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A Review and an Approach of Flying Electric Generators as Alternate Source of Energy

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***Abstract*—** *This paper presents a review of flying electric generators which are used to harness kinetic energy in powerful, persistent high altitude winds. It has been found that FEGs could give individual output of up to 40MW. It is a lighter wind turbine that rotates about a horizontal axis in response to wind, generating electrical energy. This electrical energy is transferred down for immediate use, or to a set of batteries for later use, or to the power grid. This paper presents the critical analysis of existing literature which is relevant to flying electric generator Though, the literature consists of a lot many research contributions, but, here, we have analyzed some important research and review papers. The existing approaches are categorized based on the basic concepts involved in the mechanisms. The emphasis is on the concepts used by the concerned authors, the database used for experimentations and the performance evaluation parameters. Their claims are also highlighted. Finally, the findings are summarized related to the studied and analyzed research papers. Paper concludes with the motivation behind identified problem.*

***Keywords*—Flying Electric Generator (FEG), Wind Turbines, Alternate Source of Energy, Energy Harvesters, Magenn Air Rotor System (MARS).**

I. INTRODUCTION

Flying electric generator are proposed to harness kinetic energy in powerful, persistent high altitude winds. At 1500ft (4600m) and above, tethered rotorcraft, with four or rotors mounted on each unit, could give individual output of up to 40MW. Flying Electric Generator (FEG is one of the recently found energy source. FEG is a lighter wind turbine that rotates about a horizontal axis in response to wind, generating electrical energy. This electrical energy is transferred down for immediate use, or to a set of batteries for later use, or to the power grid. Helium (an inert non-reactive lighter than air) sustains the Air Rotor which ascend to an altitude for best wind and its rotation also causes the Magnus effect. This provides additional lift, keeps the device stabilized, and keeps it positioned within a very controlled and restricted location. This is the latest technology in Energy sector and cheaper than other techniques and Eco friendly.

The propeller turbine on the flying device or the flow induced rotational motion of the complete device drives on-board generators from where the electrical energy is transmitted to the ground by a conductive tether A good example of this category is the balloon concept developed by Magenn Power Inc. namely Magenn Air Rotor System. In this concept, a balloon filled with helium stationary at a height of 200 m to 350 m altitude rotates around a horizontal axis connected to a generator. The electrical energy produced is transmitted to the ground by a conductive tether for consumption or to a set of batteries or to the power grid. The Magenn Air Rotor System rotation also generates the "Magnus effect" which provides additional lift, keeps the rotor system stabilized and positions it within a very controlled and restricted location [4]. Flygen concept takes advantage of this principle by mounting small turbines on a wing or an array of turbines on a multi-wing structure that itself acts like the tip of a traditional turbine blade. The FEG is filled with helium gas, which is inert and non-flammable.

II. LITERARURE REVIEW

This chapter presents the critical analysis of existing literature which is relevant flying electric generator Though, the literature consists of a lot many research contributions, but, here, we have analyzed some important research and review papers. The existing approaches are categorized based on the basic concepts involved in the mechanisms. The emphasis is on the concepts used by the concerned authors, the database used for experimentations and the performance evaluation parameters. Their claims are also highlighted. Finally, the findings are summarized related to the studied and

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analyzed research papers. Chapter concludes with the motivation behind identified problem.

Table.1: Literature Review

Sr. No.	Ref. no. Concerned Author(s) and years	Concept used	Claimed by concern authors (s)	Our findings
1	Mr.Sankaran Nampoothiri Ms. Dhanya G2, Harvester, Apr-2016	Lifting mechanism using helium gas filling	Lifting is very simple by this mechanism	Complexity Is More In This Volume
2	ODoherty, R. J., Roberts, B. W. Res.Institute, Feb 1982	Upper Wind data in One Design of Tethered Wind Energy System. Solar Energy	Air pressure is very important While designing the mars system	Very helpful in designing of mars system
3	CH.Uday kiran reddy - Y.Dasarath- 2009	Lifting mechanism using helium gas	Helium gas is most suitable for lifting	Helium gas properties is given which are very helpful
4	kamini n. shelke December- 2012	This concept is used magenn air rotor systemis used	none	Magenn air rotor systemis described very simply
5	Rakesh chaudari april 2015	Electrical Energy generation by mars	a high torque less speed is of very small in size	Good performance

III. PROBLEM FORMULATION

There are many ways to generate electricity such as nuclear, thermal, diesel, solar, hydropower based generation system. In nuclear based generation there is always risk of nuclear radiation accident also it requires high initial cost and impacts on human life. In thermal based generation there is a huge production of CO2 in atmosphere and it depends on availability of coal as fuel. In diesel based generation running charges are more due to high cost of diesel and also cost of lubrication. These are the problems that occurs in generation of electricity

In flying electric generator there is no need non-renewable fuel. Also it does not have any impact on environment or human life. There are various problems that are overcome by flying electric generator

IV. PROPOSED APPROACH

A) Working

The Turbine Filled with Helium is deployed with the help of a tether made from a Vectra and high performance multifilament yarn spun from liquid crystal polymer, which is stronger than Steel with high Strength to Weight Ratio. The Flying Electric Generator (FEG) is an innovative lighter-than-air tethered device that rotates about a horizontal axis in response to wind, efficiently generating clean renewable electrical energy at a lower cost than all competing systems. This electrical energy is transferred down the tether to a transformer at a ground station and then transferred to the electricity power grid.

