Pathways to a Sustainable Aviation Ecosystem

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Sustainable Aviation for Developing Economies

In the face of climate change, developing countries are innovating to rapidly lower emissions and enable resilient, secure, and just energy transitions. Transportation accounts for roughly one-fifth of global carbon dioxide emissions, making mobility a key focus area for the international community, and is also critical in supporting social equity and human well-being. At the intersection of economic development, mobility, and clean energy, sustainable aviation systems can help simultaneously deliver key climate and clean energy goals to support advanced and decarbonized energy systems.

Sustainable Aviation Intersects Energy and Mobility

Flight demand is growing rapidly around the world. Experts predict aviation-related carbon emissions could double by 2050 if unabated. At the intersection of energy and mobility, sustainable aviation technologies can help decarbonize the growing aviation industry while expanding benefits provided to communities of all sizes.

What You Need To Know

- **Airports Are Energy Hubs**—Airports are becoming sites for both moving people and cargo and generating and storing clean energy. They can support electrified buildings, vehicles, and aircraft while powering local communities during off-peak hours and through outages caused by natural disasters.
- **Emerging Aircraft "Fuels" Can Be Domestic**—Sustainable aviation energy carriers, including sustainable aviation fuel (SAF), electricity, and hydrogen, can be created locally—even directly on-site. In this way, aviation energy resilience can support domestic industry, increase efficiency, and help communities sidestep tenuous global energy supply chains.
- **Sustainable Aircraft Can Save Money**—Next-gen sustainable aircraft can unlock new economic opportunities. Electric aircraft, for example, could reduce daily operating costs by as much as 90% (and carbon dioxide emissions by 95%) for flights less than 200 miles.[1]

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[1] Schwab, Amy, Anna Thomas, Jesse Bennett, Emma Robertson, and Scott Cary. 2021. *Electrification of Aircraft: Challenges, Barriers, and Potential Impacts*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-80220. *www.nrel.gov/docs/fy22osti/80220.pdf*

Case Study in Puerto Rico: Sustainable Aviation Fuel From Seaweed and Wood Waste

NREL researchers are developing and analyzing a process for turning record seaweed blooms in the Caribbean into SAF and graphite. Blended with 75% wood waste, regionally sourced sargassum could yield an estimated 78 million gallons of SAF and 61,000 tons of graphite annually. If successful, the project could empower a region already impacted by climate change and often underrepresented in economic development.

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NREL Helps Communities Accelerate to Sustainable Aviation

The National Renewable Energy Laboratory's (NREL's) sustainable aviation strategy paves the way for research, development, demonstration, and deployment—leading to custom solutions for decarbonizing aviation in communities of all sizes around the world. As a close partner with the U.S. Agency for International Development, NREL already provides targeted analyses and technical assistance to address a broad range of country-specific energy challenges.

Now, NREL is leveraging its expertise and partnerships to innovate three key elements of sustainable aviation that can be applied around the world.

- **Airports**—Analysis and modeling to resiliently decarbonize airports and seamlessly integrate them with communities and ground-based transportation systems.
- **Fuels**—Developing and demonstrating low- and net-zero-carbon aviation fuels, from field to fuel, electron to molecule, and bench to pilot scales.
- **Aircraft**—Research into aircraft systems and components that enable new aviation fuel types and propulsion pathways.

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Unlock the Benefits of NREL's Integrated Energy Systems Modeling

1. **Cost-benefit and life cycle emissions analyses** considering trade-offs of various designs for decarbonized energy systems, highlighting potential improvements in cost, carbon emissions, and air pollution.
2. **Improved connectivity between communities**, using advanced tools to evaluate alternative aviation energy carriers (e.g., sustainable aviation fuel, e-fuels, hydrogen, electrification), aircraft energy use, and geographic, economic, social, and functional impacts.
3. **Comprehensive multi-sectoral analysis** across electricity, hydrogen, fuels, commercial, and residential sectors.
4. **Economic development** through biorefining technologies designed to transform local agricultural, forestry, or waste resources into a domestic SAF and bioproduct industry.
5. **Energy resiliency strategies for airports and surrounding communities**, visualizing the potential of on-site generation and energy storage to support emergency services, community mobility, and commerce during natural disasters and outages.

NREL Transforming ENERGY

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