

Performance Analysis and Control of Autonomous Wind System with Afpsg Feeding

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ABSTRACT

The generate mechanical power or electricity is known as wind power or wind energy, Wind turbines convert the wind's kinetic energy into a mechanical energy-based combination of two or more energy sources that generate efficient energy power. In the existing method autonomous wind-solar hybrid energy system feeding 3-phase 4-wire loads, and it Contains some drawbacks output, not efficiency, high maintenance, Power quality is low, overcome the drawbacks wind system with AFPM feeding to improve power quality.Axial-Flux Permanent Magnet Generator for small wind turbine power generation systems with brushless motors synchronous machine. Because the generator's mechanical frequency changes, the rotor switching frequency must start changing to maintain the stator switching frequency constant. In a wind generator with variable speeds, low balanced dynamical stack, and varying wind accelerations, rotor excitation is permitted for a wind turbine's stator to supply a load or feed the grid. A boost converter is used to increase the DC voltage of the battery before it is given to the single-phase DC-DC Chopper, and the MPPT (Maximum Power Point Tracking) technique is used to maximize the energy output.When the switch is open, no current flows through it, converting the unregulated DC input to a controlled DC output with the desired voltage level, there is no voltage drop across the switch when it is closed in the DC-DC Chopper. The proposed system is simulated using MATLAB Simulink, the output result is improved and getting better efficiency when compared to the proposed method.

Keywords: *Axial Flux Permanent Magnet Generator (AFPSG), AC-DC Converter, Battery, Chopper, Single Phase DC-AC Inverter, Solar.*

INTRODUCTION

Power Quality

At peak and minimal supply, modules must be properly controlled to avoid voltage drops and surges, respectively. One of the most important advantages of DGs, aside from the implantation of power factors and the supply of connected load, is the injection of reactive power at the Common Coupling Point (CCP). Wind turbine generation is one of the most common sources used in micro grids for this intention. Recent wind turbine systems were less

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prominent and efficient than electronically controlled constant power wind turbines.

The advancement of technology in the management and protection of renewable energy technologies, as well as the growing demand for maintaining high sources, has shifted the focus to this type of energy source. Apart from ensuring optimal operation under normal conditions, checking a power system under fault conditions is one of the most difficult concerns. Energy quality is one of the most important considerations when using distributed generation. In moreover to sampling rate and power factor, power output and reactive power should be limited and controlled at predetermined intervals [1].

Grid Voltage Condition

The winding current control strategy method, which can be used with either armature current or phase currents direction, is typically used to regulate the frequency and voltage of the commutator. Supplementary lead-lag compensators or dual rotor current control have been proposed to enhance the productivity of the Axial Flux Permanent Magnet Generator (AFPSG) under grid voltage unbalance shown in Figure 1. According to the new grid codes, wind turbines must tolerate the most likely unbalanced faults as well as asymmetric Single-phase electromagnetic interference close the transmission line point of connection. Controlling the reactive power of a Distributed generation can improve the attributes of the power supply in various network switching states, particularly in the event of defects.

According to a stability, the AFPSG has multiple sloppily decelerated poles near the constant frequency due to stator transients, and the framework is unsteady within a certain operating condition. In this case, an input active compensation is suggested. Wind energy insertion into electric grids, on the other side, has the potential to reshape grid stability and regarding power system operation. The need for accelerated rotor current control was negligible in both cases because the control systems resolved with slow evolution or small external disturbances [2].

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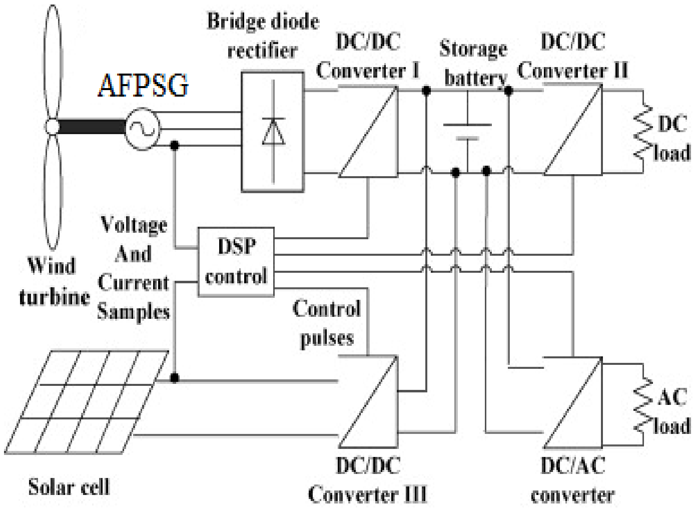

Figure 1 Architecture of DFIG based micro-grid.

