

# **Review paper of revolutionizing energy generation with the aid of tethering kite.**

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## **Abstract**

*The paper provides an information about energy kits which is a significant method for generating power. As well as carbon footprint and rising technological innovations that need energy at a cheaper rate. Also the inconsequential greenhouse effect has become important. There are various leading companies in the field of energy that are showing amazing interest in these ideas. Therefore, transformation has been an outbreak for the solution of this problem. There are different types of sources in the renewable sources. The wind power in the sky is gaining popularity among the people. As for its higher strength, steadiness, and coverage. When compared to traditional ground-based wind power with wind turbines. In our research, we try to set up a framework for different analysis. This provides a stepping stone for other kite energy researchers and engineers to develop more efficient systems. In this paper, we have analyzed and experimentally investigated the effects of aerodynamic forces ranging from different angles from 0 to 90. We have studied the power potentials of a kite corresponding to these different forces. This work will surely help the scientists and other researcher from many countries. They will be able design a more efficient kite energy. Wind energy is gaining a platform in the field of generating power. The most important idea of wind energy is to replace the wind turbine system with the energy kites. The wind energy can generate upto 600 KW of power. The mass to power ratio of the energy kite is highly dependent on the absence of heavy tower and big blades. As the wind energy is one of the promising energy. Due to this we can fully use the atmosphere for the generation of the power. Many companies such as google has already invested around \$ 20 million in wind energy.*

## **Keywords**

*Revolutionizing, aerodynamic, renewable, innovations, turbine, trajectory, altitude, generation, tether, tremendously, threshold.*

## **Introduction**

The energy kite has replaced the old wind turbine. These new technologies of wind energy is gaining frame in generating power. The energy kites are installed in the ground along with the DC motor and wind turbines. The DC motor is generating the power of energy kite by using circular trajectory of the kite. The tension in the line of kite is directly proportional to the velocity of the air. The kite of the system is strongly tethered by a strong fiber. The power generated on kite is transferred to the ground by high voltage wire. These high voltage wire are inserted in tethering material. At the end, they are connected to ground.

This system of energy kite reduces the use of gear box in ground. Due to this the complexity of kite system is very low. The generated electricity by the motors on the Kite board is due to the trajectory in the air. Due to this they are known as on-board power generator. The wind energy density at high altitude is nearly in order of two in magnitude. As the average turbine height is 50 meters in the ground. High power is generated due to wind velocity that increases rationally when compared to the traditional wind turbine in old times.

Now a day's wind energy has gained a global platform. Due to this many countries are producing energy from wind. We can see the fast growth in energy kite in recent time. The world is ready to see the giant wind farms. The small wind turbine are used in cities. In the year 2015, the total electricity generated from the wind was around 4% by United States, 6% Europe and around 1.5% by China. Many

people agree with the usage of wind energy to a greater extend. By the year 2050, United States are aiming to generate around 25% of energy with wind. We can calculate the total power carried by wind is around: -

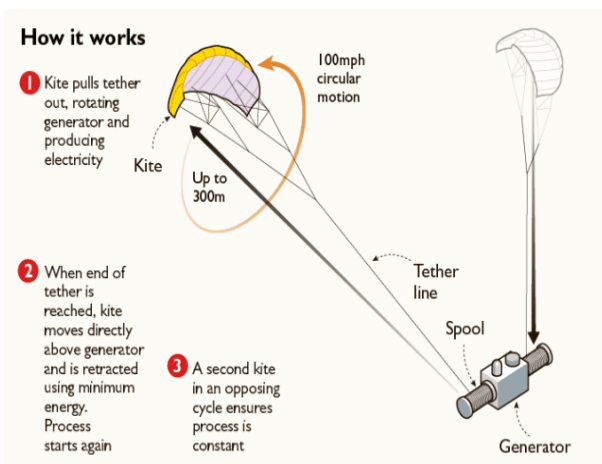
$$P = 1/2\rho Av^3$$

Where, air density is denoted by  $\rho$  and the cross section area of the wind is denoted by  $A$  while  $v$  is the velocity of wind. As we can see that the total wind energy generated per unit area increase with the wind speed. As to increase the velocity of wind the height of the tower is also increase from 20m to 100m. There are various facts that needs to be noted energy generation from kite. The kite is soft when compared to the wind turbines. The wings of kite are designed to make the movement of kite in up direction. This keeps the kite in the air. As the kite needs to be curved in shape.

