IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 5, June 2025
Impact Factor: 7.67

Design and Fabrication of Wind Mill for Pumping Water System

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Abstract: *The growing concerns over the depletion of fossil fuels, climate change, and the intensifying greenhouse effect—combined with to increasing global demand for energy and diminishing conventional resources—have highlighted the importance of adopting renewable energy solutions. Among these, wind energy stands out as one of the most practical and accessible options. Today, people are increasingly harnessing natural forces such as sunlight, wind, and flowing water to generate electricity and supply it to various power systems. In rural regions, wells and dugouts are commonly used for water supply, but access to conventional electricity is often limited. Therefore, alternative energy sources are essential for transporting water from its source to areas where it is needed. Renewable energy technologies are especially beneficial in such environments because of their flexibility and sustainability. Wind power, in particular, is abundant and well-suited for generating electricity and operating water pumps in remote locations. Historically, windmills were among the earliest tools used to harness wind energy for pumping water. Building upon this concept, our project focuses on developing a wind-powered electric water pumping system designed specifically for irrigation in off-grid rural areas*

Keywords: water pump, non-conventional, wind energy, electric power

I. INTRODUCTION

Water pumping remains a critical function and a fundamental energy requirement in many rural regions around the globe. Research indicates that a significant portion of the rural population still lacks consistent access to clean and dependable water sources. In agricultural settings, water is often sourced from rivers, wells, or dugouts, but transporting it to where it is needed demands a reliable energy supply. In remote or off-grid areas, wind energy offers a sustainable alternative for water pumping. Utilizing wind power to lift water—historically achieved through windmills, also referred to as wind pumps—represents one of the earliest methods of employing renewable energy for practical use. Unlike fossil fuels, which are limited and environmentally harmful, renewable energy sources like wind offer long-term, environmentally friendly solutions. Windmills, capable of producing both mechanical and electrical energy, are an efficient and cost-effective option for rural energy needs. As awareness grows regarding the environmental consequences of carbon emissions and global warming, the shift toward clean energy sources is accelerating. Technologies harnessing solar, wind, and hydro energy are increasingly being adopted for electricity generation and power supply to various infrastructures. Among these, wind turbines have emerged as a popular means of harvesting environmental energy. Historically, wind power was widely used to operate pumps for drawing water from wells. Though their reliance on wind availability limits their use, modern advancements have improved their effectiveness. Small-scale wind turbines, in particular, can efficiently power household appliances, reduce dependence on fossil fuels, and lower electricity expenses. When installed in optimal locations, these systems can produce sufficient energy for residential lighting and electrical needs. Nevertheless, like all engineered systems, household wind turbines come with limitations, including noise generation, visual impact, and initial investment and maintenance costs.

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DOI: 10.48175/568

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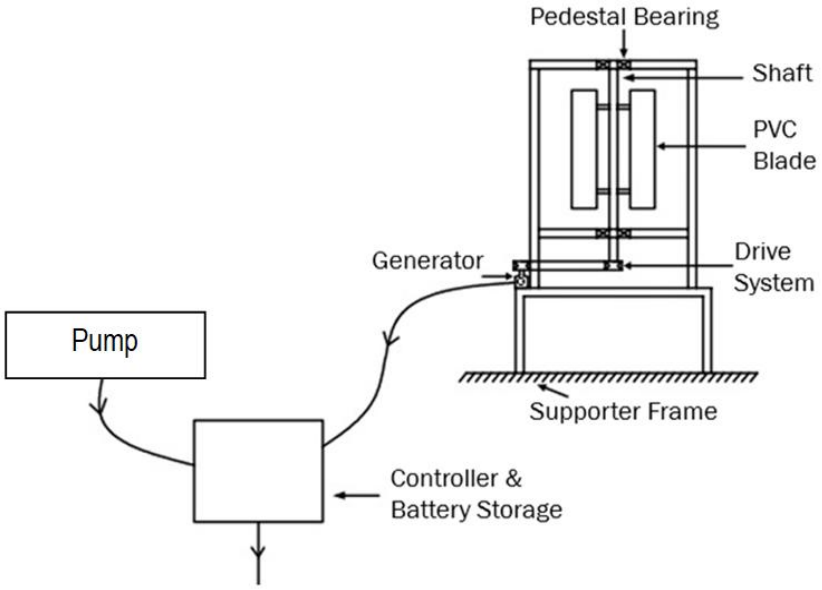

Working design of windmill power electric water pumping system.

II. PROBLEM STATEMENT

Farmers face numerous challenges related to water irrigation in the current agricultural landscape, as outlined below:

1. Insufficient power supply for electric water pumps
2. Increased labour requirements for effective resource management
3. High electricity costs
4. Carbon emissions from diesel generators and traditional pumps
5. Lack of access to power infrastructure in remote regions
6. Safety hazards associated with handling high-voltage irrigation systems

To overcome these challenges, our proposed solution involves developing a cost-effective, wind-powered electric water pumping system. Windmills offer an efficient means of capturing wind energy and converting it into mechanical work for water pumping. A carefully engineered design process ensures the windmill operates with optimal torque and power output.

