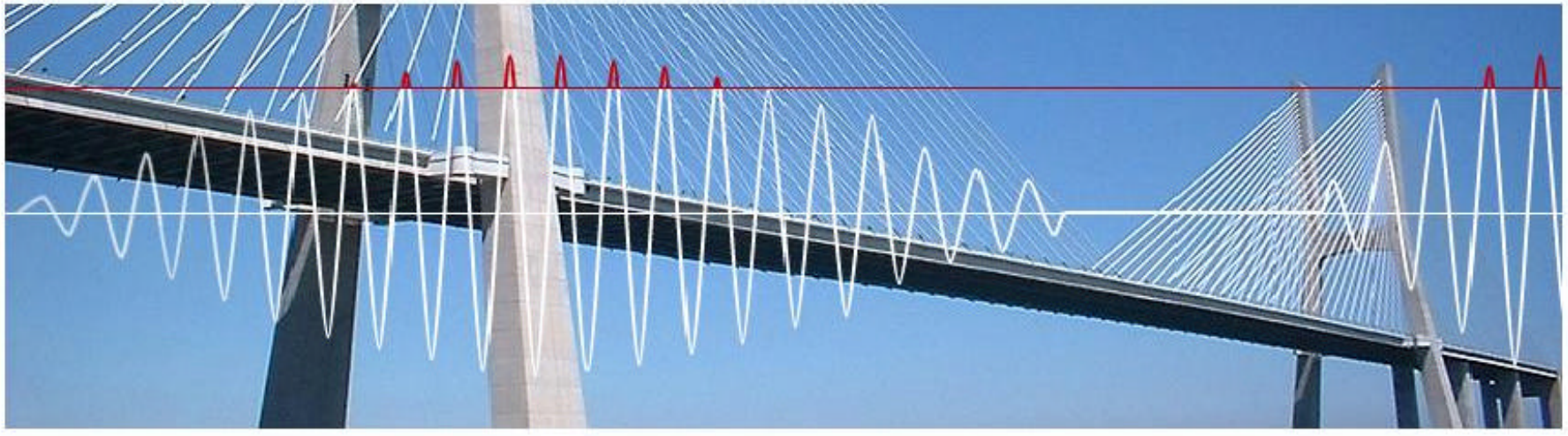


SEQUOIA

Expert vibration monitoring solutions

High altitude wind generation

The Rotokite

Preview

The idea of the Rotokite started with Gianni Vergnano, director of the company SEQUOIA IT, to which the patent is registered.

The great simplicity of the project, which uses known technology, makes us certain of the possibility of developing a wind generation system quickly and at low cost.

The lack of funding for innovative wind power by the European Community and Italian research funds has led us to participate in Google '10 ^ 100 ', with the aim of giving visibility to a too neglected resource, that of wind at high altitudes.

High altitude wind power generation with the use of kites

The idea of using kites or ultra-light wing profiles to generate energy has been proposed in various forms and is covered by numerous patents.

Up to today, the proposals that have been made have been based on an increased size of the wing profiles and on the lengthening of the control cables.

The problems of automatic control of flight and the aerodynamic implications linked to the lengthening of the cables have not enabled significant developments to today.

The Rotokite, even if based on profiles similar to kites, is greatly innovative as it uses a new form of aerodynamic profile rotating around its own axis and as it simplifies radically the difficult problem of the control of flight.

The importance of high altitude wind energy

It is estimated that wind has energy potential equal to 270 times the entire human energy need.

The unevenness of the ground slows the flow of wind at low altitudes.

High altitude wind blows stronger, is almost constant and its energy increases with the increase of speed cubed.

Satellite vision of cloud fronts clearly shows the differences of speed between high altitude winds and those at ground level, often absent, especially in the Po Valley.

