World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(Research Article)

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Investigating the effectiveness of a mobile wind turbine generating electricity from vehicle air movement

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World Journal of Advanced Research and Reviews, 2024, 22(01), 210–218

Publication history: Received on 26 February 2024; revised on 02 April 2024; accepted on 05 April 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.22.1.0992

Abstract

This study presents an evaluation of the effectiveness of a portable wind generator designed to harness wind flow generated by moving vehicles for electricity production. With a growing emphasis on renewable energy sources and the need for sustainable power solutions, innovative approaches such as utilizing vehicle-induced wind currents have gained attention. The portable wind generator under examination is engineered to capture airflow from passing vehicles and convert it into electrical energy. Through a combination of field experiments and theoretical analysis, the performance and efficiency of the device were assessed under various environmental and traffic conditions. Factors such as wind speed, direction, and vehicle velocity were considered in the evaluation process. The results indicate promising potential for the portable wind generator as a supplementary power source, particularly in environments with high vehicular traffic. However, challenges such as variability in wind patterns and optimal positioning of the generator remain areas for further investigation and refinement. Overall, this study contributes to the understanding of utilizing unconventional wind resources and provides insights into the practical implementation of mobile wind energy technology for sustainable electricity generation.

Keywords*:* Renewable energy; Wind Energy; Motor; Voltage.

1. Introduction

As the global demand for clean and sustainable energy solutions continues to rise, researchers and engineers are exploring novel approaches to harness renewable resources. One such innovative concept involves utilizing the airflow generated by moving vehicles to generate electricity through portable wind generators. Traditional wind turbines have predominantly been stationary structures erected in specific locations with favorable wind conditions. However, advancements in technology have led to the development of portable wind generators capable of capturing wind energy in diverse environments, including urban areas with high vehicular traffic.

The concept of harnessing vehicle-induced airflow for electricity production presents an intriguing opportunity to tap into a readily available and often underutilized resource. With the proliferation of automobiles worldwide, the potential for generating electricity from this source is significant. Moreover, portable wind generators offer flexibility and versatility in deployment, enabling energy generation in various settings and applications. This approach aligns with the growing emphasis on distributed energy generation and the decentralization of power infrastructure. In this study, we aim to evaluate the effectiveness of a portable wind generator designed to harness wind flow from moving vehicles for electricity production. Through a combination of field experiments and theoretical analysis, we assess the

