High Altitude Wind Turbine Concept

Giannis Michailidis

Abstract:

High altitude wind energy has the potential to provide a reliable and cost-effective source of renewable electricity. However, current high altitude wind energy systems have limitations, including high costs and complex mechanisms for transferring energy to the ground. In this paper, we present a new high altitude wind turbine concept that combines the advantages of traditional wind turbines and high altitude wind energy systems, while addressing many of their limitations. Our system utilizes a helium-filled balloon to lift a spinning turbine into the air, where it can capture the wind's energy more efficiently than traditional wind turbines. The energy is transferred to the ground via ropes that move at high speeds in a circular motion, which simplifies the process of generating electricity compared to kite systems. The system is relatively lightweight, with a low cost of construction, and has the potential to provide a reliable source of renewable electricity at high altitudes.

Introduction:

Wind energy is a clean and renewable source of electricity that has the potential to significantly reduce greenhouse gas emissions and mitigate climate change [1]. Traditional ground-based wind turbines are a well-established technology for generating electricity from wind energy, but they have limitations in terms of the amount of energy that can be extracted from the wind [1]. In particular, the energy content of the wind decreases with altitude, which means that traditional wind turbines are not able to capture the full potential of the wind [1].

High altitude wind energy systems, which are designed to capture the wind's energy at higher altitudes where the wind is stronger and more consistent [2], have the potential to overcome these limitations and provide a more reliable and cost-effective source of renewable electricity. Current high altitude wind energy systems include kite systems and tethered systems [3]. Kite systems use a computer to control the movement of the kite, which can be complex and expensive [3]. In addition, the push and pull of the kite is limited in speed, which can impact the efficiency of energy transfer [3]. Tethered systems involve lifting a turbine into the air using a tether, which can be expensive and prone to failure [3]. Both kite systems and tethered systems have limited energy transfer capacity due to the capacity of the tether or rope [3].

In this paper, we present a new high altitude wind turbine concept that combines the advantages of traditional wind turbines and high altitude wind energy systems, while addressing many of their limitations. Our system utilizes a helium-filled balloon to lift a spinning turbine into the air, where it can capture the wind's energy more efficiently than traditional wind turbines. The energy is transferred to the ground via ropes that move at high speeds in a circular motion, which simplifies the process of generating electricity compared to kite systems. The system is relatively lightweight, with a low cost of construction, and has the potential to provide a reliable source of renewable electricity at high altitudes.

Description:

The zeppelin-shaped balloon is an integral part of the turbine and lies at the center of it. The turbine is a robust structure and spins as a whole without moving parts, reducing construction complexity and maintenance costs. The turbine consists of six triangular sails that are attached to the balloon in two circles. The bases of the triangular sails are attached to the balloon, while the tops are stabilized by two circular steel parts. The sails have a curved attachment at their base, which allows them to control the air flow and create a pressure that drives the rotation of the system. The sails are angled against the axis of the balloon in such a way that the pressure of the wind drives the rotation of the system and balances the push of the air to the balloon. The circular steel parts are used to stabilize the tops of the sails and provide a surface for the ropes to move around.

