International Journal of Trend in Research and Development, Volume 3(1), ISSN: 2394-9333
www.ijtrd.com

Wind Energy Generation Using Power Kites

D.Meher Srija and D.P.Sowjanya,
Department of Electrical and Electronic Engineering, GMR Institute of Technology, Rajam, A.P., India

Abstract: The paper presents the technology of high altitude wind energy generation, indicated as Kitenergy. The technology exploits the powerful high-altitude wind of the troposphere and convert it into electricity by means of power kites. Two hi-tech cables link the kite to the generator placed on the ground where electrical power is generated. It is a radical innovation which extract energy from wind blowing between 200 and 800 m above the ground. At such elevations, winds are stronger and more constant compared to the elevation where actual wind towers operate. The flight of the airfoils is tracked using on-board wireless instrumentation and it is suitably driven by an automatic control unit, able to differentially pull the ropes to influence the wing motion.

Keywords: *High-Altitude Wind Energy, Wind Energy, Wind Power Generation.*

I. INTRODUCTION

Wind is the movement of air from an area of high pressure to an area of low pressure. In fact, wind exists because the sun unevenly heats the surface of the Earth. As hot air rises, cooler air moves in to fill the void. As long as the sun shines, the wind will blow. And as long as the wind blows, people will harness it to power their lives [1].Ancient mariners used sails to capture the wind and explore the world. Farmers once used windmills to grind their grains and pump water. Today, more and more people are using wind turbines to wring electricity from the breeze. Over the past decade, wind turbine use has increased at more than 25 percent a year. Still, it only provides a small fraction of the world's energy. Most wind energy comes from turbines that can be as tall as a 20-story building and have three 200-foot-long (60- meter-long) blades. These contraptions look like giant airplane propellers on a stick. The wind spins the blades, which turn a shaft connected to a generator that produces electricity. Other turbines work the same way, but the turbine is on a vertical axis and the blades look like a giant egg beater.

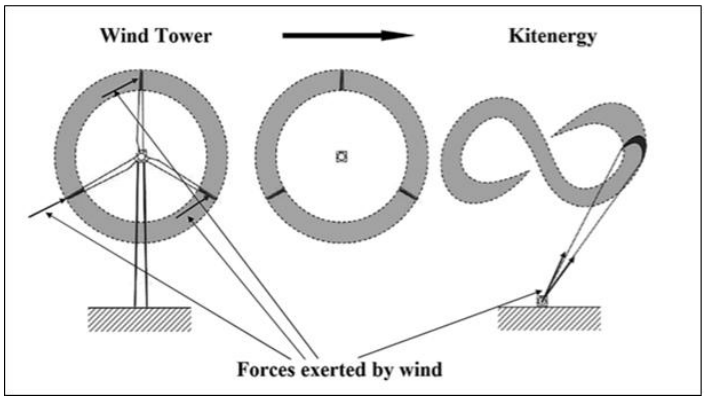
Wind is a clean source of renewable energy that produces no air or water pollution. And since the wind is free, operational costs are nearly zero once a turbine is erected. Mass production and technology advances are making turbines cheaper, and many governments offer tax incentives to spur wind-energy development.

Kite power is a innovative technology for converting wind energy into electricity at a higher capacity factor and, for many applications, at a lower cost than conventional wind turbines [2]. Electricity is generated at ground level by converting the traction forces acting on the wing ropes into electrical power, using suitable rotating mechanisms and electric generators placed on the ground. The system composed by the electric drives, the drums, the on-board sensors and all the hardware needed to control a single kite is denoted as Kite Steering Unit (KSU) and it is the core of the Kitenergy technology.

II. KITEGEN STRUCTURE

The pivotal idea of the Kitenergy project is to harvest high altitude wind energy with the minimal effort in terms of generator structure, cost and land occupation. In actual wind towers, the outermost 23% of the blade surface contributes for 77% of the generated power[3]. The main reason is that the blade tangential speed (and, consequently, the effective wind speed) is higher in the outer part, and wind power grows with the cube of the effective wind speed. Thus, the tower and the inner part of the blades do not directly contribute to energy generation. Yet, the structure of a wind tower determines most of its cost and imposes a limit to the elevation that can be reached.

The problem of "capturing" the wind is solved by the use of Power Wing Profiles (Power kites) whose movements are controlled automatically by a computer. Through cables the kites are anchored to a structure that rotates, generating electricity. This structure is the turbine of the high altitude wind farm while the kites are the "blades" of the turbine.



