

Dual Power Generation by Solar and Wind Mill Generator

Ravi Kiran Reddy

Department of Electrical and Electronics Engineering
Ballari Institute of Technology and Management, Ballari, Karnataka, India

ABSTRACT

The increasing demand for electrical energy and the depletion of conventional energy resources have created a need for reliable and environmentally friendly renewable-energy systems. This paper presents a hybrid dual power generation system that combines solar photovoltaic (PV) generation with a vertical-axis wind turbine (VAWT) to improve the availability of renewable power. The proposed system uses solar energy as the primary generation source and wind energy as a complementary source when solar availability is low. The generated energy from both sources is conditioned and stored in a 12-V battery. An ATmega328 microcontroller is incorporated for monitoring and control, while an LCD displays the system voltage. The wind subsystem employs a Savonius-type vertical-axis turbine, coupled to a generator through a gear mechanism. The project prototype uses a 12-V, 100-RPM permanent-magnet DC generator and a 12-V, 7.2-Ah lead-acid battery. The developed hybrid vertical-axis wind turbine was reported to operate under satisfactory conditions and demonstrates the feasibility of combining solar and wind resources for applications such as street lighting, emergency backup, remote electrification and other small-scale loads.

Keywords— Hybrid renewable energy, solar energy, wind energy, vertical-axis wind turbine, Savonius turbine, ATmega328, battery storage, dual power generation.

INTRODUCTION

The continuous growth in population, urbanization and electrical demand has increased dependence on conventional energy resources. The project report identifies the depletion of fossil fuels and associated environmental impacts as important reasons for adopting renewable energy technologies. Solar and wind energy are attractive because they can be combined to compensate for the intermittent nature of individual renewable sources. In the proposed hybrid arrangement, the two sources are connected so that one source can support the system when the other is unavailable.

Solar photovoltaic systems convert incident solar radiation directly into electrical energy, whereas wind turbines convert the kinetic energy of moving air into mechanical and subsequently electrical energy. However, solar generation is dependent on sunlight and wind generation depends on wind conditions. The combination of the two sources can therefore improve energy availability compared with reliance on a single source. The project specifically uses a vertical-axis configuration because it can receive wind from different directions without requiring a yaw mechanism.

The proposed system combines a solar panel, vertical-axis wind turbine, generator, rectifier, battery and microcontroller-based monitoring arrangement. The generated energy is stored in a 12-V battery and can subsequently be used for street lighting and domestic-purpose loads. The project therefore focuses on utilizing renewable sources while reducing dependence on conventional electricity generation.

The main contribution of this work is the development of a compact hybrid renewable-energy prototype using solar and Savonius wind generation with battery storage and microcontroller-based voltage monitoring. The developed prototype provides a practical platform for small-scale renewable power generation and demonstrates how complementary renewable resources can be integrated into a single system.

LITERATURE SURVEY

The integration of solar and wind energy has been investigated as an effective approach for improving the reliability of renewable power generation. Alnaimi and Al-Muhsen [8] developed a dual power generation system combining a solar PV module, wind turbine, energy storage system, and microcontroller-based charging control. Their system demonstrated the feasibility of combining the two renewable sources for improved energy availability. Kirubhakaran *et al.* [9] proposed a dual solar-wind generation system for supplying home appliances and highlighted its suitability for rural and remote communities where reliable grid electricity is unavailable. Khare, Nema, and Baredar [10] reviewed the status of solar and wind energy in India and reported that technological improvements and further research are required to improve the performance and reduce the cost of renewable-energy systems.

Research on vertical-axis wind turbines has mainly focused on improving their performance under low and variable wind speeds. Dhote and Bankar [2] investigated the design and fabrication of a Savonius vertical-axis wind turbine, while Jagadish Venkata Sai and Venkateswara Rao [3] studied the design and analysis of vertical-axis Savonius turbines. Brusca *et al.* [5] examined the influence of aspect ratio on vertical-axis wind-turbine performance, and McGowan *et al.* [6] investigated optimization of micro wind turbines for low tip-speed-ratio operation. Studies reported in the project also indicate that Savonius turbines offer simple construction and good starting characteristics at low wind speeds, making them suitable for small-scale hybrid renewable-energy applications.

PROBLEM STATEMENT

The increasing demand for electricity and depletion of conventional energy sources create a need for sustainable power-generation methods. Remote areas may experience unreliable electricity supply and increased transmission losses. Solar and wind sources are intermittent when used independently.

OBJECTIVES

1. To effectively utilize solar and wind energy for renewable power generation and battery charging.
2. To reduce dependence on conventional energy sources by storing the generated renewable energy for applications such as street lighting.

PROPOSED SYSTEM

The proposed system consists of two renewable generation units operating together: a solar PV unit and a vertical-axis wind turbine. The solar panel converts sunlight into DC electrical energy, while the wind turbine converts wind energy into mechanical rotation and then electrical energy through a generator. The outputs are combined through appropriate electrical conditioning and supplied to the battery-storage system. An ATmega328 microcontroller monitors the system and displays the voltage on an LCD.

