Advanced Air Mobility (AAM)

FUTURE OUTLOOK FOR DELAWARE

Final Report: Sections 1-5

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TABLE OF CONTENTS

SECTION 1

Background Research for Advanced Air Mobility

SECTION 1: BACKGROUND RESEARCH FOR ADVANCED AIR MOBILITY (AAM)

1.1. Introduction to AAM

AAM represents an emerging aviation sector that utilizes innovative technologies to enhance the movement of people and goods. This sector includes various types of aircraft such as electric vertical takeoff and landing (eVTOL) vehicles, conventionally powered VTOL aircraft, drones, and supporting infrastructure. AAM encompasses several use cases including urban air mobility (UAM), regional air mobility (RAM), cargo delivery, emergency response, and private/recreational use. The primary objective of AAM is to improve transportation efficiency by leveraging new aircraft technologies and operational concepts to offer on-demand air transport services.

Importance and Potential Impact on Transportation in Delaware

The implementation of AAM in Delaware holds significant potential to improve the State's transportation functions. Delaware, situated within the densely populated BosNYWash corridor, is well-positioned to benefit from AAM due to its strategic location and existing transportation infrastructure. Potential positive impacts of AAM in Delaware include:

- Enhanced Connectivity: AAM can offer faster and more direct transportation options between key urban and rural areas, improving accessibility and reducing travel times.
- Workforce Development: The adoption of AAM technologies can stimulate local economies by creating new job opportunities in manufacturing, maintenance, operations, and other related sectors.
- Environmental Benefits: By promoting the use of electric and hybrid propulsion systems, AAM can contribute to reducing greenhouse gas emissions and noise pollution compared to traditional aircraft.
- Emergency Response: AAM can enhance emergency medical services and disaster response capabilities by providing rapid transportation options for critical situations.

Comparison with Traditional Air Transportation Methods

Traditional air transportation relies heavily on fixed-wing aircraft operating from large airports, which often require extensive infrastructure and long runways. In contrast, AAM focuses on the use of smaller, more versatile aircraft that can operate from a variety of locations, including existing airports, vertiports, and heliports. Key differences between AAM and traditional air transportation include:

- Infrastructure Requirements: In addition to locating vertiports at airports, AAM requires the development of vertiports and charging stations, which can be more easily integrated into urban environments compared to large airports.
- Operational Flexibility: AAM aircraft, such as eVTOLs, can take off and land vertically, allowing them to operate in confined spaces and closer to passenger destinations.
- Sustainability: AAM technologies prioritize the use of electric and hybrid propulsion systems, which offer environmental benefits over traditional jet fuel-powered aircraft.

Developmental Constraints

The development and implementation of AAM in Delaware will face several constraints related to regulatory frameworks, planning, infrastructure needs, and funding.

- Regulatory Constraints: Establishing certification processes and safety standards for new AAM technologies is technically difficult and time-consuming. This involves coordination with the Federal Aviation Administration (FAA) to ensure compliance with existing regulations and their development of new guidelines tailored to AAM operations. Integrating AAM operations into the national airspace system may require software and control systems not yet developed.
- Planning Constraints: Identifying suitable locations for vertiports and other AAM infrastructure within urban areas will require collaboration with local planning and zoning authorities. This includes addressing potential land use conflicts and ensuring community acceptance. For this reason, locating vertiports at existing airports is highly viable. These facilities would have the advantage of existing aviation use, greater acceptance by the public relative to new urban vertiports, and fewer environmental impacts such as noise pollution, visual pollution, and the potential effects on wildlife and natural habitats.
- Infrastructure Needs: Establishing vertiports in strategic locations and equipping them with the necessary amenities, including charging stations, passenger waiting areas, and maintenance facilities will be challenging. Again, using existing airports in Delaware to the maximum extent possible would help alleviate the initial funding and logistical pressures associated with AAM.
- Electric Grid: Charging stations at AAM facilities may present a challenge to Delaware's electric grid. A typical AAM charging station may operate at 500 kilowatts, and if demand necessitates 24/7 charging of eVTOL aircraft, one station would require more electricity than

400 typical American households. Investments in grid capacity and the development of localized microgrids may be necessary to support high-speed charging infrastructure.

- Funding Constraints: Significant capital investment is required to develop AAM infrastructure, including vertiports, charging stations, and supporting facilities. This will likely involve a combination of public and private funding sources. Collaboration between government entities, private companies, and other stakeholders will be essential to secure funding and drive the development of AAM infrastructure.

Locating Vertiports on Existing Airports

Integrating AAM into Delaware's transportation network can be significantly enhanced by utilizing existing airports as vertiport locations. This approach better uses existing infrastructure, reduces development costs, and accelerates the deployment of AAM services.

In addition to the publicly owned airports in the state (Wilmington, Delaware Airpark, and Delaware Coastal Airport), Delaware is home to several privately-owned public use airports, including Smyrna, Jenkins, Chandelle, Chorman, Summit, and Laurel. Using these airports as needed for landing sites and vertiport locations for AAM can jumpstart the adoption of this new technology. This gives the State further interest in preserving the privately owned public-use airport system in Delaware.

Using Delaware airports for collocated vertiports can provide numerous benefits:

- Infrastructure Utilization: Existing airports have established runways, maintenance facilities, and airspace designations that can be adapted for AAM operations.
- Cost Efficiency: Utilizing current infrastructure can lower the need for new construction, significantly reducing capital expenditure.
- Community Engagement: These airports already serve local communities, making them familiar and potentially more acceptable locations for new AAM services.

To effectively integrate AAM, on-airport plans should include:

- Designated Vertiport Areas: Specific zones within airports should be allocated for vertiports, ensuring seamless integration with existing aviation activities.
- Charging and Maintenance Facilities: Establishing high-capacity charging stations and maintenance hangars within airports will support the operational needs of eVTOL aircraft.
- Passenger Amenities: Airports should consider the future need for amenities such as waiting lounges and auto parking facilities tailored for AAM passengers.

In addition to collocating at existing airports, developing new vertiports in strategic urban and suburban locations in Delaware will be important in the future:

- Urban Integration: New vertiports can be strategically placed in urban centers to provide convenient access for passengers, reducing travel time to and from the airport.
- Infrastructure Expansion: These new vertiports can be designed with the latest technology, including advanced air traffic management systems and sustainable energy solutions.
- Economic Development: Building new vertiports can stimulate local economies by creating jobs and attracting investment in AAM infrastructure.

1.2. Early Visions and Expectations for AAM Technology

The concept of AAM has evolved significantly since its inception. Early visions of AAM were characterized by a high level of enthusiasm and optimism, largely driven by the potential for revolutionary changes in urban transportation. Concepts such as electric vertical takeoff and landing (eVTOL) aircraft promised to alleviate urban congestion, reduce travel times, and provide new forms of mobility in both urban and rural settings[1]. These early projections envisioned a future where eVTOLs would dominate the skies, offering quiet, efficient, and environmentally friendly alternatives to traditional forms of transportation.

Since the early enthusiasm, there has been a realization of the challenges facing the opportunities. While early visions were ambitious, practical considerations related to battery technology, regulatory frameworks, and infrastructure needs have shaped the current trajectory of AAM development.

Initial Projections and Enthusiasm for Battery-Powered Electric Engines

The initial excitement around AAM technology was predominantly centered on electric propulsion, which was seen as a key enabler of AAM due to its potential for reducing noise, emissions, and operational costs. Early projections suggested that advancements in battery technology would soon make it feasible for eVTOLs to achieve significant ranges and payload capacities, thereby transforming urban mobility.

This period saw substantial investments in research and development, with numerous startups and established aerospace companies exploring the possibilities of electric aviation. The collaboration between NASA and Uber in 2017, for instance, epitomized the high hopes for creating

[1] Avitech Hub, "The Future of Aviation: Exploring eVTOL Aircraft Technology," modified September 11, 2024, https://avitechhub.com/evtol-aircraft-future-aviation-technology/.

a viable urban air mobility market. However, as the technology matured, several challenges related to battery energy density, weight, and charging infrastructure became apparent, leading to a reassessment of initial expectations[2].

Overview of Key Milestones in AAM Development Over the Past Decade

Since 2014, there have been a number of key milestones in the development of AAM technologies:

- 2014-2016: Early Prototypes and Testing
  - Companies like Joby Aviation, Volocopter, and Lilium began testing early prototypes of their eVTOL aircraft.
  - NASA initiated its AAM project to explore the potential of urban air mobility and develop a regulatory framework[3].
- 2017-2019: Regulatory Progress and Public Demonstrations
  - The FAA started granting waivers for Beyond Visual Line of Sight (BVLoS) operations, facilitating more advanced drone and eVTOL testing.
  - Public demonstrations by companies such as Volocopter in Dubai showcased the new technology.
- 2020-2022: Increased Investment and Pilot Programs
  - The global AAM market valuation reached $8.2 billion in 2022, with projections for significant growth[4].
  - Companies like Joby Aviation and Archer Aviation secured major investments from corporations such as Toyota, Intel, and United Airlines.
  - Pilot programs and test flights increased, with significant progress in safety certifications and air traffic management systems.
- 2023-2024: Commercial Expansion and Infrastructure Development
  - Major milestones achieved in eVTOL flight testing and certifications, including Joby Aviation reaching 8,000 flight hours and regulatory advancements by FAA and EASA. In addition, Joby Aviation recently received the FAA's approval to use ElevateOS, its in-house software, as it gears up for commercial air-taxi operations by 2025.
  - Infrastructure development for vertiports and charging stations began in earnest, supported by partnerships between aerospace companies and local governments.

[2] Peter Schmidt, COO Transcend Air, "AAM as Reality Sets In," Delaware Aviation Summit, January 31, 2024.
[3] Mary Lou Jay, Composites Manufacturing Magazine, "EVTOLs Closer to Lift Off," modified September 11, 2024, https://compositesmanufacturingmagazine.com/2024/02/evtols-closer-to-lift-off/
[4] FTI Consulting , "Sky Limit Advanced Air Mobility Market," modified September 11, 2024, https://www.fticonsulting.com/insights/fti-journal/sky-limit-advanced-air-mobility-market.

Investment in AAM Aircraft Types

Investment in AAM has been strong, driven by the potential for high returns and the transformative impact of the technology on transportation. The global AAM market, valued at $8.2 billion in 2022, was expected to nearly double to more than $14 billion by January 2024. This market is projected to grow at a compounded annual growth rate of 24.6% from 2023 to 2035, potentially reaching $137.11 billion by 2035.[5]

Some have argued that the financialization of the global economy has contributed to the significant investment in AAM. They believe that with enough "hype" a bad idea can garner significant investment from private equity firms and large capital markets. To them, this explains the rush of capital into AAM. It is only a matter of time before the market separates the good ideas from the bad – the products that will work from those that won't. At that time, there will be winners and losers in the AAM industry.[6]

1.3. Industry Players and Key Collaborations

The AAM sector is rapidly evolving, driven by significant contributions from companies ranging from innovative startups to established aerospace giants. Among the frontrunners in this space is Joby Aviation, a California-based company that has conducted extensive flight testing of its electric vertical takeoff and landing (eVTOL) aircraft. Joby's progress has been bolstered by a strategic partnership with Toyota, leveraging the automotive giant's manufacturing expertise to accelerate the development and testing phases. This collaboration has positioned Joby at the forefront of the AAM industry, supported by substantial investments from major corporations.

Similarly, Archer Aviation has emerged as a key player, focusing on the development of eVTOL aircraft designed for urban air taxi services. Archer's aircraft have shown promising results in test flights, thanks in part to significant investments from United Airlines and Ark Invest. The partnership with United Airlines has been particularly valuable, providing Archer with critical insights into operational requirements and market needs.

Volocopter, a German company, has also made notable strides in the AAM sector. Known for its eVTOL designs, Volocopter has conducted numerous high-profile public demonstrations, including a significant showcase in Singapore. Financially backed by Daimler and Japan Airlines, Volocopter has benefited from substantial support in advancing its urban air mobility solutions. This financial

[5] Grand View Research, "Advanced Air Mobility Market Size & Share Report, 2035," modified September 11, 2024, https://www.grandviewresearch.com/industry-analysis/advanced-air-mobility-aam-market-report.
[6] Peter Schmidt, Op. cit.

backing has been instrumental in supporting the company's testing and certification processes, bringing its aircraft closer to commercial readiness.

Another notable player is Lilium, a German-based company developing an all-electric vertical takeoff and landing jet for regional air mobility. Lilium's innovative approach aims to transform regional transportation, and the company has received major backing from Google Ventures and Fidelity.

Beyond these leading companies, several other significant players are contributing to the advancement of AAM technologies. Eve Air Mobility, a subsidiary of Embraer, focuses on developing urban air mobility solutions, including eVTOL aircraft and supporting infrastructure. BETA Technologies, an American company, is working on electric aviation solutions that include both eVTOL and fixed-wing aircraft. Vertical Aerospace, a UK-based firm, is developing eVTOL aircraft with a strong emphasis on safety and efficiency. Meanwhile, Airbus continues to explore urban air mobility through its CityAirbus project, showcasing the involvement of traditional aerospace giants in this emerging sector.

Other companies, such as General Motors, Honeywell, Airo Group Holdings, Textron, ResilienX, and Wingcopter, are also developing various AAM aircraft types, including hybrid-electric aircraft and autonomous drones.

Collaboration is a cornerstone of progress in the AAM sector, with numerous partnerships formed to advance technology, develop infrastructure, and establish regulatory frameworks. A notable example is the partnership between NASA and AFWERX, focused on developing a digital operations center for AAM. This collaboration aims to streamline operations and enhance safety through advanced data integration and management systems. Another significant partnership was initially formed between Uber Elevate and NASA, which explored urban air mobility and developed operational frameworks. Although Uber has since sold its Elevate division, the research and insights gained continue to benefit the industry.

In Europe, the European Union Aviation Safety Agency (EASA) works closely with industry players like Volocopter and Lilium to establish certification processes and safety standards for eVTOL aircraft. In the United States, the FAA collaborates with AAM companies and research institutions to develop regulatory guidelines and integrate AAM into the national airspace system. A recent Memorandum of Understanding (MOU) between the FAA and AFWERX highlights a significant step towards integrating AAM technologies, focusing on sharing flight test data and accelerating regulatory changes to support the safe integration of eVTOL and autonomous aircraft.

1.4. Shift from Battery-Powered to Hybrid Systems and Sustainable Aviation Fuels

While early efforts in AAM focused primarily on battery-powered electric engines, recent developments have seen a shift towards hybrid propulsion systems. This shift addresses some limitations of battery technology, including energy density, weight, and charging infrastructure. Notable components in this shift include:

- Battery-Powered Systems: On paper, battery-powered systems offer significant advantages such as zero emissions during operation, low noise levels, and simpler mechanical systems with fewer moving parts, potentially leading to lower maintenance costs. However, they face critical limitations due to current battery technology, which restricts energy density, range, and payload capacity. Additionally, they require long charging times and significant infrastructure for high-speed charging stations. The heavy weight of batteries can also reduce overall efficiency and performance.
- Hybrid Propulsion Systems: Hybrid systems combine electric batteries with conventional engines or alternative fuel sources, providing extended range and increased operational flexibility. These systems can operate efficiently in areas where charging infrastructure is limited or unavailable and combine the benefits of electric propulsion with the reliability of traditional engines. However, hybrid systems are more complex, requiring the integration of multiple power sources, which can increase maintenance and operational complexity. Companies like Joby Aviation and Archer Aviation are actively developing and testing hybrid propulsion systems for their eVTOL aircraft. NASA and other research institutions are optimizing hybrid propulsion designs, focusing on improving efficiency, reducing weight, and enhancing integration with existing air traffic management systems.
- Sustainable Aviation Fuels (SAFs): SAFs are a viable alternative to traditional aviation fuels, offering significant reductions in lifecycle greenhouse gas emissions compared to conventional jet fuel. They can be produced from various renewable resources and waste materials and used with existing aircraft and fuel infrastructure, facilitating quicker adoption. However, the production of SAFs is currently limited and more expensive than conventional fuels. Scalability remains a challenge, requiring substantial investment in production infrastructure and addressing potential competition with food production and land use for biofuel feedstocks. Major airlines and fuel producers, including United Airlines and Neste, are investing in SAF development and production. Collaborative efforts aim to scale up production, reduce costs, and expand availability. Research initiatives by organizations such as the International Air Transport Association (IATA) are exploring various feedstocks and production processes to enhance SAF sustainability and economic viability.

- Potential Use of Hydrogen in AAM: Hydrogen propulsion systems are emerging as a promising solution for reducing carbon emissions and extending the operational range of eVTOL aircraft in the AAM sector. Hydrogen fuel cells generate electricity to power the aircraft's motors, producing only water vapor and heat as by-products, making them environmentally friendly. Hydrogen has a higher energy density compared to batteries, allowing for longer flight durations and increased payload capacities. Additionally, hydrogen can be refueled quickly compared to the time required to recharge batteries, improving turnaround times and operational efficiency. Current developments in hydrogen propulsion include efforts by companies like ZeroAvia, which is developing hydrogen-electric powertrains for regional aircraft and working towards commercial certification. Airbus is exploring hydrogen propulsion through its ZEROe initiative, aiming to introduce the world's first zero-emission commercial aircraft by 2035. A collaboration between General Electric and Airbus is also exploring hydrogen propulsion systems, integrating hydrogen fuel cells with electric propulsion for various aerospace applications.