The kites are flown on a predetermined trajectory, that can transform the exerted force on the cable, to an overall mechanical torque which rotates the vertical axis turbine. About twenty automatically controlled kites can keep rotating a turbine of 1,600 meters diameter at a speed of 15 revolutions per hour. This can generate 1 Gigawatt of power, equivalent to a medium size nuclear power station

but with an estimated capital cost 10 times lower. In other words, 1 cubic Km of sky is able to provide 1 Giga Watt of power for 80% of the time in a year.

The above figure represents the basic concept.

The kites extra added benefit lies in the fact that the length of cables allows them to reach heights over 500 meters, where the high altitude wind flows, without introducing structural weaknesses.

III. KITE STEERING UNIT

Among the various concepts and patents available for the kite power system, a concept similar to the existing models with some modifications in its driveline and energy storage system is aimed for this technology. The primary objective is to have a constant speed and continuous power output of the designed model [2]. The design concept for the thesis has the following mechanisms:

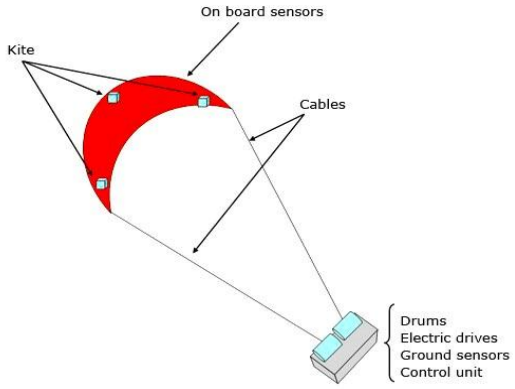
1. A kite power system utilizing single kite undergoing two alternating phases while generating power in traction phase and consuming power in the recovery phase is selected for the design purpose.
2. A geared generator with proper speed ratio is used to generate electrical power during traction phase.
3. A flywheel is used as an energy reservoir to store the surplus kinetic energy during traction phases and supply it during recovery phases.
4. A motor with suitable speed reduction drive is used to pull down the kite during recovery phase.
5. A freewheel clutch and a centrifugal clutch are used to maintain a unidirectional rotation in the driveline.

The concept is based on wings linked to a kite steering unit (KSU) on the ground. Two lines serve both to control the Kite's flight and to convert the aerodynamic forces into electrical power by using sustainable rotating mechanism and electric drives kept on the ground. The system composed by the electric drives, the drums, and all the hardware needed to control a single kite is denoted as Kite Steering Unit (KSU) and it is the core of the Kitenergy technology.

IV. TECHNICAL DETAILS

The KSU consists of following sensors:

1. Opening control of the Manipulator
2. Control of the stem contains 2 angular encoders
3. Air space control contains 1 radar
4. Flight control contains 6 accelerometers, 2 magnetometers, 2 pilot tubes, 2 GPS, 2 gyroscopes, 2 barometers



5. Tension control on the structure contains 9 nanometers on the stem,6 nano guage on the igloo
6. Engine room control : 4 angular encoders on drums and pulleys, temperature sensors, flowmeter, voltmeter.

CONCLUSION

The paper described the advances of the Kitenergy project. Kitenergy technology, capturing the wind power at significantly higher altitude over the ground than the actual wind towers, has the potential of generating renewable energy, available in large quantities almost everywhere, with production cost lower than that of fossil energy. Thus, high- altitude wind power may contribute to a significant reduction of the global dependance on the fossil sources in a relatively short time. Indeed , the industrialization of this technology may require from 3 to 5 years, since no breakthrough is actually needed in any of the involved engineering fields (like aerodynamics and flight mechanics, materials, modeling and control theory, mechatronics, etc.) to apply this technology, but rather the fusion of advanced competencies, already existing in each field, in order to increase the efficiency and the reliability of the system. Indeed, substantial new technological innovations, for example in the field of high-efficiency airfoils, may lead to further great performance improvements.

References

[1] C. L. Archer and M. Z. Jacobson, "Evaluation of global wind power," J. Geophys. Res., vol. 110, p. D12110, 2005.

[2] R. Thresher, M. Robinson, and P. Veers, "To capture the wind," IEEE Power Energy Mag., vol. 5, no. 6, pp. 34–46, 2007.

[3] Lorenzo Fagiano, Mario Milanese, and Dario Piga," High-Altitude Wind Power Generation," IEEE Transactions On Energy Conversion, Vol. 25, No. 1, March 2010