### Wind energy used as energy kite.

The velocity of the wind is directly correlated with the height of the kite. The profile of wind can't be calculated at any point of time. There is no equation that can relay this information. As there are some laws that can help in studying wind energy. The logarithms law of air or wind. This law is based on monin-obukhov similarity theory. With the help of logarithmic law, we can describe the velocity of wind at certain height.

### Model of kite with analysis of force.



**Figure 1. Analysis of forces in kite.**

(Source- [engineeringforchange.org](http://engineeringforchange.org))

### 1. Kite modeling in physical form.

The kite in the sky is in horizontal position. This position of the kite can also be called as zenith point. While the wind is parallel to the kite. The kite is also known as airfoil. As the chord plane of the airfoil is parallel to the wind. In the kite, the airfoil is specially connected to two bridled lines in the kite. One of the edge is leading one and other is on the edge of trailing. The tether of the kite is connected to the chord plane. This tether is linked through the aerodynamic center. As the cross section of kite is seen as a airfoil. So, basically the kite is a combination of a some of the airfoil. The airfoil are having a linear lift and drag coefficient. This are same throughout the system. As the kite in the sky is similar to the airplane wings. They both are having a same aerodynamic system.

### 2. Analysis of force in energy kite.

As we can see that the kite system is similar to the airplane wings. But still is some fundamental difference between both the systems. The kite system has a high angle of attack. This angle of kite is much higher than the stall angle of kite. On the other hand, the airplane has some basic rule i.e., it flies higher than the critical angle. As if the rule is not followed then the velocity of plane is decreased. So, the aerodynamic force on the kite and airplane is different. The following wind in the sky is as following: -

Flying velocity of wind is FVW, which can be stated as-

$$FVW = W * V * \cos\theta$$

Pushing velocity of wind is PVW,

$$PVW = W * V * \sin\theta$$

The system of kite is tremendously affected by these forces. The forces of aerodynamic is generated by them.

### Background of energy kites

Kite energy was invented by an American engineer. His name as Miles Loydin in the year between 1970 to 1980. There were two ideas proposed by him as lift

and drag mode. By these methods the power can be generated. As the old wind turbines contribute very less to the total power generation. Energy kite is light weighted when compared to the wind turbine in the fields. As the kite is flying in the sky, they are following a circular trajectory of the wind. In the similar manner the huge kite is also following the same sequence of trajectory. We can use the circular motion to generate the power in the sky. When the power is generated using the tension in the tether if the rope then, this method of power generation is called lift mode. The second method to generate the power is through the motors set up in kites. This method of power generation is known as drag mode of kite. We are using the drag mode to generate power so its called as energy kite system.

### Detail construction of energy kite.

Energy Kite system consist of three main components

1. Ground station of kite
2. Kite of energy kite
3. Tether in the rope of ground station

#### 1. Ground station of kite.

The ground system is most important part of the energy kite. As the whole system is dependent on the station on the ground. Ground station is also the place for resting of the kite. So, if we don't want to use the kite then its placed on the ground. The space required for the ground station is not very large.

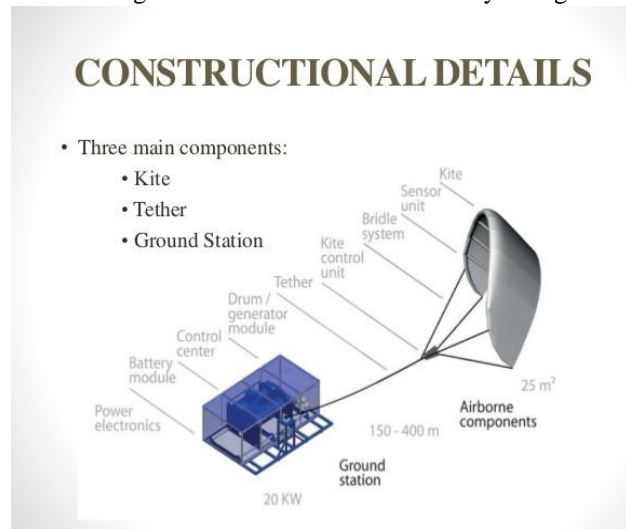


Figure 2. Construction of energy kite.

(Source- slideshare.net)

When compared to the wind turbine the space is very less for the energy kite. All the forces are acting directly to the ground. The ground station should have an adequate strength to control the kite energy. The length of the link between the ground station and kite is dependent on the power of the station in the ground.