The vertical-axis turbine is based on the Savonius operating principle. Its curved blades generate rotational motion from the difference in aerodynamic forces acting on the concave and convex surfaces. Since the rotor is vertical, wind from different directions can drive the turbine without requiring a yaw mechanism. The turbine shaft is coupled to a generator through a gear mechanism. The resulting electrical output is rectified before being supplied to the battery.

BLOCK DIAGRAM

The Fig 1 illustrates a hybrid energy generation system that utilizes both vehicle-induced wind energy and solar energy to generate electrical power. The generated energy is processed through charging circuits to store it in a battery, which can then be converted from DC to AC using an inverter for street lighting and domestic applications.

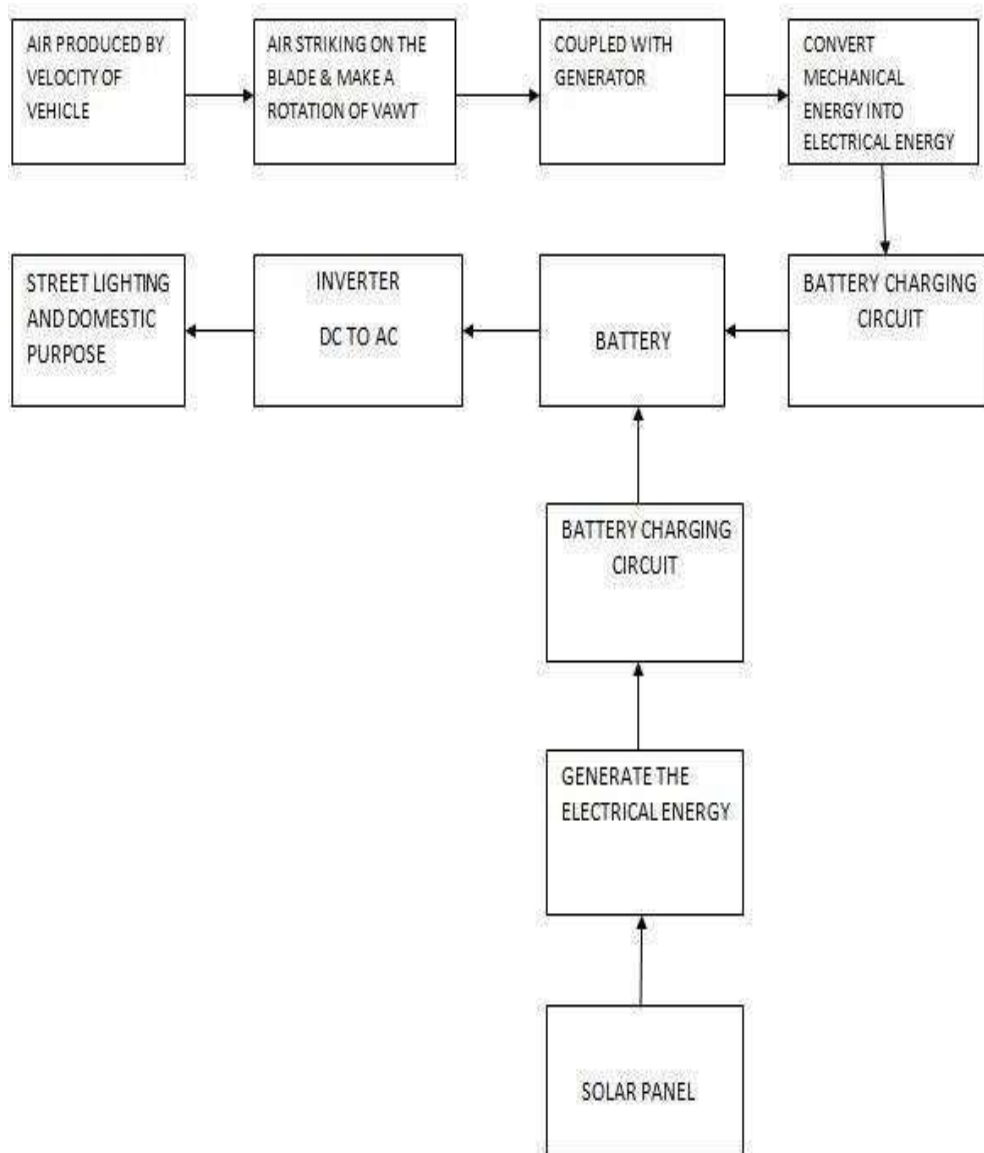


Fig 1 Block Diagram of dual power generation by solar and windmill

METHODOLOGY

The proposed system integrates a solar photovoltaic (PV) panel and a vertical-axis Savonius wind turbine for hybrid power generation. The solar panel converts sunlight directly into DC electrical energy, while the wind turbine converts the kinetic energy of wind into mechanical energy. The turbine consists of curved lightweight blades mounted on a vertical shaft, which is coupled to a generator through a gear mechanism. The generated electrical output from the wind generator is rectified and combined with the solar-generated power for battery charging.

