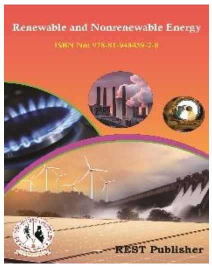
Renewable and Nonrenewable Energy

Vol: 5(1), 2026

REST Publisher; ISBN: 978-81-948459-2-8

Website: https://restpublisher.com/book-series/ese/

DOI: https://doi.org/10.46632/rne/5/1/11



Wind Turbine Stability Improvement Under Low Wind Speed Condition by Using External Battery

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Abstract: *The objective of this project is to drive the load at low wind speed in order to get continuous power supply. Actually, the wind speed is 5-10kmph to generate power. In these specified speeds the wind plant generates the power with different frequencies because the speeds will be changing continuously. The generated power will be converted to variable DC with the help of converter circuit. This variable DC output from converter circuit will be given to fixed DC voltage regulator circuit. This particular voltage regulator gives constant DC supply. But the load requires or operates on particular AC voltage with fixed frequency. So, fixed output voltage of regulator can be converted to fixed AC and frequency with the help of inverter. The discussed procedure will be failed if the wind speed is low. So, another procedure is adapted when this condition happens. When the wind speed is low by comparing the terminal voltage with voltage comparator at the generator and regulator the voltage to be added in series with the terminals so constant limits of supply voltage is applied across the load terminal.*

Keywords: *Generated Power (GP), Voltage comparators (VC), DC voltage regulator, low voltage ride-through capabilities (LVDC).*

1. INTRODUCTION

In recent years, wind energy has become one of the most important and promising sources of renewable energy, which demands additional transmission capacity and better means of maintaining system reliability. The evolution of technology related to wind turbines that present many advantages compared to the fixed speed wind turbines. These wind energy conversion systems are connected to the grid through Voltage Source Converters (VSC) to make variable speed operation possible (1). Renewable energy sources like wind turbine, solar and geothermal all are work their respective conditions only. If absent the source of each individual it will fails to generate electrical power to loads. Around the world, the renewable energies such as wind energy have been considered to be the fastest growing source of energy generation due to the economical ways of harnessing (1). The increased penetration of wind power (WP) in weak distribution networks is challenged by capacity constraints imposed by power quality dictated criteria. More specifically, a major concern in distribution networks is voltage quality that experiences deterioration after WP connection due to the fluctuating nature of the generated active power. From a voltage quality perspective, WP fluctuations occur in two frequency ranges: 1) low-frequency range prompting changes in the steady-state voltage level; and 2) high-frequency range resulting in a flicker contribution (2). The wind in this paper deals with power continuity when low wind speed conditions. Actually, power generated by the wind turbine is under specified conditions only, that iswind speed is required 5-10 kmph. Wind results from air in motion arise from a pressure gradient. On a global basis one primary forcing function causing surface winds from poles toward the equator is convective circulation. Solar radiation heats the air near the equator, and this low-density heated air is buoyed up. At the surface it is displaced by cooler denser higher-pressure air flowing from the poles. Local winds are caused by two mechanisms. The first is differential heating of land and water. The second mechanism of local winds is caused by hills and mountain sides. Conversion of the kinetic energy of the wind into mechanical energy that can be utilised to perform useful work, or to generate electricity. Wind turbines produce rotational motion; wind energy is readily converted into electrical energy by connecting the turbines to an electrical generator. The combination of wind turbine and generator is sometimes referred to as aero generator. A step-up transmission is usually required to match the relatively slow speed of the wind rotor to the higher speed of an electric generator. The generated power will be converted to variable DC with the help of converter circuit. This variable DC output from converter circuit will be given to fixed DC voltage regulator circuit. This particular voltage regulator gives constant DC supply. But the load requires or operates on particular AC voltage with fixed frequency. So, fixed output voltage of regulator can be converted to fixed AC and frequency with the help of inverter. The discussed procedure will be failed if the wind speed is low. At this condition terminal voltage of generator do not supply the required voltage to load. So we adapt the advanced system to supply continuous voltage to the load. comparator circuit compares the normal voltage of load terminals (constant voltage supplied to load) to variable voltage of generator terminal voltage.