LITERATURE REVIEW

In this framework, the Monte Carlo simulation method is used to model load and wind energy factual errors as well as irregular perturbations as scenarios these uncertainties must be taken into account when computing the voltage regulation regulators. For a double fed induction generator with independent variables, this method introduces a reliable PI controller with stability analysis based on the scientific theory. The Frequency response diagram is suitable for analyzing the system's stability with the objective of verifying the PI controller's reliability. Wind power framework, double fed induction machine are key terms. The Distributed Generator (DG) and BESS facilities, while the energy dissipation in the system is represented by the second optimization method. Wind and solar DGs with uncertain output powers are also regarded with the BESSs.

The batteries have lower losses and costs, a better voltage profile, and a longer lifespan, according to the findings. Over the last decade, the trend in power generation has shifted from centrally controlled to distributed generation. Synchronous motor wind turbines were more efficient than more subsequent wind energy conversion systems, which have used electronic power technology to help boost productivity by incorporating wind energy conversion power sources into renewable power [3].

Describes the electrical grid connection analysis between a wind turbine with the ability and storage units for power generation Moreover, a battery sizing and model, as well as the power conversion prototype and regulate to properly charge and dispose of the battery, are all clearly outlined.[4].

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This work proposes a flexible Unified Power Quality Conditioner (UPQC) for conducting circuit consists power-line endurance in both three-phase three-wire and three-phase four-wire transmission lines [5]. One of the most significant characteristics of energy production is renewable power conversion using a Doubly Fed Induction Power source. Wind turbine power output varies a lot caused by change in wind speed. Due to the varying nature and uncertainly of wind, the proposed design includes a Battery Energy Storage System (BESS) in the DC link to reduce power fluctuations on the grid. The power fed to the grid is always levelled, resulting in a convenient and accurate source of electricity for the circuit.

Though only a three-phase three-wire power position is capable at a processing facility, the UPQC can undertake power-line recompense for activated peak load that requires a fair and balanced transmission line [6].The capacitor connected to the DC-link serves as a source of constant Output amplitude, battery storage, and voltage regulation. The control system produces the commands that regulate the rotor side VSC as well as the grid side VSC (to control the electrical power). The rotor-side VSC, in turn, regulates the wind turbine's power, while the grid-side VSC regulates the DC-bus voltage and reactive power at the grid base stations.

As a consequence, the series converter is set to be a frequency response power source, while the simultaneous converter is set to be a sinusoidal voltage source [7]. Because although the voltage and current controllers are implemented in a synchronous machine, their control observations are constant. For most UPQC application areas, which use control strategies with non-sinusoidal controlled quantities, UPQC uses a dual compensation strategy with waveform operating constraints. [8].

For sensitive end-users who want to improve their PQ (Power Quality), the Unified Power Quality Conditioner (UPQC) is such a well employment device [9]. The amount of wind power access to the power grid has steadily increased over the last decade. Wind power, on the other hand, is naturally unpredictable, posing a threat to the reliability of the power grid [10]. For the Doubly Fed Induction Generator (DFIG) wind turbine, a new method for gaining access to the reactive current control service has been developed. The proposed method, which combines gravity control and parameter regulation, allows wind turbines to release active power reserves [11].

A Doubly Fed Induction Generator (DFIG) control strategy designed for a wind energy conversion system able to operate under electrical grid interruption. The variability of its output power and the Low-Voltage Ride Trough capability (LVRT) of power converter systems are the two primary components of DFIG behavior and attitude evaluated.

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A control strategy for the Battery Energy Storage System was developed to smooth the output power implanted into the electrical grid and to improve the dynamic response of a variable speed wind turbine power generation system under perfectly straight voltage sags[12].

The DFIG wind turbine lacks an inertia slow response to the decoupling between the machine's rotation and the grid intensity. The DFIG then continues to operate as an asynchronous motor with DC current in the armature conductors, which means no active power is generated in the rotor windings and all active power from the DFIG machine is directed to the power network. When the circuit is turned, the current flowing through the inductive load inside a clockwise direction, and the inductive load stores energy by producing a magnetic field. The left side of the transformer has a positive electrical charge. The switching frequency will be reduced if the switch is opened because the impedance is extremely high. To keep the current flowing towards the massive amount, the magnetic field that was previously created will be disturbed [13].

