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Airborne Wind Energy System

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Abstract: In last few years, new alternative energy system for power generation appeared which overcomes the drawback of traditional system. To satisfy the large population human needs, there is continuous advancement in technology which leads to develop the Airborne Wind Energy System. Wind is most economical type of renewable energy which largely contributes in energy requirement. The Airborne Wind Energy System (AWES) has conceptually developed to challenge the both technical and non-technical limitation of traditional windmill. The AWES is built on principle i.e. wind speed increases with height with using aircraft or airfoils for generation of energy.

Keywords: Renewable Energy, Windmill, Airfoils, FG-AWES, GG-AWES

I. INTRODUCTION

The paper published "Self-erecting windmill" by MR. Payne and MR. Cutchen in 1975 nearly contained all concepts of airborne wind energy system. Circulation of air in atmosphere is because of non-uniformity in heating of earth's surface. Average wind velocity is greater in hilly and coastal area. For ex. nearly at 60 meter velocity is 30%-60% greater because of reduction of drag force. Wind at higher altitude is steadier because of velocity cube law.

Traditional windmill has some limitation such as:-

- 1) Limited height of turbine hub and length of blade
- 2) Noisy operation which indirectly contributes in noise pollution
- 3) Interference by nearby television
- 4) Wind is unpredictable at lower altitude
- 5) Impact on wildlife. (Collision of birds with blades). [6]

II. SYSTEMS OF AIRBORNE WIND ENERGY

The limitations of traditional windmill are overcome by using AWES. There are mainly 2 types of AWES based upon generation of energy

A. Ground Generation AWES (GG-AWES)

In GG-AWES electric energy is produced transmitted by aircraft to ground through ropes. There are mainly two types, fixed and moving ground stations. In this type energy conversion is achieved by 2-phase cycle, where one is generation phase and other is recovery phase.

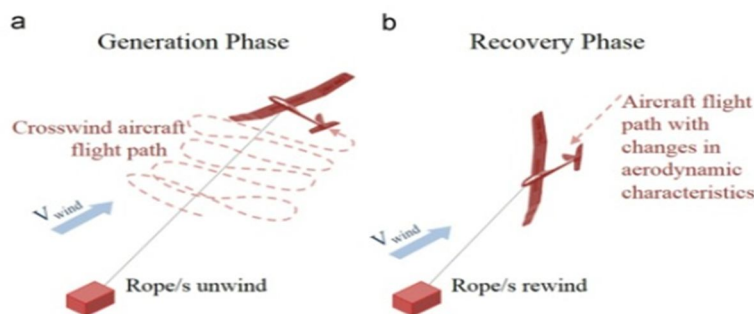


Fig.1 Two phase energy production for GG-AWES [1]

In this, ropes are subjected to traction force, are wound on winch and connected to motor-generator axes. During generation phase, aircraft is driven to produce lift force and simultaneously traction force on ropes which rotates axes. In recovery phase, aircraft brings back to original position by rewinding ropes with motor consuming small energy. In order to have a positive balance, the net energy produced in the generation phase has to be larger than the energy spent in the recovery phase. [1]

B. Fly Generation AWES (FG-AWES)

In FG-AWES, the rotor & generator are floating in air. The generator will be enclosed in inflammable structure and held by tether. Helium is used to lift as it is light inert gas. It provides extra lift & keep unit in desired altitude even in very low velocity air.

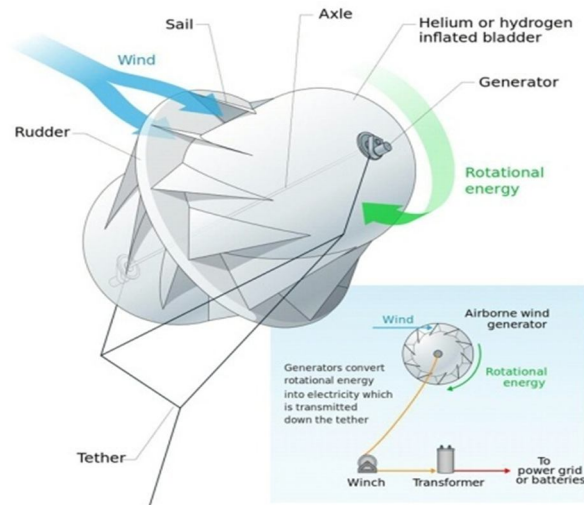


Fig 2 Fly generation air AWES [9]

As rotor of windmill rotate due to high velocity wind, it produces high torque. There is gearbox setup, which is use to increase speed of generator shaft. Electric energy produce is transfer down through tether. [6]

III. FACTORS EFFECTING UPON PERFORMANCE OF AWES

A. Effect of Flying Mass

As the mass of system increases, tension in cables decreases. As per that, in GG-AWES energy production decreases and in FG-AWES there is no effect on energy production [3]

B. Optimal Altitude

Another important aspect is how much is the optimum altitude. As the altitude decide the cable length and elevation angle, it should be sufficient to give the maximum power output.[3]

C. Cable

Cables used for AWES are made of Ultra-High-Molecular Weight Polyethylene (UHMWPE) which is a low cost material with excellent mechanical properties. [3]

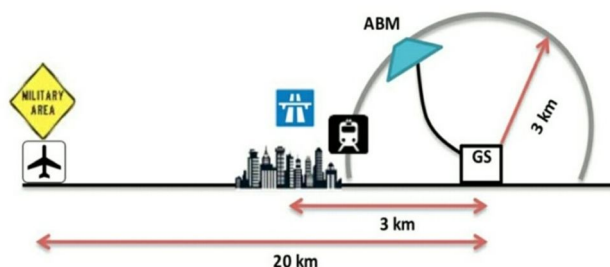


Fig.3 Restrictions on cable length.[2]

D. Elevation angle

E. Aerodynamic drag

F. Cable drag



IV. CONCLUSION

AWES are most promising and renewable source for producing energy. The FG-AWES is better to use than GG-AWES. Nearly, 45%-55% of energy production is increase by using AWES at 3000 to 10000 meter from ground surface rather than using traditional windmill. AWES is cost effective, eco-friendly, less noisy way for electric generation. This system opens the new area for research and within few years, a rapid acceleration will be there.

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