International Journal of Engineering Applied Science and Management
ISSN (Online): 2582-6948
Vol. 3 Issue 10, October 2022

A Review on Grid-Connected Wind-Photovoltaic Cogeneration Using Back-to-Back Voltage Source Converters

Tarun Kumar Rao[1], Dr. Sameena Elyas Mubeen[2]
M.Tech. Scholar, Department of Electrical &Electronics Engg. REC Bhopal (India)[1]
Professor, Department of Electrical &Electronics Engg. REC Bhopal (India)[2]

Abstract: *Increasingly, India is turning to renewable energy to replace grid power, expand access to electricity, cut down on fossil fuel use, and pave the way for a low-carbon economic future. Concerns are growing, which means that renewable energy sources have room to improve. This paper reviews both the vitality of the wind and the photovoltaic (PV) energy conversion strategies. In order to maximize the benefits of the available renewable resources, the combination of the wind and solar energy in the same vicinity has been considered and several literatures have been studied here regarding the same.*

Keywords: *Wind turbine, solar photovoltaic array, voltage-source converter, renewable energy.*

1. Introduction

Over the past decade, rapid growth of photovoltaic (PV) technologies and wind energy systems has been experienced over the world. The PV and wind energy are considered as the most promising and major renewable energy source due to providing a clean energy at various power levels and in various sites including domestic, due to a vast and unfailing energy, and constantly replenished energy supply. [1] They offers significant improvement to the energy security, national income, public health, and protecting the environment. Solar power and wind energy has become the worlds most attractive and in some cases the cheapest form of new electricity generations.[2]

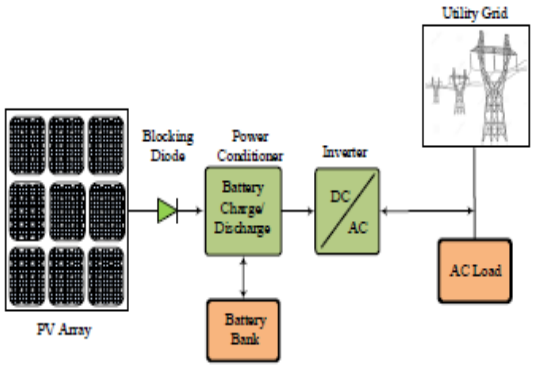

Fig. 1: Block diagram of basic Photovoltaic system

1.1 Wind energy

For hundreds of years, people have used windmills to harness the wind's energy. Today's wind turbines, which operate differently from windmills, are a much more efficient technology. In past windmills have been used for pumping water or grinding grain. Today, the windmill's modern equivalent - a wind turbine - can use the wind's energy to generate electricity. Human resort to rely on wind turbines to extract energy from wind, electric power generation ones, as wind power is used to produce mechanical energy in so-called windmills. In fact, wind is considered to be a sort of solar energy, and around 2% of the sunlight that hits the Earth's surface is converted into kinetic energy by the wind. Electrical energy may be generated from this enormous quantity of stored potential kinetic energy. In order to harvest as much energy as possible, wind turbines, which resemble windmills, are erected atop a tower. Above earth, at a height of 100 feet (30 metres), they may take use of the more rapid and less turbulent wind to their benefit. [3][4]

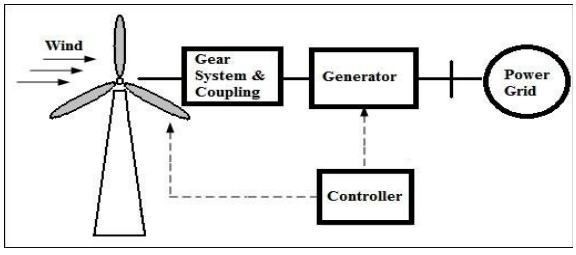

Fig. 2: Basic of wind power system

2. Literature Review

(Ramakrishna et al., 2021) [1] Voltage sags and variations are common when using various renewable energy sources linked to the grid at the same time. Different FACTs devices attached to the PCC improve the voltage profile and alleviate these issues. Better results are achieved using the "STATCOM module", which is incorporated into the controller's grid and FIS structure. Renewable energy resources linked at PCC in parallel to the main grid and STATCOM are included in the analysis's distribution grid, which includes a PVA module and a PMSG wind farm.