Wind turbines, on the other hand, have a lot of inertia, which can be used to control system frequency [14]. The virtual inertia method is proposed to discharge the mechanical energy excess energy in the wind turbine to achieve variable speed operation.A variable speed generator is needed to match the wind frequency, which is where the doubly-fed generator appears throughout [15] [16].

The DFIG-based wind turbine becomes unstable in the event of a power interruption, resulting in a grid power failure, frequency variations, and functionality of grid imbalance strength, renewable power flexibility specifications, and the need for an immediate control method. As a result, vector control is the most effective method of doubly-fed induction generator control [17] It will demonstrate vector control, which allows for independent control of active and reactive power exchanged between the generator's stator and the matrix using a direct torque control principle (with stator flux or voltage direction) and conventional PI controllers. Various simulation tests are performed to monitor behavior of a system and evaluate the control's performance against some optimization criteria (clean energy and control durability) [18].

Unbalanced voltage's effect on a traditional PLL with direct and quadrature conversion. A doubly-fed electromotive force is used because a regular is required. In the event of a grid failure, the DFIG-based wind turbine becomes unstable, which is dangerous. There is an instant need for a control strategy due to grid voltage instability,

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bandwidth variations, and transmission line utility wind power flexibility criteria & imbalance authority operate [19] [20].

MATERIALS AND METHOD

An independent wind-solar integrated renewable energy system consuming three-phase multiple output loads was designed, controlled, and tested using the existing process. The wind energy block, which consists of a Doubly Fed Induction Generator, has the Maximum Power Point Tracking (MPPT) algorithm [21-24] built-in DFIG. The Bidirectional DC-DC converter is controlled by a DC link that connects the Rotor Side Converter (RSC) and the Load Side Converter (LSC). Bandwidth control is required for MPPT operation, which is accomplished using RSC's field-oriented control. The rotor position necessary for vector control is estimated using the Model Reference and Adaptive System (MRAS) algorithm. Both voltage and frequency are controlled by LSC. Solar Photovoltaic (PV) power is extracted to a common DC link using a DC-DC boost converter.Solar Photovoltaic (PV) power is extracted to a common DC link using a DC-DC boost converter [25]. To extract even more power from the occurrence irradiation level, the MPPT algorithm is also included in the DC-DC converter.

The proposed modern control strategy is designed for a grid-connected Axial Flux Permanent Magnet Generator (AFPSG) based wind energy conversion system [26]. The AFPSG rotor circuit's grid and rotor side converter control techniques, as well as computational mathematics of the WECS configuration used, are mentioned. The proposed design includes a Battery Energy Storage System (BESS) to minimize the power oscillations on the grid due to the varying environment and uncertainly of wind. Characterized by rapid wind speed and direction, the penetration of wind output varies greatly. A new control strategy has been developed for a grid-connected Axial Flux Permanent Magnet Generator (AFPSG) based wind energy conversion system. The AFPSG rotor circuit's grid and rotor side converter control methods, along with computational mathematics of the WECS [27] configuration used, are discussed. Figure 2 shown the proposed topology includes a Battery Energy Storage System (BESS) to reduce power fluctuations on the grid due to the differing nature and unexpectedness of wind. Due to abrupt wind speed and direction, wind turbine power output varies [28].