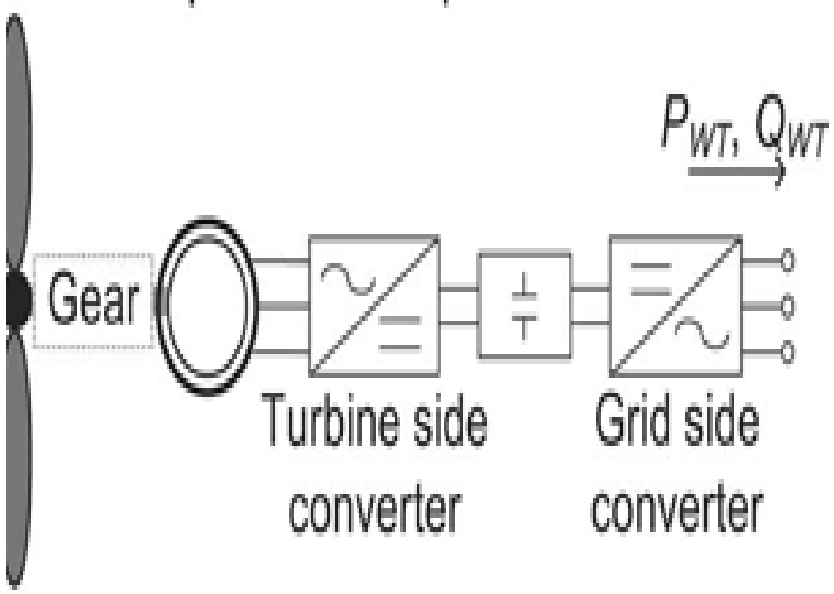

FIGURE 1. Basic wind conversion system

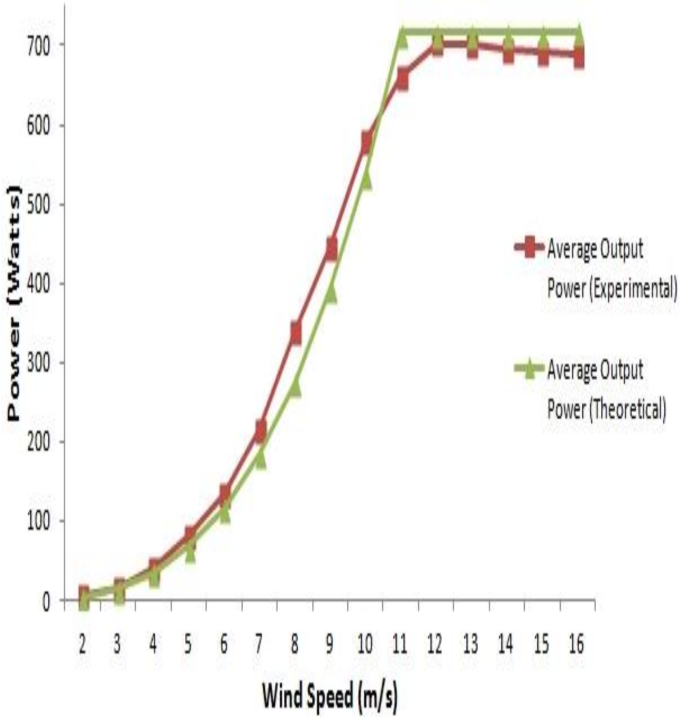

FIGURE 2. Graph between power and wind speed

Specially designed for low wind speed regime and for the first time attempted and installed a grid tied rooftop micro wind turbine. Further improvement is needed to reach to a level to work on concrete proof. We need to test our suggested method's usefulness to the society as well as to the industry. In this respect, more exhaustive experiments could be devised with data logging facilities. The wind braking and motor system will be upgraded and automated in near future for better results (4). A control system could also be attached which disconnects the generator to grid when the grid supply is off. During the monsoon season, when the wind velocity is fair enough, our method can be a real asset at least for rooftop wind turbines. The only limitation being it will be commercially beneficial only when the wind speed ranges from 3 to 6 m/s.

