Aircraft of the future—powered by sustainable aviation fuel, hydrogen, or batteries—can decarbonize flight and improve mobility for companies and consumers. Still, integrating them into existing energy systems and rightsizing their design for unique duty cycles, geographies, and industry needs can be complicated, especially in a shifting regulatory landscape. Aircraft manufacturers, utilities, and airport operators need a flexible, user-friendly tool to rapidly screen and validate technology designs across a range of parameters.

Understand the Value of Validated Vehicle Simulations

Emerging aircraft—such as electric vertical takeoff and landing (eVTOL) vehicles—promise operational flexibility 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

- **Information Must Be Actionable for Many Parties**—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. These are only possible through shared and validated profiles from manufacturers on emerging aircraft.

- **Existing Tools Provide Data Patchwork**—A range of powerful emissions and aircraft design tools already exist. But today’s tools may be too general or specialized to adequately support the planning needs of diverse stakeholders.

- **Energy and Emissions Are Becoming Regulatory Priorities**—Various state, federal, and international agencies are considering regulating or incentivizing reductions in greenhouse gas emissions. Securing any credits will likely mean validating aircraft energy, emissions, and performance with a standardized method.

The Vision: Regearing Ground Vehicle Tools for Flight

The National Renewable Energy Laboratory’s (NREL’s) Future Automotive Systems Technology Simulator (FASTSim) provides a quick way to compare powertrains and estimate the impact of technology improvements on ground vehicle efficiency, performance, cost, and battery life. NREL can work with industry stakeholders to regear the tool for advanced aircraft, enabling the same level of ease for comparing aircraft designs across a range of scenarios.
Case Study: How FASTSim Helped Transform Google Maps

NREL’s FASTSim was foundational to Google Maps’ eco-friendly routing, which shows users the relative emissions impact between routes. Along with other NREL modeling and analysis tools, as well as Google’s own capabilities, FASTSim helped the company capture key influences of vehicle fuel economy, performance, and cost.

Aviation Insights With FASTSim

NREL’s arsenal of integrated modeling and analysis tools\(^1\) is helping vehicle manufacturers overcome technical barriers and accelerate the development of advanced transportation technologies and systems. Adapting the architecture of FASTSim\(^2\) for aircraft would provide unique benefits to industry stakeholders. Companies could share, troubleshoot, and optimize vehicle designs, fueling systems, and energy storage systems for aircraft prototypes and fueling systems based on a range of parameters, including:

- Type of aircraft (e.g., eVTOL, fixed-wing, unmanned aerial vehicles)
- Occupancy
- Design cruise speed
- Weather conditions
- Powertrain (e.g., fuel cell, turbine, hybrid)
- Energy carrier (e.g., sustainable aviation fuel, hydrogen, electricity).

Unlock the Benefits of FASTSim for Aviation

1. Anticipate energy infrastructure and electrical charging needs at airports and vertiports of all sizes.

2. Rightsized aircraft and components for specific applications and flight paths, minimizing cost and maximizing reductions in air pollutants and greenhouse gas emissions.

3. Reliable method for demonstrating technology energy and emissions claims to regulators and policymakers.

4. Validated data for manufacturers, airlines, and partners to inform larger, ecosystem-wide planning (i.e., budgeting, staffing).

5. 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.

6. Value stacking by pairing insights with other NREL tools, such as its Highly Integrated Vehicle Ecosystem framework that can improve system efficiencies using a data-driven controller to schedule flights and optimize charging.

Contact Us

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\(^1\)www.nrel.gov/transportation/data-tools.html
\(^2\)www.nrel.gov/fastsim