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performance, efficiency, and practical feasibility of this technology under different environmental and traffic conditions. By exploring the viability of mobile wind energy solutions, we contribute to the advancement of sustainable energy initiatives and address the challenges of transitioning towards a cleaner and greener future. The technique of using the natural flow of wind to create mechanical power or electricity is known as wind energy or wind power. Wind turbines convert the wind's kinetic energy into mechanical energy, which is then utilized to generate electricity. Although wind power generation has certain negative environmental consequences, such as noise, visual, and climatic effects, these are negligible in comparison to the negative consequences of burning fossil fuels. [3] Wind power generation, ranked second only to solar energy in social acceptance among alternative electrical power production technologies, has garnered increasing interest since the late twentieth and early twenty-first centuries. With a growing emphasis on renewable energy sources, particularly wind energy for electricity generation, researchers have accelerated the development of design criteria for wind energy generation. The significance of energy studies cannot be overstated given our reliance on energy and its societal implications. Wind energy has emerged as a favored option due to its perceived cleanliness, practicality, cost-effectiveness, and environmental acceptability [4]. The primary challenge with wind power generation lies in the typically low wind speeds, with infrequent occurrences of strong winds that are profitable for turbines. Therefore, careful consideration is essential in the installation of wind turbines. The global surge in investments in renewable wind energy sources can be attributed to concerns regarding escalating oil prices and climate change [5]. This study [6] presents a cost-effective method for converting wind energy into electric energy using piezoelectric bimorph actuators on a small scale. The electric energy generator has dimensions of $5.08 \times 11.6 \times 7.7$ cm^3, with a rectangular, box-shaped body constructed from 3.2-mm thick plastic. Under test conditions with a wind speed of 12 mph and a load of 1.7 kilo Ohm, the prototype generated 1.2 mW of electricity. Additionally, wind energy harvesting from moving railways, where significant wind energy is wasted due to vehicle drag, is explored. A converging air duct tunnel with a spiral casing on the roof powers a vertical axis turbine, generating electricity that can be utilized to power an alternator [7]. [8] The adoption of variable-speed wind turbines (VSWT) necessitates active power control (APC) to manage power system operation effectively. The power reference used in APC performance significantly impacts its effectiveness. Traditionally, the optimistic reference, derived from available wind power (AWP) based on maximum power point, faces challenges in maintaining stability throughout the dispatch period due to VSWT instability. Thus, there's a growing need to develop alternative control techniques to enhance APC performance in variable-speed wind turbine systems. Noman et al. (2020) and Hoque et al. (2024) have undertaken a commendable and noteworthy project, showcasing a robust data retrieval approach coupled with an advanced framework for predicting data accuracy. This project stands as a valuable augmentation to the data generation work for electricity generation [18,19,28,24,29]. Biswas et al (2024) describes gently in her 3 different papers industrial sustainability and mechanical characterization works in different industry [20,21,22,23,25].The performance of wind energy conversion systems (WECs) relies on various subsystems such as the aerodynamic wind turbine, mechanical gears, and electrical generator [9]. Conducting a wind survey is crucial to assess the availability of wind resources, which is determined by the region's climatic conditions. The application of wind power is evident in illuminating the Solar Energy Institute building in the north, aligning with green building strategies. Additionally, an energy analysis of a 1.5 kW small wind turbine system (SWTS) in Turkey, featuring a hub height of 12 m above ground level and a rotor diameter of 3 m, will be conducted [10]. [11] Considering wind energy applications, an examination reveals that at an average wind speed of 2 kph, an automobile traveling at 10 kph generates 8 kWh of electricity. Given that a conventional car requires 20 kWh for a full charge, the study suggests that by driving at 10 kph while charging, the vehicle can fully charge and cover 200 kilometers within two hours. Alternatively, if the car travels at 60 km/h, it can achieve a full charge and cover the same distance within 20 minutes.[12] Evaluation of wind data from various locations in Bangladesh indicates a minimum wind velocity of 4 m/sec necessary for viable wind energy system generation. During low wind periods, a diesel generator supplements the wind system, while additional components such as converters and batteries are integrated to store surplus energy. This study [13] compares horizontal axis wind turbines (HAWT) with two designs of vertical axis wind turbines (VAWT), namely the Darrieus turbine and the H-rotor. It suggests that in strong wind conditions, such as on rooftops, VAWTs outperform HAWTs. Additionally, it proposes that the H-rotor should have three blades instead of two. [14] Another study delves into the fundamental aspects of aerodynamic design for modern wind turbine blades, covering topics such as blade plan shape/quantity, aerofoil selection, and optimal attack angles. The determination of twist angles and chord lengths for optimal aerodynamic performance depends on the lift and drag characteristics of the aerofoil. [15] Kamal et al. highlight the significant impact of RFID technology on electricity testing systems.[16] This study presents the key technological challenges associated with integrating wind power into power systems, addressing issues such as the effects of wind power on system stability, running costs, power quality, and imbalances. Research indicates that wind power has minor impacts on system running costs at low wind penetrations (approximately 5% or less) but becomes more significant at higher penetration levels, reaching up to around 20 percent.

Some Researchers have explored the concept of generating clean energy from fast-moving vehicles, such as trains, by designing various wind turbines to harness the wind flow against the vehicle's motion [16]. This research explores the generation of electric power using renewable energy through a small-scale portable wind turbine, targeting individuals traveling for extended periods by motorcycle, bus, or speedboat. The portable wind turbine allows for electricity production, storage in a battery, and charging of mobile or other electrical devices [17]. By focusing on motorbikes as a vehicle medium, this study offers a solution for harnessing wind flow to generate electricity efficiently. The lightweight and portable nature of the wind generator enables easy transportation, reducing dependence on traditional power sources like hydropower or nuclear energy and providing a sustainable energy source while traveling.

