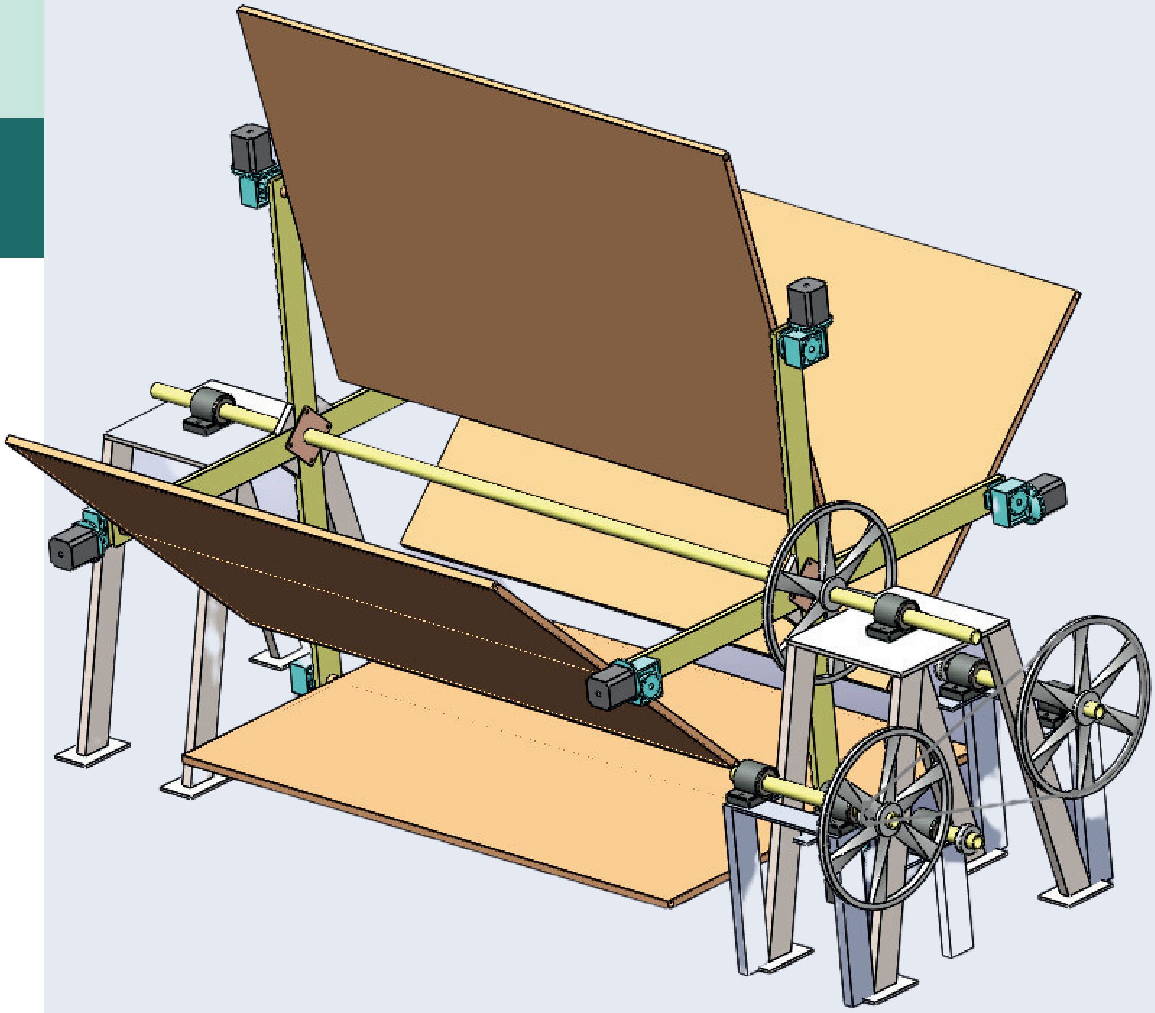
GURV TECHNOLOGY



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DRAG CUM LIFT

BASED

WIND TURBINE SYSTEM

Rakesh Aggarwal (Inventor)

Mr. Rakesh Aggarwal is an Ex ISRO-scientist and founder of **COMCON** group of companies. He started his carrier with ITU sponsored SITE experiment at SAC Ahmedabad and soon diversified in to manufacturing of professional broadcast equipment. He is known worldwide for his expertise in prominent digital radio standards DRM and HD Radio and commissioning of world's largest digital radio network of AIR/Prasar Bharti.