However, the development of a hydrogen supply infrastructure, including production, storage, and refueling stations, is crucial and requires significant investment and coordination between public and private sectors. Estimates suggest that establishing an adequate delivery system could cost up to two trillion dollars. Hydrogen's high flammability necessitates stringent safety protocols for handling storage and refueling processes. Additionally, current hydrogen production methods are expensive, and scaling up production to meet aviation demands will require technological advancements and economies of scale.

1.5. Overview of Regulatory Advancements and Hurdles

Regulatory Challenges

The development and deployment of AAM faces significant regulatory challenges. Regulatory frameworks need to evolve to accommodate the unique characteristics and operational requirements of AAM technologies. While there have been notable advancements, several hurdles remain:

- Certification and Safety Standards: Establishing a uniform certification processes for eVTOL aircraft and other AAM technologies is a critical challenge. These processes must ensure safety without stifling innovation.
- Airspace Integration: Integrating AAM operations into existing airspace requires automation and careful planning, particularly in airspace under 500 feet above ground level (AGL), to avoid conflicts with traditional aviation and ensure safe and efficient traffic management.

- Public Acceptance and Policy Support: Gaining public trust and securing policy support at local, state, and federal levels are essential for the successful deployment of AAM.

Regulatory Advances

- FAA Integration Efforts: The FAA has been proactive in developing regulations and guidelines for AAM. This includes the introduction of the Urban Air Mobility Concept of Operations (ConOps) and the issuance of waivers for Beyond Visual Line of Sight (BVLoS) operations. The FAA's Innovate28 plan aims to scale AAM operations by 2028, focusing on integrating eVTOL aircraft into the national airspace system. This initiative highlights the collaboration between the FAA and U.S. Air Force to exchange flight test data and mature AAM technologies within the regulatory framework.[7]
- European Union Aviation Safety Agency: EASA has been working on creating a regulatory framework for Urban Air Mobility (UAM), including certification standards and operational guidelines. Recent regulatory updates from EASA have introduced comprehensive frameworks for safe operations of eVTOL aircraft, which include guidelines for certification, operations, and maintenance.[8]
- International Collaboration: Organizations like the International Civil Aviation Organization (ICAO) are facilitating global collaboration to harmonize AAM regulations across different countries.

Certification Processes for eVTOL and Other AAM Technologies

As mentioned, certification is a crucial aspect of bringing AAM technologies to market. The certification process involves a number of steps:

- eVTOL Certification:
  - FAA Certification Pathways: The FAA has established specific pathways for certifying eVTOL aircraft, including Special Class Airworthiness Certification and Part 23 Certification for small aircraft. These pathways involve detailed evaluations of aircraft design, manufacturing processes, and operational capabilities.
  - EASA's Special Condition VTOL: EASA has introduced the Special Condition VTOL framework, which outlines the requirements for the design and airworthiness of eVTOL aircraft. This framework addresses various aspects such as structural integrity, propulsion, flight performance, and safety.

[7] Flying Magazine, "New Collaboration Between Air Force and FAA Could Give AAM a Lift," October 27, 2023, https://www.flyingmag.com/new-collaboration-between-air-force-and-faa-could-give-aam-a-lift/
[8] Flying Magazine, "EASA Charts Future of Drone AAM Industry With Proposed Framework," September 1, 2023, https://www.flyingmag.com/easa-charts-future-of-drone-aam-industry-with-proposed-framework/

- Operational and Maintenance Certification:
  - Pilot and Operator Certification: Certifying pilots and operators for eVTOL and other AAM technologies is essential to ensure safe operations. This includes developing new training programs and certification standards specific to AAM.
  - Maintenance Standards: Establishing maintenance standards for AAM technologies is critical to ensure ongoing safety and reliability. These standards must account for the unique characteristics of electric and hybrid propulsion systems.

Potential Impact of AAM on Existing Power Grids and Necessary Upgrades

The widespread adoption of AAM will place additional demands on existing power grids, necessitating significant upgrades and enhancements.[9] Some study of this is needed to assess Delaware's existing and future capabilities in this area.

- Increased Energy Demand:
  - High Power Consumption: eVTOL aircraft and other electric AAM vehicles require substantial amounts of electricity for charging. This increased demand can strain existing power grids, particularly during peak operating hours.
  - Grid Capacity and Reliability: Enhancing grid capacity and reliability is essential to support the energy needs of AAM operations. This includes upgrading transmission and distribution infrastructure and implementing advanced grid management technologies.
- Grid Upgrades:
  - Infrastructure Investments: Significant investments are needed to upgrade power infrastructure, including the development of new substations, transmission lines, and distribution networks. These upgrades must ensure that power supply meets the demand of AAM operations (and other EV demand) without compromising grid stability.
  - Smart Grid Technologies: Implementing smart grid technologies can enhance the efficiency and reliability of power delivery. This includes advanced metering infrastructure, demand response systems, and real-time monitoring and control capabilities.
- Sustainability Considerations:
  - Renewable Energy Integration: Integrating renewable energy sources into the power grid can support the sustainable growth of AAM. This involves expanding the capacity of renewable energy generation and storage facilities to meet the energy demands of electric AAM vehicles.

[9] Peter Schmidt, Op. cit.

- Energy Storage Solutions: Developing advanced energy storage solutions, such as battery storage systems and pumped hydro storage, can help balance supply and demand, ensuring a stable and reliable power supply for AAM operations.

1.6. Summary of Key Points

The AAM sector represents a positive direction for the future of transportation and the environment, characterized by innovative technologies such as eVTOL aircraft, hybrid propulsion systems, and Sustainable Aviation Fuels (SAFs).

Key Points

Key points discussed in this background section include:

- Historical Perspective: Early visions and high expectations for AAM technology focused on battery-powered electric engines. Over the past decade, significant milestones have been achieved, driven by substantial investments from major corporations and venture capital firms.
- Industry Players and Collaborations: Leading companies, major investors, and significant partnerships have driven the growth of the AAM sector. Collaborations between industry players, regulatory bodies, and research institutions are important for advancing technology and establishing regulatory frameworks.
- Recent Developments: The shift from purely battery-powered systems to hybrid propulsion systems has addressed some limitations of battery technology. Key advancements in eVTOL and drone technologies highlight the progress made, while regulatory and infrastructure challenges continue to shape the landscape.
- Hybrid Propulsion and SAFs: Comparative analyses show the benefits and drawbacks of battery-powered, hybrid systems, and SAFs, with ongoing research and development efforts aimed at enhancing their viability for AAM applications.
- Regulatory and Infrastructure Challenges: The development and deployment of AAM face significant regulatory hurdles and infrastructure requirements. Certification processes, vertiport development, charging infrastructure, and power grid upgrades are primary areas that need addressing.

Potential Future Outlook for AAM in Delaware

The future outlook for AAM in Delaware is promising, given the state's strategic location within the BosNYWash corridor and its existing transportation infrastructure. Potential benefits include:

- Enhanced Connectivity: AAM can provide faster, more direct transportation options, improving accessibility and reducing travel times within Delaware and to neighboring states.
- Economic Growth: The adoption of AAM technologies can stimulate local economies by creating new job opportunities and attracting investment in related industries.
- Environmental Sustainability: The use of hybrid propulsion systems and SAFs can significantly reduce the carbon footprint of transportation in Delaware, contributing to the State's sustainability goals.
- Improved Emergency Response: AAM can enhance emergency medical services and disaster response capabilities, providing rapid transportation options for critical situations.
- Using Existing Airports for Vertiport Locations: As mentioned, the early adaptation of AAM technology in Delaware should include the development of vertiports at existing airport locations. There are three publicly owned airports in Delaware and six privately owned, public-use airports in the state. Therefore, preserving the private airports is a key strategy for welcoming AAM to Delaware. Benefits of this approach include compatible land use, greater public acceptance, lower environmental impacts, and existing airspace designations.

Importance of Continued Research and Development to Overcome Existing Challenges

Continued research and development is needed to overcome the challenges facing the AAM sector, including:

- Battery and Hybrid Propulsion Technologies: Improving battery energy density, reducing weight, and enhancing the efficiency of hybrid propulsion systems are crucial for expanding the operational capabilities of AAM.
- Sustainable Aviation Fuels: Advancing the production, scalability, and cost-effectiveness of SAFs is essential for reducing the environmental impact of aviation.
- Regulatory Frameworks: Developing comprehensive regulatory frameworks that ensure safety while fostering innovation is critical for the successful deployment of AAM technologies.
- Infrastructure Development: Investing in the development of vertiports, charging stations, and power grid upgrades is necessary to support the widespread adoption of AAM.
- Public Engagement and Acceptance: Building public trust through demonstrations, education, and engagement efforts is crucial for gaining acceptance and support for AAM initiatives.

The AAM sector holds great potential for the future of transportation, offering significant benefits in terms of connectivity, economic growth, and environmental sustainability. However, realizing this potential requires overcoming a number of regulatory, infrastructural, and technological challenges through continued research and development. With effective collaboration and investment, Delaware can participate in the power of AAM to improve its transportation infrastructure and services, while also boosting workforce development.

SECTION 2

Potential Demand for AAM

SECTION 2: POTENTIAL DEMAND FOR AAM

2.1. Introduction

Estimating the potential demand for AAM in Delaware involves a comprehensive approach that integrates national trends with local demographics, economic factors, and geographic considerations. This section of the analysis aims to quantify the possible impact of AAM in Delaware by examining three key components:

- National Demand Extrapolation: Reviewing and summarizing key national studies on AAM demand conducted by agencies such as the FAA and NASA, as well as private industry reports. These studies provide a broad understanding of the AAM market, which serves as a foundation for estimating Delaware's share.
- State-Level Adjustments: Tailoring these national estimates to Delaware's unique characteristics, including its population distribution, urbanization patterns, and proximity to major metropolitan areas.
- Sector-Specific Demand Estimates in Delaware: Identifying and estimating demand across various segments, including urban commuting, inter-city connectivity, tourism, cargo logistics, and public services.

2.2. National AAM Demand Projections

Summary of Key National Studies

The demand for AAM in the United States is rapidly evolving, with several key studies outlining the market's potential.

- FAA's UAM Market Study: The FAA's research indicates a significant future for Urban Air Mobility (UAM) as cities become increasingly congested. Their studies project the integration of eVTOL (electric Vertical Take-Off and Landing) aircraft into the National Airspace System, emphasizing the need for infrastructure, regulatory frameworks, and public acceptance to support this growth. FAA-sponsored research estimated revenues from AAM/UAM operations to be modest; at around $150 million in around 2025- 2026 that is likely to reach around $2.7 billion in 2030.[10] In light of other forecasts, this can be considered the more conservative estimate for UAM growth in the early years.

[10] Federal Aviation Administration, 'FAA Aerospace Forecast – FY2024-2044', modified September 16, 2024, https://www.faa.gov/dataresearch/aviation/aerospaceforecasts/faa-aerospace-forecast-fy-2024-2044, pp. 58.

- Roland Berger's UAM Market Outlook: This consultancy predicts that the global UAM market could reach $80 billion by 2050, driven by early infrastructure investments and public-private partnerships. Of the $80 billion annual value projected for the new UAM market by 2050, Roland Berger calculates that airport shuttle and inter-city flights will account for most of that amount (respectively 50 and 40 percent), while city taxi journeys take the remaining 10 percent. They stress that public acceptance and regulatory clarity will be critical to achieving these projections. More than 160,000 eVTOL aircraft are expected to be carrying passengers in urban air mobility (UAM) services by 2050. This study if paired with the FAA lower estimate for 2030 serves as a lower-bound estimate for 2030-2050 that takes a cautious view of infrastructure development and public acceptance.[11]
- Aviation Week Network: A recent forecast from Aviation Week's fleet data team calls for 2,000 commercial deliveries of eVTOL vehicles by 2030, double the 1,000 units predicted in last year's study. By 2040, Aviation Week's projections call for nearly 12,000 eVTOL deliveries worldwide, marking a 20 percent increase from the 2023 forecast of 10,000. And it sees 33,000 eVTOL deliveries by 2050, up 10 percent from 30,000 predicted from the previous year. Despite doubling its 2030 estimate to 2,000 aircraft, Aviation Week's fleet data team still describes its forecast as "pragmatic," reflecting industry headwinds ranging from shortcomings with batteries to timeline delays and a difficult fundraising environment that appears unlikely to change soon.[12]
- Custom Market Insights: The global market for AAM could be worth more than $68 billion by 2032, according to a market research report published today by Custom Market Insights. Researchers noted that the AAM industry had a valuation of approximately $8.2 billion in 2022 and that they expect it to reach $14.1 billion by the end of 2023. Between now and 2032, the AAM market is projected to expand at a compound annual growth rate of about 35.2 percent.[13] This forecast can be viewed as a mid-range scenario, offering a contrast to the more aggressive estimates, providing a spectrum of possible outcomes which depend on how various factors play out (e.g., technological advances, regulatory changes).
- Morgan Stanley Industry Analysis: According to Morgan Stanley, the global UAM market is expected to grow to $15.1 billion in 2030 and $1.474 trillion in 2040. Currently, the global UAM market is on the verge of establishing a mass production system by companies such as

[11] Charles Alcock, Aviation International News, 'New Study Projects UAM Market at $80 Billion by 2050', modified September 16, 2024, https://www.ainonline.com/aviation-news/business-aviation/2020-07-23/new-study-projects-uam-market-80-billion-2050
[12] Serge Mouraret, Aviation Week Network, 'Aviation Week Doubles eVOTL Forecast; Expects 2,000 Deliveries by 2030', modified September 16, https://aviationweek.com/aerospace/advanced-air-mobility/aviation-week-doubles-evtol-forecast-expects-2000-deliveries-2030#:~:text=A%20new%20forecast%20from%20Aviation,predicted%20in%20last%20year's%20study
[13] Custom Market Insights, 'Global Advanced Air Mobility Market 2024-2033', modified September 16, 2024, https://www.custommarketinsights.com/report/advanced-air-mobility-market/

"JOBY Aviation" in the United States.[14,15] This forecast, because it is dated (originally published in 2018), is considered overly optimistic, particularly for the 2040 timeframe.

- EASA's AAM Impact Study: Although focused on Europe, the European Union Aviation Safety Agency's (EASA) research provides relevant insights for global AAM markets. The study emphasizes the importance of international standards and forecasts a significant reduction in urban congestion, with AAM potentially decreasing road traffic by up to 30 percent in some areas.[16]

Quantified Market Segments

Based on these studies, the following market segments are identified as key drivers of AAM demand:

- Urban Air Mobility (UAM)/Regional Air Mobility (RAM): The UAM segment targets short-range intra-city travel, while the RAM segment includes inter-city trips spanning 50 to 300 miles. Deloitte's research suggests a substantial potential for the combined AAM market, with estimates indicating a total addressable market size of $75 billion to $115 billion by 2035. Assuming the U.S. share of the global market at 33 percent (which is its approximate size of the global commercial aviation market), the domestic RAM market could be roughly $25 to $38 billion by 2035, with significant opportunities in regions with poor rail or highway connectivity.[17]
- Cargo and Logistics: The cargo and logistics segment focuses on using AAM technologies to offer faster, more efficient delivery options. This includes urban last-mile delivery and certain longer-distance just-in-time (JIT) packages. The U.S. AAM cargo mobility market is expected to be $58 billion by 2035.[18]
- Public Services: AAM could revolutionize public services by providing rapid-response capabilities for emergency services, medical transport, and other critical public functions. The Insight Partners estimate the global Helicopter Emergency Medical Services market to grow to $17.7 billion by 2035. With the U.S. holding roughly 35-40 percent of the market, and

[14] Park Jeone and Sora Park, Maeil Business Newspaper, 'Hyundai Motor Group is Speeding up its Expansion of Urban Air Transportation', modified September 16, 2024, https://www.mk.co.kr/en/business/11039003#:~:text=According%20to%20reports%20published%20by,2032%20trillion%20won)%20in%202040.
[15] Morgan Stanley, 'Are Flying Cars Preparing for Takeoff?', modified September 16, 2024, https://www.morganstanley.com/ideas/autonomous-aircraft
[16] European Union Aviation Safety Agency, 'Study on the Societal Acceptance of Urban Air Mobility in Europe', modified September 16, 2024, https://www.easa.europa.eu/sites/default/files/dfu/uam-full-report.pdf, pp. 31.
[17] Aijaz Hussain and David Silver, Deloitte Insights, 'Advanced Air Mobility: Can the United States Afford to Lose the Race?', modified September 16, 2024, https://www2.deloitte.com/us/en/insights/industry/aerospace-defense/advanced-air-mobility.html
[18] Ibid.

assuming a 10 percent market share for AAM by 2035, the value of AAM for domestic public services could conservatively reach $700 million by then.[19]

These projections provide a framework for understanding the potential market size and growth opportunities for AAM in the United States, which can then be tailored to Delaware's specific context.

2.3. Delaware's Share of the AAM/RAM Market

Population and Demographics

Delaware, with a population of approximately 1 million residents, presents a unique opportunity for AAM adoption due to its concentrated urban areas and strategic location within the Mid-Atlantic region. Each of the state's three counties has distinct characteristics that influence the potential demand for AAM services.