2. Methodology

Electricity is produced in the generator by obeying Faraday's electromagnetic induction principle. In both AC and DC generators, the electricity is produced on the same working principle. Faraday's electromagnetic induction principle states that when a current-carrying conductor cuts a uniform magnetic field, an EMF (electromotive force) or voltage is generated in the conductor wire. Electromotive force (EMF) is generated either by rotating a conductor coil within a stationary magnetic field or by rotating the magnetic field around a stationary conductor coil. The resulting voltage or EMF is determined by several factors: the number of turns in the armature coil, the strength of the magnetic field, and the rotational speed of the magnetic field. These parameters collectively dictate the rate at which EMF is induced, playing a crucial role in the efficiency and effectiveness of electromagnetic systems [1]. Understanding and optimizing these variables are essential for designing and operating efficient electrical generators and motors. Ullah et.at (2023) find the best scenario of a schedule production using Johnson's algorithm and this theme is very useful when we have studied the production scheduling for electricity generation from motor vehicle and it helps a lot during productivity improvement [30] at our current research.

This study involves a systematic approach to evaluate the performance of a wind generator in generating alternating current (AC) power under varying vehicle speeds as we have taken our main methodology from this electricity generation paper [27]. Firstly, the wind generator is set up and configured for operation. This step entails positioning the generator in a suitable location to capture wind energy efficiently and ensuring all components are properly connected and functioning. Once the setup is complete, the wind generator is activated, and AC power is generated through its operation. This phase involves monitoring the output of the generator as it converts wind energy into electrical energy. Subsequently, the study focuses on observing the electricity produced by the wind generator in response to changes in the vehicle's speed. Various speeds are tested to assess the impact on electricity generation, allowing for the analysis of how the generator's performance varies with different driving conditions. Through these steps, the study aims to gain insights into the effectiveness of utilizing wind energy for power generation in mobile applications, such as vehicles, and to determine the relationship between vehicle speed and electricity production, thereby informing the development of efficient renewable energy solutions for transportation.

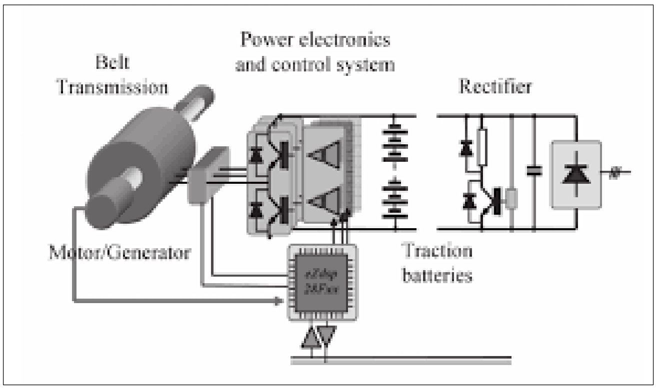

Figure 1 Principle of Electric Generator [2].

2.1. Wind generator Set up

A 50-watt wind generator is assembled by integrating a 50-watt brushless generator motor with a fan mechanism. The setup includes affixing a four-blade fan onto the shaft or rotor of the generator. As wind currents interact with the fan blades, they induce rotation, thereby setting the fan in motion. This rotational movement of the fan, in turn, drives the rotor of the generator. Consequently, the armature coil within the generator rotates within a magnetic field, facilitating the production of electricity. In this configuration, the fan serves as the primary driver, harnessing wind energy to initiate the generator's operation. Consequently, the system qualifies as a wind generator, given its reliance on wind energy to propel the fan and subsequently generate electrical power. This setup exemplifies a simple yet effective means of converting wind energy into usable electrical energy, offering a sustainable solution for small-scale power generation in various applications, from off-grid power sources to renewable energy experiments.

Figure 2 Parts of the wind generator

2.2. AC power Generation through the wind generator

In a wind generator, multiple components collaborate to facilitate the generation of electricity. The "field" component encompasses a magnetic field where the primary magnetic flux is generated. This field can be established by incorporating permanent magnets or by supplying a direct current (DC) voltage to the field winding conductor coil. Acting as the primary driving force, the "prime mover" component serves as the converter and energy transmitter. Its role involves converting various energy sources such as fuel, steam, hydro, wind, or atomic energy into mechanical energy. This mechanical energy is then transmitted to the rotor, initiating its rotation. Through the collective operation of these components, the wind generator harnesses the kinetic energy of wind currents to drive the rotor's rotation within the magnetic field, inducing the generation of electricity. This process exemplifies the intricate interplay of mechanical and electromagnetic principles to produce renewable energy from wind resources.