Inventions and patent holding

GURV wind turbine technology for **A DRAG CUM LIFT BASED WIND TURBINE SYSTEM HAVING ADJUSTABLE BLADES** granted patent in India 368515 and PCT/IB2020/059302 and many more jurisdictions in pipeline. This Patented technique is capable of uniquely combining best of both mutually perpendicular, Drag and lift forces in a super-efficient design. The turbines can produce more than 2-3 times more energy from the same wind resource.

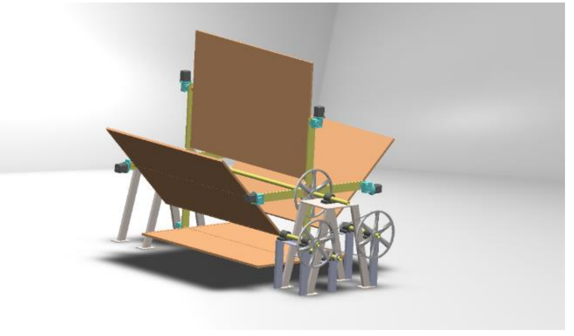
SVURG/Z-Mod technology Indian Patents 351456, 351458, 360271, 368356 and international patents US 10,979,368 B2, US 2021/0144038 A1 and many more. This concept directly generates modulated carrier sine waves with **"ZERO SIDE BANDS"** making carrier itself, to carry large amount of data saving bandwidth.

Dr. Pritanshu Ranjan (Advisor)

He has done his graduation (B. Tech) in Mechanical Engineering from GJUS&T, Hisar. He did his masters in Fluids Engineering from Motilal Nehru National Institute of Technology, Prayagraj. He was awarded a Gold medal for standing first in order of merit in M. Tech for the 2010 batch. During his masters, he developed an interest in Numerical Modeling of Fluid Flow and went on to do PhD in the area of Computational Fluid and Heat Transfer from the Department of Applied Mechanics, IIT Delhi. In December 2017 he joined the Department of Mechanical Engineering at BITS Pilani –K K Birla Goa campus, Goa, as an Assistant Professor and is still working there.

His research interest mainly comprises numerical modelling of fluid flow and heat transfer in turbulent regimes. He has worked on various Hybrid turbulence models especially, Partially Averaged Navier-Stokes (PANS) modelling. His current area of research includes drag reduction, the study of primary and secondary instabilities for flow over bluff-bodies, acoustics analysis of centrifugal pumps, and CFD-DEM study of the fluidization process. He has published various articles in reputed international journals and conferences.

Introduction:



Drag Cum Lift Wind Turbine

Fig :1

The groundbreaking Drag Cum Lift Wind Turbine concept, protected by national and international patents. It stands out as a remarkable solution addressing the ever-increasing demand of green electricity. The essence of the design lies in its ability to continuously adjust the attack angle of the blade in response to its rotatory position with respect to wind direction. This dynamic adaptation of attack angle optimizes the drag force generated as the blades move with the wind and ingeniously converts reverse drag into lift force during part rotation as the blades move against the wind.

This innovative design possesses the remarkable capability of harnessing more energy per square meter of wind area. The basis for this extraordinary claim lies in simple yet compelling principles utilizing drag coefficient of 2.1, whereas conventional aero-foil lift designs typically have a lift factor of 0.56. Moreover, the design boasts of higher blade contact area with the wind, ranging between 70% to 90%, in stark contrast to conventional wind turbines where the blade's contact area with the wind is less than 10% of the swept area.

GURV System's Advantages:

The design offers several key advantages that set it apart:

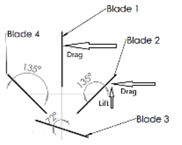
- Super-efficient Design
- Smaller Size Per MW
- Adaptable to widest range of wind resource
- Utilization of Smaller Parts:
- Easy On-Site Installation:
- Cost-Effective Manufacturing:
- Lower cost of ownership.
- Lower Overheads:
- Quickest ROI
- Adaptable from few KW to Megawatts

Proof of Concept

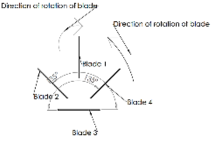
Our journey into the Drag Cum Lift wind turbine systems began with astounding bench test results, conducted with a small wind tunnel, and a precisely crafted test jig. These initial experiments (even with a inefficiently small size) were able to transform from reverse drag into positive lift. It also demonstrated the capacity to generate over two times torque per square meter swept wind area in comparison to traditional wind turbines. This remarkable initial test performance, which represents a very conservative estimate encouraged us to go after simulation and physical model tests.

