Airborne Wind Energy Systems

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ABSTRACT Wind turbines are widely used today as a clean, low-cost method for renewable energy. Yet, they can also be unreliable and bring numerous challenges. Airborne wind energy systems, however, are a developing type of wind technology that generate power from high altitude winds. Instead of a tall tower with rotating blades, an airborne wind system uses a movable free-floating device to capture the wind's energy and then transfers that energy to the ground via a long tether cable. This paper analyzes the capability of the airborne wind energy systems – specifically designs of current Ground-gen and Fly-gen systems – and where this technology stands in the wind power sector. The amount of energy that can be produced, material and operational costs, and limitations of such systems will also be identified and explored. Although the airborne wind energy system seems like an impossible feat today, its advantages over current wind turbines make it a promising solution for the future of renewable energy.

Keywords: Airborne wind energy; Ground-gen; Fly-gen; high altitude wind; crosswind pattern

INTRODUCTION

Conventional wind turbine placement is limited to only certain locations, transportation and setup of large-scale turbine parts depend highly on fossil fuels, and operation is at most times below maximum capacity due to inconsistent wind availability and speeds. The airborne wind energy concept, however, emerged in the mid-seventies and is essentially an innovated version of the conventional wind turbine. Among the various airborne wind energy systems developed, the Ground-Gen system and Fly-Gen system are largely used today. In a Ground-Gen system, conversion of mechanical energy into electrical energy takes place on the ground while such conversion is done on an aircraft for a Fly-Gen system. With its unique design and operation, airborne wind systems simplify the process of generating energy from wind power.

METHODOLOGY

Designs for the conventional wind turbine and airborne systems were researched first for comparison. Ground-Gen and Fly-Gen systems and certain companies involved in each systems' development were then explored. Energy production, costs, and limitations of the airborne system were evaluated from this data to determine the future possibility of using airborne wind systems over conventional wind turbines.

RESULTS AND DISCUSSION

Ampyx Power and AWESCO both specialize in the Ground-gen system while Makani Power, Altaeros Energies, and Joby Energy specialize in the Fly-gen system. All three companies follow the same principles: an advanced system is suspended in the air with a tether cable and moves across the sky in a crosswind pattern to maximize generated power. A 3MW conventional turbine's blades may sweep 8,000m^2 of area while an airborne device sweeps 1,000,000m^2 – energy potential is roughly increased by 125 times. Compared to the conventional wind turbine, airborne wind energy technology brings greater possibilities for harnessing wind power.

CONCLUSION

Crosswind patterns at high altitudes enable the harnessing of stronger, more consistent winds, and due to the abundance in these winds across most parts of the world, airborne wind energy technology is feasible in a wide range of locations. The fewer components and self-launching system also translate to a less-costly, efficient manner for generating energy. Airborne wind power is a promising solution with numerous advantages which surpass those of the conventional wind turbine. Though commercialization remains an

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issue, airborne wind energy systems have potential in shaping the future of the wind sector for renewable resources, providing economically cleaner energy worldwide.

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