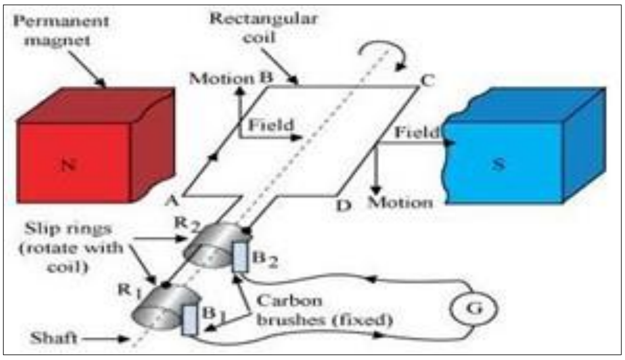

Figure 3 Procedure for electricity generation [18].

The rotor or shaft serves as the rotating element of a generator, facilitating the transmission of mechanical energy from the prime mover to the armature coil, inducing rotation within the magnetic field. The armature, comprising a conductor coil, allows for the induction of electromotive force (EMF) or voltage as it rotates within the magnetic field, adhering to Faraday's electromagnetic principle. Slip rings, hollow rings affixed to the armature coil's end, function to transmit the electric power induced in the armature coil to the fixed brushes. These brushes, acting as stationary conductors, are connected to the rotating slip rings and facilitate the passage of generated output power out of the generator. Together, these components orchestrate the conversion of mechanical energy into electrical energy, enabling the generator to produce electricity efficiently.

2.3. Energy transmission and conversion

To observe the electricity generated against vehicle speed, apparatus includes a portable wind generator, a multimeter set for measuring electricity, a motorbike for varying speeds, and a smartphone for recording data in figure 4. This setup enables real-time monitoring of electricity output under different vehicle velocities.

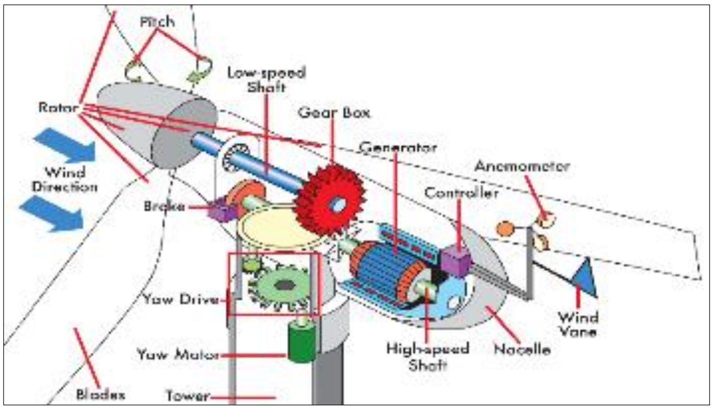

Figure 4 Wind turbine energy conversion

2.4. Working Principles

The experiment commenced with the setup of a multimeter, with its two leads connected to the output neutral and conductor phase of the portable wind generator. Positioned against the wind flow generated in the opposite direction of a motorbike, the generator's fan faced the frontal direction of the bike. Subsequently, the multimeter was configured to measure 200V AC. As the motorbike began to move, the output voltages displayed on the multimeter screen were monitored, and approximate stable readings were recorded for speeds ranging from 20 kph to 60 kph. Following this, the multimeter settings were adjusted to measure 20mA AC, and the average readings for each speed interval were documented. Throughout the observation of electricity generation, data recording was facilitated using a smartphone, capturing audio clips to document the experimental process and results accurately. This systematic approach allowed for the comprehensive analysis of the relationship between vehicle speed and electricity production, providing insights into the performance of the wind generator under varying operational conditions. By meticulously recording and analyzing the generated data, valuable information regarding the efficiency and effectiveness of the wind generator in converting wind energy into electrical power at different speeds was obtained. This experimental methodology, combining precise measurement techniques with modern recording technology, ensured the reliability and accuracy of the findings, thereby contributing to the advancement of research in renewable energy utilization for mobile applications.