Various methods adopted so far to validate our findings included in house mathematical calculations, static torque tests with wind tunnel and CFD analysis. BITS Pilani Goa Campus, confirmed our excellent findings independently. In further optimized configurations, we anticipate these gains could potentially surge into double-digit multiples. This super-efficient innovative system has, transformative power to render centuries-old reliance on fossil fuel sources obsolete, forever altering the landscape of wind energy generation.

Harnessing Drag Force:



Conventional wind turbines predominantly rely on the conversion of drag forces, which naturally align with the wind's direction, into lift forces that act perpendicular to the wind's direction. While this approach is the most commercially successful technology today, it incurs notable energy losses due to the change in force direction.

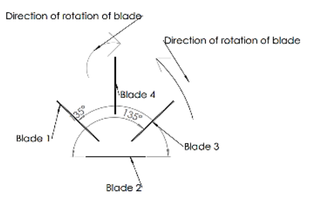


One particularly daunting challenge in harnessing drag force is dealing with reverse drag, especially during the blade's half rotation against the wind. Historically, this obstacle hindered the success of drag-based Darrius designs, dependent of the shape of blades to minimize the reverse drag effect to some extent.

The GURV Solution:

This “Drag cum Lift” design predominantly use drag force as prime mover and addition of lift force with drag force is the uniqueness of the design. This innovative technique not only mitigates reverse drag but ingeniously transforms it into a valuable lift force coherent with the drag force, that contributes positively to increase efficiency. This paradigm-shifting approach stems from the recognition, that wind applies all its energy in dragging whatever comes in its way.

In contrast to conventional 3 blade turbines converting drag into lift, GURV employs a novel control technique to continuously adjusts the attack angle of its blade panels, aiming to optimize torque from forward drag in part rotation of blades, and convert reverse drag into usable lift force, all through a single coordinated intelligent control action.



Maximizing Energy Harvesting:

This unique approach allows to harness maximum wind energy by aligning torque generated from drag forces with torque generated from lift forces, seemingly an impossible task. During one half rotation, when the blades move with the wind, it efficiently captures drag forces, always oriented in the wind's direction. During the other half rotation, when blade moves against the wind, it generates a net lift force, again in the direction of rotation. This harmonious combination of drag and lift forces sets GURV apart, as a groundbreaking innovation in wind energy harvesting.

Energy to Weight Ratio Performance:

Moreover, the innovative design uses simple blade structure reducing wind turbine weight and blade component sizes, even for turbines generating several megawatts of power. This design approach uses smaller size, nearly flat plate, type sub blades making them light weight. These thin sub-blades also provide control to change effective area of the blade panel to allows working at higher stormy wind speeds. Notably, **Drag cum Lift turbines** do not require stalling even in severe storm conditions, ensuring peak power generation even in wind speeds exceeding 180 KMPH.

This unique design approach also minimizes the impact of drag on the tower structures, allowing them to be made lighter and more cost-effective. The fact that wind drag is dependent on the area and we are directly converting most of the drag into energy, it advantageously changes the ratio of total drag to output. Which means tower in new design will have less drag for any given size of the wind turbine.

Adaptive Energy Optimization & ROI:

One of the most intelligent features of this technique is its self-regulating mechanism within the blade panels. This dynamic control of effective blade area, optimizes energy generation across wind speeds that are 10 to

15 times higher than the turbine's rated optimum wind speed. This unique capability allows designers to optimally balance electrical equipment capacity with local wind potential, revolutionizing the way turbines are designed with higher utilization factor. By improving the utilization factor by at least tenfold, GURV significantly boosts the net production of electricity, making it a highly cost-effective and sustainable solution. These factors producing higher output and less initial cost can reduce **ROI to less than ten years** form existing ROI of more than thirty years.

Re-visiting the Air Foil Design:

In sharp contrast to traditional wind turbines, which predominantly draw inspiration from the aviation industry's airfoil designs, GURV charts a groundbreaking path of combining drag and lift together. While airfoil designs are characterized by a delicate balance between increasing lift and minimizing drag force, it introduces a paradigm shift in using drag as the main propellent. Conventional airfoil designs are constrained by the fact that the blade directly encounters less than 10% area of the swept wind at any given moment. This limitation implies that most of the wind passes through without significantly contributing to energy generation, relegating it to a supplemental role.