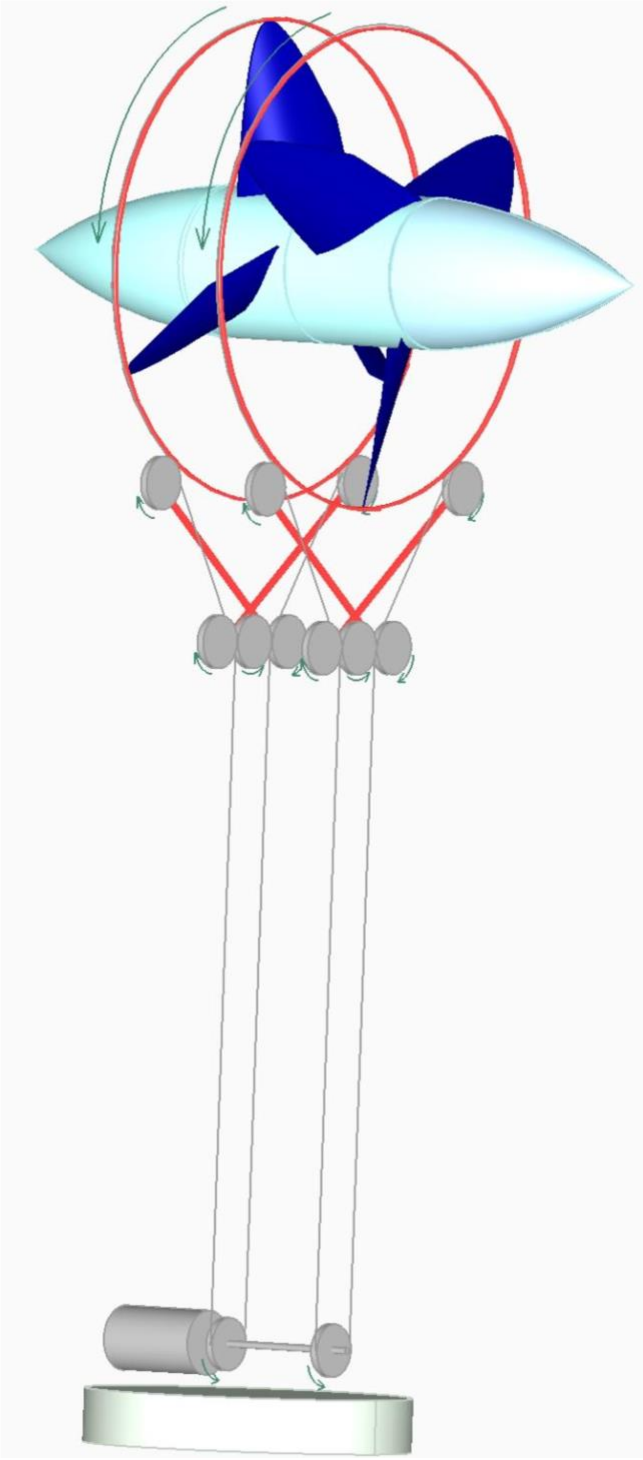

Image 1. The zeppelin-shaped helium baloon is depicted in a pale blue color, with triangular sails mounted on it in blue. The circular steel parts that support the sails are colored in red. The generator, its basement, the wheels and the ropes that transfer the energy on the ground are depicted in grey. Additionally, the green arrows in the image indicate the direction of the wheel rotation, which is synchronized with the rotation of the turbine.

By using a simple mechanism, consisting of ropes, to deform the sails relatively to the wind speed, the aerodynamic effect can be reduced, allowing the balloon to maintain balance and protecting it from the risk of damage in high wind speeds. This mechanism could be controlled directly from the ground, or indirectly through a tiny motor attached to the balloon.

The energy transfer system consists of ropes that are tightened around the circular steel parts and moved in a circular motion by the spinning turbine. In order to ensure efficient energy transfer, the ropes move at high speeds due to their binding on the large diameter circular steel parts [4]. The ropes can be made of wire ropes from steel or from any other modern materials such as synthetic nano fibers [5].

Underneath the balloon is a device that is used to tighten the ropes around the circular steel parts of large diameter. This device is made up of a wheel system, which is designed to allow one rope to go down as the other rope goes up. As a result, the device is able to maintain its position and not fall, even as the ropes move in opposite directions. The ropes are tightened around the circular steel parts in order to create friction, which allows the ropes to move together with the spinning turbine as it spins around its horizontal axis. The importance of this tightness cannot be overstated, as it ensures that the system is able to efficiently and effectively transfer the energy from the turbine to the ground-based power generation system.

The ground-based power generation system consists of two wheels that are driven by the ropes anchored to the circular steel parts at the top of the sails. The axis of the wheels transfers the energy from the ropes to a generator, which converts the mechanical energy into electricity. The generator can be connected to the power grid or used to charge batteries or other energy storage devices.