(Puchalapalli et al., 2020) [2] As an alternative to using a diesel generator to satisfy the location's electrical needs, this article proposes a green energy option for a microgrid. This microgrid is fueled by wind energy utilising a "doubly fed induction generator (DFIG)" and solar photovoltaic. On the rotor side of the DFIG, a DC bus connects the solar PV array to the common DC bus of the "back-to-back voltage source converters (VSCs)". In addition, the DFIG's extra stator power is routed via a bidirectional buck/boost DC-DC converter coupled to a "battery energy storage (BES)" on the same DC line.

(Porté-Agel et al., 2020) [3] When it comes to reducing climate change and attaining long-term energy security, wind power is likely to develop significantly over the next several decades. It is difficult to forecast wind farm performance because of the complicated two-way interactions between wind farms and the turbulent atmospheric boundary layer on a multiscale, which makes optimizing wind farm design and operation difficult. The high Reynolds numbers of the ABL flow, its intrinsic unsteadiness owing to the "diurnal cycle and synoptic-forcing variability", the pervasive presence of thermal impacts, and the complexity of the terrain complicate these interactions from a "fluid mechanical standpoint".

(Oussama et al., 2019) [4] "PMSG (permanent magnet synchronous generator)-based DC microgrid and wind turbine generator" are discussed in this study. To feed a DC demand under 400 VDC, the system includes "an AC/DC converter and DC/DC converter type boost converter coupled to a DC-microgrid based WECS (wind energy conversion system)". The MPPT approach has been used to increase the efficiency of the wind turbine model for the production of 10 KW. MATLAB environment has been used to model and simulate WECS, and the results have been achieved.

(N. K. Singh & Kumar, 2019) [5] When compared to other renewable energy sources like solar, geothermal, and so on, wind's application landscape is expanding more faster in the twenty-first century. The non-conventional fuels such as oil and chemical become the first two main energy resources to be replaced by this new energy source. Renewable wind energy is the best-ever-developing and most promising form of electricity. The wind is a renewable energy source that is both clean and cost-free. "Power quality and harmonic distortion" management are becoming more important for "wind energy generation systems (WECS)".

(Ansari, 2019) [6] There is an abundance of renewable energy, and the underlying technologies are constantly developing. With renewable energy, the possibilities are almost limitless. We've come to grips with the fact that our fossil and atomic fuels are finite, and that using them leads to pollution of the environment. Energy that may be generated from renewable sources, such as the sun, offers the potential for an endless and environmentally friendly energy supply. "Coal and mineral oil-based power plants", which produce a significant amount of greenhouse gas emissions, account for the majority of India's electricity output. Thus, the emphasis is on prudent use of plentiful renewable energy supplies to solve the energy dilemma.

(Tekale et al., 2018) [7] A For fulfilling growing energy needs and dwindling fossil fuels, renewable energy sources are considered the next generation of energy. Renewable energy sources that may generate large amounts of electricity include solar, biomass, geothermal, hydroelectric, and wind. A vertical axis turbine (VAT) or horizontal axis turbine (HAT) may be used to capture energy from wind current. Depending of the flow direction, a vertical axis turbine may harvest energy from the wind. The sun's energy is absorbed by the solar PV cells, which turn it into usable electricity. Both day and night can be used to collect energy from a wind mill, but solar PV cells can only be used during daylight hours. Future elements will benefit from the hybrid system's inclusion. "Hybrid power production using solar cells/solar energy and wind mill energy utilising solar tracking and vertical axis wind turbines" is the goal of this work.

(Ma Lu, 2018) [8] As the use of renewable energy sources and sustainable technology becomes more popular as a means of reducing society's reliance on fossil fuels, finding ways to capture and convert these clean energies into electricity at their peak efficiency is critical. However, the method used to connect the renewable energy sources to the main grid is as important. A microgrid based on multiple parts is being designed, modelled, controlled, and simulated step by step in the current project, with a particular emphasis on the "Photovoltaic (PV) System and the Voltage Source Converters (VSC)".