3. Result and Discussion

While traveling with the bike, the generator was held against the airflow. Initially, there wasn't a significant voltage as the speed wasn't high enough, but as the bike started to move faster with the increase in speed of the vehicle, a significant voltage was found in the multimeter. For the convenience of our dataset, we've considered observing the voltage in three states (minimum, maximum, and steady state). Although we can consider the steady value of the generated voltages, even if we consider the minimum voltage generation from this process, it is still substantial. From 20 kph to 60 kph, the generated AC voltages are shown in Table 1. From Figure 5, it's obvious that the graph of voltages is gradually increasing, maintaining 20 volts at a speed of 20 kph while producing 105 volts at a speed of 80 kph as the steady value.

Table 1 Generated AC Voltage against Speed

Speed [kph]	Min voltage (V_{min}) [Volt]	Max voltage (Vmax) [Volt]	Steady voltage(v)
15	15	24	20
20	17	31	29
25	20	36	35
30	38	45	44
35	50	60	50
45	53	57	56

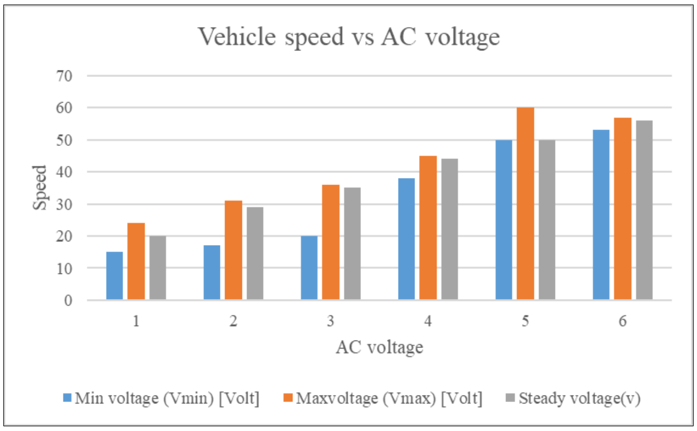

Figure 5 Speed vs AC voltage

Following the observation of generated voltage, the multimeter was adjusted to measure current, set at 20 mA AC to determine the generator's current output. Initially, the current generated was modest, but it increased proportionally with rising speed. Additionally, voltage measurements were conducted under varying conditions—minimum, maximum, and steady state—providing comprehensive insights into the generator's performance. Table 2 presents the recorded currents across the speed range of 20 kph to 60 kph. Figure 6 illustrates a notable increase in electricity production, with a steady current output of 3 mA at 20 kph and 15.5 mA at 80 kph, indicating a significant improvement in power generation at higher speeds.

Table 2 Generated AC Current against Speed

Speed (kph)	Min current (Imin) [mA]	Max current (Imax) [mA]	Steady Current(I) [mA]
15	2.95	3.75	3
20	3.93	4.57	4.2
25	5	5.56	5.35
30	5.7	6.48	6.4
35	6.13	7.2	7
45	7.3	8.51	8.16