FIGURE 3. 0.7 kW SNT-1 rooftop wind turbine installed at GERMI rooftop

2. LITERATURE SURVEY

The stability can be achieved by output power control of the turbine. Major part of many countries like India, the annual mean wind speed is not high. The rated wind speed of turbine remains around 11 m/s and cut in is around 3.5 m/s. Due to this problem we aimed to develop a sustainable wind energy system that can provide stable power supply even at the locations of low wind speed of 2 - 4 m/s. To address this issue, a momentary impulse or external torque to the rotor by external motor is one of the good options to maintain the momentum of blades and thus provide stability for sufficient time. Various theoretical calculations and experiments are conducted on the above method. This would increase the output power and also the efficiency of wind turbine (4). Various wind turbine systems with different generators and power electronic converters are described, and different technical features are compared. The electrical topologies of wind farms with different wind turbines are summarized and the possible uses of power electronic converters with wind farms are shown. Finally, the possible methods of using the power electronic technology for improving wind turbine performance in power systems to meet the main grid connection requirements are discussed. (5). The wind energy stands out to be one of the most promising new sources of electrical power in the near term. The latest technological advancements in wind energy conversion and an increased support from governmental and private institutions haveled to increased wind power generation in recent years. Wind power is the fastest growing renewable source of electrical energy hence it has become necessary to address problems associated with maintaining a stable electric power system. Unlike conventional sources, wind does not provide reactive power, which is necessary to maintain acceptable voltage conditions on the network. The use of Flexible AC Transmission Systems (FACTS) in distribution network to compensate for vagaries such as production related to wind energies and to control the voltage is an optimal solution. (6). Most of the renewable energy generation systems, such as wind power generation system do not have constant power generation pattern due to their dependence on climate conditions. Therefore, it becomes impractical to install them as an isolated system without an optional power generation unit or battery backup for getting consistent output power. In remote areas, the grid electrification may not always be feasible. Above factors have led to conceptualization of isolated wind power generation system (IWPGS) working under varying wind and load conditions. However, the harmonics generated due to the power electronic interface, non-linear loads connected to the system and reactive power consumption by all such loads, leads to power quality deterioration (7). Keeping the generators operating during transient grid faults becomes an obligation for the bulk wind generation units connected to the transmission network and it is highly desired for distribution wind generators. Regulatory standards for grid interconnection require wind generators to ride through disturbances such as faults and support the grid during such events (8).

3. PROPOSED SYSTEM

The block diagram used for the proposed system is show in the fig. Variable voltage obtained from the wind turbine and this voltage is given to the rectifier circuit which gives variable DC voltage. A voltage regulator is device which gives constant DC voltage with variable DC supply. This DC supply will give to the constant voltage regulator to maintain constant voltage, but low wind speed conditions the converter cannot perform their operation because there is sufficient wind in the atmosphere. The constant voltage regulator all so stop the working so we need to another source to drive the circuit. We are using external battery to drive the proposed system. This battery voltage is aiding the terminal voltage of wind turbine then the voltage regulator circuit stats the working. The proposed circuit shown in the fig (5).

