Analysis of Airborne Wind Energy Systems in a Wind Tunnel to Enhance Electricity Generation Efficiently

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Airborne Wind Energy Systems (AWESs) offer an efficient, environmentally sustainable, cost-effective, portable, and safe method of generating electricity. An AWES consists of a tethered glider, with wind turbines attached to the wings, that flies along the circular path of the blade tips of a horizontal axis wind turbine (HAWT), eliminating over 90% of materials while significantly increasing generation efficiency. Since the glider's aerodynamic design is the main determinant of efficiency, by implementing new and experimental airframe designs into mainstream AWES technology, the cost of electricity and the effects of climate change can be reduced. In this experiment, a prototype flying wing configuration and the conventional configuration were tested in a 25-foot-long wind tunnel with a 30-mph maximum airspeed that was designed and built for this project. The wind tunnel models were optimized for the highest Lift Coefficient / Drag Coefficient (Cl/Cd) ratio and incorporated integrated 3D printed pressure taps, which is a concept invented during this project. Dynamic pressure, lift force, and drag force were measured at angles of attack (AOAs) ranging from -5° to 20° in order to optimize the glider's propeller position and to determine efficiency. Analysis of the wind tunnel data shows that the flying wing had a 42% higher maximum Cl/Cd ratio than the conventional configuration. The flying wing configuration has the potential to be implemented in AWES design and would increase electrical output, lower electricity costs, lower production costs, and reduce carbon emissions.

Awards Won:

Second Award of $2,000

National Aeronautics and Space Administration: First Award of $2500

Society of Experimental Test Pilots: Third Award of $500