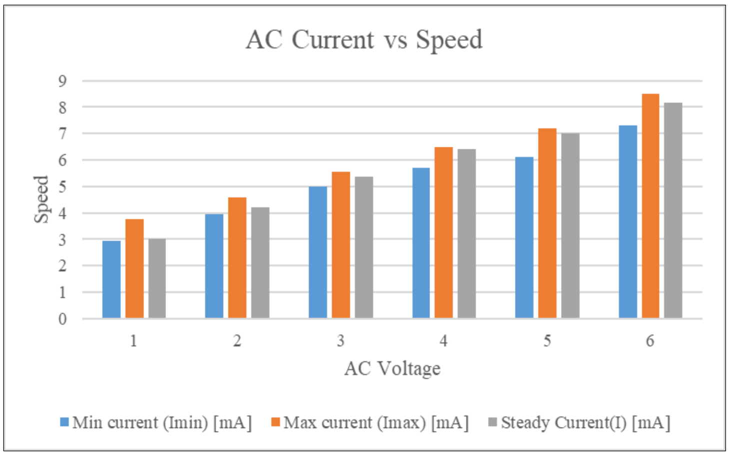

Figure 6 Generated AC current against Speed

3.1. Data Calculation

The generated power (P) is determined by the product of the generated voltage (V) and current (I), expressed as P = VI. By applying this formula, the minimum, maximum, and average powers generated are computed for each vehicle speed. These calculations provide insights into the varying levels of power output corresponding to different speeds. The minimum power represents the lowest achievable power output under specific conditions, while the maximum power indicates the peak potential power generation capability. Additionally, the average power offers a comprehensive overview of the generator's performance across the range of vehicle speeds tested. By utilizing the P = VI equation, this analysis enables a quantitative assessment of the wind generator's efficiency and effectiveness in converting wind energy into electrical power under dynamic operating conditions.

Table 3 Generated AC Power against Speed

Speed [kph]	V_{min} [Volt]	I_{min} [mA]	V_{max} [Volt]	I_{max} [mA]	V_{avg} [Volt]	I_{avg} [mA]	P_{min} [Watt]	P_{max} [Watt]	P_{avg} [Watt]
15	15	3.01	22	3.75	18	4	0.05525	0.08	0.07
20	18	3.85	32	4.57	27	5.2	0.07781	0.2198	0.2341
25	21	4.85	32	5.56	38	4.99	0.12	0.2132	0.2781
30	35	4.99	38	6.48	49	7.01	0.2166	0.1287	0.9827
35	45	6.32	59	7.2	49	7.2	0.4065	0.5110	0.46
45	52	8.1	51	8.51	58	8.32	0.4869	0.4892	0.7643

At speeds of 30kph, 40kph, 50kph, and 60kph, stable alternating current voltages of 20v, 35v, 50v, 70v, and 105v were measured, coupled with steady currents of 3mA, 5.35mA, 7mA, 11mA, and 15.5mA (Fig 7). Hence, the generated steady powers are 0.06w, 0.19w, 0.35w, 0.77w and 1.63w respectively. Maximum AC 113v, 16.43mA hence, 1.86w power was found in the portable generator against the 60kph bike speed Which indicates that a reasonable power is generated in the portable wind generator.

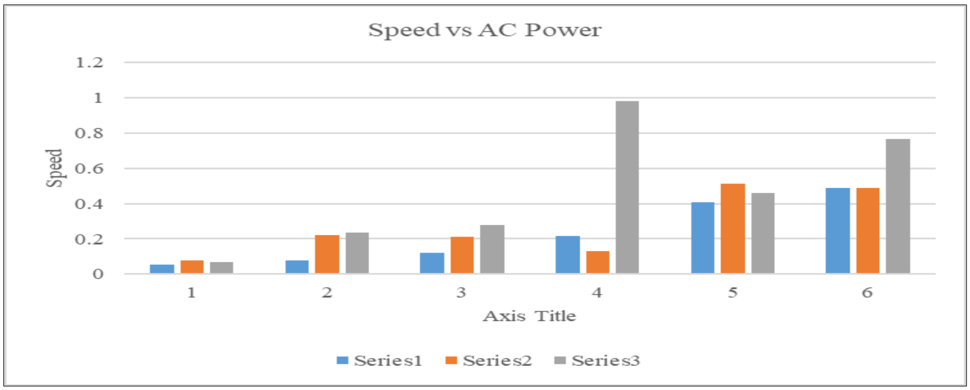

Figure 7 Speed vs Ac Power

Converting this generated AC power into DC can be stored in a power bank using modular and other components. And mobile phones, torchlight batteries, or other small electronic devices can be charged simultaneously or later. Various electronic components used in vehicles can be operated by this power.

4. Conclusion

A portable wind generator offers a readily available solution for generating electricity, providing crucial support to travelers by mitigating the uncertainty of power outages. Its installation on fast-moving vehicles allows for continuous power generation, which can be utilized immediately or stored for later use with power banks. This innovation presents an unlimited power source for travelers, potentially replacing conventional power banks. During storms or loadshedding scenarios, the generator can swiftly produce electricity, reducing reliance on the national grid and minimizing environmental impact. However, existing generators and their fans may not be optimally designed for this specific application, suggesting room for improvement through precise design modifications. Given the need to position the generator against high-speed wind flows, ensuring robust clamping force during installation is imperative. This study aims to enhance our understanding of portable wind generators' potential as renewable energy sources in transportation. By elucidating their effectiveness and addressing design challenges, the research will contribute to the advancement of cleaner and more sustainable energy solutions. Moreover, the findings will guide future developments and promote the widespread adoption of wind energy technologies in mobile applications.

