



Photo from Joby Aviation

Learnings From the 2022 NREL Partner Forum: Research Needs for Aircraft

During the 2022 Partner Forum¹ at the National Renewable Energy Laboratory (NREL), stakeholders and experts from across aviation came to the whiteboard to outline common goals, align interests, understand technologies, and discuss steps for safely and seamlessly decarbonizing aviation.

Experts identified challenges, strategies, and needed research on sustainable aviation fuel, alternative propulsion, infrastructure, and aircraft. Initial insights, strategies, and high-level suggestions from the aircraft workshop are summarized below, including potential barriers and synergies for achieving bold decarbonization goals.

Electric Regional Aircraft

Electric aircraft could have compelling use cases for regional flights, package delivery, and intercity transport, but more strategic development and deployment may be needed.

Specific challenges to address:

- Increase research and development for regional electric aircraft beyond electric vertical takeoff and landing (eVTOL) aircraft, which focus on trips less than 60 miles.
- Understand how technologies stand up to meet increases in demand and usage.
- Reduce uncertainty in use cases for regional electric aircraft to lower investment risks.
- Support advances in solid-state and novel battery chemistries.

Security and Safety

Regulators and the public need to understand how novel aircraft fit into existing safety systems.

Specific challenges to address:

- Develop safety and security best practices for aerial vehicles, which do not meet the Transportation Security Administration threshold of 60 passengers.
- Evaluate local safety requirements for other modes of public transportation to identify overlap.
- Evolve technologies for advanced safety to support consumer trust and adoption.
- Develop methodologies to incorporate new technologies, energy systems, and flight management systems into the Federal Aviation Administration's safety management systems.

Hydrogen Aircraft

Hydrogen remains a flexible energy carrier for a range of aviation uses, but research is needed to improve its safety, storage on aircraft, and delivery and storage at airports.

Specific challenges to address:

- Advance lightweight liquid hydrogen storage, which is currently at a low technology readiness level.
- Develop alternative solutions for aircraft hydrogen storage and use, including composite cryogenic hydrogen tanks and hydrogen combustion.
- Develop strategies for leakage detection and safety across the supply chain.

¹ Discover other insights from the 2022 NREL Partner Forum: www.nrel.gov/docs/fy23osti/84111.pdf.

Commercial Application and Market Deployment

Moving aircraft innovations into the market requires strategic commercial applications with compelling use cases.

Specific challenges to address:

- Ensure technologies are supported by compelling commercial applications, especially for technologies that look different than today's aviation demand model.
- Evaluate the feasibility of vertiport locations, how long charge times might constrain duty cycles, and noise implications for urban areas.
- Prioritize sustainable aircraft that fit existing aviation business models.
- Develop research funding sources to support companies developing fixed-wing electric aircraft.
- Explore markets between small communities and hub airports made possible by reductions in operating costs for advanced fixed-wing aircraft.
- Build robust funding and collaboration models to support and accelerate technology deployment, from product development to certification, pressure tests, and market acceptance.
- Develop high-fidelity analytical models, supported by advanced computational methods, to accelerate experimental prototyping.

Urban Air Mobility

Key questions remain on how air mobility might complement existing urban mobility systems and alleviate community concerns.

Specific challenges to address:

- Evaluate synergy and competition with ground vehicles, which already have extensive supporting infrastructure.
- Explore integrated, intermodal solutions—which connect train, bus, and airport hubs—to help alleviate urban congestion.
- Develop quiet propulsion technologies to address noise and vibration.

Technology Readiness

Improving hardware could be critical for showcasing the value of sustainable technologies as better, cheaper, and faster than baseline aircraft.

Specific challenges to address:

- Develop high-efficiency components for light, compact power electronics, electric machines, and motors—potentially including cryogenic fluid and advanced materials and architectures.
- Innovate additive manufacturing for cheap, lightweight aerospace materials.

Strategic Funding and Partnerships

Novel funding systems and partner networks may be critical for addressing bottlenecks, avoiding redundancy, and facilitating strategic knowledge-sharing around new technologies.

Specific challenges to address:

- Develop a road map that outlines strategic partners, regulators, and investors to help guide rapid technology development and certification.
- Identify research convener(s) to guide the large community of diverse stakeholders—including industry competitors and public and private entities—toward shared goals aligned with public transportation policy.
- Facilitate strategic connections between multiple federal agencies to ensure capabilities and mission spaces align to support aviation innovation.
- Create new cost-sharing and collaborative models to advance the entire industry while protecting sensitive intellectual property.
- Evaluate funding sources that place weight on deployment and market viability.