3. Conclusion

There will be a significant portion of the electric generating mix covered by grid-connected wind-PV co-generation systems, since both the number of installations and the rated power of each plant are on the rise. Several literature studies are used to provide a comprehensive view of wind PV co-generation systems that are linked to the grid in this article. As power electronics have evolved,

so have the strategies adopted to reduce harmonic distortion and provide reliable power with high quality standards. Control systems may be broken down into two broad categories: traditional and cutting-edge. Performance requirements dictate which technique is used.

References

[1] J. Ramakrishna, K. Rakesh, and T. A. Kumar, "IMPROVEMENT OF VOLTAGE PROFILE IN HYBRID PV- WIND SYSTEM USING STATCOM," vol. 9, no. 3, pp. 348–353, 2021.

[2] S. Puchalapalli, S. K. Tiwari, B. Singh, and P. K. Goel, "A Microgrid Based on Wind-Driven DFIG, DG, and Solar PV Array for Optimal Fuel Consumption," IEEE Trans. Ind. Appl., vol. 56, no. 5, pp. 4689–4699, 2020, doi: 10.1109/TIA.2020.2999563.

[3] F. Porté-Agel, M. Bastankhah, and S. Shamsoddin, Wind-Turbine and Wind-Farm Flows: A Review, vol. 174, no. 1. Springer Netherlands, 2020.

[4] H. Oussama, A. Othmane, C. Abdeselem, and H. M. Amine, "Wind turbine generator based on PMSG connected to DC microgrid system," vol. 7, pp. 40–43, 2019.

[5] N. K. Singh and D. Kumar, "A Review on Wind Turbine and Wind Generator Used in WECS," Int. J. Sci. Res. Sci. Eng. Technol., no. July, pp. 01–04, 2019, doi: 10.32628/ijsrset19635.

[6] S. Ansari, "Assessment of Renewable Energy Sources of Iran," vol. 6, no. 12, pp. 206–211, 2019.

[7] A. Tekale, V. Ware, and V. Devkar, "Hybrid Power Generation by Solar & Vertical Axis Wind Turbine: A Review," Ijireeice, vol. 6, no. 10, pp. 15–19, 2018, doi: 10.17148/ijireeice.2018.6103.

[8] S. Ma Lu, "Modelling, Control and Simulation of a Microgrid based on PV System, Battery System and VSC," Attrib. 3.0 Spain, no. January, p. 81, 2018, [Online]. Available: Google Scholar.

[9] A. Muhtadi and A. M. Saleque, "Modeling and simulation of a microgrid consisting solar PV & DFIG based wind energy conversion system for St. Martin's island," 2017 IEEE 3rd Int. Conf. Eng. Technol. Soc. Sci. ICETSS 2017, vol. 2018-Janua, no. March 2018, pp. 1–6, 2018, doi: 10.1109/ICETSS.2017.8324152.

[10] A. Muhtadi, "Solar PV & DFIG based Wind Energy Conversion System for St . Martin ' s Island," 2017 IEEE 3rd Int. Conf. Eng. Technol. Soc. Sci., 2017, [Online]. Available:https://ieeexplore.ieee.org/document/8324152.

[11] P. S. Sujay, W. M. M, and S. N. N, "A Review on Floating Solar Photovoltaic Power Plants," Int. J. Sci. Eng. Res., vol. 8, no. 6, pp. 789–794, 2017, [Online]. Available: http://www.ijser.org.

[12] P. S. U. Kulkarni and T. Gupta, "A Review on PMSG Based Wind Energy Conversion System," vol. 2, no. 1, pp. 271–275, 2017.

[13] K. M. Abo-Al-Ez and R. Tzoneva, "Active power control (APC) of PMSG wind farm using emulated inertia and droop control," Proc. Conf. Ind. Commer. Use Energy, ICUE, vol. 2016-Octob, no. August 2016, pp. 140–147, 2016.

[14] T. Khatib, I. A. Ibrahim, and A. Mohamed, "A review on sizing methodologies of photovoltaic array and storage battery in a standalone photovoltaic system," Energy Convers. Manag., vol. 120, pp. 430–448, 2016, doi: 10.1016/j.enconman.2016.05.011.