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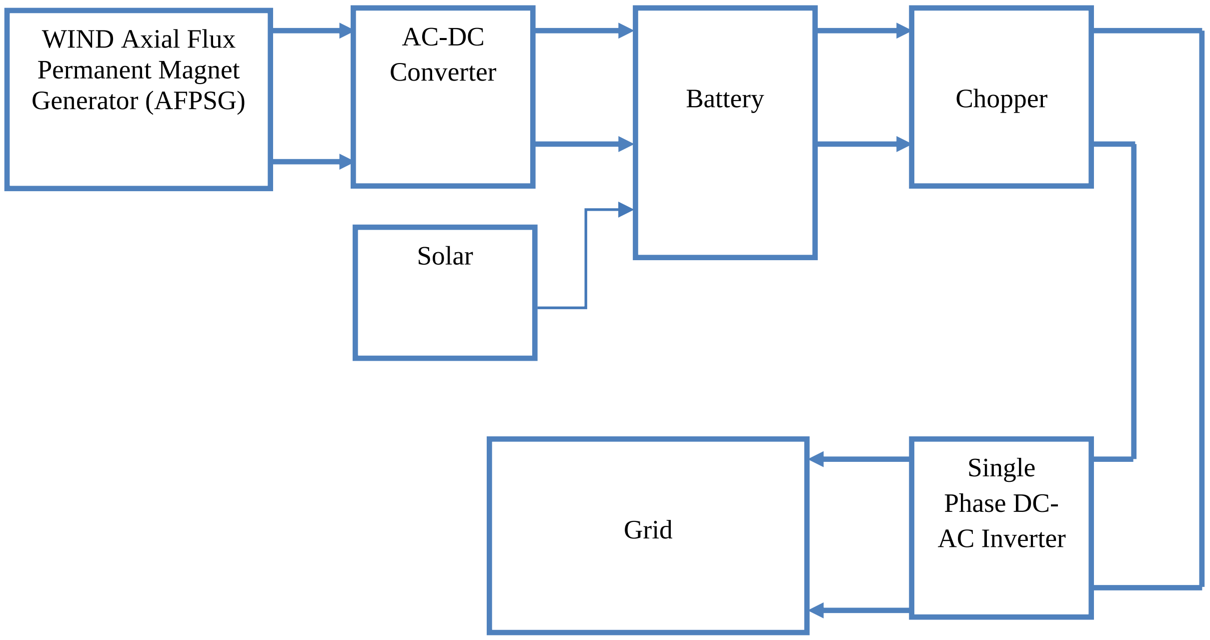

Figure 2 Block Diagram of Proposed System

Axial Flux Permanent Magnet Generator (AFPSG)

Direct-drive wind energy systems are a viable option for wind energy systems because they do not require any gear. An AFPMG (Axial Flux Permanent Magnet Generator) is a viable alternative to a radial flux machine in wind turbine applications. An axial flux type machine can be used in a direct-drive wind energy system for reduced, elevated operation. For High - torque wind energy conversion, AFPMG is required to reduce quantity dimensions, gravity, and vibration while increasing performance and accuracy. When designing for compactness and high efficiency, a full-wave electromagnetic finite element analysis Three-Dimensional Finite Element (FE) and a thermal behavior are typically needed.

Figure 3 shows Axial-flux permanent magnets with non-overlapping air-cored concentrated stator windings showed that a highly focused winding machine can perform in the same way as a traditional overlapping winding machine. The effect of winding and pole amount on the switchbacks component and output torque is also begun to look into. The highest winding component is found in a winding with one coil in a phase band and several poles divisible by four. Because a no interlaced winding's end-turn length is shorter than that of a normal overlapping winding, fewer metals are necessary for a particular load.

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An AFPMSG (Axial-Flux Permanent-Magnet Synchronous Generator) The armature winding has a non-integral coil pole proportion and is comprised of no interlaced concentrated winding with a brushless motors primary coil and a formally and privately electric motor. By selecting a suitable armature coil to pole number values, the AFPMSG's fundamental winding factor can be made close to that of a full-pitched integral slot winding. The field distribution and load effectiveness of a prototype machine are calculated using a two-dimensional, time-stepping finite element method. The origin of torque ripple and the brushless motors armature winding's armature reaction effect are also explored.

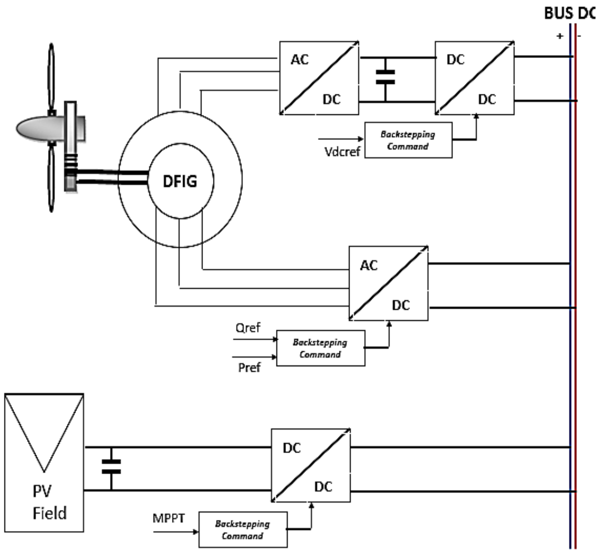

Figure 3 working architecture of Block diagram of Axial Flux Permanent Magnet Generator (AFPSG)

