Improving Aerodynamic Characteristics of Helical Wind Turbines With Modified Blades

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Amidst rising energy prices, electricity use is being reduced in Germany. This necessitates shutting down streetlights, their operation being cost-inefficient for communities. The efficiency of Savonius rotors is to be enhanced to enable autonomous powering of energy systems. Two 3D printers were refitted to manufacture twenty-four prototypes with altered rotor blade overlaps, curvatures, wall thicknesses, dimensions, materials and added end plates. The turbines' power coefficients were examined to ascertain power output at different rotational speeds, which were determined at three inflow velocities in a self-built wind tunnel. Optical analyses visualized vortexes using fog to examine the effects of varying end plate sizes. Blade deflection measurements were conducted using a self-constructed test rig, assessing rotor blade stiffness under applied force. End plates 40 to 75 % the size of circular ones enhance effective profile resistance and reduce turbulence. Torsional stiffness is achieved through a central composite structure of the rotor blades and subtle bulges whose depth and number can be tailored to prevailing wind speeds. Utilizing height to diameter ratios of 1.9 : 1 and aforementioned modifications, wall thicknesses of 1 mm are sufficient to minimize blade deflection, which was unattainable using only fiber composite materials. An optimized turbine with a power coefficient of 0.17 is 5 % more efficient than the initial turbine. Empirical investigations revealed efficiency-enhancing parameters of helical rotor geometries when constructed from inexpensive thermoplastics. Environmentally friendly power generation enables decentralized operation of various energy systems at low wind speeds, offering substantial benefits over conventional rotors.