Creating batteries to power air travel

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Researchers at the Ohio State University Center for Automotive Research have created new computer models to predict the life and performance of batteries that could power some passenger airplanes—a step forward for cleaner, more efficient air travel.

The models show that adding lithium-ion batteries to a regional airplane could reduce that airplane's fuel needs by up to 20 percent, the researchers said.

The team presented the findings last week at the American Institute of Aeronautics and Astronautics Electric Aircraft Technologies Symposium in Indianapolis.

"We are working on ways to make air travel less carbon-intensive," said Marcello Canova, a co-presenter and associate professor of mechanical and aerospace engineering at Ohio State. "Lithium-ion batteries, including the technology that is commercially available today, appear to be a promising option."

The research is conducted under NASA's University Leadership Initiative program, and focuses on evaluating the trade-offs between fuel savings and a battery pack's size, weight and costs, while also including the carbon impact of the electricity necessary to recharge the battery pack. The models and tools developed were a joint effort between researchers at Ohio State and Georgia Institute of Technology, and could help airplane and airplane battery designers better understand how an aircraft's design affects its ability to be powered by a battery.

In preliminary designs, the researchers focused on lithium-ion battery packs that could supplement the power produced by the engines of a regional jet—one traveling 600 or fewer miles, carrying 50 to 100 passengers.

Their model showed in tests that a battery has the ability to power about 30 percent of the total power required for an airplane to climb to cruising altitude, and about 20 percent of the power required to cruise.

That could reduce levels of carbon dioxide—a primary driver of climate

change—that airplanes contribute to the atmosphere. Air travel contributes about 2 percent of the carbon dioxide humans put into Earth's atmosphere, according to the Air Transit Action Group. This research team, led by Ohio State and four other universities, has been funded by NASA to find new, less carbon-intensive ways to power air travel.

"Our team is focusing on evaluating the feasibility and economics of introducing lithium-ion batteries to air travel," Canova said. "And we're working on the ways to make that safe and reliable."

Their work also considers how to make batteries for air travel more efficient. Batteries that power automobiles differ from those that help power airplanes, Canova said: Airplane batteries must abide by more-strict weight, safety, durability and reliability standards.

But batteries deteriorate with use, offering less power over time and decreasing the range an airplane can travel. That deterioration also means less power is available to help an airplane accelerate and reach its maximum speed. Temperature affects batteries, as well.

To lay the groundwork for a better battery, Canova said, the team built a computer model of an electro-thermal battery pack and added an algorithm that simulated the effects of time and use on batteries. Then they tested to see how that model performed after repeated use and under various temperatures.

The team planned for the battery to be used for six flights per day, and calculated the power necessary for takeoff, climbing, cruising, landing and taxiing to the runway. They allotted one hour between flights to charge the battery pack, and assumed that the pack could be used for two years, 24 hours a day, seven days a week.

They found that a battery pack's performance is limited by capacity fade, a term used to describe energy loss in a battery over time. And they found that time, not use, is the main driver of battery deterioration.

What they developed, Canova said, is essentially a tool that can be used to predict the effect stressors such as aging and use might have on a lithium-ion battery powering a regional aircraft, which is a very important factor when evaluating costs and benefits of introducing this technology in air travel.

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