- New Castle County: As the most populous county, with over 578,000 residents, New Castle County is the economic hub of Delaware, encompassing Wilmington, the state's largest city.[20] The county experiences substantial daily commuter traffic, particularly along key corridors such as I-95 and Route 1. The high levels of traffic congestion during peak hours make New Castle County a prime candidate for AAM services, particularly for urban commuting and short-distance regional travel.
- Kent County: Home to Dover, the state capital, Kent County has about 190,000 residents.[21] While less urbanized than New Castle County, Dover and its surrounding areas still face traffic challenges, especially during major events and peak commuting times. The presence of Dover Air Force Base adds to the congestion, making AAM an attractive option for reducing travel times during high-traffic periods.
- Sussex County: With an estimated 263,500 year-round residents, Sussex County is known for its popular beach communities, including Rehoboth Beach, Bethany Beach, and Dewey Beach.[22] These areas experience significant seasonal traffic, particularly during the summer months when Route 1, the primary corridor, becomes heavily congested. The influx of tourists from nearby metropolitan regions such as Washington, D.C., Baltimore, and Philadelphia

[19] The Insight Partners, 'Helicopter Emergency Medical Services Market Growth by 2031', modified September 16, 2024, https://www.theinsightpartners.com/reports/helicopter-emergency-medical-services-market. These projections are extrapolated to 2035.
[20] U.S. Census Bureau, 'QuickFacts: Newcastle County, Delaware', modified September 16, 2024, https://www.census.gov/quickfacts/fact/table/newcastlecountydelaware/PST045223
[21] Ibid.
[22] Ibid.

creates unique transportation challenges, making AAM solutions particularly appealing during peak tourist seasons.

Urbanization and Traffic Congestion

Delaware's urbanization patterns and traffic congestion levels vary across its three counties, each presenting different opportunities for AAM deployment.

- New Castle County: The Wilmington metropolitan area, as the state's primary urban hub, has experienced significant suburban sprawl, leading to increased traffic congestion. Commuters in urban Delaware spend an average of 30.8 hours per year stuck in traffic, which is the seventh highest delay for U.S. states (ranking just below California).[23] The high levels of congestion suggest a strong potential demand for AAM services to alleviate urban commuting pressures.
- Kent County: While less congested than New Castle County, Dover and its surrounding areas still experience traffic issues, particularly during events at the Dover International Speedway and other major venues. AAM could provide a valuable alternative for travelers during these peak periods, helping to reduce road congestion and improve access to key locations.
- Sussex County: The seasonal influx of tourists to Sussex County's beach communities exacerbates traffic congestion along Route 1 and other major routes. This seasonal surge presents a unique opportunity for AAM to serve as a transportation solution during the summer months, offering tourists a quicker and more convenient way to reach their destinations.

2.4. Sector-Specific Demand Estimates in Delaware

Urban Commuting and Inter-city Connectivity

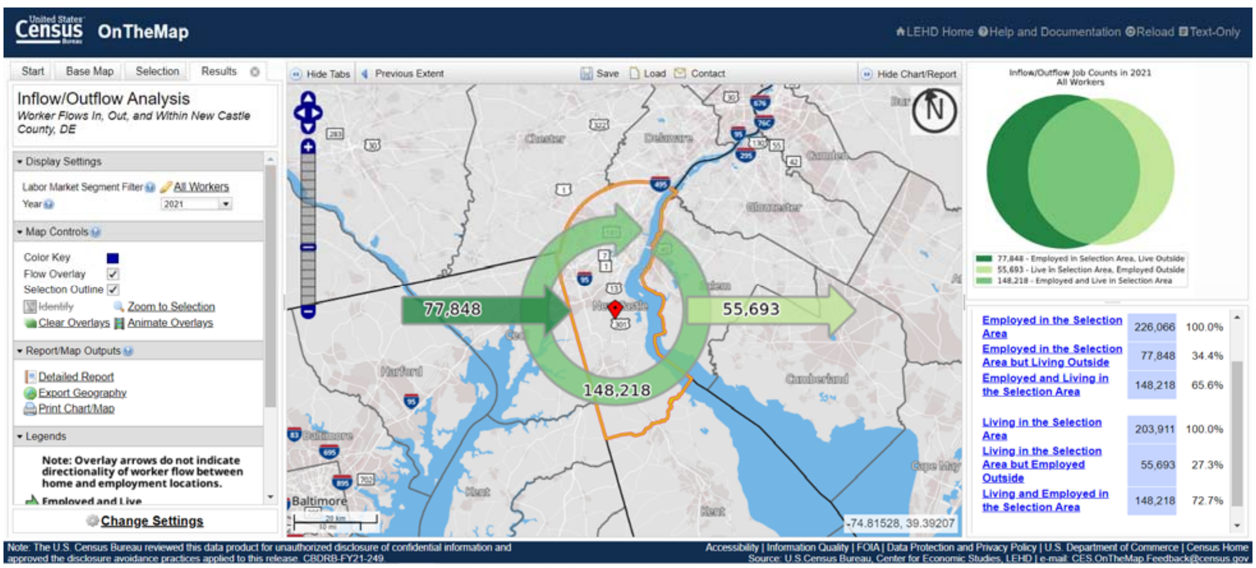
Delaware's location and concentrated population make it a candidate for AAM services focused on urban commuting and inter-city connectivity.

- Urban Commuting: With New Castle County serving as Delaware's economic center, the daily commuter population is substantial. Approximately 204,000 residents of New Castle County are employed, with a significant portion commuting daily to Wilmington. In Kent County, around 77,700 residents are employed, many commuting to Dover.[24] Assuming that only 1 to

[23] Baruch Feigenbaum, Thuy Nguyen and Truong Bui, Reason Foundation, '27th Annual Highway Report: Urbanized Area Congestion', modified September 16, 2024, https://reason.org/policy-study/27th-annual-highway-report/urbanized-area-congestion/
[24] Delaware Department of Labor, 'Current Employment Statistics: September 2023', modified September, 2024, https://lmi.delaware.gov/ces

2 percent of these commuters would consider using AAM services due to time savings and convenience, the potential market size could be 2,000 to 3,000 daily users. Depending on various factors, AAM services could reduce travel times significantly, making them an attractive option for high-income commuters.[25]

- Inter-city Connectivity: Delaware's proximity to major metropolitan areas like Philadelphia, Baltimore, and Washington, D.C., makes it a candidate for Regional Air Mobility (RAM) services. Approximately 15 percent of New Castle County's workforce commutes to jobs in neighboring states, particularly Pennsylvania and Maryland. This translates to roughly 55,700 commuters who may benefit from faster travel options. Assuming a higher participation rate of up to 10 percent because of the distances involved, the potential market size for inter-city AAM services in Delaware could reach roughly 6,000 daily trips, particularly for high-income professionals and frequent business travelers.[26]



Tourism and Leisure Travel

Tourism is a significant driver of Delaware's economy, particularly in Sussex County, where coastal attractions draw millions of visitors each year.

- Coastal and Event-driven Tourism: Delaware's beaches, including Rehoboth Beach, Bethany Beach, and Dewey Beach, attract over 6 million visitors annually.[27] During the peak summer

[25] European Union Aviation Safety Agency, 'Study on the Societal Acceptance of Urban Air Mobility in Europe', modified September 16, 2024, https://www.easa.europa.eu/sites/default/files/dfu/uam-full-report.pdf, pp. 63.
[26] United States Census Bureau, 'OnTheMap', modified September 16, 2024, https://onthemap.ces.census.gov/. Data is for 2021.
[27] Rachel Sawicki, Delaware Public Media, 'Rehoboth and Dewey Beach Visitor on Track to Exceed Seven Million Average in 2024', modified September 16, 2024, https://www.delawarepublic.org/business/2024-07-02/rehoboth-and-dewey-beach-visitors-on-track-to-exceed-seven-million-average-in-2024

season, the population in the coastal towns can swell by 200 to 300 percent, creating substantial demand for transportation solutions. AAM could provide a faster, more efficient alternative to the often-congested roadways, particularly for high-income tourists seeking quicker access to resorts and vacation homes. Assuming only 1 percent of the visitors used AAM, the potential demand for AAM in tourism could range up to 60,000 trips annually, with peak demand occurring during the summer months.

- Event-driven AAM Demand: Delaware's beaches and coastal towns also host a variety of events that draw large crowds, such as the Rehoboth Beach Jazz Festival and the Sea Witch Festival. These events further strain local infrastructure, making AAM a viable alternative for rapid transportation. AAM services could be tailored to these events, providing direct flights to and from event venues, thereby reducing traffic congestion and enhancing the overall visitor experience.
- Cultural and Historical Sites: Delaware's cultural and historical attractions, such as the Winterthur Museum and the Brandywine Valley, attract approximately 1.5 million visitors annually. AAM could cater to high-income day-trippers from nearby states, offering faster, more convenient access to these sites. Again, assuming only 1 percent of these visitors used AAM, the potential demand could translate to 15,000 AAM trips annually, particularly during peak tourism seasons.
- State Parks and Nature Reserves: Delaware's state parks, including Cape Henlopen State Park and Bombay Hook National Wildlife Refuge, attract over 2 million visitors annually. AAM could support eco-tourism by providing quick access to these natural areas, particularly for tourists looking to avoid the hassle of road travel. Given the overwhelming use of ground vehicles for state parks and nature reserves, the potential demand for AAM in eco-tourism was estimated at one-quarter percent or around 5,000 trips annually.

Cargo, Logistics, and Public Services

While AAM is not suitable for large-scale cargo transport in the near term, it holds significant potential in the rapidly growing markets for small package delivery, medical logistics, and public services.

- Small Package Delivery: Delaware's e-commerce market is large, with the state's population receiving an estimated 64 million packages annually.[28] If AAM could capture 1-2 percent of this market, it would translate to between 640,000 and 1.28 million packages delivered annually in Delaware. The demand for AAM in small package delivery would likely be

[28] Pitney Bowes, 'Parcel Shipping Index 2023, Featuring 2022 Data', modified September 16, 2024, https://www.pitneybowes.com/content/dam/pitneybowes/us/en/shipping-index/23-mktc-03596-2023_global_parcel_shipping_index_ebook-web.pdf. (U.S. Parcels generated per person – 64/year).

concentrated in urban areas like Wilmington and Dover, where AAM could bypass ground traffic and deliver packages more efficiently.[29]

- Medical Supply and Prescription Deliveries: AAM could also play an important role in the healthcare sector, particularly in delivering medical supplies, pharmaceuticals, and prescription medications. Quick and reliable delivery of these items is essential, especially for patients in rural areas or those requiring urgent medication. The potential demand for AAM in medical logistics could involve thousands of deliveries annually, particularly in time-sensitive situations.
- Public Services: AAM technology could augment State Police helicopter services in Delaware, including emergency medical services (EMS), law enforcement, and disaster response. For EMS, AAM could provide rapid response capabilities that are critical in life-threatening situations, reducing response times and potentially saving lives. Law enforcement agencies could leverage AAM for aerial surveillance, search and rescue operations, and rapid deployment during emergencies. The projected demand for AAM in public services could support hundreds of operations annually, particularly in scenarios requiring rapid response or aerial coverage.

2.5. Summary and Conclusion

The analysis of potential demand for AAM in Delaware highlights significant opportunities across several key sectors. The state's unique demographic, economic, and geographic characteristics position it well for the adoption of AAM technologies, with substantial demand projected in urban commuting, inter-city connectivity, tourism, logistics, and public services.

National studies show significant ranges of predicated AAM activity, depending mostly on when the studies were conducted. The earlier studies were optimistic, while the more recent studies have incorporated the developmental realities into the numbers. The estimates of demand discussed in this report include:

- Low Range Estimates: Early-stage estimates suggest that revenue from urban air mobility (UAM) operations could reach around $2.7 billion by 2030, reflecting the challenges of building infrastructure, establishing regulatory frameworks, and gaining public acceptance. In a more cautious view, the global UAM market could reach about $80 billion by 2050, driven by factors like early infrastructure investments and public-private partnerships.
- Upper Range Estimates: More optimistic forecasts predict a global market size of approximately $1.5 trillion by 2040, assuming widespread adoption and the resolution of key

[29] Natasha Santha and George Woods, L.E.K. Consulting, 'The Potential for Advanced Air Mobility Beyond the Congestion Use Case', modified September 16, 2024, https://www.lek.com/sites/default/files/PDFs/2353_Potential-for-Advanced-Air-Mobility.pdf

regulatory and technological challenges. The number of eVTOL aircraft could scale up from 2,000 deliveries by 2030 to around 12,000 by 2040, reflecting growth in urban centers where demand for alternatives to ground transportation is highest. A mid-range scenario suggests the global market for AAM could be around $68 billion by 2032, expanding at a compound annual growth rate of about 35.2%, depending on technological advancements, regulatory changes, and public acceptance.

Estimates for Delaware, as developed in this study included:

- Urban Commuting and Inter-city Connectivity: The high levels of traffic congestion in New Castle County and the strategic location of Delaware near major metropolitan areas make AAM an attractive solution for both urban commuting and regional travel. The potential market size for AAM in these segments could range from 8,000 to 9,000 daily users.
- Tourism and Leisure Travel: Delaware's coastal attractions, cultural sites, and natural reserves draw millions of visitors each year, creating substantial demand for AAM services, particularly during peak tourist seasons. The estimated demand for AAM in tourism could range from 50,000 to 80,000 trips annually.
- Cargo, Logistics, and Public Services: While AAM may not be suitable for heavy cargo, its potential in small package delivery, medical logistics, and public services is significant. The demand for these services could translate to hundreds of thousands of deliveries and operations annually, particularly in urban areas and during emergencies.

Market Segment	Estimated Demand
Urban Commuting	2,000 - 3,000 daily users
Inter-city Connectivity	6,000 daily trips
Tourism and Leisure Travel	50,000 - 80,000 trips annually
Small Package Delivery	640,000 - 1.28 million deliveries annually
Medical Logistics	Thousands of deliveries annually
Public Services (EMS, Law Enforcement, Disaster Response)	Hundreds of operations annually

Delaware's potential as a market for AAM is strong, driven by its concentrated population, strategic location, and significant tourism activity. AAM could play a crucial role in enhancing the state's transportation infrastructure, offering innovative solutions to address traffic congestion, improve regional connectivity, and support critical public services. As AAM technology continues to develop, Delaware is well-positioned to be an early adopter, benefiting from the efficiencies and opportunities that AAM can provide.

SECTION 3

Electric Grid

SECTION 3: ELECTRIC GRID

3.1. Introduction

The rise of electric vertical takeoff and landing (eVTOL) aircraft and electric vehicles (EVs) represents a significant shift in the transportation vehicle types and fueling infrastructure, which may change urban mobility and contribute to environmental sustainability. As Delaware prepares for the adoption of these advanced technologies, it is important to assess and enhance the state's electric grid capacity to accommodate the increased demand. This Section of the report provides an analysis of Delaware's grid infrastructure, potential future demand projections, and policy and funding recommendations for State of Delaware leadership to help the grid support the transition to electric mobility.

The Section is structured to address the following key areas:

- Electric Grid Capacity in Delaware: An overview of the existing grid infrastructure, its estimated capacity, and the challenges it faces. This section highlights the need for modernization and identifies potential limitations that could hinder future growth.
- Future Demand for eVTOL Aircraft and Electric Vehicles: Projections for the adoption of eVTOL aircraft and EVs, and their expected impact on electricity consumption. This section includes estimates of energy demand and case studies from regions with high EV adoption rates.
- Estimating Grid Capacity Requirements: Methodologies used to forecast future grid capacity needs, including scenario analysis and key assumptions. This subsection outlines different adoption scenarios and their implications for grid demand.
- Micro-Grids and Decentralized Energy Solutions: An exploration of micro-grids as a solution for enhancing grid resilience and integrating renewable energy sources. Case studies and examples demonstrate the potential benefits and applications of micro-grids in Delaware.
- Planning for Future Grid Enhancements: Strategies for overcoming regulatory and technical challenges associated with grid enhancement projects. This section discusses technological innovations, investment opportunities, and the role of public-private partnerships in driving grid modernization.
- Challenges, Mitigation Strategies, and State Policy for Grid Development: Identification of infrastructure development delays and proposed mitigation strategies to expedite project timelines. This section also includes recommendations for policy measures and potential funding sources to assist in the strengthening of Delaware's electric grid. Emphasis is placed on policy reforms, streamlined approval processes, private-public partnerships, and leveraging federal and state funding programs.

- Conclusion: A summary of the main findings and strategic recommendations for State of Delaware leadership and other non-governmental stakeholders. This section also outlines future research directions to further understand and prepare for evolving grid demands.

3.2. Current Electric Grid Capacity in Delaware

Overview of the Existing Grid

Delaware's electric grid is primarily served by the Delaware Electric Cooperative (DEC) and Delmarva Power. The grid infrastructure includes various substations, transmission lines, and distribution networks that deliver electricity to residential, commercial, and industrial customers across the state. Delaware's grid is integrated with the larger PJM Interconnection, which coordinates the movement of wholesale electricity in 13 states and the District of Columbia.

In recent years, significant efforts have been made to modernize the grid, including the implementation of smart meters and Advanced Metering Infrastructure (AMI). Smart meters provide benefits such as improved billing accuracy, faster response to service requests, and enhanced outage management capabilities. The rollout of smart meters by Delmarva Power began in 2009 and aimed to cover all residential and commercial customers by the end of 2011.

Capacity and Load

Delaware's current grid capacity is designed to handle the state's typical load and peak demand. The DEC and Delmarva Power continuously monitor and manage the grid to ensure reliable service. The recent rate restructuring by DEC in March of 2024 aims to distribute costs equitably among customers while maintaining grid reliability. On average, DEC members enjoy some of the lowest energy costs in the region, with efforts to balance supply and delivery charges effectively.[30]

Delaware's electric grid has sufficient capacity to meet current demand, but the increasing adoption of electric vehicles (EVs) and the anticipated introduction of eVTOL aircraft will require careful planning to ensure continued reliability. Initiatives like the federal Grid Resiliency Grants under Section 40101(d) of the Bipartisan Infrastructure Law are administered by the Department of Energy. This program allocates approximately $1.4 million annually for five years to Delaware to improve grid resilience against disruptions and natural hazards.

