state would also have a bigger say in how manufacturing and support jobs were distributed.

Key Enablers Helping Massachusetts to Reap the Benefits of AAM

Policymakers will need to overcome significant challenges to make AAM a reality in Massachusetts. We've identified seven key enablers to achieve a successful AAM market in the state:

Safety and planning. An effective regulatory and policy framework that meets the requirements of national organizations such as the Federal Aviation Administration will be required to ensure that AAM is safe and develops in a controlled way. To start with, AAM will need to be incorporated into the Commonwealth's long-term strategy and planning activities. An ecosystem of emergency services and law enforcement will need to be created and properly equipped to support AAM operations.

Public support. To succeed, AAM technology must first gain acceptance among Massachusetts' residents. Public concerns about noise and other factors will need to be understood and addressed. AAM players will have to work closely with local and city governments to ensure that public interests are upheld. Community engagement will also be key to communicate the societal benefits of AAM and create demand for services.

Infrastructure. Unlike small drones, larger VTOL vehicles – whether crewed or uncrewed – will operate out of vertiports. These facilities will provide the infrastructure for vehicles to take off and land, charge up or refuel, and enable personnel to carry out maintenance. The more vertiports that Massachusetts possesses, the more convenient AAM transportation is likely to be for the Commonwealth's residents, and the more popular and successful AAM will become. We recommend that policymakers consider retrofitting some existing airports so that they also offer AAM facilities to reduce costs. Telecommunications networks and ground-based sensors will also be needed to support AAM operations.

Air space management. New systems and processes will be needed so that cargo drones and passenger VTOLs can navigate air space alongside conventional aviation. In addition, a clear plan will be required setting out how these systems will evolve over time as the volume of AAM trips increases.

A skilled workforce. To succeed, AAM players will need a strong talent pool in the following areas: advanced manufacturing; avionics; AI, data systems and software; flight operations (for on-board and remote piloting); maintenance and repair; air traffic control; and training.

Industry players. A robust ecosystem will need to be established, comprising AAM operators, manufacturers, AI and tech developers and other players. These companies will need to be encouraged to set up operations or relocate to Massachusetts so they can invest resources, and develop and scale technologies, unlocking new AAM markets and use cases.

Industry coordination: Cross-industry alignment, led by members of ITF, will play an essential role in making AAM a success. Activities will need to focus on coordinating planning and funding across the AAM ecosystem, partnering with national bodies (like NASA) and other states, and annual reports on progress, barriers, and learnings.

Conclusion

By making the air-based transportation of goods and passengers for short trips and last-mile deliveries routine, AAM will usher in a new era of mobility. Using drones and VTOL vehicles, consumers and companies will be able to avoid many of the problems of road-based transportation. And while the technologies behind them will be cutting-edge, AAM vehicles won't just be toys for the rich. All parts of society will benefit from the convenience and efficiency that AAM will bring.

By leading in Advanced Air Mobility, the Commonwealth will also be in a stronger position to capture benefits in the broader mobility technology market. However, Massachusetts will need to act early and make the most of its existing strengths in innovation, high-tech skills, and entrepreneurship if it is to build an unassailable advantage over competitors. The Commonwealth can start by creating a dedicated office to oversee and coordinate AAM activities in the state. It should also take steps to attract innovators in the AAM space, for instance by easing regulations. It should support relevant R&D and create the right frameworks for public and private-sector partnerships. And it should factor AAM into its capital investment proposals, multi-modal strategies, and skills development and regional development plans. (We will explore these action steps in the AAM roadmap, which will set out detailed milestones and provide a pathway to a thriving market).

There is much to do. But the view from the top is worth the climb. And by starting on the ascent now, Massachusetts can leave competitors far behind.

Note on methodology

Modeling the economic, environmental, energy efficiency, and employment impacts of the AAM Market in Massachusetts

- **Economic impact.** We used a top-down, demand-driven approach based on projected travel patterns for people and cargo in Massachusetts in 2040 MA. AAM demand is estimated based on the number of trips per year, multiplied by the projected revenue per trip. This process was repeated for all six use cases. Our estimates for projected demand were based on instances where AAM provided greater convenience and efficiency at a comparable cost. By using premium passenger travel options as the addressable market and sticking to just six use cases, the economic impact of our estimates is likely to be on the conservative side.

We chose 2040 for our calculations because it allows time for the maturing of nascent industries and supporting infrastructure, moderate improvements to key technologies, and the resolution of political and public acceptance hurdles. 2040 also aligns with Massachusetts' long-term transportation plan.

Among our main assumptions, we have assumed that, while AAM use cases will create more transportation connections, overall demand will not be materially changed by AAM technologies. We expect key enabling infrastructure to be available for AAM use. AAM operating costs will include the use of infrastructure, but not development and construction costs.

- **Employment.** Our approach included a value chain-based analysis that used the US Bureau of Economic Analysis's Regional Input-Output Modeling System (RIMS). AAM revenues (projected in our economic impact analysis) are allocated proportionally to AAM-supporting industries in the value chain and represent increased economic demand for those industries. The increase in demand (in US dollars) is then used to estimate the number of jobs created in Massachusetts by means of the RIMS tool.

The AAM value chain included avionics manufacturing; AI/data-based services; flight operations (on-board and ground-based pilots/operators); vertiport/ground facilities; maintenance, repair, and overhaul (MRO); customer services; and other (insurance, energy, etc.).

A bottom-up cost structure was used to determine the relative sizes of value-chain industries. Our modeling used current airline cost reports and projections of the technical capabilities of AAM vehicles to estimate what percentage of costs would be spent on avionics manufacturing, AI/data services, and so on. This percentage was then applied to overall demand to measure the sub-industry's size.

We assumed that, with the exception of AI/data-based services, value chains supporting AAM would be similar to those which support the automotive and airline industries.

- **Environment & Energy Efficiency.** A comparative trip analysis was used. Average projected AAM flight times, energy usage and emissions saved were compared with those for ground-based transportation options for the same trip. The differences between the two were multiplied by the annual number of trips.

Our key assumptions were that ground-based travel modes would become more energy efficient and meet Massachusetts' emissions reduction targets for 2040 (the Commonwealth is targeting carbon net-neutrality by 2050). However, congestion and travel times would remain roughly similar. Our technical assumptions were that AAM vehicle capabilities (flight times, energy usage) would show only modest improvements over capabilities today.

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