

Aviation Energy Research and Operation Simulator (AEROSim)

Aircraft of the future—powered by sustainable aviation fuel, hydrogen, or clean electricity—can decarbonize flight and improve mobility for companies and consumers. Still, integrating them into existing energy systems and choosing aircraft to fit geography and future passenger demand can be difficult. Aircraft manufacturers, utilities, airport operators, and other stakeholders need a flexible, user-friendly, and accurate tool to rapidly screen and validate technology designs across a range of scenarios.

Understand the Value of Fast, Accurate Aircraft Simulations

Emerging aircraft—such as electric vertical takeoff and landing (eVTOL) vehicles—promise operational flexibility, improved mobility, and lower emissions for select market segments. Still, questions remain about the energy consequences of deploying new technologies. How often do they need to charge or refuel? What kind of energy demands do they present? Where and how should energy be delivered? How will the grid be impacted?

What You Need To Know

- **Stakeholders Need Data To Make Decisions**—Aircraft operators, airports, and utilities need to understand energy requirements of emerging aircraft. Airlines need cost and energy requirement estimates for operational and budgetary planning. Until these aircraft are widely deployed, in-use energy consumption data will be insufficient or entirely unavailable.
- **Energy and Emissions Are Becoming Regulatory Priorities**—Various state, federal, and international agencies are considering regulating or incentivizing reductions in greenhouse gas emissions. Simulating the operations, energy consumption, and emissions of advanced aircraft will improve public policies by supporting better decision making.

Taking Successes From Advanced Ground Vehicle Modeling to the Skies

The National Renewable Energy Laboratory (NREL) has developed highly accessible tools for ground vehicle modeling, making it easy to quickly compare powertrains and estimate the impact of technology improvements on fuel/energy consumption, performance, cost, and battery life. With AEROSim, NREL applies that expertise to advanced aircraft, enabling the same level of ease and versatility in comparing aircraft designs across a range of scenarios and conditions.



Case Study: Vertiport Infrastructure

In a study¹ funded by the U.S. Federal Aviation Administration, NREL surveyed aircraft manufacturers and potential vertiport sites to analyze realistic service routes and study the infrastructure investments that could make eVTOL possible. Using AEROSim, in combination with other publicly available tools, authors evaluated the charging demand, costs, emissions, hazards, regulations, and technical requirements of developing electrified vertiport infrastructure at diverse locations.



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New Tool Capabilities To Support Advanced Air Mobility

NREL's arsenal of integrated modeling and analysis tools² is helping overcome technical barriers and accelerate the development of advanced transportation technologies and systems. Building upon the foundation of successful ground vehicle modeling tools, NREL is extending the benefits of advanced simulation and analysis capabilities to aviation. That way, companies can understand performance limitations and potential infrastructure needs for new technologies based on a range of parameters:

- Type of aircraft (e.g., eVTOL, fixed-wing, multi-rotor)
- Occupancy
- Design cruise speed
- Weather conditions
- Powertrain (e.g., fuel cell, battery-electric, gas-electric hybrid)
- Energy carrier (e.g., sustainable aviation fuel, hydrogen, electricity).

Unlock the Benefits of AEROSim for Aviation

- 1. Anticipate energy infrastructure and electrical charging needs** at airports and vertiports of all sizes.
- 2. Reliable method for demonstrating technology energy and emissions claims** to regulators and policymakers.
- 3. Representative vehicle models validated with manufacturer and federal government data** to inform larger, ecosystem-wide planning (i.e., flight demands, infrastructure needs).
- 4. Quick answers to large-scale simulation and novel transportation network controls** such as reinforcement learning or other techniques that require huge data sets and iterative approaches.
- 5. Value stacking by pairing insights from a range of NREL tools**, such as tools for grid impact analysis and hydrogen refueling.

¹<https://www.nrel.gov/docs/fy24osti/86245.pdf>

²www.nrel.gov/transportation/data-tools.html