[30] U.S. Energy Information Administration, "Delaware Electricity Profile 2022", modified September 11, 2024, https://www.eia.gov/electricity/state/delaware/

Challenges and Limitations

Delaware, like many states, faces several challenges in maintaining and upgrading its electric grid:

- Aging Infrastructure: Delaware must address the aging components of its grid. The cost of materials and labor for maintaining and upgrading infrastructure has risen, necessitating increased investment.
- Increased Demand: The growing use of electric vehicles and the future integration of eVTOL aircraft will place additional load on the grid. Ensuring that the grid can handle this increased demand without compromising service quality is essential.
- Regulatory Hurdles: The process of getting new power plants online can take several years due to regulatory requirements. Streamlining these processes will be needed to meet future energy needs in a timely manner.

To address these challenges, Delaware is focusing on grid modernization, increased use of renewable energy sources, and the implementation of micro-grids to support local energy needs. The state's commitment to enhancing grid resilience and capacity is evident in its strategic investments and forward-looking policies.

3.3. Future Demand for eVTOL Aircraft and Electric Vehicles in Delaware

Projected Growth of eVTOL and EVs

The adoption of eVTOL aircraft and EVs is expected to grow significantly in the coming years, driven by technological advancements and increasing demand for sustainable transportation solutions.[31] The global eVTOL market is projected to have more than 1,000 deliveries of electric vertical-takeoff-and-landing aircraft by 2030[32], and to expand at a compound annual growth rate (CAGR) of approximately 22.43% from 2023 to 2030. This growth is fueled by the need to alleviate urban traffic congestion and a desire to reduce carbon emissions. Major companies like Joby Aviation, Archer Aviation, and Volocopter are making significant strides in eVTOL development, with expectations to begin commercial operations in the next few years.[33]

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[31] International Energy Agency, “Global EV Outlook 2024”, modified September 11, 2024, https://origin.iea.org/reports/global-ev-outlook-2024
[32] Aviation Week Network, “Aviation Week Forecasts 1,000 eVOTL Deliveries by 2030”, modified Septmember 11, 2024, https://aviationweek.com/shownews/paris-air-show/aviation-week-forecasts-1000-evtol-deliveries-2030
[33] GloblNewswire, “eVOTL Aircraft Market Projections Show Soaring Growth to 2030: Comprehensive Global Industry Analysis and Forecast”, modified September 11, 2024, https://www.globenewswire.com/news-release/2024/03/19/2848901/0/en/eVTOL-Aircraft-Market-Projections-Show-Soaring-Growth-to-2030-Comprehensive-Global-Industry-Analysis-and-Forecast.html

In Delaware, the state is studying the integration of eVTOL aircraft in order to develop a broader strategy for AAM. The federal regulatory environment is evolving to support this transition, with the Federal Aviation Administration (FAA) working on certification processes for eVTOL aircraft.[34]

Similarly, the adoption of electric vehicles in Delaware is expected to follow national trends. According to the Global EV Outlook 2024 by the International Energy Agency (IEA), EV sales are projected to continue rising, driven by policy support, technological improvements, and increased consumer awareness. The report highlights that leading markets are seeing substantial growth in EV adoption, which Delaware is likely to mirror as it enhances its charging infrastructure and promotes clean energy initiatives.[35]

Energy Consumption Estimates

The integration of eVTOL aircraft and the increasing number of EVs will significantly impact Delaware's electric grid. Estimations of energy consumption for eVTOL operations vary based on aircraft design and operational patterns. For example, a typical eVTOL aircraft might consume between 200-300 kWh per hour of flight. Considering an average utilization rate, this could add substantial load to the grid, especially during peak operational hours.

For EVs, the energy consumption depends on the vehicle type and usage patterns. On average, an electric vehicle consumes about 30 kWh per 100 miles. With the projected increase in EV adoption, Delaware could see a significant rise in electricity demand. The IEA report indicates that widespread EV adoption could increase electricity demand by up to 30% in regions with high EV penetration.[36]

To accommodate this increased demand, Delaware's grid will need enhancements in capacity, load management, and renewable energy integration. The state is already investing in grid modernization projects, including the deployment of smart meters and advanced metering infrastructure (AMI), which will help manage the additional load more efficiently.[37]

Whether these actions will help Delaware or not is yet to be seen. However, the State can certainly encourage the use of renewable energy capacity, deploying smart grid technologies, and incentivizing the adoption of energy-efficient practices among consumers.

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[34] Reed Smith, HeliHub, "US Explored eVOTL and Drone Adoption as AAM Summit", modified September 11, 2024, https://www.helihub.com/2022/08/19/us-explores-evtol-and-drone-adoption-as-aam-summit/
[35] International Energy Agency, "Global EV Outlook 2024", modified September 11, 2024, https://origin.iea.org/reports/global-ev-outlook-2024
[36] Ibid
[37] Delaware Electric Cooperative, "2024 Rate Restructuring", modified September 11, 2024 https://www.delaware.coop/about/2024-rate-restructuring

3.4. Estimating Grid Capacity Requirements

Demand Forecasting Methods

Several methodologies are employed to estimate future grid capacity requirements, each offering unique insights:

- Historical Data Analysis: Analyzes past electricity usage patterns to predict future demand. This method considers factors like seasonal variations, peak demand periods, and long-term trends.
- Load Forecasting Models: Uses statistical and machine learning models to forecast future electricity demand. These models incorporate variables such as population growth, economic development, and technological advancements.
- Scenario Analysis: Develops different scenarios based on varying assumptions about the future, such as high, medium, and low adoption rates of eVTOL aircraft and EVs.
- Simulation Models: Uses detailed simulations to model the behavior of the electric grid under different conditions, including the integration of new technologies, changes in consumer behavior, and policy interventions.
- Demand-Side Management (DSM): Evaluates the potential for reducing or shifting electricity demand through measures like energy efficiency improvements, demand response programs, and smart grid technologies.[38]

Scenario Analysis

Scenario analysis involves creating projections based on various levels of eVTOL and EV adoption.[39] These scenarios help identify the range of possible impacts on grid demand and guide planning efforts.

- Low Adoption Scenario: Assumes a slow adoption rate of eVTOL aircraft and EVs, resulting in a modest increase in electricity demand. This scenario might consider factors such as limited infrastructure development, slower technological advancements, and lower consumer adoption rates.
- Medium Adoption Scenario: Represents balanced growth in eVTOL and EV adoption, including moderate investments in charging infrastructure, steady technological improvements, and supportive policies.

[38] Federal Energy Regulatory Commission, "FERC Transmission Reform Paves Way for Adding New Energy Resources to Grid", modified September 11, 2024, https://www.ferc.gov/news-events/news/ferc-transmission-reform-paves-way-adding-new-energy-resources-grid
[39] Op. cit., https://origin.iea.org/reports/global-ev-outlook-2024

- High Adoption Scenario: Assumes rapid growth in eVTOL and EV adoption, driven by significant technological advancements, robust infrastructure development, and strong policy support. This scenario anticipates a substantial increase in electricity demand, requiring significant grid capacity enhancements.

Key Assumptions

From research by others, key assumptions used in estimating grid capacity requirements include:

- Average Energy Consumption per eVTOL Flight: Assumes an average energy consumption of 200-300 kWh per hour of flight, depending on the aircraft design and operational patterns.
- Average Energy Consumption per EV: Assumes an average consumption of 30 kWh per 100 miles driven. This figure can vary based on the type of EV, driving conditions, and usage patterns.
- Charging Patterns: Considers typical charging behaviors, such as home charging during off-peak hours and public charging during peak hours. The distribution of charging events across different times of the day influences peak demand and grid load.
- Population and Economic Growth: Assumes steady population growth and economic development in Delaware, leading to increased electricity demand across residential, commercial, and industrial sectors.
- Technological Advancements: Includes assumptions about improvements in battery efficiency, charging technology, and grid management systems that can influence overall energy consumption and grid capacity needs.
- Policy and Regulatory Environment: Assumes the implementation of supportive policies and regulations that encourage the adoption of eVTOL aircraft and EVs, as well as investments in grid infrastructure and renewable energy sources.

Forecast Numbers

Based on current data and projections, the following figures provide an estimate of future demand and grid capacity requirements for Delaware:

1. eVTOL Aircraft:
   - Projected Adoption: The eVTOL market is expected to grow at a CAGR of 22.43% from 2023 to 2030.[40]

[40] Op. cit., https://www.globenewswire.com/news-release/2024/03/19/2848901/0/en/eVTOL-Aircraft-Market-Projections-Show-Soaring-Growth-to-2030-Comprehensive-Global-Industry-Analysis-and-Forecast.html

- **Energy Consumption:** Assuming an average of 250 kWh per hour of flight and a utilization rate of 5 hours per day per aircraft, each eVTOL could consume approximately 1,250 kWh per day. With an estimated 100 eVTOLs operating by 2030, the total daily consumption would be 125,000 kWh.

2. Electric Vehicles (EVs):
   - **Projected Adoption:** By 2030, Delaware is expected to have around 100,000 EVs on the road.[41]
   - **Energy Consumption:** Assuming an average consumption of 30 kWh per 100 miles and an average driving distance of 30 miles per day per vehicle, each EV would consume approximately 9 kWh per day. The total daily consumption for 100,000 EVs would be 900,000 kWh.
3. Grid Impact:
   - **Total Additional Load:** Combining the consumption from eVTOLs and EVs, the additional daily load on Delaware's grid by 2030 could be approximately 1,025,000 kWh (1.025 GWh).
   - **Peak Demand Management:** Effective demand-side management and infrastructure improvements will be critical to accommodate this increased load without compromising grid reliability.

Accurate estimation of future grid capacity requirements is essential for ensuring that Delaware's electric grid can accommodate the growing demand from eVTOL aircraft and electric vehicles. By employing the above demand forecasting methods, conducting comprehensive scenario analysis, and making well-founded assumptions, planners and policymakers can develop effective strategies to enhance grid capacity, ensure reliability, and support sustainable transportation solutions.

3.5. Micro-Grids and Decentralized Energy Solutions in Delaware

Definition and Overview of Micro-Grids

A micro-grid is a localized energy system that operates independently or in conjunction with the main electrical grid. It consists of interconnected loads and distributed energy resources (DERs) such as solar panels, wind turbines, batteries, and generators. Micro-grids can switch between grid-connected and island modes, providing flexibility and resilience to the energy system.[42]

[41] Op. cit., https://origin.iea.org/reports/global-ev-outlook-2024
[42] Balam Vinayagam, Schneider Electric Blog, "Unveiling 10 Game-Changing Microgrid Trends Shaping 2024 and Beyond", https://blog.se.com/sustainability/2024/01/09/unveiling-ten-game-changing-microgrid-trends-shaping-2024-and-beyond/

Benefits of Micro-Grids:

- Enhanced Reliability and Resilience: Micro-grids can operate autonomously during grid outages, ensuring a continuous power supply to critical facilities.
- Integration of Renewable Energy: They facilitate the incorporation of renewable energy sources, reducing reliance on fossil fuels.
- Reduced Transmission Losses: By generating and consuming energy locally, micro-grids minimize transmission losses.
- Energy Independence: Communities and facilities can achieve greater energy security and independence from the main grid.
- Cost Savings: Through demand response and peak shaving, micro-grids can reduce energy costs by managing consumption during peak periods.

Integration with Delaware's Main Grid

Micro-grids can significantly enhance Delaware's energy infrastructure by supporting increased demand and improving grid stability. The integration involves advanced control systems that allow micro-grids to operate in coordination with the main grid. This integration provides several benefits:

- Peak Load Management: Micro-grids can supply additional power during peak demand periods, reducing the strain on the main grid.
- Renewable Energy Integration: By incorporating renewable energy sources, micro-grids can support the state's goals for clean energy and sustainability.
- Grid Resilience: In the event of a grid failure, micro-grids can operate independently, ensuring that critical services remain operational.[43]
- Economic Efficiency: Micro-grids can participate in demand response programs, providing financial incentives for reducing consumption during peak times.

Case Studies and Examples

Cape Cod Gateway Airport Micro-Grid

The Cape Cod Gateway Airport in Hyannis, Massachusetts, serves as a notable example of a successful micro-grid project. Supported by a $1.95 million grant from the U.S. Department of Transportation's SMART Program, the airport is developing a smart micro-grid to enhance its

[43] Maximiliano Ferrari, Ben Ollis, Michael Starke and Arturo Massol-Deyá, Institute of Electrical and Electronics Engineers, "Why the Next Microgrid Will be Well Connected", modified September 11, 2024, https://spectrum.ieee.org/microgrid

energy resilience and sustainability. The micro-grid will facilitate the charging of electric ground vehicles, including buses and potentially electric aircraft in the future. This project demonstrates how micro-grids can support transportation infrastructure and contribute to energy independence and reduced emissions.[44]

Puerto Rico Solar Micro-Grids

In Adjuntas, Puerto Rico, solar-based micro-grids provide power to local businesses and critical facilities. These micro-grids, which include over 700 photovoltaic panels and large battery storage systems, operate independently during grid outages. This ensures energy availability for essential services, demonstrating the potential for micro-grids to enhance community resilience and economic stability.[45]

Vertiv Data Center Micro-Grid

At its Delaware, Ohio facility, Vertiv has implemented a 1.0 MW micro-grid to address grid capacity challenges and improve energy resilience. The micro-grid includes solar photovoltaic arrays, hydrogen fuel cells, and battery energy storage systems. This setup reduces reliance on the traditional grid and enhances the facility's operational efficiency and sustainability. This project illustrates the potential for micro-grids to support data centers and other critical infrastructure.[46]

It is believed micro-grids offer a partial solution for enhancing Delaware's energy resilience and supporting the growing demand for eVTOL aircraft and electric vehicles. Successful case studies, such as the Cape Cod Gateway Airport micro-grid, highlight the significant benefits and potential of micro-grid technology in managing local energy needs and improving grid stability.

3.6. Planning for Future Grid Enhancements in Delaware

Regulatory and Approval Processes

Delaware's regulatory framework for grid enhancement projects involves multiple agencies and processes to ensure that new developments meet both state and federal standards. Key players include the Governor’s Energy Advisory Council (GEAC), the DNREC Division of Climate, the

[44] Cape Cod Gateway Airport, “Smart Grants Lead to Clean Energy Initiatives For Massachusetts Infrastructure”, modified September 11, 2024, https://flyhya.com/smart-grants-lead-to-clean-energy-initiatives-for-massachusetts-infrastructure/
[45] Op. cit., https://spectrum.ieee.org/microgrid
[46] Deepak, Data Center Post Middle East Africa, “Vertiv Unveils Data Center Microgrid Installation at Delaware, Ohio Facility”, modified September 11, 2024, https://www.dcpostmea.com/2023/10/vertiv-unveils-customer-experience-center-data-center-microgrid-installation-delaware-ohio-facility/

Delaware Public Service Commission (PSC) and the Federal Energy Regulatory Commission (FERC).[47]

Governor's Energy Advisory Council (GEAC)

The Governor's Energy Advisory Council (GEAC) was established under the Delaware Energy Act of 2004 and is responsible for monitoring Delaware's energy system. The Council identifies and proposes actions to enhance the state's energy system, including mitigating climate change impacts. It provides counsel to the Governor on promoting an economic, reliable, and competitive energy market. GEAC comprises 25 members from various state agencies and constituencies, appointed for terms of one, two, or three years, with a Chair appointed by the Governor.

DNREC Division of Climate

The DNREC Division of Climate, Coastal and Energy, also referred to as the State Energy Office, plays a pivotal role in Delaware's climate and energy initiatives. The Division is tasked with facilitating the development of a comprehensive State Energy Plan, promoting energy conservation, and encouraging the use of renewable energy and alternative energy technologies. The Division also supports the Governor's Energy Advisory Council by providing staff support and assisting in the development of recommendations for updates to the Delaware Energy Plan and Climate Action Plan.

Delaware Public Service Commission (PSC)

The PSC oversees utilities' operations, ensuring that they provide reliable and reasonably priced services to consumers. Projects involving new power plants or transmission lines typically require approval from the PSC, which includes a review process involving public hearings and environmental impact assessments.

Federal Energy Regulatory Commission (FERC)

FERC's recent reforms, such as the Interconnection Final Rule (Order No. 2023), aim to streamline the integration of new generating facilities into the existing grid. These reforms are designed to reduce project backlogs, improve process certainty, and facilitate the deployment of new

[47] Delaware Department of Natural Resources and Environmental Control, "Delaware Energy Plan Framework", modified September 11, 2024, https://documents.dnrec.delaware.gov/energy/geac/DRAFT-Delaware-Energy-Plan-Framework.pdf#:~:text=URL%3A%20https%3A%2F%2Fdocuments.dnrec.delaware.gov%2Fenergy%2Fgeac%2FDRAFT

technologies. Transmission providers must file compliance plans detailing how they will implement these requirements.