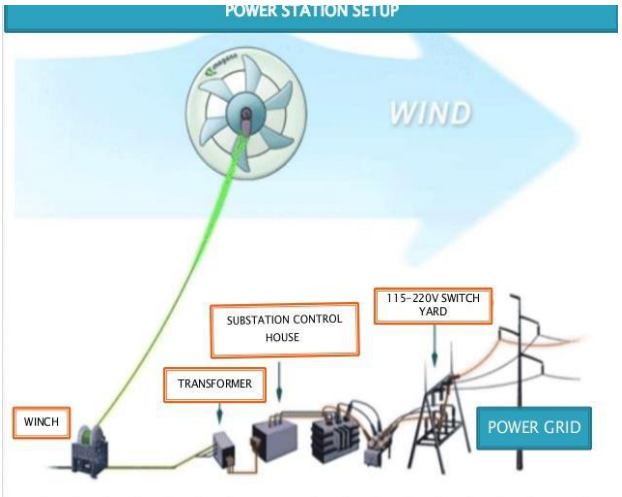

Fig.1: Functional Block Diagram

- As the rotor of the electric generator rotates due to high velocity wind it produces very high torque. u
- There is a step-up gear box which connects the low-speed shaft to the high-speed shaft and increases the

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rotational speeds from about 30 to 60 rotations per minute (rpm) to about 1200 to 1500 rpm. u

- The electrical energy thus produced is transferred down the tether for consumption, or to a set of batteries or the power grid.
- It is a windmill similar to a conventional one in its working principle but here the rotor and generator will be floating in air just like a hot air balloon.
- The generator will be enclosed in an inflatable structure and this structure is held by a Tether and tied to the ground.

B) Lifting Mechanism

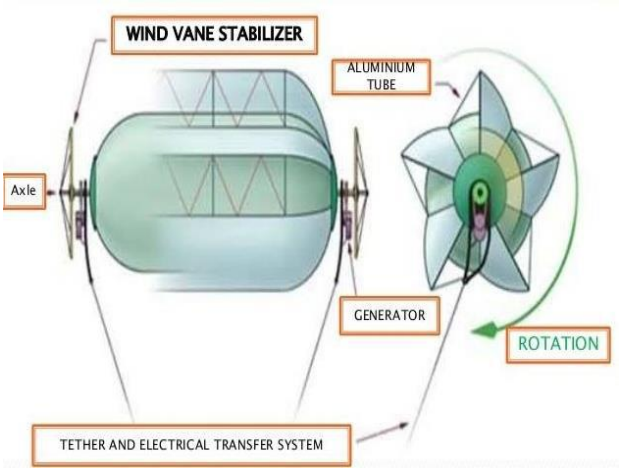

Fig.2: Magenn Air Rotor System

The helium filled MARS is a buoyant turbine made of vectran – a bulletproof material that is stronger than steel of the same thickness – and is connected to the ground by an insulated conductive tether. The unit can rise to a height of 300 to 1,000 feet to take advantage of more constant and higher wind speeds at higher altitudes that conventional wind turbines are unable to reach. While in the sky, the MARS turbine spins in the wind, generating electricity. The current is transferred down the tether for consumption, battery storage or transmitted to a power grid.

The MARS units will have an internal bladder system to maintain pressure. Helium leakage is not an issue under normal conditions; excess air turbulence and gusting might present a small risk but this craft has been designed to withstand challenges. Unlike in a child's balloon, helium leaks at a rate of only half of a percent per month in these designs.

Helium is a light inert gas and the second most abundant element in the universe. Helium provides extra lift and will keep MARS at altitude in very low winds or calm air. It is also plentiful, inexpensive and environmentally safe. Helium's inert quality over other lifting gases makes it very acceptable.

MARS will be constructed with composite fabrics used in airships today. The fabric will be either woven Dacron or Vectran with an inner laminated coating of Mylar to reduce porosity and an exterior coating of Tedlar which will provide ultra-violet protection, scuff resistance and color.

Over speed controls are built into the design of MARS. On the larger MARS units, excessive speed is controlled by moderating tether height. Pressure is constantly monitored and controlled. Rotation speed, wind speed, and generator functions are also monitored. Depending on size, either DC or AC generators will be used, with rectification as necessary.

MARS units must and will have lighting every 50 feet, and the lights must flash once per second. All MARS units must and will have a mechanism to quickly deflate in case a unit gets detached from its tether.

