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Energy Generated By Fixed Ground Generation Airborne Wind System

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Abstract— Living in an era where technology is growing so fast one should not forget about maintaining the balance of the environment. Due to high demand in the production and mobility sector across the globe, it is now a challenging task to provide a source of energy along with a healthy environment and higher efficiency. The research on AWE's started in the mid-seventies and It took a rapid boost in the last few decades. Various models for the AWE's have been developed and tested by the researchers. In this paper, we have researched the Ground Generation Airborne wind energy system. Airborne wind energy can be produced in different ways but we have chosen the Ground generation Airborne system considering its high efficiency than other types. This paper comprises of Design, Objective, Calculation, and Methodology for the Ground generation AWES.

Keywords: AWE, AWES, Renewable Energy, Aircraft, Aerodynamics

I. Introduction

Sustainable energy is the need of the future. Due to advancements in technology and sustain human needs we now require strong sources of energy to produce electricity. Storage of conventional sources has begun to deplete and one challenge has come In front of humans to produce an alternate source of energy that is Renewable and Environmental friendly. Other than food, clothes, and shelter; Electricity has now become an inseparable part of our life. Low electricity is the new sign of poverty.

Among the different renewable energy sources, wind energy is the most promising and has higher efficiency. According to data, the Production of Wind Energy is the fastest developing renewable source of energy in the last few years. The wind is easily available everywhere and we can use the motion of air to produce electricity. The production of electricity depends on different patterns formed by air. Even though the nature of is wind is intermittent, at particular site wind patterns are found the same year by year. Average wind speeds are greater in hills and coastal areas.

II. Objectives

- The main objective of the Ground Generation airborne wind turbine project is to design, build and test a lightweight airborne wind turbine.
- To reduce the construction cost of Wind turbine and use Ground Generation AWT in replacement of conventional wind turbine
- Increase the generation of Energy with less investment and the safe environment.

III. Airborne wind energy system (AWES)

The airborne wind energy system is a new source of energy that is renewable and environmentally friendly. AWES consists of various components like Rotor, Generator, Tether, Aircraft. The AWES is working on the concept of converting the mechanical motion of the rotor into electricity. Airborne wind turbines may operate in low or high altitudes depending upon the flow of air. Just by adjusting the length of the tether electricity can easily be produced. Aircraft come down when there is insufficient wind. Also, bad weather such as lightning or thunderstorms could temporarily stop the use of the machines, probably requiring them to be brought back down to the ground and covered.

A. Ground Generation AWES:

In the ground generation AWES electricity is produced by transmitting the force from the kite to the ground station through the ropes. Because of the rotation force, Rotor at the ground station starts to rotate and converts Rotational Mechanical Energy to Electrical Energy with the help of generators.

Types of ground generation AWES:

1) Fixed Station GG- AWES
2) Moving Ground Station GG-AWES

Fixed station GG- AWES: When high-velocity air hits the turbine blade starts to rotate. There is the set-up gearbox that connects the low-speed shaft to the high-speed shaft. This set-up gearbox increases the rotational speed of the shaft to almost 40 times the previous.

1) Fixed station GG-AWES:

In the fix station GG-AWES the ropes which provide traction force, are wounded around the winches and connected to the generator.

In the generation phase, air-craft is driven in such a way that it will produce an uplift force and hence increase the traction force. An increase in the traction force consequently increases the electricity. For the generation phase most followed the path by the air-craft is 8 shape or crosswind shape because it creates better traction than the non-crosswind shape. In the recovery phase, motors rewind the ropes and bring the aircraft back to the ground.

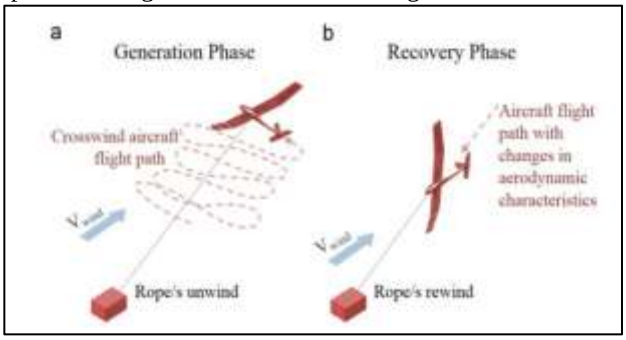

Fig. 1: Generation and Recovery Phase

2) Moving Ground Station GG-AWES:

Moving-ground-station GG-AWES are generally complex systems that aim at providing an always positive power flow which makes it possible to simplify their connection to the

grid. There are different concepts of moving-ground-station GG-AWESs but no working model has been developed yet.
Calculations for Fixed Ground generation AWES:
Reference Fig.2
$V(k)$= Aircraft speed
V_a =Apparent wind speed
V_w*=Wind speed felt by aircraft
V_r = velocity felt by tether
θ = Angle between cable and wind direction
G= Aerodynamic efficiency
L=Lifting Force
D=Drag Force
T_K=Tether Tension
C_L = Lift Coefficient

From the diagram

$$v_w{*}=V_W COS\ \theta - V_r$$

the velocity triangle and the force triangle are similar because of the force equilibrium at the aircraft and hence

$$V(k)= v(w){*}G$$

Assuming $V_a \cong V_k$ and applying equilibrium at the aircraft

$$T_K= ½{*}\ \rho{*}\ V(k)^{\wedge 2} * A{*}$$

(ρ is air density , A is area of kite)
Power output is

$$P = \quad T_{(K)}{*}\ V_r$$

For the maximum tether velocity

$$dP/d(V_r)=0\ ;$$

$$V_r0 =1/3{*}\ v(w){*}cos\ \theta$$

$$P= ½{*}\ \rho{*}(\ V_W COS\ \theta)^{\wedge 3}{*}4/27\ {*}G^{\wedge 2}{*}C_L{*}A$$

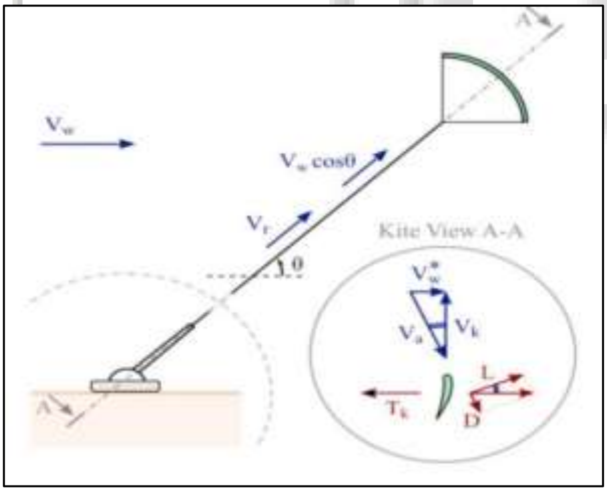

Fig. 2: Fixed Ground Gen AWE

IV. Advantages and Disadvantages

A. Advantages of GG - AWES:

- Lower noise
- Low cost of electricity
- Fewer limits on placement location.
- Wide range of wind speeds - Generally 2 to more than 27 meters/second.
- They do not require land and heavy machinery for assembly. Can easily install near the power grid.

B. Disadvantage of GG - AWES:

- Initial cost is high
- Need modern technology for safer operation.
- It cannot be installed within 10 Miles from Military area and 5 Miles of boundary from any Airport.

C. Factors Affecting GG-AWES

1) Flying mass

In Ground Generation AWESs when the the flying mass Increases, the tension in tether decreases. As Ground-Gen systems depends on cables tension to generate electricity, a higher mass of the aircraft and cable decreases the energy production and should not be neglected when modelling .

2) Rigid or soft wings

Soft wings are: crash-free t and lower in weight (therefore higher power) because of the inherent tensile structure. Conversely, rigid wings have better aerodynamic efficiency (therefore higher power) and they do not share the durability issues of soft wings.

3) Optimal altitude

Increasing the altitude results in more powerful winds, but, at the same time, increasing the cable length or the elevation angle reduces the power output.

4) Take-off and landing challenges

Starting and stopping energy production require special takeoff and landing maneuvers. These are the most laborious to automate and are requiring a lot of research in private companies and academic laboratories.

V. Conclusion

Airborne wind turbines are currently a promising and sustainable source of developing electricity. Development in new technology and some changes in the designing efficiency could be increase. This paper is consists of basic information about AWES, types, and its calculations. Nowadays because of pollution caused by conventional energy sources, We need an energy source that is completely Environmental friendly and efficient. AWES is the best way to produce electricity and can fulfill the future need for electricity.

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