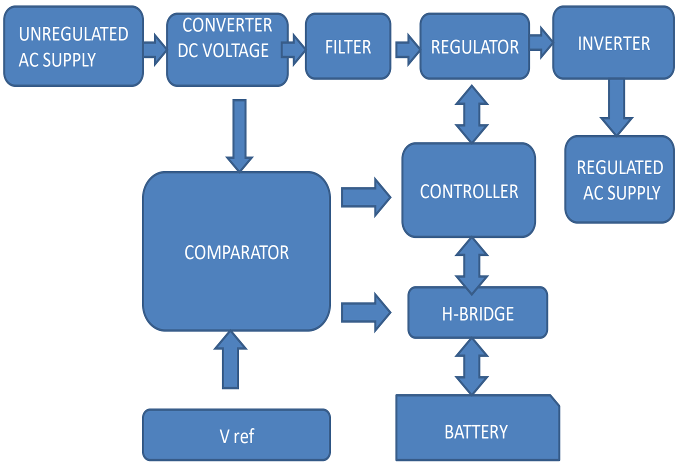

FIGURE 4. Block diagram of proposed system

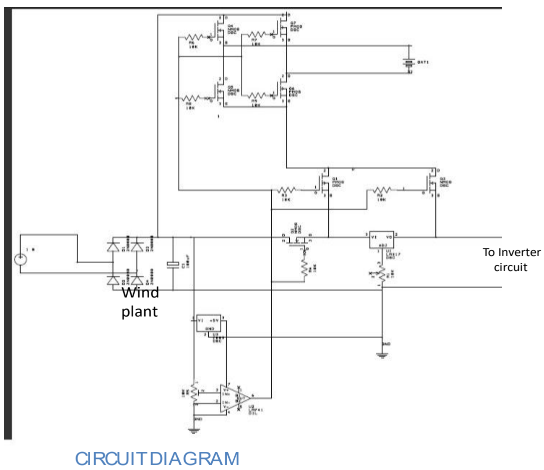

FIGURE 5. Circuit diagram for proposed system

4. WORKING PRINCIPLE

The power generated from the wind turbine is variable due different atmosphere conditions. So we need to stabilize the power by adapting a new technology. That is a variable AC voltage can be converted in to variable DC voltage by rectifier circuit. This variable DC voltage is given to the constant voltage regulator to get constant voltage. The comparator circuit compares the voltage of terminal and reference voltage set in comparator. The terminal voltage is greater than the reference voltage the comparator gives positive signals to transistor arrangement; at same time excess amount of voltage can be stored in external battery. If the terminal voltage is less, thanit send negative signals to transistor arrangement. Automatically battery can be discharged in series with the terminal voltage of the generator.

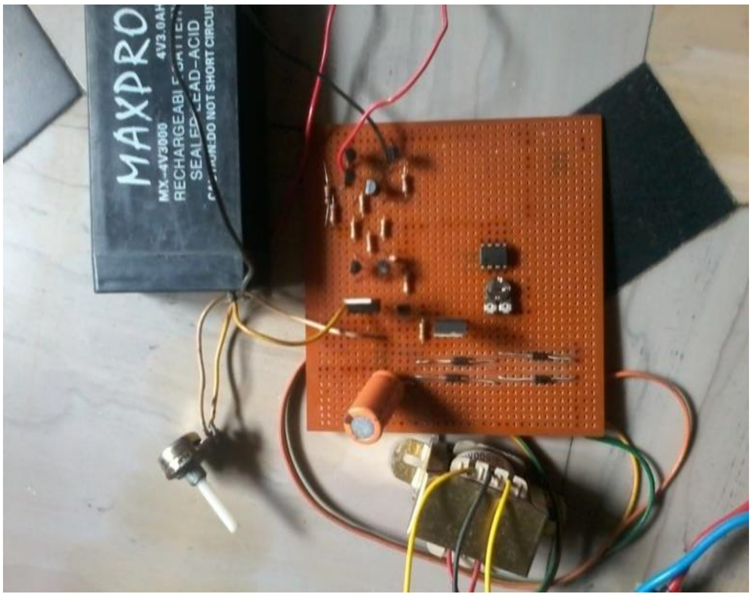

FIGURE 6. Experimental setup of adapted system

5. RESULTS

It is implemented and validated the proposed design of circuit. The summary of the results are given below table (1).

TABLE 1. Summary Of Results

S No	Output voltage of Rectifier (Vo)	Comparator compares Vo and Vref and send	Battery status	Total output voltage given to inverter
1	12.4 V	POSITIVE	CHARGE	9 V
2	11.2 V	POSITIVE	CHARGE	9 V
3	10.0 V	POSITIVE	CHARGE	9 V
4	9 V	POSITIVE	CHARGE	9 V

If the output voltage of rectifier is less than the reference voltage set in the comparator circuit then results are given below table (2).

TABLE 2. Summary of results

S No	Output voltage of Rectifier (Vo)	Comparator compares Vo and Vref and send	Battery status	Total output voltage given to inverter
1	8.2 V	NEGATIVE	DISCHARGE	9 V
2	7 V	NEGATIVE	DISCHARGE	9 V
3	6 V	NEGATIVE	DISCHARGE	9 V
4	5 V	NEGATIVE	DISCHARGE	9 V

In this case the proposed design of the circuit acts as a stabilized voltage regulator. Since the system voltage at the end of process is constant even at starting point less than the reference voltage.

6. CONCLUSION

From the results it is seen that proposed design, stabilized the output voltage even though the speed of wind turbine is less than the prescribed speed. So, these types of systems will increase total working time of turbine and utilize the maximum recourses which are available in the nature. So, this system stability improves at low wind speed condition. The draw backs of the circuit are H bridge inverter are relatively high cost(switches) and relatively high switching losses in one of the four switches.

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