To ensure that the structure is able to be directed to the wind direction without the ropes being bent, the generator and the wheels which take the energy through the ropes are based on a horizontally rotating basement. This horizontal rotation allows the turbine to always face the wind direction and transfer the energy more efficiently.

Conclusion:

There are a number of advantages to our high altitude wind turbine concept that make it an attractive alternative to traditional wind turbines and other high altitude wind energy systems, such as kite systems.

First, because the system is suspended in the air by ropes, it can be deployed at high altitudes where the wind is stronger and more consistent, which can potentially increase the amount of electricity that can be generated. Traditional wind turbines are limited to lower altitudes where the wind is weaker and more variable, which reduces their efficiency and power output.

Second, our system uses a helium-filled balloon to lift the sails and other components of the system into the air, which reduces the weight and complexity of the system compared to traditional wind turbines. The balloon and sails are relatively lightweight and can be easily transported and assembled on site, which reduces the cost and effort of deploying the system.

Third, the use of triangular sails and circular steel parts allows our system to capture the wind's energy more efficiently than kite or tethered wing systems, as the sails can be designed to optimize the flow of air.

Fourth, our system has a simpler power generation system compared to kite systems, which require complex control systems to stabilize the kite and regulate the power output. In our system, the energy is transmitted to the ground via ropes that move at high speeds in a circular motion to transfer the energy from the turbine to the ground, which simplifies the process of generating electricity compared to kite systems.

Fifth, one of the major advantages of our wind turbine concept is that it is primarily constructed out of cheap materials, such as cloth and ropes. Only the circular parts and the wheel system are made of steel, which reduces the overall cost of the system compared to traditional ground-based wind turbines, which use a large quantity of metal and concrete in their construction. By using cheap and lightweight materials, our system is able to be deployed at a lower cost and with less effort than traditional wind turbines, which makes it more widely adoptable when it is fully developed and well tested. Overall, the use of cheap materials in the design of our wind turbine concept makes it a highly cost-effective solution compared to existing ground-based wind turbines.

Additionally, there are several advantages to placing the generator on the ground as opposed to lifting it into the air with the turbine. First, ground-based generators, which allow for a wider range of design options and a cheaper construction process, are generally less expensive to build and maintain due to their simpler design and lack of exposure to physical stresses such as wind and turbulence. Second, by placing the generator on the ground, it is possible to use a heavier and more robust construction, which may be more durable and efficient than a lightweight airborne generator. Third, ground-based generators are generally safer due to their lack of exposure to physical stresses and the risk of falling from a height. Fourth, they are easier to access and maintain due to their location on the ground and do not require specialized equipment or techniques to reach them. Finally, ground-based generators can be easily integrated into existing electrical grids and infrastructure, while airborne generators may require the development of new technologies and infrastructure in order to be utilized.

One potential drawback of this high altitude wind turbine concept is the cost of lifting the helium-filled balloon and spinning turbine into the air. While the use of a helium balloon allows for a lighter and more cost-effective lifting mechanism compared to other high altitude wind energy systems, it may still be expensive to lift and maintain the balloon and turbine at high altitudes.

Another challenge is the potential impact on aviation and wildlife. The spinning turbine and ropes moving at high speeds may pose a hazard to aircraft, and measures will need to be taken to ensure that the system is safe to operate in airspace. Additionally, the system may have an impact on wildlife, particularly birds and other aerial animals, and measures will need to be taken to minimize this impact.

Finally, there may be technical challenges associated with the design and operation of the spinning turbine and energy transfer system. Ensuring that the system is efficient, reliable, and safe will require significant research and development efforts.

Overall, our high altitude wind turbine concept has the potential to provide a cost-effective and reliable source of renewable electricity at high altitudes. It combines the advantages of traditional wind turbines and high altitude wind energy systems, while addressing many of their limitations. As such, it could be a promising alternative for the generation of renewable electricity in the future.

References:

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