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A Review: Smart Portable Wind Turbine

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***Abstract*— This review study examines the potential new technology of portable wind turbines, which provide an off-grid or remote location's clean and renewable energy production alternative. The study gives a general review of the design tenets, functional features, and performance indicators of various portable wind turbine types, including vertical axis and horizontal axis designs. Also, the report assesses the benefits and drawbacks of using portable wind turbines for military operations, disaster relief, boating, camping, and other activities. The article also covers prospects and obstacles in the design and marketing of portable wind turbines, including the requirement for affordable and dependable energy storage options. Overall, this review article provides a thorough analysis of the state of portable wind turbines today and their future applications as a renewable energy source.**

Keywords:-Portable, clean and renewable, affordable energy storage;

I. INTRODUTION

One of the cutting-edge technologies that have arisen in response to the growing demand for clean, renewable energy sources is portable wind turbines. These turbines are designed to produce electricity in remote or off-grid places where traditional power sources are not readily available or practical. Portable wind turbines offer a flexible and reliable energy source for a range of activities, such as camping, sailing, disaster assistance, and military tasks.

Portable wind turbines are designed differently from normal wind turbines and have different operational characteristics since they need to be light, small, and easy to transport. Recent advances in materials science, aerodynamics, and control systems have allowed for the construction of incredibly powerful and durable portable wind turbines that can function in adverse weather conditions.

Notwithstanding the potential benefits of portable wind turbines, one problem still needs to be solved: the requirement for energy storage systems to ensure a constant supply of electricity. Also, more research and development is needed to boost the productivity and decrease the cost of portable wind turbines.

In-depth analysis of the current state and possible uses of portable wind turbines as a renewable energy source is provided in this research study. In the article, various types of portable wind turbines' design concepts, operating characteristics, and performance metrics are discussed along with an evaluation of their benefits and drawbacks in various applications.

II. LITERATURE SURVEY

Ravi Anant Kishore al [1] has proposed about the design andcharacterization Describes a portable small-scale wind energy turbine (SWEPT) intended for use in winds under 5 m/s. During extensive wind tunnel testing, We looked into SWEPT's aerodynamic performance parameters. It was discovered that at a tip speed ratio of 2.9, the performance coefficient reached its maximum value of 14%. At the 5 m/s rated wind speed, SWEPT produced 0.83 W of electricity with a relatively low cut-in wind speed of 2.7 m/s. Moreover, Computational Fluid Dynamics (CFD) simulations were used to create a diffuser structure for SWEPT. It was discovered that SWEPTs can generate 1.4–1.6 times more electricity using diffusers that are around the same length as their diameter. It is also discussed a different approach to calculating mechanical power that does not call for a torque measurement device and is therefore particularly useful for common laboratory experiments.

Rutivarman Subramaniam et al [2] has developed The global society is becoming more conscious of the value using energy from renewable sources including solar, wind, and geothermal as a primary replacement for fossil fuels. In order to provide electricity to its citizens, many nations, like the United Kingdom, Spain, the United States, and The development of renewable technology, especially wind energy, has begun in Japan. Due to the East Coast region's typical wind speed of 3-6 m/s and its inefficiency for large-scale power production, wind energy is not regularly utilised in Malaysia for power generating. Nonetheless, a tiny windmill may generate power from light winds. Also, remote places where there isn't enough electricity to run a small device can use the mobile wind turbine. This project aims to develop and construct a movable vertical wind turbine for small-scale energy production. The design research starts with an analysis of the wind speed in Malaysia, the various types of wind turbines, their features, and the popularity of portable wind turbines right now. The best method for building a movable type of wind turbine was chosen, hence a vertical wind turbine was chosen. Also, the Savonius and Darrieus wind turbines' wind blades were chosen.

Ravi Anant Kishore et al [3] has improved the work carried out by the author [1], Compared to large-scale wind turbines (LSWTs), small-scale wind turbines (SSWTs) have received far less research interest, particularly for applications requiring low wind speeds. Theoretical and practical results for a SWEPT with a 40 cm diameter and a rated wind speed of 4.0 m/s are presented in this work The rated power output of SWEPT is 1

W. and can produce up to 2.2 W of energy, according to tests conducted in a wind tunnel. at 5.5 m/s of wind speed. SWEPT is one of the most effective wind turbines accessible at small according to research that have been published, scales (rotor diameter: 50 cm) and incredibly low wind speeds (o5 m/s). At its rated wind speed, SWEPT demonstrated a power coefficient of 32% and an overall efficiency of 21%. In our opinion, the findings of this study will immediately assist in the development of power sources for wireless sensor nodes that monitor the structural health of roads, bridges, and conventional home security systems..