Future recommendation

Investigating alternative designs and materials for the wind turbine blades could optimize energy capture efficiency, ensuring maximum utilization of available airflow. Additionally, implementing advanced aerodynamic principles and computational modeling techniques could refine the turbine's design to minimize drag and maximize power generation potential. Furthermore, exploring innovative methods for integrating the wind turbine seamlessly with different types of vehicles, such as trucks, buses, or bicycles, could broaden the scope of its applicability and effectiveness. Research could also focus on developing sophisticated control systems to dynamically adjust the turbine's orientation and speed in response to varying airflow conditions, thereby maximizing energy extraction efficiency. Moreover, conducting field experiments and real-world deployments across diverse geographic and climatic regions could provide valuable insights into the turbine's performance under varied environmental conditions. Lastly, investigating the feasibility of incorporating energy storage solutions, such as batteries or capacitors, could enable efficient utilization of generated electricity, enhancing the overall effectiveness and practicality of the mobile wind turbine system for sustainable energy generation on the move.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Byjus (2008) “AC Generator” [Online]. Available at: https://byjus.com/physics/ac-generator/. [Accessed on August 2018].

[2] AC Generator – Principle, Construction, Working, Applications," Geeksforgeeks, 02 December 2021. [Online]. Available: https://www.geeksforgeeks.org/ac-generator-principle-construction-working-applications/.

[3] M. H. A. Md Maruf Hossain, "Future research directions for the wind turbine generator system," Renewable and Sustainable Energy Reviews, vol. 49, pp. 481-489, September 2015.

[4] Şahin, A. D. (2004). Progress and recent trends in wind energy. Progress in energy and combustion science, 30(5), 501-543.

[5] Lakatos, L., Hevessy, G., & Kovács, J. J. W. F. (2011). Advantages and disadvantages of solar energy and wind-power utilization. World Futures, 67(6), 395-408.

[6] Chen, C. T., Islam, R. A., & Priya, S. (2006). Electric energy generator. IEEE transactions on ultrasonics, ferroelectrics, and frequency control, 53(3), 656-661.

[7] Srivastava, A., Singh, A., Joshi, G., & Gupta, A. (2015, March). Utilization of wind energy from railways using vertical axis wind turbine. In 2015 International Conference on Energy Economics and Environment (ICEEE) (pp. 1-5). IEEE.

[8] Yin, M., Xu, Y., Shen, C., Liu, J., Dong, Z. Y., & Zou, Y. (2016). Turbine stability-constrained available wind power of variable speed wind turbines for active power control. IEEE Transactions on Power Systems, 32(3), 2487-2488.

[9] Bansal, R. C., Bhatti, T. S., & Kothari, D. P. (2002). On some of the design aspects of wind energy conversion systems. Energy conversion and management, 43(16), 2175-2187.

[10] Ozgener, O. (2006). A small wind turbine system (SWTS) application and its performance analysis. Energy conversion and Management, 47(11-12), 1326-1337.

[11] Hossain, M. F. (2021). Application of wind energy into the transportation sector. International Journal of Precision Engineering and Manufacturing-Green Technology, 8, 1225-1237.

[12] Eriksson, S., Bernhoff, H., & Leijon, M. (2008). Evaluation of different turbine concepts for wind power. renewable and sustainable energy reviews, 12(5), 1419-1434.

[13] Hossain, M. S., Raha, B. K., Paul, D., & Haque, M. E. (2015). Optimization and generation of electrical energy using wind flow in rural area of Bangladesh. Research Journal of Applied Sciences, Engineering and Technology, 10(8), 895-902.

[14] Schubel, P. J., & Crossley, R. J. (2012). Wind turbine blade design review. Wind engineering, 36(4), 365-388.