Chopper

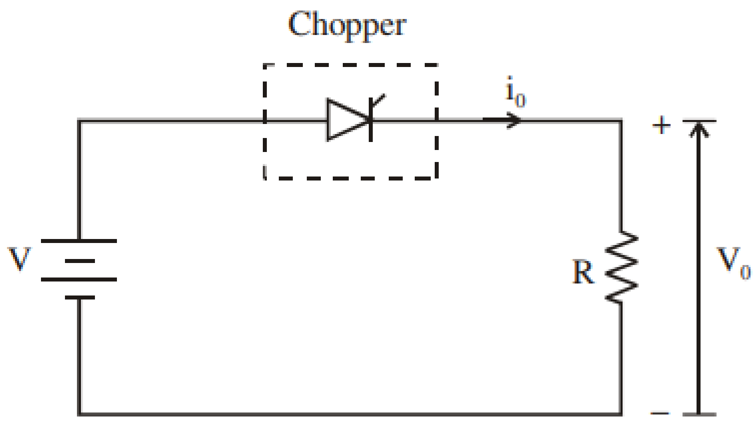

Figure 4 Circuit diagram of Chopper.

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Figure 4 shows Chopper Circuits are circuits that convert a fixed DC voltage to an adjustable DC voltage. A DC chopper or a DC to DC converter are other names for it. Choppers are thought to be the constant current equivalent of AC transformers because they can step up or down a fixed Source voltage, much like transformers. It's a type of passive power electronics device for increasing or decreasing voltage levels. This circuit is a static chopper that converts a fixed dc input voltage to a variable voltage. It works in the same way as an AC transformer, converting one stage at a time

This conversion method is more efficient than the AC link chopper. A chopper is a permanent device that converts a constant DC power supply to a variable DC voltage source. A chopper is another name for a DC-to-DC converter. The thyristor transformer is more effective, responds quicker, requires minimal, is relatively small, and has a gentler control. Choppers are used in trolley cars, battery-operated vehicles, vehicles, traction motor control, and control of a large number of switches motors. They're also used in dc motor regenerative braking, as well as DC voltage regulatory authorities, to utilize the resources to the supply.

Definition of a Chopper Circuit Chopper circuits is used to convert a fixed dc voltage to an adjustable DC voltage. A DC chopper or a DC to DC converter are other names for it. Modules are thought to be the DC closest approximation of input power transformers because they can step up or down a fixed source voltage, just like transformers. It's a type of stationary power electronic devices device that's used to raise and lower voltage thresholds.

INVERTER

In renewable energy systems such as wind and solar power, DC–AC inverters are critical components in energy conversion. Figure 5 illustrates voltage-source converters and current-source micro grids are the two types of DC–AC inverters. Standard half-bridge inverters, single additional inverters, two additional distributed generation, multi-stepped inverters, and constant amplitude pulse width modulation inverters are described in detail for DC–AC voltage-source inverters. Production harmonics are mentioned, as well as performance economic indicators such as message signal and proportion. The principles of current-source inverter operation, respectively single-phase and multiple inverters, are always shown.