Vlastimir Nikolić et al [4] has worked on The use of wind energy has drastically increased in recent years. Due of this, the efficiency of wind turbines should be improved. It is appropriate to examine aspects that are actually pertinent to the converted wind energy in order to create wind turbines with the best qualities and the maximum efficiency. The theory of inventive problem solving (TRIZ) is examined in this study as a systematic strategy for creativity in the field of wind turbine original design. The TRIZ methodology should offer innovative concepts for wind turbine design. The primary objective This essay's objective is to show that a methodical approach to innovation can be a good way to increase the capacity for creating creative goods and to solve the key design issues. The TRIZ approach will be utilised to get rid of any technical inconsistencies in wind turbine systems.

G. Subhashini et al [5] has worked to Create a System for collecting wind energy to move the charge of a 5V electronic gadget from one location to another. This method was created to address the issue of two-wheelers that depended on standard power outlets since it is possible to use natural energy to generate electrical energy. An As part of the power storage unit system, a supercapacitor and an arduino microcontroller were utilised to display the voltage and the proportion of electrical energy stored in the device. According to testing, the geared DC generator can run at a maximum speed of 1297 rpm and create a maximum voltage of 17V at this speed, which is enough to power the complete system because it needs 5.3V to function. Because the system will be mounted on a two-wheeler, it was also converted to an acrylic board, which was designed with user-friendliness in mind. In a nutshell, the system's functionality was successfully achieved based on the set goals and by overcoming a previous research effort's limitation.

Tooraj Nikoubinet al [6] articles about an Ab-initio field research on the use of using portable, obtainable radars to record the coherent wind turbine Doppler signals for structural analysis health monitoring (SHM) applications. The Doppler signatures of a turbine's blades are measured from various angles and distances using a portable, affordable K-band radar sensor. Spectrograms are created, in particular, and studied. The resulting Doppler data can be linked to the blades' kinematic and physical properties, according to preliminary research. This shows that there is a lot of promise for real-time wind-turbine monitoring with these low-cost radar sensors SHM.A cooperative effort is made with a view to increasing the amount of electricity generated by wind power in order to a more diversified energy portfolio and increased energy efficiency. There is an increasing requirement for structural as wind farms grow and demand greater initial capital inputs, The importance of wind turbine health monitoring (SHM) is rising. SHM should in particular alert users to potential mechanical or structural issues,allowing for maintenance or shutdown processes to prevent further damage from occurring. The wind turbine system must be constantly monitored because even slight structural degradation could have catastrophic results. For instance, could you possibly provide some advice on blade breakage or yaw damage? The majority of wind turbines are known to experience mechanical problems most frequently with their bearing systems. In addition, repairing blade damage costs the greatest time and money. If mass imbalances caused by minor faults are not immediately discovered, they may result in significant additional damages to the entire wind-turbine system.

H F Liew et al [7] provides a study on One of the unconventional kinds of energy is wind energy, which is accessible in wealthy areas. Additionally, it is claimed that wind energy is a clean, free source of energy that might eventually replace fossil fuels. A wind turbine generator is capable of producing electricity. A detailed evaluation of the most recent portable wind energy harvesters has been done for this study. Many challenges with the grid for wind energy systems as well as the design of wind turbine components (blades, gearboxes, generators, and transformers),have been explored. Also, experimental analysis focuses on behaviour, particularly affect wind energy features and performance due to extensive prior advanced research effort or using renewable wind energy continues. A different model wind turbine from those used for earlier testing has been examined in this review paper. This study's goal is to use wind energy as efficiently as possible to generate the most amount of electricity possible. As a result, the government can consider installing the right kind of wind turbine configuration. We chose a highway because it is inexpensive and has moving traffic on both sides as our installation location.

Ali M. Rasham et al [8] experimented in the field on Resources for producing renewable energy are a successful replacement for conventional resources. As fossil fuel reserves are gradually depleted, air pollution results, which fuels global warming. Due to its sustainability, affordability, cleanliness, and environmental friendliness, renewable energy systems have become increasingly popular on the global markets. The wind energy systems are among the most significant of the renewable energy systems. Large-scale wind turbines are used in both on- and offshore wind farms. Whereas small-scale wind turbines are used in rural and populous locations for home and industrial purposes, pumping water to farms, charging batteries, lighting up roads and bridges, and other uses. The majority of earlier studies were primarily concerned with huge wind turbines. wind turbines in a testing environment.