High altitude wind

Traditional wind generators work with winds of speeds between 5 and 20 m/s

The average speed of ground level wind in Europe is below those limits

(Ref. chart)

Even at altitudes between 400 and 800 m, wind has a speed that enables full and continuous exploitation of wind energy

(Ref. chart)

Fig. 2. Variation in the wind speed, as a function of the altitude, based on the average European wind speed (3 m/s at ground level).

High altitude wind: the state of the art

Many energy generation projects have been presented that exploit high altitude wind but only the type using the traction of large vessels with kites has passed the study phase.

The five following slides will present the German project Skysails that developed this technology.

A view of vessel towage images, available in full on the Internet site www.skysails.com, highlights beyond all doubt the interest in and feasibility of collecting high altitude energy.

The Rotokite project, which is presented later, has much in common with the vessel traction but differs in its use of an aerodynamic figure composed of two or more kites.

Large vessel towage with the use of a piloted kite

The kites may seem to be ‘toys’ but they are actually objects of refined aerodynamic technology and are the easiest approach for the generation of high altitude wind energy.

The development of technology, with the increase in sail size and automatic control in flight, is the basis of the **Skysails** project, the towage of vessels with large kites.

www.skysails.com

The piloted kite

The photos show that to obtain great energy it is necessary to drive the kite so as to achieve large and fast maneuvers in the wind.

In this way the intercepted wind surface is no longer linked to the size of the kite but to the area in which it carries out its movements.

The piloted kite

To obtain results similar to those of the vessel in the images, which is driven by a kite of only 500 m², a sailing ship of the same length needed 3000 m² of sail area.

With this technique we can obtain traction energy of over 500 kW with a sail of only 500 m².

From an aerodynamic viewpoint, the kite behaves in a way similar to the blade of a wind turbine that is freed from its center of rotation.

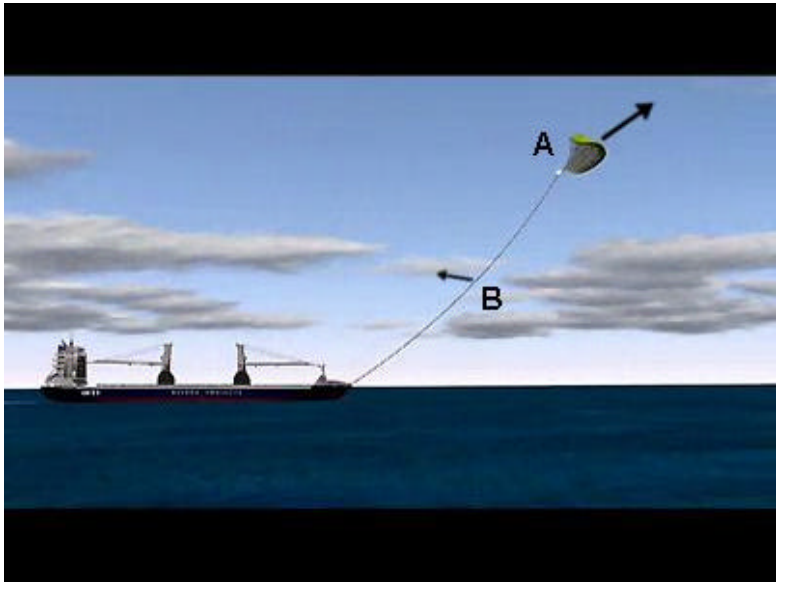
See the site www.skysails.com.

Energy generation by the piloted kite

The potential to generate electricity with the same technique used for vessel towing is a possibility that has been studied and tested and is covered by numerous patents that did not have significant developments at the time.

The main difficulties are linked to the length of the bonding cables that create problems of control and that limit the exploitation of high altitude winds.

As shown in the figure, traction force A generated by the kite is reduced by the resistance to shifting of cable B; such shifting is required to drive the required changes.