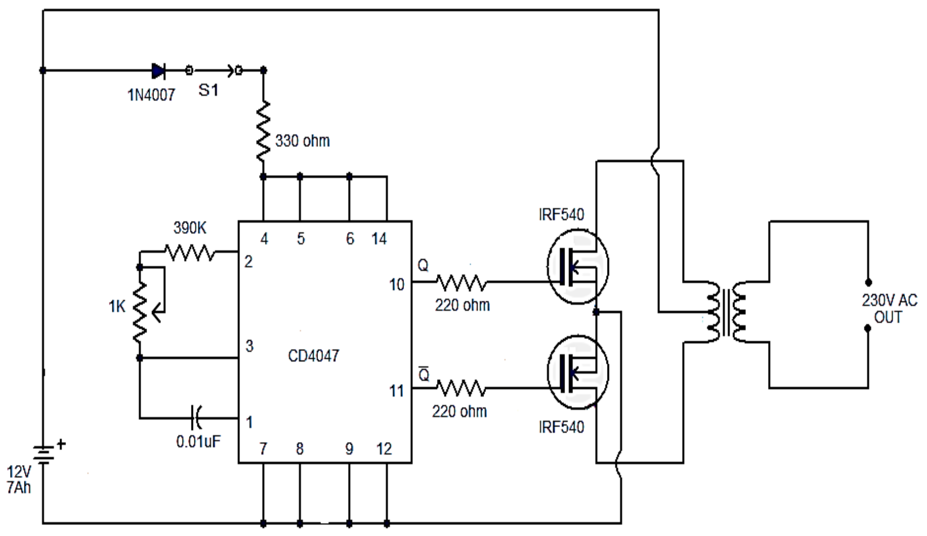

Figure 5 DC - AC Inverter

An inverter is a small, rectangle electrical device that converts Direct Current (DC) voltage to Alternating Current (AC) voltage in common appliances [29]. DC applications make use of a variety of small pieces of equipment, such as solar energy. Direct current is used in many small electrical devices, such as solar power systems, power batteries, power sources, and fuel cells because it is easy to produce.

The principal tool in an inverter converts electrical power into mechanical power. The public utility can supply AC power to homes and businesses; otherwise, the generators' rotating systems can only store Energy generated. In addition, almost all power systems and other electronic devices can be run on AC power. The input voltage is generally lower when the output voltage is roughly comparable to the voltage level of either probably depending on the continent. These are standalone equipment that can be used in photovoltaic application areas. Different types of inverters are commercially available based on the switching waveform structure.

3.4 GRID

An electrical grid is a network of interconnected power lines that transports electricity from generators to customers. The electrical generation station is located, high-voltage transmission lines that transport power from two or more sources to request facilities, and distribution equipment that connect existing consumers. Power plants are often located away from densely populated areas, near a fuel source, at a hydropower plant, or perhaps to reap the benefits of renewable energy sources. To take advantage of technology, they are usually

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quite large. The generated electricity is stepped up to a higher voltage before connecting to the electrical transmission and distribution system.

The bulk power transmission network will move the power long distances, sometimes across international boundaries, until it reaches its wholesale customer usually the company that owns the local electric power distribution network. On arrival at a substation, the power will be stepped down from a transmission level voltage to a distribution level voltage. As it exits the substation, it enters the distribution wiring. Finally, upon arrival at the service location, the power is stepped down again from the distribution voltage to the required service voltage(s).