Widad Yossri [9] had expressed his perspective on significant developments in creating and enhancing large-scale wind turbines that have occurred over the past few decades, which has produced several really effective and potent designs for the large-scale wind energy sector. accepting such advances without question and supplying them to their small-scale equivalents, however, can backfire and hinder them from achieving their full potential and performing as intended. These various operating circumstances require us to devote considerable time and energy to building effective small-scale wind turbines that can produce enough power even in the presence of low wind speeds. The ultimate goal is to build reliable and efficient power sources that could work together to create a wide range of new opportunities for use with wireless and portable electronics where there is a lack of electricity.

Wei Teng et al [10] worked on Vibration analysis can be used to monitor and diagnose faults in the powertrain of wind turbines. By enabling the Locating mechanical subassembly flaws and building health indicators for predicting remaining useful life reduces the cost of operating and maintaining wind farms. This study introduces a vibration data gathering method and studies the structural characteristics of several drivetrains used in commercial wind turbines. The results of nearly all the research conducted over the last ten years on the wind turbine vibration-based diagnosis approach are reviewed. Many challenging challenges are presented for the viability of wind turbines from the viewpoint of vibration-based drivetrain defect detection and their solutions. The development of health indicators, feature extraction from faults in nonstationary situations, One of them is the defect detection of planetary subassemblies in multistage wind turbine gears, and another is fault information enhancement techniques. A number of naturally damaged cases demonstrating the operational characteristics of industrial wind turbines are also shown are offered while examining the failure process of defective parts in wind turbine drivetrains. Due to its clean and sustainable qualities, wind energy has had a remarkable expansion during the last ten years. Around 650 GW of installed wind energy capacity will be operational globally by the end of 2019. Its capacity is 237 GW in China, with over 100,000 installed wind turbines. Of them, doubly fed wind turbines with gearboxes and direct-drive wind turbines without gearboxes provide the wind energy that accounts for 80% of the power supply contribute 20%.

Md Rabiul Awal et al [11] proposed a an automobile Vehicle-mounted horizontal axis wind turbine systems are known as mounted wind turbines (VMWT). The design and installation of a VMWT to produce power from a vehicle are presented in this work. VMWT includes a number of clever features, such as a high rpm turbine, a reasonable weight, a useful design, and portability. This article also assesses the power generating efficiency of the VMWT. It has been demonstrated that a well designed VMWT can provide about 200 W of power at 80 km/hr. To guarantee that VMWT functions properly in real-world settings, a variety of design factors were taken into account. Since there are numerous written works on the subject, there have been numerous attempts to produce power by vehicle. Nevertheless, none of these ideas ever reach the practical level the execution. Most often, these suggested models are either excessively inefficient or negatively impact the cars' visual appeal. Hence, electricity production from vehicle is still a subject of exploration.

Robert E. Sheldahl et al [12] In a Low-speed wind of 4.6 x 6.1 m tunnel, the proposed 2-M-DIAM Darrieus vertical axis wind The NACA-0012 air foil-equipped turbine underwent extensive testing. 1 ' 2 The knowledge gained from these experiments served as the basis for the development of additional turbines. The positioning of the wind-tunnel model at the Sandia National Laboratories Wind Turbine Site was prompted by concerns regarding the application of wind-tunnel data, gathered under ideal conditions, to turbines operating in the field. To see if field data and data from the wind tunnel agreed, the 2-m turbine was run for a brief period of time. The outcomes of this side-by-side comparison are shown. A 2:1 right-angle gear transmission, a speed-controlled 3.7 kW (5 hp) electric motor/generator, and a precision torque and rotation transducer make up the power and instrumentation train that the rotating tower is connected to. The 2:1 Better compatibility between the wind turbine and the motor/generator load characteristics was made possible by the gearbox. A Morse LTV-5 ac adjustable-speed controller was used to regulate the speed of the motor/generator. Later, the Sandia National Laboratories Wind Turbine Test Site erected the identical 2-m installation. A neighbouring control building3' 4that also has a minicomputer and recording system to convert the raw data to usable form and record the data for later use, houses the controls and equipment for the turbine.