This project will incorporate a magnetic repulsion mechanism to enhance efficiency. One of the primary limitations of traditional wind turbines is reduced energy generation during periods of low wind speed. To tackle this issue, we are designing a Magnetic Repulsive Vertical Axis Wind Turbine (VAWT), which integrates magnetic repulsion principles to improve performance under variable wind conditions. This approach aims to overcome the inefficiencies of conventional wind systems and provide a more reliable power supply for rural irrigation.

III. OBJECTIVES

1. To evaluate the feasibility and cost-effectiveness of using a standalone power system based on magnetic repulsion-driven wind energy for meeting the energy demands of water pumping.
2. To modify a non-traditional windmill design to ensure consistent and adequate power generation for water pumping under varying operational conditions.
3. To enhance electrical energy utilization by integrating a magnetic repulsion-based generation mechanism in place of conventional methods.
4. To create an affordable, energy-efficient solution for power generation and water pumping, offering a sustainable alternative to traditional systems.

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IV. SYSTEM OVERVIEW

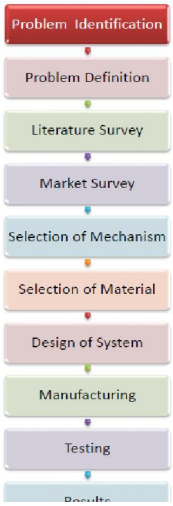
Water is vital for human life and plays a key role in fostering rural development. Traditionally, these regions rely on diesel engines or manual pumps to access water. The research targeted three specific areas—Siyad Berand Wayu, Adami Tulu, and East Enderta—investigating the implementation of a windmill-driven pump system to meet their water needs.

With the global concerns of fossil fuel depletion, the greenhouse effect, and rising energy demands, wind energy stands out as a key solution. For everyday applications, small wind turbines must be reliable, affordable, and require minimal maintenance. While they tend to be more expensive than larger turbines, especially in regions with limited wind resources, their affordability and sustainability make them ideal for certain uses.

Further research on windmill-operated reciprocating water pumps, like that by Mr. Amit Dashmukh, Mr. Pranay Wankar, Mr. Chetan Potdar, and Mr. Shubham Deshmukh, illustrates how wind turbines can power both water pumping systems and generate electricity. This method transforms wind energy into mechanical power that drives a reciprocating pump, which is an affordable solution for rural power shortages.

In the field of alternative energy, the work of Ramanan M., Balasubramanian M., and Ilaiyaraja S. explores magnetic reciprocating systems, which reduce dependence on fossil fuels and offer a cleaner alternative for power generation. This magnetic system, using repelling magnets, eliminates combustion-related pollution, further reducing the environmental impact associated with traditional energy systems.

V. METHODOLOGY



VI. CONCLUSION

In closing, we are pleased with the timely completion ofDesign and Fabrication of Wind Mill for Pumping Water Systemand the valuable hands-on experience gained while meeting the production deadlines of the working project model. We are also satisfied to note that the mechanical aptitude calculation proved to be highly beneficial. With the help of excellent reference materials, we were able to overcome the challenges posed by the design specifications. By using high-quality raw materials, we were able to machine each component to precise tolerances, which minimized balancing issues with the crankshaft. We took great care in the machining, fabrication, and assembly of the project model to ensure its quality.

Given that the model meets the project's requirements, we are satisfied with the results. The device is capable of generating approximately 5 watts of power, which can be stored in a battery to continue powering the water pump. This device efficiently generates electricity using its Magnetic Repulsive technique. The aim is to determine the practicality and cost-effectiveness of using standalone power systems based on magnetic repulsion wind for water pumping. Once a few adjustments are made, this innovative windmill system will continue to provide sufficient power for water pumping

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under all operating conditions. It offers a cost-effective alternative to traditional methods for energy-efficient power generation and water pumping.

VII. ACKNOWLEDGMENT

Design and Fabrication of Wind Mill for Pumping Water Systema project is a vital component of an engineering student's academic journey, serving as a practical extension of theoretical learning. It not only deepens subject-specific knowledge but also enhances technical skills, making the learning process more application-oriented. While textbooks and discussions provide foundational understanding, real-world projects offer a platform to apply and validate that knowledge, fostering both competence and confidence. We express our sincere gratitude to Matoshri College of Engineering and Research Center, Nashik, for offering us this opportunity. We extend heartfelt thanks to our project guide, Prof. Mr. G.D. Katale, for his important support and constructive suggestions during the project. We are also deeply thankful to our Principal, Dr. G.K. Kharate, and the Head of Department, Dr. J.H. Bhangale, for their constant support. Additionally, we acknowledge the faculty and staff of the Mechanical Engineering Department for their assistance. A special note of appreciation goes to our friends for their help and encouragement during various stages of this project.

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