RESULTS AND DISCUSSION

MATLAB SIMULATION OUTPUT

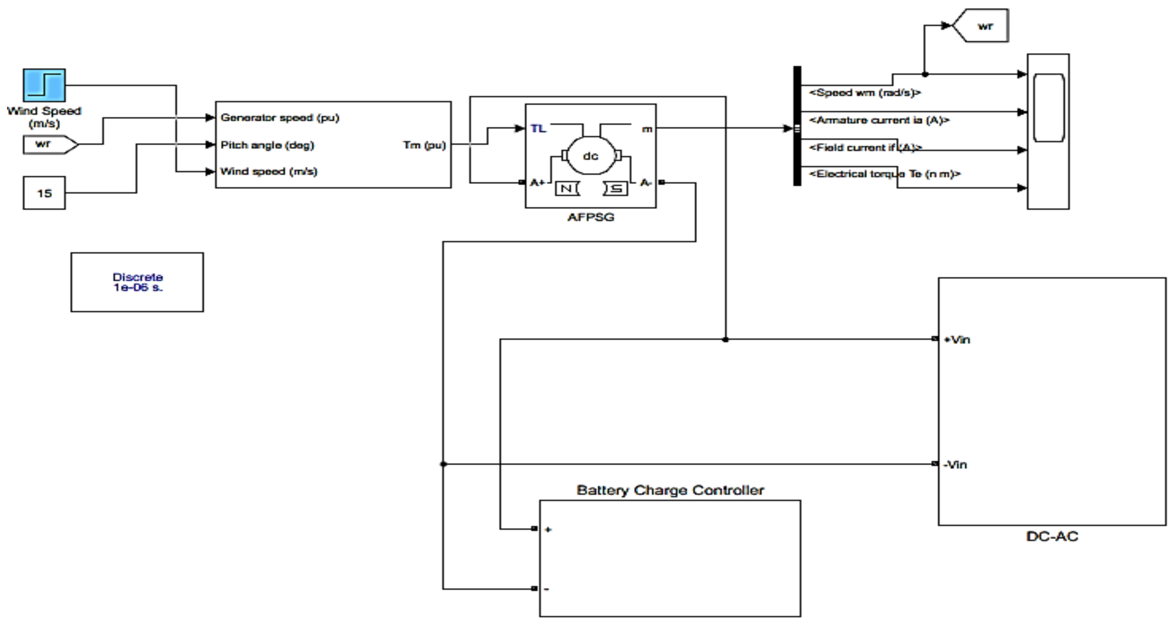

Figure 6 Mat lab Simulation

Figure 6 Shows to regulate the rotor- and grid-side converters, a new process for getting the highest power output of an Axial Flux Permanent Magnet Generator (AFPSG) wind turbine is suggested. Under presumptions that represent physical conditions, the efficiency of the maximum power point tracking method proposed is potentially assured. To ensure the quality of system reliability, several control variables can be modified.

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To derive the control method, an AFPSG method was originally and a creation based on the function is now used. The adequacy of the model is demonstrated using MATLAB/Simulink computational modeling of a wind turbine. The simulation results demonstrate that when the proposed scheme is used, the wind turbine is capable of effectively observing the optimum process point; additionally, when the proposed technique is used, the generator's available power generated is higher than it was when the methodology is used rather than.

OUTPUT WAVEFORM

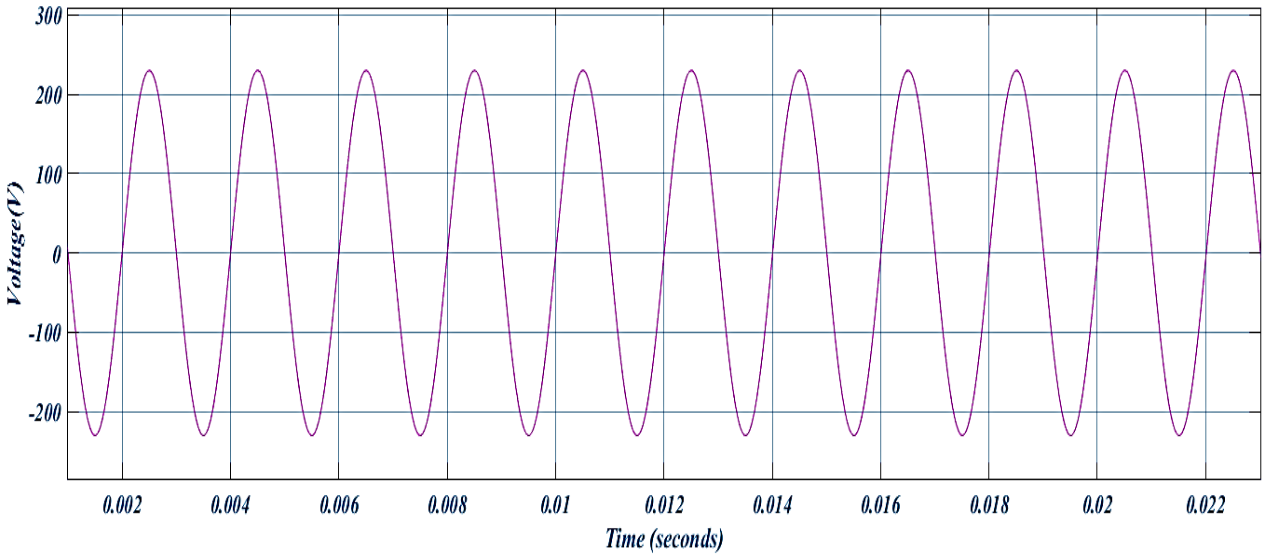

Figure 7 Output waveform

Figure 7 showsfor stability studies, the Axial Flux Permanent Magnet Generator (AFPSG) and the corresponding converter were used. A reduced-order AFPSG model is developed to enable efficient computation by limiting the arithmetic to the basic frequency. The model enhancement proposed in this chapter, on the other hand, allows for the evaluation of the alternating components of the rotor current, which is required for the hammer operation to be activated. For the rotor and grid side adapters, as well as the DC-link, appropriate models are presented, taking into account all four potential switching states. When wind and rotor speed variations are important, the developed framework for speed and pitch angle control could be used.

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ADVANTAGES

- Improves the accuracy of harmonic detection
- Capable of separating harmonics from feeder current
- Harmonic current and unbalanced voltage can then be alleviated with compensation
- Ability to supply reactive power to the grid.