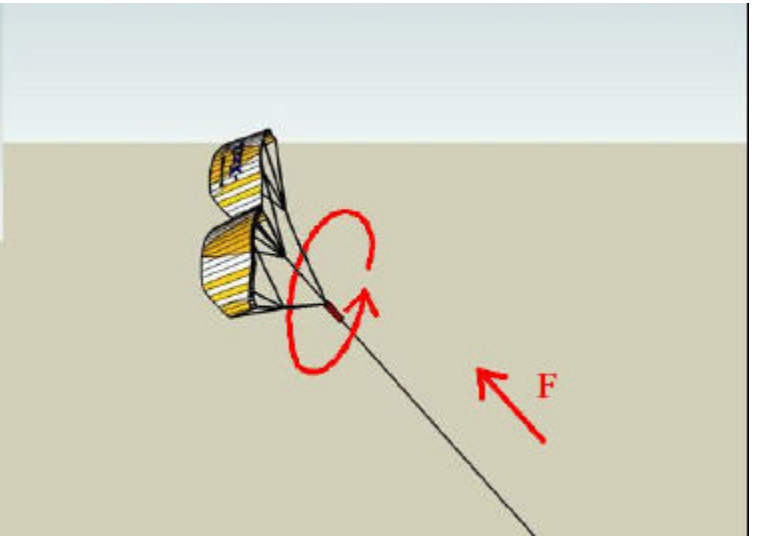


The innovation of Rotokite

To overcome the highlighted difficulties Rotokite proposes a different approach: not the enlargement of the kite and its control cables but a new aerodynamic figure that exploits the kite's performance with a flight control principle that is completely different.

By using two opposed kites, it is possible to change their profile during rotation, achieving an aerodynamic figure that rotates in the presence of wind by generating lift and traction.

The area of energy uptake will be where the kites complete their rotational maneuver.



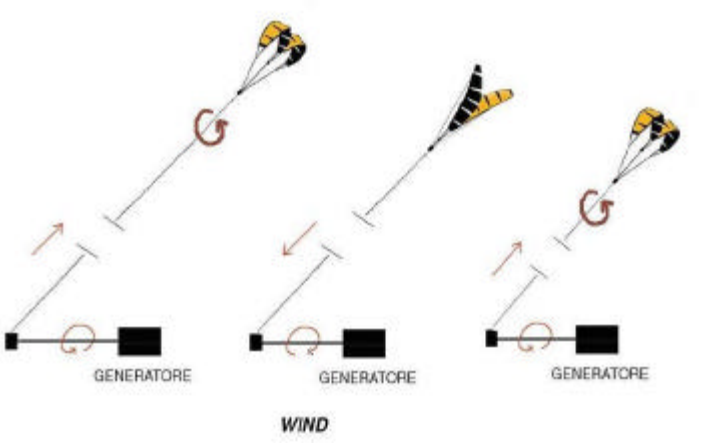
The Rotokite

The principle of operation is easy to see.

When placed in rotation by the wind, Rotokite exercises traction on the cable connection to the generator.

The pulley on which the cable is wrapped transforms linear traction into rotating motion.

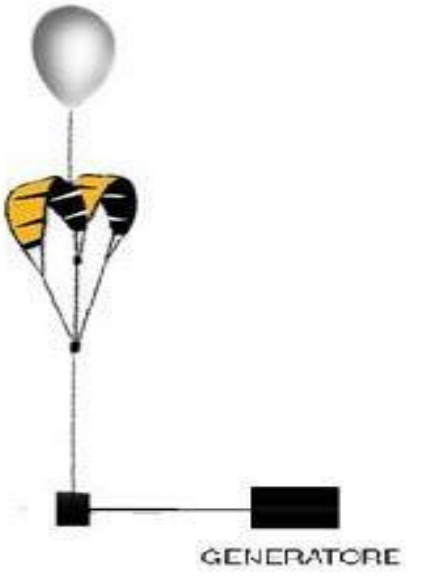
Once the programmed altitude is reached, the traction phases shown in the first and third images are alternated with a quick recovery phase at the initial altitude, with warped wing profiles to offer the minimum aerodynamic resistance.