#### 2. Kite of energy kite.

Kite is the most important part of the energy kite. It's one of the wind energy that is used to generate the energy. The kite system is having some small turbine. These are small turbine are mounted on the surface of the kite. The kite is using the speed of the air in the atmosphere to generate the power. The kite is located at a certain height, which is having a certain velocity. The power generated by the kite is send to the ground station. The kite energy is made of certain light weighted material, which is strong in nature. To increase the productivity of the kite energy, some rotors are mounted on it. As the number of rotors are increased, the power generated is also increased. California is using energy kite to generate 600 KW of power.

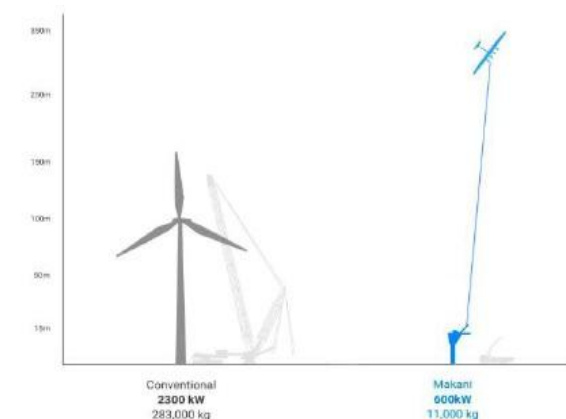


Figure 3. Conventional and makani power generator.

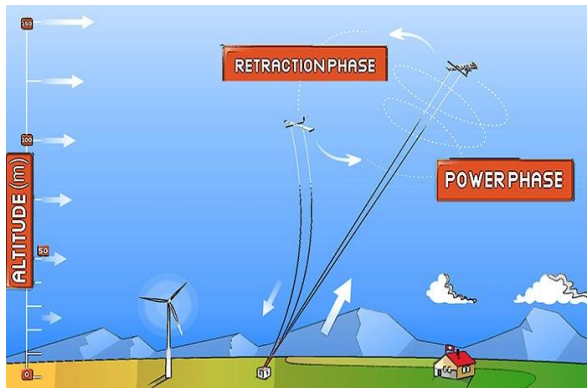
(Source- seminarsonly.com)

The estimated energy generated by kite using around 15 m/s of velocity is 225 KW per meter square of area. The force that is used to generate power is called drag force. There is a limit of every situation in the nature. In the same way if the kite force is greater than certain threshold force then it can't be controlled by station. As the tether in the kite is also controlled

by the ground station. To reduce the tether in the kite, certain number of kite are used in the system. Due to this, there is a certain drag force loss in the system.

### 3. Tether in the rope of ground station.

The conductive aluminium wire is used as a link between ground station and the kite. The tether is one of the most important part in the kite system. It connects the station on the ground to the kite. The wire is also used transfer the power to the station. The length of the tether is very significant factor. The tether should be strong which can withstand the different forces of the kite.



**Figure 4. Flying energy kite.**

(Source- thebulletin.org)

### Conclusion

The best current estimates for this technology, projects a life cycle cost of 0.5 to 1.5 cents per Kilowatt hour compared to traditional wind turbine which is currently costing 5 to 12 cents per kilowatt hour. By using the Energy Kites, we open a new world of opportunities in the field of wind power generation. Energy kite is making complete use of air at high altitude. These technology is implemented on a large scale. As the use of power plants that burn out conventional resources could be decreased to a great extent. Therefore, this decreasing air pollution. The energy kites will produce electric power, which will be available at cheaper rates. By using wind energy, we surely decrease the rate of global warming. If more Research is carried out in the field of Energy Kites, then the power generation rate will also be increased to more than 40 KW/m<sup>2</sup> of wing area.

### References

Moritz, Diehl. 2013. Airborne Wind Energy: Basic Concepts and Physical Foundations <https://homes.esat.kuleuven.be/~highwind/wpcontent/uploads/2016/08/Diehl2013a.pdf>

Lloyd, M., 1980, Crosswind Kite Power, Journal of Energy, 4(3):106–111.

Mario, Zanon, Sebastien Gros, Johan Meyers and Moritz Diehl. 2012, Airborne Wind Energy Based on Dual Airfoils, In Proceedings of the 19th IFAC World Congress, 2014, 5814-5819