[15] Kamal, T., Islam, F., & Zaman, M. (2019). Designing a Warehouse with RFID and Firebase Based Android Application. Journal of Industrial Mechanics, 4(1), 11-19.

[16] Prasanth, G., & Sudheshnan, T. (2011, December). A renewable energy approach by fast moving vehicles. In Proceedings of the National Seminar & Exhibition on Non-Destructive Evaluation (pp. 8-10).

[17] Topper learning (2015) "Draw a labeled diagram of an a.c. generator. Explain briefly its principles and working." [Online].

[18] Noman, A. H. M., Das, K., & Andrei, S. (2020). A Modified Approach for Data Retrieval for Identifying Primary Causes of Deaths. ACET Journal of Computer Education and Research, 14(1), 1-13. Available at: https://scholar.google.com/scholar?oi=bibs&hl=en&q=related:WqiaY1iFCtUJ:scholar.google.com/.

[19] Noman, A. H. M. (2018). WHO Data: A Modified Approach for Retrieval (Doctoral dissertation, Lamar University-Beaumont).

[20] Das, S., Biswas, J., Siddique, M. I., (2024). Mechanical characterization of materials using advanced microscopy techniques. World Journal of Advanced Research and Reviews, 2024, 21(03), 274–283. 10.30574/wjarr.2024.21.3.0742.

[21] Biswas, J., (2024). Decoding COVID-19 Conversations with Visualization: Twitter Analytics and Emerging Trends. Journal of Computer Science and Software Testing, Volume- 10, Issue- 1.

[22] Biswas, J., Das, S., Siddique, I. M., & Abedin, M. M. (2024). Sustainable Industrial Practices: Creating an Air Dust Removal and Cooling System for Highly Polluted Areas. European Journal of Advances in Engineering and Technology, 11(3), 1-11. https://doi.org/10.5281/zenodo.10776875.

[23] Hasan, M. I., Tutul, M. T. A., Das, S., & Siddique, I. M. (2024). Adaptive Risk Management and Resilience in Automated Electronics Industry. Journal of Scientific and Engineering Research, 11(2), 82-92.

[24] Joyeshree Biswas, S M Mustaquim, S.M. Saokat Hossain, & Iqtiar Md Siddique. (2024). Instantaneous Classification and Localization of Eye Diseases via Artificial Intelligence. European Journal of Advances in Engineering and Technology, 11(3), 45–53. https://doi.org/10.5281/zenodo.10813807.

[25] Hoque, R., Das, S., Hoque, M., & Haque, E. (2024). Breast Cancer Classification using XGBoost. World Journal of Advanced Research and Reviews, 21(2), 1985-1994.

[26] Bazgir, E., Haque, E., Sharif, N. B., & Ahmed, M. F. (2023). Security aspects in IoT based cloud computing. World Journal of Advanced Research and Reviews, 20(3), 540-551.

[27] Hossain, M. Z., Rahman, S. A., Hasan, M. I., Ullah, M. R., & Siddique, I. M. (2023). Evaluating the effectiveness of a portable wind generator that produces electricity using wind flow from moving vehicles. Journal of Industrial Mechanics, 8(2), 44-53.

[28] Noman, A.H.M., Mustaquim S.M., Molla, S., and Siqqique, M.I., (2024). Enhancing Operations Quality Improvement through Advanced Data Analytics. Journal of Computer Science Engineering and Software Testing. Vol. 10, Issue 1 (January – April, 2024) pp: (1-14). https://doi.org/10.46610/JOCSES.2024.v10i01.001.

[29] Mustaquim, S. M., Noman, A. H. M., Molla, S., Siddique, A. A., & Siddique, A. A. (2024). Enhancing Accident Risk Prediction with Novel Data and Findings from Heterogeneous Sparse Sources. Journal of Data Mining and Management, 9(1), 1-16.

[30] Ullah, M. R., Molla, S., Siddique, I. M., Siddique, A. A., & Abedin, M. M. (2023). Utilization of Johnson's Algorithm for Enhancing Scheduling Efficiency and Identifying the Best Operation Sequence: An Illustrative Scenario. Journal of recent activities in production, 8(3), 11-29.