Technological Innovations

Emerging technologies are needed to increase grid capacity and efficiency in Delaware. Key innovations include:

- Smart Grids: Smart grids utilize advanced digital technology to improve the reliability, efficiency, and sustainability of the electricity network. They enable real-time monitoring and control, allowing for better management of electricity flows and quicker response to outages.
- Advanced Energy Storage Solutions: Technologies such as lithium-ion batteries and hydrogen fuel cells are becoming more prevalent. These energy storage systems can store excess energy generated during low demand periods and release it during peak demand, thus balancing the load and enhancing grid stability.[48]
- Micro-Grids and Distributed Energy Resources (DERs): Micro-grids, which can operate independently or in conjunction with the main grid, provide localized energy solutions. They are particularly useful for integrating renewable energy sources and improving resilience against grid outages.

Investment and Funding

Significant investment is required to upgrade Delaware's electric grid to meet future demands. Planning for future grid enhancements in Delaware involves navigating regulatory frameworks, adopting technological innovations, and securing diverse funding sources. By leveraging federal and state programs, as well as private sector investments, Delaware can enhance its grid capacity, integrate renewable energy sources, and ensure a reliable and efficient energy system for the future.

- Federal Funding: Programs such as the Grid Resiliency Grants under the Bipartisan Infrastructure Law provide substantial funding to enhance grid resilience. Delaware can leverage these grants to support projects aimed at improving grid infrastructure and integrating renewable energy sources.
- State Programs: Delaware's Energy Efficiency Investment Fund (EEIF) offers financial incentives for energy efficiency improvements, which can include grid modernization projects. These programs help offset the costs of implementing advanced technologies and infrastructure upgrades.

[48] Microknowledge, "Microknowledge.com", modified September 11, 2024, https://www.microgridknowledge.com/

- Private Sector Investments: Partnerships with private companies can drive innovation and funding for grid enhancements. For example, the implementation of micro-grids and energy storage solutions often involves collaboration between utilities and technology firms. These partnerships can accelerate the deployment of new technologies and improve grid reliability and efficiency.

3.7. Challenges, Mitigation Strategies, and State Policy for Grid Development

Infrastructure Development Delays

Developing new grid infrastructure, such as power plants and transmission lines, involves extensive planning, regulatory approvals, and construction phases, often resulting in long project timelines. In Delaware, these projects can take seven years or more to complete. Several factors contribute to these delays:

- Regulatory Approvals: Obtaining the necessary permits and approvals from various federal, state, and local agencies can be a lengthy process. Each project must undergo environmental impact assessments, public consultations, and compliance checks with numerous regulations.[49]
- Technical Complexity: Grid enhancement projects often involve complex technical requirements, including integrating new technologies and ensuring compatibility with existing infrastructure. This complexity can lead to extended design and engineering phases.
- Funding and Financing: Securing adequate funding and financing for large-scale infrastructure projects is a significant challenge. Delays in funding approvals or budget allocations can stall project timelines.
- Public Opposition: Infrastructure projects sometimes face opposition from local communities and stakeholders concerned about environmental impacts, property values, and other issues. Addressing these concerns through public hearings and negotiations can add to project delays.

Growth Strategies

To address these challenges and expedite the development of grid infrastructure, several growth strategies can be employed:

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[49] Federal Energy Regulatory Commission, "Explainer on the Interconnection Final Rule", modified September 11, 2024, https://www.ferc.gov/explainer-interconnection-final-rule

- Policy Changes: Implementing policy reforms to streamline regulatory processes can significantly reduce project timelines. This could include simplifying permitting procedures, setting clear timelines for approvals, and reducing bureaucratic hurdles. For example, FERC's Interconnection Final Rule aims to expedite the integration of new generating facilities by improving interconnection procedures.[50]
- Streamlined Approval Processes: Establishing fast-track approval processes for critical infrastructure projects can help mitigate delays. This might involve creating dedicated task forces or committees to oversee and expedite the approval process for high-priority projects. The adoption of a single-window clearance system, where all necessary approvals are coordinated through a single agency, can also be effective.
- Private-Public Partnerships (PPPs): Encouraging collaboration between the public and private sectors can mobilize additional resources and expertise for infrastructure projects. PPPs can provide alternative financing options, share risks, and leverage private sector efficiency in project execution. Successful examples of PPPs include joint ventures for renewable energy projects and micro-grid implementations.
- Community Engagement: Proactively engaging with local communities and stakeholders throughout the project development process can help address concerns and build support for the project. Transparent communication, regular updates, and involving stakeholders in decision-making can mitigate opposition and facilitate smoother project execution.

Delaware State Policy and Funding Options

- Grid Modernization Incentives: Delaware can implement policies to incentivize utilities and private companies to invest in grid modernization. This includes offering tax credits, grants, or low-interest loans for projects that enhance grid resilience, integrate renewable energy sources, and deploy advanced technologies like smart grids and micro-grids.
- Streamlined Regulatory Processes: Simplifying and expediting the State regulatory approval process for grid enhancement projects can significantly reduce development timelines. This can be achieved by establishing fast-track approval mechanisms for critical infrastructure projects and creating dedicated task forces to oversee and coordinate the approval process. Such approaches have been successful in states like California and New York, where streamlined processes have facilitated quicker deployment of renewable energy projects.
- Public-Private Partnerships (PPPs): Encouraging collaboration between the public and private sectors can attract additional resources and expertise for grid development. Delaware can adopt PPP models that have been successful in other states, such as the partnership between the New York Power Authority and private investors to fund grid modernization projects.

[50] Ibid

These partnerships can mobilize private capital, share risks, and accelerate the implementation of grid enhancement initiatives.

Potential Funding Sources

- Federal Grants and Programs: Delaware can tap into federal funding sources such as the Grid Resiliency Grants provided under the Bipartisan Infrastructure Law. These grants are designed to support projects that enhance grid resilience against disruptions and integrate renewable energy sources. Additionally, programs like the Department of Energy's Loan Programs Office offer financing for innovative energy projects.
- State Bond Issuances: Issuing state bonds specifically for grid enhancement projects can provide a significant funding source. This approach has been used successfully in other states to finance large infrastructure projects. For instance, California has issued green bonds to fund renewable energy and grid modernization projects.
- Green Banks: Establishing a state-level green bank can help finance grid development by leveraging public funds to attract private investment. Green banks provide low-cost financing for energy efficiency and renewable energy projects. States like Connecticut and New York have successfully used green banks to support their energy goals.[51]
- Utility Tariffs and Surcharges: Implementing utility tariffs or surcharges dedicated to funding grid modernization can generate a steady revenue stream for infrastructure projects. These charges can be structured to minimize the impact on consumers while providing the necessary funds for grid enhancements. This method has been employed in various states to support energy infrastructure improvements.

By combining the identification of challenges with proposed mitigation strategies and policy recommendations, this section provides a comprehensive approach to strengthening Delaware's electric grid. Through policy reforms, streamlined approval processes, strategic funding mechanisms, and leveraging best practices from other states, Delaware can effectively prepare its grid for future demands, ensuring a reliable, resilient, and sustainable energy system.

3.8. Example Electric Charging Facilities and Specs for a Vertiport

Electric charging facilities at vertiports are critical components that ensure the efficient operation of eVTOL aircraft. These facilities must be designed to meet the high energy demands of eVTOL operations, providing rapid and reliable charging solutions to minimize downtime and enhance operational efficiency.

[51] National Renewable Energy Laboratory, "Green Banks, modified September 11, 2024, https://www.nrel.gov/state-local-tribal/basics-green-banks.html

Components of Electric Charging Facilities

- High-Capacity Charging Stations:
  - Types of Chargers: The charging stations must be equipped with high-capacity chargers that can deliver substantial amounts of power quickly. This typically includes DC fast chargers, which can provide high power output in short periods.
  - Power Output: DC fast chargers for eVTOL aircraft should have power outputs ranging from 150 kW to 500 kW, depending on the specific requirements of the aircraft. These chargers can recharge eVTOL batteries within 20-30 minutes, enabling quick turnaround times.
  - Connector Types: Standardized connectors ensure compatibility with various eVTOL models. These connectors should be designed to handle high power levels and provide secure, efficient connections.
- Energy Storage Systems (ESS):
  - Battery Storage: Large-scale battery storage systems can store energy during off-peak hours and provide it during peak demand periods. This helps manage grid load and ensures that high-capacity charging stations have a consistent power supply.
  - Capacity: Battery storage systems at vertiports may range from several hundred kilowatt-hours (kWh) to several megawatt-hours (MWh) in capacity, depending on the expected volume of eVTOL operations.
- Renewable Energy Integration:
  - Solar Panels: Installing solar panels on vertiport rooftops or nearby areas can generate renewable energy to power the charging stations. Solar energy can be stored in the ESS for use during periods of high demand.
  - Wind Turbines: In regions with suitable wind conditions, small to medium-sized wind turbines can be installed to supplement the power supply.
- Grid Connection and Management:
  - Grid-Tied Systems: Vertiport charging facilities should be connected to the main electric grid to ensure a reliable power supply. Advanced grid management systems can help balance the load and optimize energy use.
  - Smart Grid Technology: Implementing smart grid technology enables real-time monitoring and control of the charging facilities. This includes demand response capabilities, which allow the charging system to adjust power usage based on grid conditions and availability.

Example Specifications for a Vertiport Charging Facility

- Charging Capacity:

  - Total Power Output: 2 MW (megawatts)
  - Number of Charging Stations: 10 stations with 200 kW output each
- Energy Storage System (ESS):
  - Total Storage Capacity: 5 MWh (megawatt-hours)
  - Battery Type: Lithium-ion batteries with advanced thermal management and safety features
- Renewable Energy Integration:
  - Solar Panel Installation: 500 kW capacity
  - Wind Turbine Installation: 1 MW capacity (if applicable)
- Grid Connection:
  - Transformer Capacity: 2.5 MVA (megavolt-amperes) to handle peak loads
  - Smart Grid Integration: Advanced energy management system with real-time monitoring and demand response capabilities

Benefits of Advanced Charging Facilities

- Operational Efficiency: High-capacity charging stations enable rapid turnaround times for eVTOL aircraft, reducing downtime and increasing the number of flights per day.
- Energy Management: Integration with renewable energy sources and ESS helps manage energy costs and reduces dependence on the main grid.
- Scalability: Modular design of charging facilities allows for easy expansion as the demand for eVTOL services grows.
- Environmental Sustainability: Using renewable energy sources and efficient energy storage systems minimizes the environmental impact of vertiport operations.

By incorporating these advanced charging facilities and specifications, vertiports can support the efficient and sustainable operation of eVTOL aircraft, ensuring that the infrastructure is well-prepared for the future of urban air mobility.

3.9. Findings

Summary of Key Points

The analysis of Delaware's electric grid capacity for future demands from eVTOL aircraft and electric vehicles (EVs) highlighted several critical aspects:

- Current Grid Capacity: Delaware's electric grid can handle existing demand but will require significant upgrades to meet future needs due to the anticipated increase in eVTOL and EV adoption.
- Future Demand Projections: The growth in eVTOL and EV usage is projected to substantially increase electricity demand. By 2030, Delaware will need to accommodate an additional 1.025 GWh daily due to these new technologies.
- Micro-Grids and Decentralized Energy Solutions: Micro-grids offer a promising solution for enhancing grid resilience and integrating renewable energy sources. Successful case studies such as those at Cape Cod Gateway Airport and Vertiv's data center demonstrate their potential.
- Planning for Future Enhancements: Technological innovations like smart grids, advanced energy storage solutions, and micro-grids are crucial for increasing grid capacity and efficiency. Effective planning involves regulatory reforms, streamlined approval processes, and substantial investments from both public and private sectors.
- Challenges and Mitigation Strategies: Infrastructure development delays pose significant challenges, but strategies such as policy changes, private-public partnerships, and advanced planning can mitigate these delays and expedite project completion.

Recommendations

To prepare Delaware's electric grid for the future demand from eVTOL aircraft and electric vehicles, stakeholders should consider the following strategic recommendations:

- Invest in Grid Modernization: Prioritize investments in smart grid technologies and advanced energy storage solutions to enhance grid reliability and efficiency. These technologies will help manage increased loads and integrate renewable energy sources.
- Streamline Regulatory Processes: Implement policy reforms to simplify and expedite the approval processes for grid enhancement projects. This includes adopting fast-track approval mechanisms and establishing dedicated task forces to oversee critical infrastructure projects.
- Develop Micro-Grids: Encourage the deployment of micro-grids, particularly in areas with critical infrastructure and high energy demand. Micro-grids can provide localized energy solutions, improve resilience, and reduce dependence on the main grid during peak demand periods.
- Foster Private-Public Partnerships: Leverage private sector investments and expertise through partnerships to fund and implement grid enhancement projects. These partnerships can accelerate the deployment of new technologies and infrastructure improvements.

- Enhance Community Engagement: Engage local communities and stakeholders throughout the project development process to address concerns and build support for grid enhancement initiatives. Transparent communication and involvement in decision-making can mitigate opposition and facilitate smoother project execution.

Future Research Directions

Further research and data collection are essential to better understand and prepare for future grid demands in Delaware. Key areas for future research include:

- Impact of High EV Adoption Rates: Conduct detailed studies on the impact of high EV adoption rates on grid stability and capacity, drawing on examples from regions with significant EV penetration.
- eVTOL Energy Consumption Patterns: Research the specific energy consumption patterns of eVTOL aircraft to develop more accurate demand forecasts and integration strategies.
- Renewable Energy Integration: Investigate the best practices for integrating renewable energy sources into the grid, focusing on maximizing efficiency and reliability while minimizing environmental impact.
- Advanced Energy Storage Solutions: Explore the latest advancements in energy storage technologies and their applications in enhancing grid capacity and resilience. This includes studying the performance and cost-effectiveness of various storage solutions.
- Policy and Regulatory Frameworks: Analyze the effectiveness of current regulatory frameworks and identify opportunities for reforms that can facilitate quicker and more efficient grid enhancement projects.

By addressing these research areas and implementing the recommended strategies, Delaware can effectively prepare its electric grid to meet the future demands of eVTOL aircraft and electric vehicles, ensuring a sustainable and resilient energy system for the years to come.

SECTION 4

Potential Infrastructure Needs: Vertiport Landing Areas

SECTION 4: POTENTIAL INFRASTRUCTURE NEEDS: VERTIPORT LANDING AREAS

As the adoption of electric vertical takeoff and landing (eVTOL) aircraft becomes more widespread, the development of vertiport landing areas will be critical to supporting this new mode of transportation. Vertiports are specialized facilities designed to accommodate the takeoff, landing, and servicing of eVTOL, helicopters, and other VTOL aircraft. This subsection will explore the potential infrastructure needs for vertiport landing areas, required technologies, order of magnitude cost estimates for infrastructure development, along with case studies of successful vertiport development.

4.1. Overview of Vertiport Infrastructure

Vertiport facilities are integral to the urban transportation ecosystem, facilitating the seamless integration of eVTOL and other VTOL aircraft into urban environments. Vertiports provide the necessary infrastructure to support the operation, maintenance, and management of aircraft, thereby enhancing urban mobility, hopefully reducing traffic congestion, and promoting sustainable transportation solutions. The development of vertiports is necessary for realizing the full potential of AAM and addressing the growing demand for efficient and eco-friendly transportation alternatives in urban areas.[52]

Vertiport Components

A fully functional vertiport comprises several key components that ensure the safe and efficient operation of eVTOL aircraft:

- Takeoff and Landing Pads (TLOF and FATO) and Safety Area:
  - Touchdown and Liftoff Area (TLOF): The TLOF is a designated area where VTOL aircraft land and take off. It must be a solid, non-slippery surface capable of supporting the weight and dynamic loads of the aircraft. According to FAA Engineering Brief No. 105, the TLOF should have a minimum dimension of 1 rotor diameter (1D) of the largest VTOL aircraft intended to use the vertiport.[53]

[52] American Institute of Aeronautics and Astronautics, "Advanced Air Mobility", accessed September 9, 2024, https://engage.aiaa.org/communities/community-home/digestviewer?communitykey=85b88e41-2717-43b7-a285-46488cb64798
[53] Federal Aviation Administration, "Engineering Brief No. 105, Vertiport Design", accessed September 9, 2024, https://www.faa.gov/airports/engineering/engineering_briefs/engineering_brief_105_vertiport_design

- Final Approach and Takeoff Area (FATO): Surrounding the TLOF, the FATO is a larger area that provides the necessary space for the final approach and initial climb of the VTOL aircraft. The FATO ensures that aircraft have sufficient clearance from obstacles during these critical phases of flight. The FATO should have a minimum dimension of 2 rotor diameters (2D).

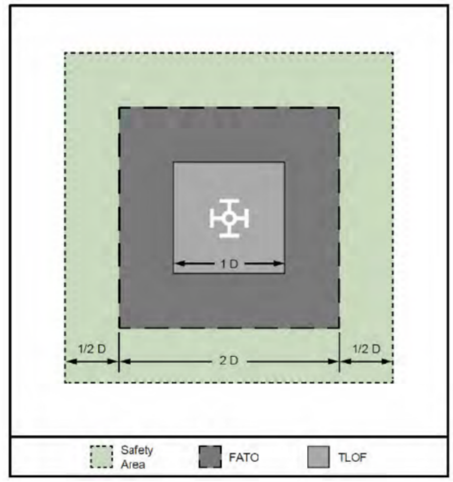

Figure 1 - Dimensions of TLOF, FATO, Safety Area
Source: FAA EB 105, Vertiport Design

- Safety Area: The safety area surrounding the TLOF and FATO is an additional buffer zone that enhances operational safety. This area must be free of obstacles and provides extra space in case of emergencies or deviations during takeoff and landing. The dimensions and requirements for the safety area depend on the specific characteristics and operational profiles of the eVTOL and VTOL aircraft being used. The Safety Area should have a minimum dimension of 3 rotor diameters (1/2 D added to the edge of the FATO).
- Vertiport Footprint: Assuming a 50-foot rotor diameter, the minimum size of a vertiport would be roughly 22,500 square feet (150’ times 150’), or about one-half acre. With additional amenities, the facility could take up five acres or so, with auto parking, terminal buildings, service hangars and so on.