Fig.3: Helium Gas Filling

The Magenn Air Rotor System (MARS) is the next generation of wind turbines with cost and performance advantages over existing systems. MARS is a lighter-than-air tethered wind turbine that rotates about a horizontal axis in response to wind, generating electrical energy. Helium sustains the Magenn Air Rotor System, which ascends to an altitude as selected by the operator for the best winds. Its rotation also generates the "Magnus" effect. This aerodynamic phenomenon provides additional lift, keeps the MARS device stabilized, positions MARS within a very controlled and restricted location, and finally, causes MARS to pull up overhead to maximize altitude rather than drift downwind on its tether

C) Arrangement of Mars

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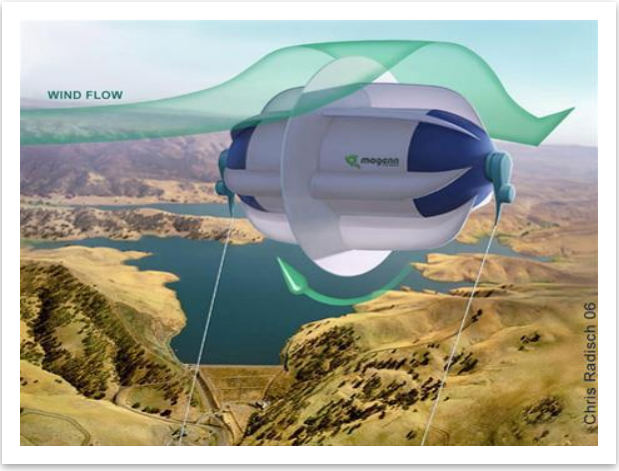

Fig.4: Arrangement

Helium is not the only thing that keeps the object aloft. Combined with its shape, the spinning generates lift using what is called the Magnus effect, which also tends to keep the craft overhead on its tether, rather than drifting downwind. The bigger the MARS unit, the easier it is to build heavier stronger structures, envelopes, and generators. As an example, the largest MARS units planned (100' x 300') will have tens of tons of buoyant (helium) lift. This is well in excess of the overall Air Rotor system weight.

Due to the inherent elegance of the design, the Magenn Air Rotors will always weather-vane properly. Regardless of wind direction, the deflection disk will ensure MARS units will automatically rotate toward the wind, with the Magnus aerodynamic effect creating additional lift.

V. EXPERIMENTAL RESULTS

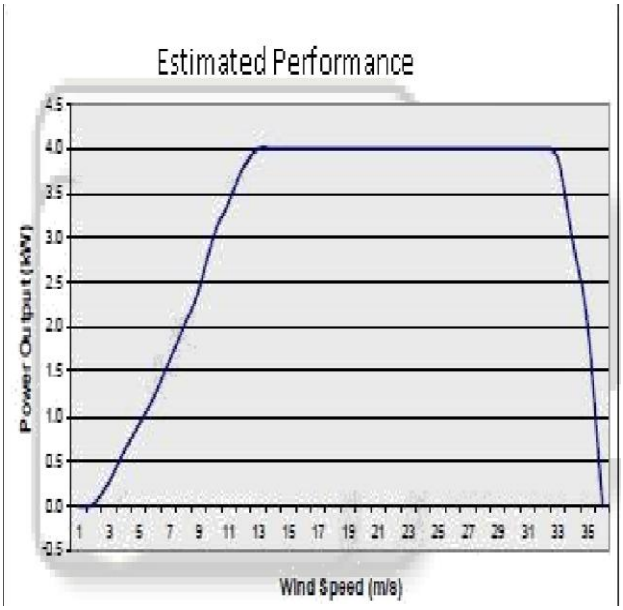

Fig.5: Graph showing estimated performance

From the graph it is verified that the power output of the floating air balloon increases exponentially as the wind speed increases. As the flow of wind is considerably high at higher altitude.

VI. CONCLUSION AND FUTURE SCOPE

This section presents the conclusions drawn from the evaluation and comparison of experimental results. The section concludes with future scope.

Conclusion:

FEG technology will be applied off-grid and combined with diesel power for developing nations, island nations, farms, remote areas, cell towers, exploration equipment, oil and gas wells, mining sites, offshore drilling stations, and backup power & water pumps. FEG could also be used for on-grid applications for farms, factories, and remote communities. We know that Wind energy is a CLEAN Energy i.e. Pollution-free and eco-friendly. Also wind energy is a renewable energy. This paper presents the critical analysis of existing literature which is relevant to flying electric generator Though, the literature consists of a lot many research contributions, but, here, we have analyzed some important research and review papers. The existing approaches are categorized based on the basic concepts involved in the mechanisms. The emphasis is on the concepts used by the concerned authors, the database used for experimentations and the performance evaluation parameters. Their claims are also highlighted. Finally, the findings are summarized related to the studied and analyzed research papers. Paper concludes with the motivation behind identified problem.

Future Scope:

- Uses: Charging batteries and using them to light up the streets, etc.
- Suitable for parking at multiplexes, malls, toll booths, signals etc.
- Such speed breakers can be designed for heavy vehicles, thus increasing input torque and ultimately output of generator
- More suitable and compact mechanism to enhance efficiency

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