The Rotokite

The addition of a small aerostatic balloon enables us to raise the system in the launching stage and maintain it in position in the event of insufficient wind.

This method reduces occupation of the ground and makes it possible to position the system in the sea, in deep waters, where it is impossible to create the foundations necessary for traditional wind generators.

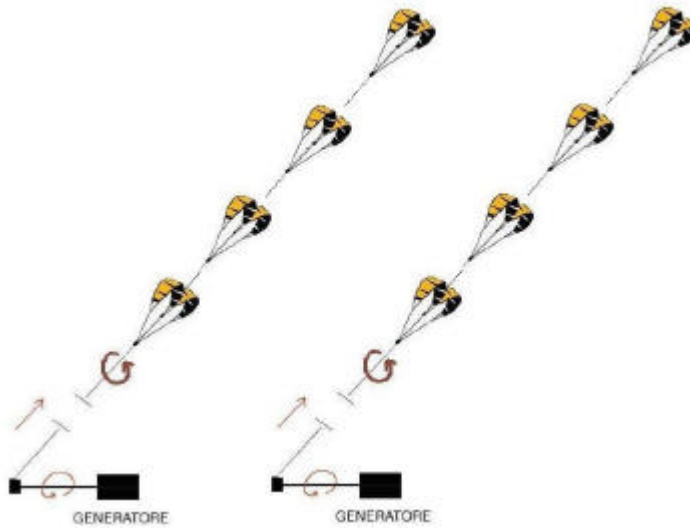


The Rotokite

Two kites with 10 m span, like those used in sporting practice, placed in rotation on their own axis, intercept a wind area of 314 m².

Modern wind generators with blades of 60 meters cover a surface of about 10,000 m² during rotation but Rotokite works at high altitude, where winds are stronger and constant.

Different configurations are possible in addition to those shown in the presented design. These can increase the power obtained with, for example, the solution shown in the design to the side or simply by distancing the kites from the center of rotation.



The main differences between Rotokite and wind generator

The traditional wind generator is a sophisticated and expensive product of very high technology.

The complexity of this structure is linked to the need to locate an electric generator that orients itself based on the direction of the wind on a tower that today can reach 100 meters in height.

The pressure on the structure is enormous and for winds exceeding 20 m/s operation must be stopped by changing the angle of impact of the blades in relation to the wind.

The main differences between Rotokite and wind generator

A megawatt wind generator costing 1 million euro is considered well positioned when, on average, it operates six hours a day and produces two million kWh in a year. The cost of the energy produced is estimated at 0.06 euro per kWh.

The Rotokite canvas structure, the positioning of the generator on the ground and the extreme simplicity of the control mechanisms lead to an assessment of system cost that is ten times lower than that of traditional generators. The cost of energy production is assessed as less than 0.006 euro per kWh.

To be competitive with the costs of high altitude wind generation, oil should have a price of 13 dollars per barrel, without considering the costs of processing and CO2 emission, evaluated in 725 g per kWh produced by a thermoelectric central.

Advantages and problems

Advantages

- ✓ Production of renewable energy without CO2 emission
- ✓ Use of simple and already known technology
- ✓ Low costs for the system and for produced energy
- ✓ Exploitation of wind at high altitude, where it is more constant and stronger
- ✓ Potential positioning in the sea, even in deep water

Problems

- ✓ Need to build wind farms on GPS maps of which any aircraft disposes
- ✓ A single system has a discontinuous output of energy

The urgency to develop projects for wind generation at high altitude

To resolve the problem of the conflict between food and fuel

To limit CO2 emission

To compensate for the depletion of fossil fuels

To control the price of oil

Any additional considerations

The project has had numerous validations from academics and industry experts as well as a Spanish aerospace company that operates in the aeroelastic profiles, available to the implementation of a prototype.

Among the many researches about the production of energy from renewable sources we believe that the project Rotokite is the fastest to implement as it uses, by a different approach, simple and already known technologies.