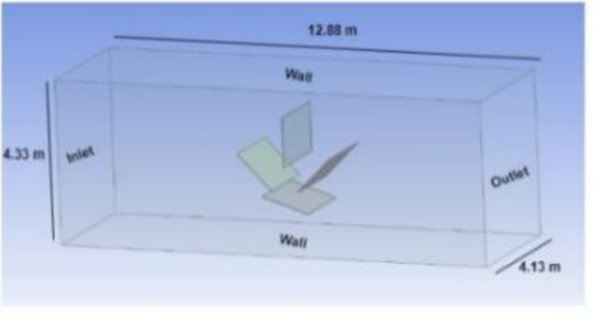
Established statistical measures such as Reynold numbers and Bejan Numbers, once developed painstakingly through practical experimentation in the past, provided reliable insights into existing designs. Now, with the advent of Drag Cum Lift Wind Turbines (DLWT), the time has come to redefine coefficients specific to GURV coefficients. A more purposeful evaluation is needed to calculate the ratio of the loss in total kinetic energy within the wind area to the energy output for a given wind area—a metric that will shed new light on the efficiency and full potential of the GURV system.

Efficiency Redefined:

Furthermore, GURV's design drastically alters the efficiency landscape. Traditional airfoil designs witness a fractional loss of wind speed in the cross-section area just after crossing the blades, resulting in a minute fraction of total kinetic energy within that volume of air being harnessed. In contrast, the GURV design provides designers with freedom to choose the rotor's rotational speed to few RPM, allowing for precise control over how much kinetic energy is converted into torque. Slower rotor speeds, for instance, yield higher drag forces, while the hypothetical scenario of stopping the rotor entirely and blocking the wind with blade panels generates maximum drag force but lacks feasibility for converting this drag force into energy.

Computational Simulations GURV:

In our quest to redefine the future of wind energy, we conducted in-depth computational simulations to analyze the performance of our patented wind turbine, GURV. Employing SteadyState simulations, we explored the blade behavior of five distinct blade positions (0°, 20°, 40°, 60°, 80°) while also varying blade configurations by rotating them around their central axes. The investigation used the finite volume-based software Ansys Fluent 2019 R2 at various blade



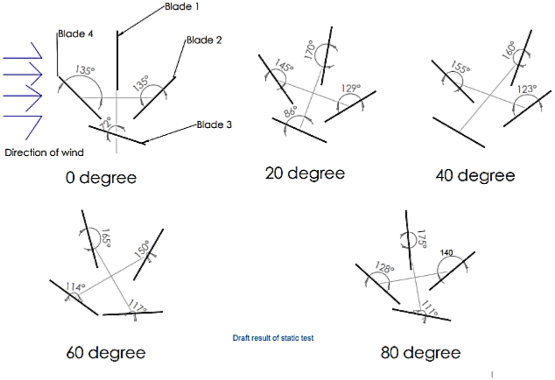
positions. The simulations were performed using the pressure-based solver and a realizable $k - \epsilon$ turbulence model. The simulations were conducted for a quarter of the rotation, as the blades acquired the same position by interchanging the 4 blades after each quarter rotation by continuously adjusting their angle of attack using advanced controls.

The outcomes of our study provide critical insights into the efficacy of GURV, and we draw the following conclusions:

1) Continuous Optimized Angle of Attack Yields Effective Lift by converting reverse drag into lift

2) Positive Lift Forces Across All Turbine Positions

3) Substantial positive Drag Forces for Enhanced Energy recovery and negligible reverse drag effect:



GURV vs. Conventional Wind Turbines:

Compared to existing wind turbine designs such as HWAT and VWAT, the GURV system shines as a true innovation. This demonstrates an impressive 100% increase in power generation while maintaining significantly lower cut-in and upper cut-off wind speeds, even in the face of storms. The transformative capabilities of the design extend beyond its energy generation prowess.

Conclusion

In conclusion, **“GURV” Drag Cum Lift wind turbine technology** represents a paradigm shift in wind energy generation. Its ability to simultaneously harness both drag and lift forces, adapt to varying wind conditions, and maximize energy output sets it on the path to redefine the future of renewable energy production.

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