- Charging Stations:
  - Vertiports must be equipped with high-capacity charging stations to support the rapid turnaround of eVTOL aircraft. These stations provide the necessary infrastructure for recharging aircraft batteries, which is necessary for maintaining operational efficiency and minimizing downtime. The types of chargers, charging times, and energy demands must be carefully planned to meet the needs of various eVTOL models.
- Air Traffic Control Systems:
  - Advanced air traffic control (ATC) systems will be needed to manage the flow of eVTOL aircraft within crowded urban airspace. These systems include communication, navigation, and surveillance technologies that would ensure safe and efficient aircraft operations. While ATC systems for eVTOL aircraft are still under development, they will be necessary in all but Class G airspace for future operations. These systems must eventually integrate with existing air traffic management infrastructure to provide seamless coordination between traditional and eVTOL aircraft.

- Maintenance Facilities (Optional):
  - Maintenance facilities enhance the overall utility of vertiports by offering upkeep and repair services for eVTOL aircraft. These facilities would include hangars, repair shops, and spare parts inventory. Not all vertiports require maintenance facilities.
- Passenger Terminals (Optional):
  - Passenger terminals at large vertiports or at airports with vertiports may be needed in the future to process passengers and baggage using AAM. These terminals would typically include waiting areas, ticketing counters, security screening, and boarding facilities. The design and capacity of passenger terminals would accommodate the expected passenger throughput and ensure smooth operations. Again, not all vertiports require passenger terminals.

4.2. Potential Development at Existing Airports

Existing Airports in Delaware

Delaware is home to nine public-use airports and one public-use heliport that offer potential sites for vertiport development. These include both publicly owned and privately owned facilities.

- Publicly Owned Airports:
  - Wilmington Airport (ILG): Also known as New Castle Airport, this facility serves the southern Philadelphia and Wilmington metropolitan area. It offers low fare airline and general aviation services. The airport features an expanded terminal building, hangars, maintenance facilities, and a variety of fixed-base operators (FBOs).
  - Delaware Airpark (33N): Located in Dover, Delaware Airpark serves general aviation needs and is a hub for Delaware State University flight training and recreational flying. The airport has a paved runway, taxiways, hangars, and support facilities for small aircraft.
  - Delaware Coastal Airport (GED): Formerly known as Sussex County Airport, this general aviation airport is near Georgetown, Delaware, and serves southern Delaware and the beach communities. It features a primary runway, a crosswind runway, hangars, and a terminal building. There is a large MRO located at the facility (ALOFT).
- Six Privately Owned, Public-Use Airports:
  - Chandelle Airport: Paved runway airport located northeast of Dover, serving small general aviation and a spray operation.
  - Chorman Airport: Paved runway airport located near the Kent County/Sussex County line, serving general aviation and a spray operation.
  - Jenkins Airport: Turf runway airport located near Camden/Wyoming serving small general aviation and a salvage operation.

- Laurel Airport: Turf runway airport located in southwest Sussex County, serving small general aviation and a spray operation.
- Smyrna Airport: Turf runway airport located east of Smyrna and Route 1, serving small general aviation.
- Summit Airport: Paved runway airport located north of Middletown, serving general aviation, with significant avionics, fabrication, and paint capabilities.

These airports may be important for locating vertiports and maintaining broad access to eVTOL and AAM aviation services across the state. Keeping these facilities open and available will likely become more important in the future, as non-airport areas suitable for vertiport location will become more difficult to develop.

Advantages of Airport Locations

Developing vertiports at existing airports presents several benefits including:

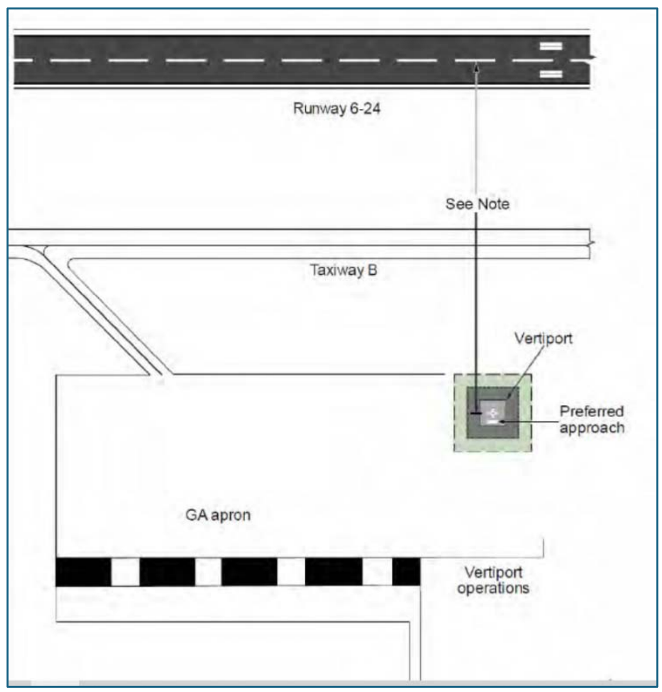

Figure 2 - Airport Vertiport Location
Source: FAA EB 105 – Vertiport Design

- Public Acceptance: Airports are already designated for aviation use, which can lead to greater public acceptance of vertiport development compared to new standalone sites. This reduces potential conflicts and simplifies regulatory approvals.
- Leverage Existing Infrastructure: Existing airports already have much of the necessary infrastructure, including runways, taxiways, hangars, and maintenance facilities. This reduces the cost and time required for vertiport development. In addition, airports are typically equipped with essential utilities such as electricity, water, and fuel supply, which can be altered for vertiport operations.
- Air Traffic Control: Wilmington Airport has established air traffic control (ATC) systems that can be adapted to manage eVTOL operations, ensuring safe and efficient air traffic management.

- Transportation Connections: Airports are usually well-connected to major transportation networks, including highways, public transit, and parking facilities. This enhances the accessibility of vertiports for passengers. In addition, the integration of vertiports with existing airports allows for seamless intermodal connections, facilitating the transfer of passengers between eVTOL aircraft and other modes of transportation such as commercial flights, trains, and buses.

Developing vertiports at existing airports in Delaware presents a viable and strategic opportunity to enhance urban mobility and support the growth of AAM. By leveraging existing infrastructure, air traffic control systems, and transportation connections, these airports can efficiently accommodate eVTOL operations.

4.3. Order of Magnitude Cost Estimates for Vertiport Development

Developing vertiports involves significant investment across several components, including land acquisition, construction, and technology implementation. Based on current market data for land in Wilmington, DE, and typical costs for similar infrastructure projects, the following rough cost estimates can be estimated:

- Land Acquisition Costs:
  - Urban Areas: Land in Wilmington, DE can range significantly, depending on location. For example, a 1.76-acre lot is priced at $225,000, while larger commercial parcels, such as a 2.6-acre lot, are listed at $5.2 million. Location is a primary factor, so there is a wide range depending upon where a vertiport is planned.[54]
  - Suburban/Rural Areas: Land costs in suburban or rural areas of Delaware suitable for vertiport development are generally lower, ranging from $50,000 to $250,000 per acre.[55]
  - On-Airport: In most cases, the cost would be either a lease for the land or possibly no cost for the use of the land, depending on service agreements. The ownership of the land would not change.
- Construction Costs:
  - Site Preparation: Including clearing, grading, and utility installation, costs are estimated between $50,000 and $100,000 per acre.

[54] For Real Estate costs concerning urban development, see Redfin, “Land Prices in Wilmington, DE”, accessed September 9, 2024, https://www.redfin.com/city/19583/DE/Wilmington/land
[55] For Real Estate costs concerning commercial development, see Redfin, “Land for Sale in Wilmington, DE”, Accessed September 9, 2024, https://www.landsearch.com/commercial/wilmington-de

  - Infrastructure Development: Building the Touchdown and Liftoff Area (TLOF), Final Approach and Takeoff Area (FATO), Safety Area, and other necessary structures can range from $100,000 to $200,000 per vertiport.
  - Facilities Construction: Costs for passenger terminals, maintenance facilities, and other buildings can vary but can range from $250/square foot to $500/square foot, depending on size and complexity.
- Technology Implementation:
  - Charging Stations: High-capacity electric charging stations for eVTOL aircraft are estimated at $500,000 per station.

Overall, the total cost of developing a vertiport can range from $1 million to $4 million, depending on location, scale, and complexity. For elevated vertiports within urban centers, the cost could be ten times that amount.

4.4. Case Studies on Vertiport Developments

1. Lilium and Ferrovial Partnership, Florida, USA

Lilium, a German eVTOL manufacturer, in partnership with Ferrovial, a Spanish infrastructure company, is developing a network of vertiports across Florida. This network is designed to facilitate regional air mobility by connecting key urban centers with short-haul flights. The first phase includes ten vertiports strategically placed to maximize coverage and accessibility. The project leverages existing infrastructure where possible to reduce costs and expedite development. Ferrovial's experience in airport management and operations plays a crucial role in ensuring that these vertiports are integrated seamlessly into the existing transportation networks. This project highlights the importance of public-private partnerships in scaling vertiport infrastructure.[56]

2. Orlando, Florida

As a subset of the partnership described above, Orlando is home to one of the most ambitious vertiport projects in the U.S., led by Lilium and Ferrovial. The project involves using Orlando as the key hub of the network of vertiports across the state, due to its central location and heavy tourist traffic. The vertiport network in Orlando will connect with major tourist attractions, the airport, and other cities in Florida. The project is designed to facilitate both passenger and cargo eVTOL operations, making it a significant part of the state's transportation infrastructure.[57]

[56] Performance Software, "Advanced Air Mobility", Accessed September 9, 2024, https://www.psware.com/urban-air-mobility-vertiports-on-the-rise/
[57] Orlando Economic Partnership, "Why Lilium Established its First U.S. Vertiport in Orlando", Accessed September 9, 2024,

3. Miami, Florida

Miami is also exploring vertiport development as part of its efforts to enhance urban mobility and reduce traffic congestion. The city has partnered with companies like Volocopter and Skyports to explore potential sites and design concepts for vertiports that could serve both passenger and cargo eVTOL operations. Miami's vertiport development focuses on integrating with the city's existing public transportation network and utilizing available spaces, such as the rooftops of parking structures and buildings.[58]

4. Los Angeles International Airport (LAX), California

LAX is actively involved in integrating vertiports into its operations as part of a broader initiative to reduce ground congestion and improve transportation efficiency. The vertiport plans at LAX are part of a public-private partnership that involves both the city and private companies specializing in eVTOL technology. The project emphasizes using existing airport infrastructure to minimize costs and expedite development. It is designed to serve as a model for integrating vertiports into large, busy airports. LAX's vertiport will connect with other transportation modes, providing seamless transfers between air, ground, and public transportation.[59]

5. Dallas-Fort Worth (DFW) Metroplex, Texas

In 1994, long before AAM was conceived, the city of Dallas constructed the world's largest urban elevated Heliport/Vertiport. This public-use facility is located in the Central Business District on the south end of the Dallas Convention Center. The Dallas Heliport/Vertiport has a dual deck, accommodating three helicopters plus two vertical-take-off and landing aircraft at the same time. Recently, Uber Elevate, now part of Joby Aviation, identified Dallas-Fort Worth as one of its initial cities for launching urban air mobility services. The region's extensive network of highways, airports, and urban centers makes it an ideal location for implementing a vertiport network. The project in the DFW area focuses on utilizing existing infrastructure, such as the existing vertiport plus airports, parking garages, and rooftops, to create a network of vertiports. This approach

https://news.orlando.org/success-stories/why-lilium-established-its-first-u-s-vertiport-in-orlando/

[58] Maggie Mullen, Skyports Infrastructure, "Skyports Joins Embraer Eve Consortium to Develop Initial Urban Air Mobility Concept of Operations in Miami-Dade County", Accessed September 9, 2024, https://skyports.net/skyports-joins-embraer-eve-consortium-to-develop-initial-urban-air-mobility-concept-of-operations-in-miami-dade-county/

[59] Phillip Butterworth-Hayes, Unmanned Airspace, "Los Angeles Airport Issues RFIC to Industry for Vertiport Development in Three Potential Sites", Accessed September 9, 2024, https://www.unmannedairspace.info/latest-news-and-information/los-angeles-airport-issues-rfic-to-industry-for-vertiport-development-in-three-potential-sites/

minimizes land acquisition costs and integrates vertiports into the urban environment with minimal disruption.[60]

These examples illustrate the diverse approaches being taken across the U.S. to develop vertiports, each tailored to the unique needs and infrastructure of the respective cities. The common thread across these projects is the focus on integrating vertiports with existing transportation infrastructure and minimizing the impact on urban environments while maximizing the potential benefits of urban air mobility.

International Vertiport Development

1. Urban Air-Port, Coventry, UK

Urban-Air Port, located in Coventry, UK, is one of the first fully operational vertiports designed to support eVTOL aircraft and drones. This city-center vertiport was developed to demonstrate the potential of Urban Air Mobility (UAM) in reducing urban congestion and facilitating sustainable transportation. The project was funded by a mix of government grants and private investment. The Coventry vertiport features a modular design, allowing for scalability and adaptability in different urban environments. Its construction costs were significant but manageable due to the use of modular and prefabricated components, making it a benchmark for future urban vertiport developments.[61]

2. Groupe ADP and RATP Group, Paris, France

In preparation for the 2024 Olympic Games, Groupe ADP, in collaboration with RATP Group and the Paris Ile-de-France region, worked to develop vertiport infrastructure as part of a broader Urban Air Mobility initiative. The project included the construction of several vertiports around Paris to serve as test beds for eVTOL operations during the Olympics. These vertiports are integrated with existing transportation networks, such as the Paris Metro and major airports, to provide seamless travel options for passengers. The initiative is part of a larger European effort to establish standardized vertiport designs that can be replicated across the continent, ensuring interoperability and safety.[62]

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[60] AllianceTexas Mobility Innovation Zone, Dallas Innovates, "Rising Above the Obstacles", Accessed September 9, 2024, https://libguides.westsoundacademy.org/chicago-citation/web-page-no-author
[61] Phillip Butterworth-Hayes, Urban Air Mobility News, "Vertiport Concepts: Seven Different Approaches to Urban Air Mobility Take-off and Landing Areas", Accessed September 9, 2024, https://www.urbanairmobilitynews.com/vertiports/vertiports-concepts-six-different-approaches-to-urban-air-mobility-take-off-and-landing-areas/
[62] Manfred Hader and Stephan Baur, Rolandberger, "How Groupe ADP Wants to Act as the Catalyzer in the Development of UAM Activities", Accessed September 9, 2024, https://www.rolandberger.com/en/Insights/Publications/Urban-Air-Mobility-Designing-vertiports-following-a-non-exclusive-ecosystem.html

3. Skyports and Volocopter, Singapore

Skyports, a UK-based vertiport developer, and Volocopter, a German eVTOL manufacturer, have partnered to develop a series of vertiports in Singapore. These vertiports are designed to support both passenger and cargo operations, facilitating urban air mobility in one of the world's most densely populated cities. The project includes the use of rooftop spaces for vertiports, taking advantage of Singapore's vertical urban landscape. This approach minimizes the need for additional land acquisition and leverages existing building infrastructure to reduce costs. The success of this project could pave the way for similar developments in other high-density urban areas.[63]

[63] Phillip Butterworth-Hayes, Urban Air Mobility News, "Vertiport Concepts: Seven Different Approaches to Urban Air Mobility Take-off and Landing Areas", Accessed September 9, 2024, https://www.urbanairmobilitynews.com/vertiports/vertiports-concepts-six-different-approaches-to-urban-air-mobility-take-off-and-landing-areas/

SECTION 5

Policy & Implementation of AAM

SECTION 5: POLICY AND IMPLEMENTATION OF AAM

5.1 Introduction

The implementation of Advanced Air Mobility in Delaware represents an opportunity to further develop the State's transportation system by integrating vertiports into the aviation infrastructure. This report outlines the necessary planning efforts for AAM deployment and includes the following sections:

- *Vertiport Location Criteria:* This section identifies the need for siting vertiport locations based on demand centers, multimodal accessibility, and environmental compatibility. This guidance can be used in system planning work to further the AAM geographic footprint.
- *Policy and Funding Initiatives:* Discussion of regulatory frameworks, policies needed for electric grid enhancements, innovative funding mechanisms, and public-private partnerships.
- *Workforce Development:* This section describes the potential valuation of AAM in terms of job creation and new industry sectors.
- *Implementation Phases:* Suggested roadmap of phased activities, including planning, infrastructure development, regulatory alignment, and operational scaling.
- *Stakeholder Engagement:* Overview of the roles and contributions of government entities, private sector partners, academic institutions, utility providers, and the community.