Christopher Jung et al [13] worked on The evaluation The changes in the available wind resources brought on by climate change must be carefully taken into account when planning the future spread of wind energy previous research used regional climate models with coarse spatial resolution to anticipate the Future wind resource behaviour was insufficient for estimating wind energy potential at the scale of wind turbines. Consequently, this work explores the notion that essential elements of Assessments of small-scale wind resources will be impacted by changes in future wind resources brought on by climate change. The geographic complementarity under climate change at the scale of wind turbines, as well as the spatial and temporal availability of wind resources, may all be measured using a novel approach that is given. The following are the results of a survey conducted by the National Institute of Standards and Technology (NIST) on the effectiveness of the standardised testing process. The near-surface wind speed time data were bias-corrected and extrapolated to a wind turbine hub height of 140 m at the locations of the present wind turbines in Germany using the highly-resolved (horizontal resolution: 200 m 200 m) Wind Speed-Wind Shear model. By comparing the quantile distributions from the wind shear and speed models to the regional climate models, bias was removed. Following that, the daily capacity factors were calculated using a modern 3.45 MW wind turbine's power curve. According to the results, under the representative concentration routes 4.5 and 8.5, the availability of the wind resource will only slightly vary over time. It was discovered that the influence of the German wind resource's interannual variability outweighs the effect of climate change. Because it provides the chance to investigate several aspects of wind resource assessment spatially explicit, The newly created method outperforms past climate change-related estimations of wind resource. It enables the creation of more complex strategies for the growth of wind energy. Although the results are solely relevant for the research area, the suggested methodology can be used in any other region of the world.

Scott Bresserset al [14] has studied and states that The small-scale wind energy portable turbine (SWEPT) is a horizontal-axis, modular wind turbine whose design, manufacture, and application are described in this paper. SWEPT's main objectives were portability, cost effectiveness, and effective operation in light winds. Together with the improvements that can increase performance, With SWEPT, We offer fabrication and component design. The prototype described in the literature has been compared. The outcomes demonstrate that the most recent SWEPT version improved output power by 150%. It was discovered that SWEPT can generate 500 mW of electricity at wind speeds more than 10 mph and 160 mW of power at rated wind speeds of 7 mph at a cut-in wind speed of 3.8 mph. The prototype was also tested in the field, and it was discovered that the average output was 40 mW despite the average wind distribution being centred at 3 mph.

Hongye Pan et al [15] has suggested the operational High-speed rail safety has recently drawn significant attention on a global scale. It is increasingly important to maintain and supply electricity to the electronic monitoring equipment positioned adjacent to high-speed railway tunnels. In this study, an S-rotor and H-rotor integrated portable In off-the-grid areas with insufficient electrical supply, a sustainable wind energy harvesting device has been developed to power monitoring sensors close to railroad tunnels. The proposed technology for renewable wind energy collection can capture wind energy within the tunnel and transform it into electricity for use in self-powered applications. The portable wind harvester mechanism, the generator module, and the power storage module are the main elements of the renewable wind energy harvesting system. This system combines wind harvesting S-rotor and H-rotor equipment. While a high-speed train travels through the tunnel, the S-rotor takes ambient wind energy while the H-rotor captures piston wind energy. When they move through the one-way bearing, the S-rotor and H-rotor individually rotate the generator module. Last but not least, the supercapacitors in the power storage module are what provide the electrical energy. To assess the system's effectiveness, experiments were run. According to the test results, the maximum output of electrical power was 107.76 mW, and the maximum efficiency was 23.2%. The outcomes of the studies show how valuable and useful a wind energy harvesting device is as a source of energy for renewable self-powered applications in high-speed railway tunnels.

III. CONCLUSION

In conclusion, portable wind turbines present a viable option for producing green energy in rural or off-grid areas. Portable wind turbines that are extremely efficient, robust, and able to function in low wind speeds and resist adverse weather conditions have emerged as a result of the development of novel design ideas and cutting-edge technologies.

Although while portability and dependability are two of their many potential benefits, there are still some problems that need to be overcome, such as the lack of reasonably priced and reliable energy storage alternatives. Nonetheless, the development of the renewable energy sector and advancements in aerodynamics, control technology, and materials science point to a bright future for portable wind turbines. Further study and development are needed to improve the effectiveness and price of portable wind turbines as well as address the problems with their integration into existing power systems. Also, it's critical to ensure that portable wind turbines are created and used in an environmentally sustainable manner, taking into consideration factors like how they may effect both noise pollution and animals.

Overall, since portable wind turbines have the potential to considerably assist in the transition to a more sustainable and clean energy future, further research and investment in this technology are required.

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