The generated energy from both renewable sources is stored in a 12-V, 7.2-Ah battery for subsequent use. An ATmega328P microcontroller is used to monitor the system and display the voltage on an LCD. The solar panel is positioned at an inclined angle, while the Savonius turbine can operate with wind from different directions without requiring a yaw mechanism. The stored energy can be utilized for applications such as street lighting and other small

electrical loads. The prototype uses a 12-V, 100-RPM permanent-magnet DC generator and was reported to operate under satisfactory conditions.

RESULTS AND DISCUSSION

Fig. 2 illustrates the successfully developed prototype, which was assembled using the required mechanical and electrical components. The hybrid vertical-axis wind turbine was tested and found to operate satisfactorily under the considered conditions. The implementation of the prototype provided practical experience in system planning, component selection, procurement, machining, fabrication, and assembly.

The proposed hybrid configuration offers several advantages for renewable energy generation. The vertical-axis wind turbine does not require a separate yaw-control mechanism and allows the electrical components to be installed close to ground level, simplifying maintenance and installation. In addition, the compact and relatively simple structure enables the system to utilize both solar and wind energy resources for improved energy availability.

However, the developed prototype has certain limitations. The presence of moving mechanical components increases maintenance requirements, and installation and servicing may require skilled personnel. Furthermore, variations in solar irradiation and wind velocity result in intermittent power generation. Future work can therefore focus on advanced energy-management and control strategies, along with optimization of the wind turbine and solar energy subsystems to improve the overall efficiency and reliability of the proposed system.



Fig 2 Hardware Setup

CONCLUSION

A hybrid dual power generation system integrating solar PV and a vertical-axis Savonius wind turbine has been developed and studied. The system combines two renewable resources with battery storage and ATmega328-based monitoring to improve the availability and utilization of generated electrical energy. The wind subsystem converts wind energy into mechanical rotation and then electrical energy, while the solar subsystem directly converts solar radiation into electrical energy. The generated energy is stored in a 12-V battery for subsequent utilization.

The developed hybrid vertical-axis wind turbine was reported to operate under satisfactory conditions. The project demonstrates the practical integration of renewable-energy sources into a compact power-generation system and provides potential applications in street lighting, emergency backup, remote electrification and other small-scale loads. Further development can focus on improving turbine efficiency, optimizing the solar-wind power-management strategy, reducing mechanical losses and implementing more advanced monitoring and control techniques.

REFERENCES

- [1] M. John, R. John, S. P. Syamili, and V. P. Vyshak, "MAGLEV WINDMILL," *International Journal of Research in Engineering and Technology*, vol. 03, no. 05, May 2014.
- [2] A. Dhote and V. Bankar, "Design, Analysis and Fabrication of Savonius Vertical Axis Wind Turbine," *International Research Journal of Engineering and Technology (IRJET)*, vol. 02, no. 03, Jun. 2015.
- [3] S. Jagadish Venkata Sai and T. Venkateswara Rao, "Design and Analysis of Vertical Axis Savonius Wind Turbine," *International Journal of Engineering and Technology (IJET)*, vol. 8, no. 2, Apr.–May 2016.
- [4] M. D'Ambrosio and M. Medaglia, "Vertical Axis Wind Turbines: History, Technology and Applications," Master's Thesis, Energy Engineering, Höskolan Halmstad, May 2010.
- [5] S. Brusca, R. Lanzafame, and M. Messina, "Design of a Vertical-Axis Wind Turbine: How the Aspect Ratio Affects the Turbine's Performance," *International Journal of Energy and Environmental Engineering*, vol. 5, pp. 333–340, 2014.
- [6] R. McGowan, K. Morillas, A. Pendharkar, and M. Pinder, "Optimization of a Vertical Axis Micro Wind Turbine for Low Tip Speed Ratio Operation," *American Institute of Aeronautics and Astronautics*.
- [7] J.-L. Menet and N. Bourabaa, "Increase in the Savonius Rotors Efficiency Via a Parametric Investigation," Université de Valenciennes, France.
- [8] F. B. I. Alnaimi and N. F. O. Al-Muhsen, "Design and Development of Dual Power Generation Solar and Windmill Generator," Apr. 2018.
- [9] T. Kirubhakaran, S. Harish, S. Jagatheesh, S. Senthil Prabhu, and M. Uvapreethi, "Dual Power Generation Using Solar and Wind for the Utilization of Home Appliances," Jan. 2020.
- [10] V. Khare, S. Nema, and P. Baredar, "Status of Solar Wind Renewable Energy in India," *Renewable and Sustainable Energy*, May 2020.