5.2 Strategic Vertiport Location Criteria and Planning for Delaware

The successful deployment of AAM in Delaware requires the careful planning of vertiport locations. The aviation system planning process, which is conducted by DelDOT every five years, is expected to address the vertiport questions in their new plan. In this regard, the Delaware Aviation System Plan Update began in January 2025. This plan will incorporate research by Mendonca et al. (2022), which provides key insights into the factors that should guide the planning and siting of vertiports, emphasizing the need to balance functionality with minimal disruption to communities and ecosystems.[64]

Summary of Planning Criteria

Of all the planning guidelines considered, the most important criterion is proximity to demand centers. Vertiports should be located near areas with high passenger activity, such as city centers, business districts, and airports. In Delaware, locations like downtown Wilmington, Newark, Dover, and the beach communities, represent significant opportunities to capture demand from business travelers, commuters, and government operations. Proximity to major transportation hubs like Philadelphia International Airport can also enhance regional connectivity in the broader AAM network.

Multimodal accessibility is another important consideration. In future years, when vertiports will be handling passengers, they must integrate seamlessly with existing transportation systems, such as train stations, bus terminals, and major roadways. This integration ensures efficient last-mile connectivity, making AAM services more convenient for passengers. For example, a vertiport near the Wilmington Train Station would allow travelers to easily transition between rail and air travel, creating a seamless multimodal transportation experience that enhances operational efficiency and user satisfaction.[65]

Land use compatibility is needed to ensure that vertiports do not create issues within communities that may be sensitive to aircraft noise. Preliminary studies show that the eVTOLs can be 20 times less noisy than conventional helicopters. Even so, planning for buffer zones around vertiports can mitigate noise impacts on residential neighborhoods, further promoting community acceptance. Engaging with local residents during the planning phase is important to identifying and addressing concerns, fostering trust, and building public support. Open communication and transparent decision-making processes can help align community interests with AAM objectives.

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[64] Nancy Mendonca et al., NASA Aeronautics Research Institute, "Advanced Air Mobility Vertiport Considerations Review," modified January 10, 2025, https://ntrs.nasa.gov/api/citations/20220007100/downloads/Vertiport%20Considerations%20Paper%20Final%20v2.pdf

[65] Adam Cohen, Susan Shaheen, Yolanka Wullf, American Planning Association, "Planning for Advanced Air Mobility 2024", modified January 10, 2025, https://planning-org-uploaded-media.s3.amazonaws.com/publication/download_pdf/PAS-Report-606a.pdf

Scalability and future expansion should also be factored into vertiport planning. As AAM operations grow, sites should be able to accommodate increased flight volumes and potentially larger facilities. Modular designs offer a practical solution, enabling phased expansions without requiring significant additional land. This approach can be included in the evaluation criteria to ensure that vertiports remain flexible and adaptable as demand evolves over time.

Translating Criteria into Potential Site Locations

For this planning effort, general site locations are suggested for further analysis by the Aviation System Plan. Using the criteria above, several general potential locations have been identified for vertiport development in Delaware. These include:

- *Downtown Wilmington:* As the state's largest city and economic hub, downtown Wilmington is an ideal location for at least one vertiport. A site near the Wilmington Train Station or the Christina Riverfront would provide good multimodal connectivity and serve a high volume of business travelers and commuters. Other urban vertiports could be added as the network expands.
- *Newark:* Home to the University of Delaware and a growing business community, Newark presents another strategic location. A vertiport near the Newark Train Station or the STAR Campus could support both academic and corporate travelers, enhancing connectivity and fostering economic development.
- *Dover:* The State Capital and Dover Air Force Base offer unique opportunities for AAM operations, including government and military applications. A vertiport near downtown Dover or the Airbase could support passenger or medical services, logistics, and possible military transportation needs. Coordination with military operations and ensuring public accessibility will be important to the success of this location.
- *Rehoboth Beach:* As a popular coastal destination, Rehoboth Beach could benefit from a vertiport designed to support seasonal tourism. Integrating the vertiport with existing transportation options, such as Route 1, would enhance visitor convenience while managing seasonal demand fluctuations.

Finally, rural connectivity nodes in southern Delaware, such as Georgetown, Seaford, or Laurel, could improve access to healthcare, education, and economic opportunities for underserved communities. These locations could function as gathering points, addressing gaps in mobility and fostering inclusive economic growth.

5.3 Delaware Policy and Funding Initiatives for AAM

The implementation of AAM in Delaware presents a unique opportunity for the State to embrace innovative transportation technologies while fostering sustainability and economic growth. Drawing on successful examples from other states and regions and integrating best practices, Delaware can establish a framework that aids in the development and adoption of local AAM systems. Key to this endeavor will be crafting forward-thinking regulatory policies, leveraging innovative funding mechanisms, and fostering strategic partnerships.

Regulatory Framework

The implementation of AAM in Delaware requires a state-centric approach that uses the regulatory tools and policy-making capacity of the State government and its agencies. By focusing on State-level mechanisms, Delaware can create a supportive framework to facilitate AAM adoption, while staying in its lane, so to speak. The State will focus on what it can do, versus relying on federal, local, or private agencies for implementation actions.

1. Establishing a Statewide AAM Roadmap: Similar to Massachusetts, Delaware should develop a policy roadmap tailored to AAM. This framework would help integrate AAM technologies and infrastructure into the State's long-range transportation plan and aviation system plan. It is possible that the Aviation System Plan could begin the process. The roadmap should address:

- *Standards for Vertiports and Infrastructure:* Define location, design, and operational requirements for vertiports, with an emphasis on renewable energy integration, air cargo carrier usage, potential passenger traffic, and compatibility with local land-use plans.
- *Statewide Land Use Compatibility:* Collaborate with the FAA where necessary but consider defining low-altitude flight corridors to minimize adverse impacts to land uses such as residential and other noise sensitive areas.

2. Streamlining Permitting and Approvals: AAM and other new development projects face delays due to lengthy permitting and regulatory processes. Delaware can take the following steps to reduce these barriers:

- *Centralized Permitting:* Create a single point of contact within the state government to manage permits for AAM-related infrastructure and operations, simplifying the process for developers. This should be coordinated with the Office of Aeronautics Director and the Director of Planning at DelDOT.

- *Pre-Approved Standards:* Establish pre-approved design and operational standards for vertiports and eVTOL charging facilities to expedite review timelines.
- *Fast-Track Approval Mechanisms:* Develop expedited processes for AAM projects, particularly those aligned with State economic development goals and sustainability.

3. Incentivizing Private Sector Participation: Policies should encourage private investment and innovation in AAM infrastructure and operations. Key strategies include:

- *Tax Incentives:* Provide state-level tax credits for the development of vertiports, charging infrastructure, and renewable energy systems tied to AAM.[66]
- *Grants and Funding Programs:* Use state-funded grant programs to develop vertiports at airports or other needed AAM infrastructure.
- *Public-Private Partnerships (PPPs):* Facilitate collaborations between the state and private sector to share costs and risks, particularly for large-scale infrastructure investments.

4. Soliciting Public and Stakeholder Input: Implementing an AAM system in Delaware cannot be conducted in a vacuum. Input from the public and industry stakeholders is important to making the system a reality.

Public Engagement:

- Piggyback AAM education forums with existing State outreach programs for other transportation modes, bike paths, etc.
- Include informational highlighting how AAM can improve mobility, reduce emissions, and drive economic growth, as data becomes available.
- Publicize the workforce development opportunities associated with AAM in Delaware.

Stakeholder Collaboration:

- Convene regular meetings with utility providers, transportation agencies, airport operators, and private developers to ensure that AAM policies are practical and implementable.
- Partner with DSU and other academic institutions and technology firms to study AAM impacts and refine regulatory approaches.

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[66] United States Government Accountability Office, "Transforming Aviation: Congress Should Clarify Certain Tax Exemptions for Advanced Air Mobility 2022", modified January 10, 2025, https://www.gao.gov/products/gao-23-105188

By focusing on state-level regulatory pathways and using the strengths of its agencies, Delaware can create a supportive environment for AAM. Through streamlined processes, clear standards, and incentives for innovation, the State can give Delaware residents the best possibility for AAM development and its associated transportation efficiencies and economic growth.

Policies Needed for Electric Grid Enhancements

The success of AAM hinges on an adaptive electric grid that can meet the substantial power demands of eVTOL operations. Delaware's grid must undergo upgrades to ensure reliability, efficiency, and sustainability, not just for eVTOL, but for all electrical vehicles of the future. These enhancements will include expanding the grid's capacity through upgraded transformers, substations, and distribution lines, particularly around airports and vertiport locations. Renewable energy integration will also be important, with on-site solar photovoltaic systems and advanced battery storage solutions playing a role in powering charging stations. Addressing this demand requires a coordinated policy framework involving state agencies, public boards, and utility providers.[67]

1. Regulatory Coordination and Oversight

While Delaware has made strides in grid modernization, targeted policies are needed to bridge the gap between general grid enhancements and the specific needs of AAM. These would include but not be limited to:

- *Expedited Approvals:* The Delaware Public Service Commission (PSC) should develop fast-track permitting mechanisms specifically for new infrastructure projects near vertiports and airports to reduce project timelines. Current processes for grid enhancements focus on general improvements and lack targeted provisions for AAM infrastructure.
- *Integrated Planning with PJM Coordination:* Delaware's electric grid is part of the PJM Interconnection, a regional transmission organization (RTO) that coordinates the movement of electricity across 13 states and the District of Columbia. PJM plays a critical role in managing the high-voltage grid, ensuring reliability, and operating the largest competitive wholesale electricity market in the world.[68]

[67] U.S. Department of Energy, "Grid Modernization Strategy 2017", modified January 10, 2025, https://www.energy.gov/gmi/articles/2017-grid-modernization-initiative-peer-review-report
[68] PJM Interconnection, "PJM Interconnection 2021 State of the Market Report", modified January 10, 2025, https://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2021/2021-som-pjm-vol1.pdf

- To prepare for increased EV and AAM, Delaware agencies should enhance collaboration with PJM to align grid upgrades with anticipated AAM deployment timelines. This could include:
  - Coordinating new infrastructure investments for airports and vertiports.
  - Adjusting load forecasting models to include incremental eVTOL energy demands.
  - Facilitating the integration of renewable energy sources into areas of high EV and AAM activity.
- *Grid Resilience Mandates:* Policies should formalize the integration of microgrids, battery storage, and renewable energy sources into critical AAM-related infrastructure. While Delaware promotes renewable energy broadly through its Renewable Portfolio Standards (RPS), mandates for incorporating resilience-focused technologies remain undeveloped.

2. Public-Private Partnerships (PPPs)

Public-Private Partnerships (PPPs) can help mobilize the resources, expertise, and innovation needed to modernize Delaware's electric grid and prepare it for Advanced Air Mobility (AAM) technologies. PPP policies can leverage private investment and create public benefits like sustainability, reliability, and economic growth by doing the following:

- *Incentivizing Investments:* Incentivizing private sector participation through financial and regulatory measures can accelerate grid modernization efforts.[69] Policies should focus on reducing the financial burden and increasing the attractiveness of grid enhancement projects for private entities.
- *Tax Credits:* Provide state-level tax credits to private companies investing in renewable energy systems, battery storage, or microgrid installations near AAM infrastructure such as airports and vertiports. In addition, offer additional tax benefits for projects integrating advanced technologies, such as real-time energy management systems or renewable energy solutions.
- *Grant Programs:* Establish competitive grant programs for private companies to develop infrastructure projects, particularly those that incorporate renewable energy and storage solutions at AAM facilities. In addition, allocate funding for pilot programs to demonstrate the viability and scalability of grid enhancements, which may encourage broader private sector participation.

[69] Laszlo von Lazar, Black and Veatch, "Rethinking the Modern Grid 2022-2023", modified January 10, 2025, https://cdn.bfldr.com/E1EVDN8O/at/7qmsfmjnjbhf4b2k4c8fjmz/22_Electric_SDR__Final.pdf

- *Streamlined Regulations:* Simplify permitting and approval processes for private developers to encourage faster implementation of grid modernization projects. This could include pre-approval mechanisms for standardized project designs.

3. Risk Sharing:

- Grid modernization projects often involve high upfront costs, long timelines, and uncertainties in return on investment. By sharing financial and operational risks, PPP models can create a more balanced and sustainable framework for both public and private stakeholders.
    - *Cost Sharing:* Public agencies could co-fund microgrid or renewable energy projects with private partners, covering a portion of the initial capital investment. For example, the State could provide matching funds for private investment entities. In addition, develop public funds specifically aimed at riskier projects, such as integrating new grid technologies or establishing large-scale storage systems, to reduce the financial risk for private participants.
    - *Revenue Sharing:* Create agreements where revenues from microgrid operations, such as selling surplus power or providing grid services, are shared between public agencies and private investors. This ensures long-term incentives for both parties.
    - *Long-Term Service Agreements:* Encourage private companies to design, build, and operate infrastructure projects under long-term contracts with guaranteed performance outcomes. Public agencies could pay for services like grid stabilization or renewable energy generation over time, spreading out costs.[70]
    - *Insurance and Guarantee Mechanisms:* Establish State-backed guarantees or insurance programs to reduce private sector risk in case of project delays, cost overruns, or technological failures.

3. Renewable Energy Integration

To support Delaware's sustainability goals and the increasing energy demands of EVs and AAM, policies should continue to emphasize and expand the integration of renewable energy into grid enhancements. While Delaware has made progress in this area, additional measures could be implemented.

- *Net Metering Policy Improvement:* Delaware already has established net metering policies that allow customers with on-site renewable energy systems, such as solar panels, to

[70] National Association of Regulatory Utility Commissioners (NARUC), "The Role of State Utility Commissions in Grid Modernization 2018", modified January 10, 2025, https://www.naruc.org/core-sectors/energy-resources-and-the-environment/smart-grid-grid-modernization

receive credits for excess electricity fed back into the grid. These policies are governed by Senate Bill 298, which expanded and clarified provisions for net energy metering. Customers can size their systems to produce up to 110% of their 12-month historical energy consumption, with excess energy credited to subsequent bills.

Although Delaware's net metering system is well-established, it could be further adapted to accommodate the unique needs of AAM infrastructure. For example:

- Simplify the integration of larger renewable systems at airports and vertiports.
- Encourage utilities to support AAM-specific renewable installations by streamlining interconnection agreements and offering technical assistance for vertiport operators.
- Potentially increase the energy production cap of 110 percent to allow greater incentives for energy producers.

- *Battery Storage Incentives:* Delaware provides incentives for renewable energy installations through programs like the Green Energy Program. However, specific State-level incentives for large-scale battery storage systems are limited. Large-scale storage systems are critical for stabilizing the grid, particularly during peak usage by eVTOL aircraft and electric vehicles.

  Federal incentives, such as the Investment Tax Credit (ITC) and provisions in the Inflation Reduction Act of 2022, currently offer significant support for energy storage systems, including standalone battery projects. These federal measures can be leveraged to drive adoption in Delaware.

  Delaware could develop targeted incentives to complement federal programs and promote large-scale battery storage. These could include:

  - State tax credits or grants for storage systems co-located with renewable energy sources at vertiports and airports.
  - Policies to incentivize utilities and private developers to deploy battery storage solutions as part of AAM-specific grid enhancements.

Power Grid Improvement Implementation

For successful grid modernization which would enable scaled usage by EVs and AAM, a stakeholder engagement process should include relevant entities involved in planning, implementation, and policy development. This process should be led by State agencies and involve collaboration with key players across multiple sectors.[71]

Forums for implementation and coordination for Delaware's power grid could be led by the Governor's Energy Advisory Council. These regular meetings would bring together key stakeholders from government agencies, utilities, transportation sectors, and private industry to align efforts and set actionable goals.

Task-specific working group(s) should complement these forums, focusing on critical areas such as renewable energy integration, microgrid development, and eVTOL infrastructure. By addressing these specialized topics, the working groups can delve into technical details and propose targeted solutions, ensuring that the broader forums remain strategic and high-level. This process should:

- Monitor progress against defined benchmarks, such as the number of upgraded substations or installed renewable energy systems.
- Evaluate the effectiveness of policies in achieving energy resilience and sustainability objectives.
- Recommend adjustments based on emerging AAM trends and grid technologies.

Key stakeholders include:

- *State Agencies:*
    - Delaware Public Service Commission (PSC): Oversees utilities' operations and regulatory approvals for infrastructure projects, ensuring alignment with State standards for reliability and affordability.
    - Governor's Energy Advisory Council (GEAC): Provides strategic guidance on State energy policies and recommends actions to enhance Delaware's energy system.
    - Department of Natural Resources and Environmental Control (DNREC): Plays a pivotal role in renewable energy policy, climate action, and environmental permitting, supporting sustainable infrastructure projects.
    - Delaware Office of State Planning Coordination (OSPC): Facilitates long-term infrastructure planning and alignment with broader state development goals.
    - Delaware Department of Transportation (DelDOT): Key for integrating transportation infrastructure, including airports and vertiports, into existing planning frameworks.

[71] Delaware General Assembly, "Delaware Energy Act 2010", modified January 10, 2025, https://delcode.delaware.gov/title29/c080/sc02/index.html

- *Utility Providers:*
  - Delmarva Power and Delaware Electric Cooperative: Primary utility providers responsible for ensuring electricity distribution reliability and implementing smart grid technologies.
  - Delaware Municipal Electric Corporation (DEMEC): Coordinates operations for municipal utilities, offering localized insights into energy needs and grid upgrades.
- *Local Governments:*
  - Municipalities and county planning boards with jurisdiction over land-use planning and zoning approvals for airports, vertiports, and grid infrastructure.
- *Regional and Federal Entities:*
  - PJM Interconnection: Ensures regional grid stability and integration of renewable energy sources to support Delaware's modernization efforts.
  - Federal Aviation Administration (FAA): Sets regulatory standards for vertiports and airspace integration.
  - Department of Energy (DOE): Provides funding and technical guidance for grid modernization and resilience projects.
- *Private Sector Partners:*
  - Renewable energy developers, microgrid operators, and battery storage technology firms.
  - eVTOL manufacturers and Advanced Air Mobility service providers.

2. Legislative Processes

- *Energy and Transportation Committees:* Delaware's General Assembly includes legislative committees focused on energy, transportation, and infrastructure. These committees are instrumental in drafting and reviewing bills that impact grid modernization and potential AAM integration.
- *Policy Alignment with Federal Programs:* State legislation often incorporates federal guidelines and funding opportunities. For example, federal incentives under the Inflation Reduction Act (IRA) or Bipartisan Infrastructure Law can drive the adoption of policies that prioritize grid resilience and renewable energy.

3. Funding and Incentives

Funding policies are important to support the grid modernization for EVs and AAM initiatives in Delaware.[72] The following sources may provide the financial foundation for these efforts:

[72] The State of Texas is used here as a general example. Texas Department of Transportation, "Funding Subcommittee May 1, 2024", modified January 10, 2025,

Federal Programs

Delaware should maximize opportunities provided by federal initiatives, such as the Grid Resilience Grants under the Bipartisan Infrastructure Law.[73] These grants allocate substantial funding to improve grid reliability, integrate renewable energy, and enhance resilience against natural hazards. These resources could be used for:

- *Microgrid Development:* Building localized energy systems to support airports and vertiports.
- *Renewable Integration:* Installing solar and battery systems at airports and vertiports to reduce grid dependency.
- *Capacity Upgrades:* Modernizing transformers, substations, and distribution lines to accommodate the increased load from eVTOL aircraft and other EVs as well.

State Bond Issues

State-issued bonds provide a reliable method of financing large-scale grid enhancements over the long term. Bonds can fund major capital projects, such as upgrading transmission lines or installing advanced energy storage systems, without requiring immediate outlays from State budgets. Potential approaches include:

- *Green Bonds:* Issuing bonds specifically tied to sustainability projects, including renewable energy and grid resilience improvements. Green bonds often attract environmentally conscious investors and may carry lower interest rates.
- *Revenue Bonds:* Structuring bonds to be repaid through the revenues generated by the upgraded infrastructure, such as increased electricity sales. These revenues would be primarily from the general public usage, with airport and vertiport facilities benefiting from the investment.

Utility-Driven Surcharges

Implementing modest surcharges on utility bills provides a consistent revenue stream for priority grid modernization projects while maintaining affordability. Surcharges can be structured to minimize the financial burden on consumers, such as:

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https://www.txdot.gov/content/dam/docs/advisory-comm/aam/subcomittee/aam-funding-subcommittee-meeting-slides-05-01-24.pdf

[73] U.S. Department of Transportation, "Bipartisan Infrastructure Law: a Guide for States 2021", modified January 10, 2025,
https://www.transportation.gov/bipartisan-infrastructure-law

- *Tiered Rates:* Charging higher surcharges to large-scale industrial users with significant energy consumption, while limiting the impact on residential customers.
- *Time-Limited Charges:* Introducing surcharges for a specific duration to fund targeted projects, ensuring that the additional cost is temporary and purpose-driven.
- *Rebates for Low-Income Households:* Offering financial assistance or exemptions to ensure equity in the distribution of costs.

5.4 Workforce Development

The implementation of AAM in Delaware is expected to drive a number of economic opportunities, particularly through job creation and workforce development. As an innovative industry, AAM will demand a labor force skilled in electric propulsion systems, eVTOL maintenance, vertiport management, small package air cargo integration, data analytics, and other technical fields.

Delaware has the advantage of institutions like Delaware State University and Delaware Technical Community College, which are well-positioned to adapt their programs to meet these needs. DSU has initiated a program that is designed to meet the challenging needs of AAM workforce development by creating simulation training in all facets of the AAM industry (as well as other aviation professions). In addition, collaborative initiatives with private companies can further accelerate workforce readiness and establish Delaware as a hub for AAM expertise.

The adoption of AAM in Delaware is anticipated to create new employment opportunities. These roles will evolve over time as the industry matures from initial planning and design to full-scale operations and maintenance. Key job categories and their functions include:

- *Aircraft Manufacturing and Component Assembly:* Should Delaware attract an eVTOL manufacturer or parts supplier, personnel skilled in electric propulsion, advanced materials, avionics, and component testing may be needed to support the development, production, and certification of eVTOL and related aircraft components.
- *Infrastructure Planning and Construction:* Engineers, architects, construction specialists, and vertiport planners may be needed to design and build vertiports, charging stations, hangars, and ground support facilities that accommodate AAM operations.
- *Flight Operations and Airspace Integration:* Pilots and flight crew may be initially necessary for early operations as full autonomy is phased in. Additional roles will include flight dispatchers and operations controllers who manage flight schedules, as well as air traffic integration specialists who help safely incorporate AAM into the National Airspace System.

- *Maintenance, Repair, and Overhaul (MRO):* Aircraft maintenance technicians, inspectors, and support staff will ensure the ongoing reliability, safety, and regulatory compliance of eVTOL fleets. These roles will expand as AAM operations scale, ensuring consistent and efficient fleet performance.
- *Energy and Charging Technicians:* Specialists will be needed to oversee charging infrastructure, manage battery systems, and optimize power distribution to ensure that AAM operations remain sustainable and cost-effective.
- *Autonomous Systems and Data Optimization:* As the industry transitions toward greater automation, autonomous systems engineers and related roles will emerge. These professionals will focus on developing and maintaining software, sensors, and guidance systems that enable aircraft to operate safely and efficiently. Data analysts and AI specialists may also contribute to flight route optimization, predictive maintenance, and overall operational improvements.
- *Public Service and Emergency Response:* Aerial EMS personnel, including paramedics and flight nurses, will be positioned to provide rapid medical evacuation and transport. Search and rescue teams can leverage AAM platforms for disaster response, emergency logistics, and public safety operations.
- *Safety, Compliance, and Regulatory Support:* Compliance officers, safety auditors, and inspectors will address evolving regulations, establish best practices, and ensure adherence to safety and operational standards.
- *Customer Experience and Marketing:* Customer service agents and related roles will create a welcoming environment at vertiports and manage customer-facing technologies. Marketing and branding professionals will help build public acceptance, trust, and demand for AAM services.
- *Supply Chain and Logistics Management:* Managers, staff, and delivery personnel will coordinate air cargo and small package delivery services. This would include both retail goods and medicine, as distribution lines are formulated.

Taken together, these roles span a wide range of disciplines and skill levels, offering opportunities for employment growth and workforce development in Delaware. Partnerships with educational institutions such as Delaware State University, Delaware Technical Community College, and the University of Delaware (and other academic institutions in the State) along with industry collaborations, can help build a talent pipeline equipped with the skills and expertise to support AAM's long-term success.

Job Creation

Estimating the number of potential jobs associated with AAM in Delaware is speculative at best. However, there are several methods that can be used including benchmarking against comparable industries, using academic and workforce development models, surveys of impacted industries, or use of input-output modeling such as IMPLAN.

The method selected for this analysis involves translating projected market demand and associated investments into employment impacts using IMPLAN modeling. The following methodology describes the process:

- *Identify Relevant Industry Sectors:* Classify each AAM-related activity into appropriate industry sectors recognized by IMPLAN. For example, vertiport construction can align with commercial construction sectors, while aircraft maintenance, vertiport operation, air cargo deliveries, etc., align with the air transport category. Passenger services can be related to expenditures in hospitality industries.
- *Quantify Capital and Operating Expenditures:* Translate forecasted demand into capital and operating cost estimates. For infrastructure (e.g., vertiports, charging stations), estimate total construction costs, equipment procurement, and facility development expenses. For operations (e.g., eVTOL maintenance, flight operations, administrative functions, logistics), estimate ongoing operational expenditures, including labor, materials, and support services. Assign these costs to corresponding IMPLAN sectors.
- *Use IMPLAN Multipliers:* Input the estimated expenditures into IMPLAN software to access industry-specific multipliers. IMPLAN's input-output modeling framework provides direct, indirect, and induced employment multipliers. Multipliers reflect the additional jobs generated throughout the supply chain (indirect effects) and those created when new income circulates through the local economy (induced effects).
- *Iterative Refinement:* As AAM technologies and operations mature, update the IMPLAN inputs with revised investment data, operational costs, and industry growth rates. Incorporate lessons from initial deployments, ongoing pilot programs, and results from newly formed task forces to improve forecast accuracy over time.

Estimating Jobs per Unit of Investment Using IMPLAN

Rather than try to project a specific number of total jobs created by AAM, an alternative method using IMPLAN can be to estimate jobs per unit of investment. In this regard, inputs can be developed according to assumptions about the percentage of investment in different economic sectors per million dollars. This method provides a scalable framework that ties employment impacts directly to financial commitments, offering flexibility as AAM projects evolve.

Assumptions for Actual Delaware Modeling with IMPLAN

Assumptions used for a $1 million investment in the AAM system using the IMPLAN model included the following:

- 50 Percent Air Transport Sector
- 20 Percent Construction
- 10 Percent Aircraft Manufacturing/Modification
- 20 Percent Hospitality Sector Use

Under this distribution, every $1 million of investment was associated with 6.5 total jobs (including direct, indirect, and induced effects), $1.529 million in total output, and $62,500 in state and local tax revenues. Thus, a $50 million investment would yield 325 jobs, $76.45 million in total output and $3.12 million in State and local taxes.

This type of modeling offers a scalable benchmark—allowing stakeholders to estimate how incremental investments in AAM infrastructure and operations translate into tangible employment and economic benefits. As the AAM system evolves, these IMPLAN estimates can be refined to reflect changes in industry composition, technology, policy, and market adoption. Over time, updated inputs can provide more accurate guidance on the potential gains in employment, output, and tax revenues resulting from continued investment in Delaware's AAM sector.

5.5 Adoption of AAM in Delaware: Timeline and Recommendations

The adoption of AAM in Delaware represents an opportunity to improve the State's transportation landscape, regional connectivity, and economic growth. To achieve this, a phased approach is suggested, balancing infrastructure development, regulatory alignment, and community engagement.[74] The following timeline and recommendations outline a structured path forward for Delaware to integrate AAM into its transportation ecosystem.

Phase 1 (2025-2030): Planning and Stakeholder Engagement

The foundation for successful AAM implementation begins with planning and collaboration among stakeholders. While the current AAM working group is temporary, Delaware should establish a permanent Advanced Air Mobility Task Force composed of representatives from state government (DelDOT, Delaware Prosperity Partnership, Governor's office), universities (Delaware State University, University of Delaware, Delaware Technical Community College, etc.) eVTOL manufacturers or users, utility providers, aviation business leaders, airport managers, and community leaders, as appropriate.

This Task Force would oversee the program and guide its development going forward. In addition, the Task Force could focus on developing a comprehensive regulatory framework that addresses vertiport zoning, land use compatibility, and electric grid capacity expansion. The framework should align with federal regulations while tailoring specific policies to Delaware's unique geographical and demographic needs.

Streamlining the permitting process is another important step. Simplified approvals for vertiport construction and eVTOL operations can reduce bureaucratic delays without compromising safety or environmental standards. Legislative advocacy will also play a role, as introducing laws that encourage investment in AAM technology—such as workforce development programs for training pilots and technicians at institutions like Delaware State University—will ensure that Delaware remains competitive in the evolving transportation landscape.

Other activities during this phase include overseeing feasibility studies to identify optimal locations for vertiports (such as the Delaware Aviation System Plan Update). If private companies or eVTOL manufacturers are involved in the vertiport development process, the Task Force should coordinate with them in order to ensure efforts are not duplicated by various AAM interests. As a part of this process, public forums and outreach campaigns could be launched to educate Delaware residents

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[74] The example provided here is from Atlantic County, New Jersey. National Aerospace Research & Technology Park (Deloitte), "A Strategic Roadmap for the Development of Advanced Air Mobility 2022", modified January 10, 2025,
https://www.nartp.com/wp-content/uploads/2022/08/NARTP-Advanced-Air-Mobility-Strategy.pdf

on AAM's benefits, address concerns such as noise and safety, and build community support (see Section 6 for more details).

Phase 2 (2030-2035): Infrastructure Development and Regulatory Alignment

During Phase 2, Delaware should transition to infrastructure development and alignment with regulatory frameworks. The infrastructure development may begin to occur before the 2030 time period, depending on how quickly eVTOLs are brought to market. It is likely that the first vertiports will be collocated with airports in Delaware. Ultimately, convenient vertiport locations will need to be developed in urban areas.

In this regard, vertiports will form the backbone of the AAM network. These facilities must be designed to comply with FAA standards, ensuring they meet safety and operational requirements. Modular and scalable designs should be prioritized to allow for future growth and adaptation to emerging technologies.

Leading up to Phase 2 and beyond, Delaware's electric grid infrastructure will require significant upgrades to support the emerging energy demands of electric vehicles and eVTOL aircraft. Collaboration with utility companies will be essential to integrate renewable energy sources into these upgrades, ensuring sustainability while accommodating increased power loads. During this phase, pilot programs should also be initiated in key areas such as Wilmington and Dover to test AAM operations in real-world conditions. These programs will provide valuable data on operational efficiency, user adoption, and technical feasibility.

Phase 3 (2035-2045): Expansion and Integration

The final phase focuses on scaling operations and integrating AAM into Delaware's broader transportation network. Based on insights gained from pilot programs, AAM services can be expanded to serve segments of the highway commuting traffic market, the beach market, and intercity urban centers with other urban centers, enhancing accessibility and mobility for all residents. Efforts should also include interoperability with existing transportation modes, such as public transit, ride sharing, and highways, to create a seamless multi-modal system.

Continuous monitoring and assessment should be included in this phase. Metrics related to safety, efficiency, and community acceptance should be evaluated regularly, with adjustments made as necessary to optimize performance and address any emerging challenges. Within 10 years (2035), the extent to which AAM will impact transportation in Delaware should be known. It is believed that during Phase 3, the greatest strides and integration of AAM technology will be made. This will include the scale of operations and the changing travel needs of the public. The State should remain flexible in its approach to enabling AAM within Delaware.

5.6 Stakeholder Engagement for Advanced Air Mobility in Delaware

The successful implementation of Advanced Air Mobility (AAM) in Delaware depends on the collaboration and engagement of a diverse group of stakeholders. State and local governments play a role in developing policies, streamlining regulatory processes, and securing funding for AAM initiatives. By aligning State policies with federal regulations established by the Federal Aviation Administration (FAA), and other states which have already successfully developed AAM policies, the government ensures a cohesive framework for implementing AAM.

The FAA can be an important partner in this process, providing regulatory oversight and potential funding opportunities. Through programs like the Airport Improvement Program (AIP), the FAA may be able to help Delaware finance vertiport construction and operational enhancements in the future. Their role in ensuring the safety and certification of eVTOL aircraft and in airspace management ensures that AAM projects align with national aviation standards.

The private sector, including eVTOL manufacturers and AAM operators, brings technological expertise and financial resources to the table. Their contributions include developing innovative aircraft and operational systems, conducting pilot programs, and investing in infrastructure through partnerships with the State, particularly through the Delaware State University programs. These companies must also work closely with utility providers to integrate charging stations into Delaware's electric grid and ensure that operational needs are met without overburdening existing resources. The private sector's collaboration with government and academic institutions is needed to align technological advancements with workforce training and operational goals.

Utility companies play an integral role in ensuring grid readiness for the increased energy demands of AAM. By assessing and upgrading grid infrastructure, integrating renewable energy sources, and implementing advanced grid management systems, utilities enable sustainable AAM operations. Partnerships between utility companies and the state government can foster incentives for renewable energy integration and microgrid development, aligning with Delaware's sustainability objectives. The Task Force can be the coordination vehicle for this communication and understanding of needs.

Academic institutions, including Delaware State University and others, contribute through research and workforce development. Delaware State University's aviation program is integrating an AAM simulation and testing program, along with other innovative technologies. These institutions can lead studies on autonomous operations while also developing training programs to prepare the workforce for AAM-specific roles. Academic programs that align with industry needs ensure a steady pipeline of skilled professionals, from eVTOL pilots and maintenance technicians to software engineers and urban planners.

Community engagement is needed to gain public acceptance and support for AAM initiatives. Delaware's residents, as end-users, must have opportunities to voice their concerns and priorities, particularly around issues such as noise, environmental impacts, and equitable access. Transparent communication, participatory planning processes, and educational campaigns help build trust and foster buy-in. Addressing community concerns proactively ensures smoother implementation and long-term public support.

Healthcare providers and emergency service organizations represent a unique group of stakeholders who can leverage AAM for critical applications, including medical evacuations, organ transport, and disaster response. By collaborating with AAM operators to test and refine these use cases, they demonstrate the practical benefits of eVTOL technology while addressing urgent public service needs.

Collaboration among these stakeholders is needed to overcome challenges and take advantage of opportunities. Partnerships between government and private sector entities can drive innovation while ensuring public accountability. Utility providers and manufacturers must work together to align energy solutions with operational demands, while academic institutions and industry leaders create training programs to address workforce shortages. Community input and environmental advocacy ensure that AAM projects reflect Delaware's values and priorities.

All these stakeholder engagement opportunities can be overseen by a permanent AAM Task Force, as discussed earlier. Thus, the first step in stakeholder engagement will be to formalize the Task Force and give it authority under the appropriate State agency to engage in this planning and development process.