CONCLUSION

An Axial Flux Permanent Generator Magnet (AFPSG) based Wind energy conversion system with a BESS in the output terminals has been proposed with a stator-flux value are converted control strategy. On the stator side, the vector control allows for the easy decomposition of active and reactive powers. This can be accomplished by programming the control algorithm in a two-axis synchronously rotating reference frame, with each axis controlling either active or reactive power. The proposed configuration and control strategy eliminates the need for this besides supplying constant power to the grid throughout and thus maintaining a constant energy flow to the output regardless of wind speed variations. Other important control strategies at the stator terminal, such as Maximum Power Point Tracking (MPPT) and unity power factor operation, are also observed satisfactorily. Placing a BESS (Battery Energy Storage System) link of AFPSGbased Wind Renewable Energy Control System (WECS) proves to be a successful implementation in terms of grid power stability.

REFERENCES

[1] Sun, Y., Zhong, J., Li, Z., Tian, W., and Shahidehpour, M, “Stochastic scheduling of battery-based energy storage transportation system with the penetration of wind power”, IEEE Transactions on Sustainable Energy, vol. 8(1), pp. 135–144, 2020.

[2] Khalid Mehmood, K., Khan, S. U., Lee, S.-J., Haider, Z. M., Rafique, M. K., and Kim, C.-H. “Optimal sizing and allocation of battery energy storage systems with wind and solar power DGs in a distribution network for voltage regulation considering the lifespan of batteries”, IET Renewable Power Generation, vol. 11(10), pp. 1305–1315. 2021.

[3] Avendano, N., Celeita, D., Hernandez, M, and Ramos, G. “Impact analysis of wind turbine and battery energy storage connection in power systems”. IEEE Workshop on Power Electronics and Power Quality Applications (PEPQA). 2020.

[4] J. A. Thulasi, V. Anuja, and M. A. Mary, “A novel voltage regulator — battery energy storage system for the renewable energy system”, International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT), 2021.

[5] Modesto, R. A., da Silva, S. A. O., de Oliveira, A. A., and Bacon, V. D, “A versatile unified power quality conditioner applied to three-phase four-wire distribution systems using a dual control strategy”, IEEE Transactions on Power Electronics, vol. 31, no. 8, 2015.

[6] Da Silva, S. A. O., and Negrao, F. A. “Single-phase to three-phase unified power quality conditioner applied in single-wire earth return electric power distribution grids”, IEEE Transactions on Power Electronics, vol. 33, no. 5, 2017.

[7] Campanhol, L. B. G., da Silva, S. A. O., de Oliveira, A. A, and Bacon. V. D “Single-stage three-phase grid-tied PV system with universal filtering capability applied to DG systems and AC micro-grids”, IEEE Transactions on Power Electronics, vol. 32, no. 12, 2017.

[8] Lu, Y., Xiao, G., Wang, X., Blaabjerg. F and Lu. D, “Control strategy for single-phase transformer less three-leg unified power quality conditioner based on space vector modulation”, IEEE Transactions on Power Electronics, vol. 31, no. 4, 2015.

[9] D. Li, M. Cai, W. Yang, and J. Wang, “Study of doubly fed induction generator wind turbines for primary frequency control”, IEEE 4th Conference on Energy Internet and Energy System Integration (EI2), pp. 2690-2695, 2020.

[10] S. Vajpayee, N. R. Panda, P. Behera, and S. C. Swain, “Implementation of PLL algorithm in DFIG based wind turbine connected to the utility grid”, Second International Conference on Inventive Research in Computing Applications (ICIRCA), pp. 549-553, 2020.

[11] R. Prasad and N. P. Padhy, “Coordinated frequency controller operation for DFIG based wind turbine generator control using combination selection scheme”, IEEE International Conference on Power Electronics, Smart Grid and Renewable Energy (PESGRE2020), pp. 1-6, 2020.

[12] M. A. Shobug and M. R. I. Sheikh, “Fault Management in DFIG based wind turbine using sophisticated advanced solid state fault current limiter”, IEEE Region 10 Symposium (TENSYMP), pp. 1660-1663, 2020.

[13] J. L. Rodríguez-Amenedo, S. A. Gómez, J. C. Martínez and J. Alonso-Martinez, “Black-start capability of DFIG wind turbines through a grid-forming control based on the rotor flux orientation”, in IEEE Access, vol. 9, pp. 142910-142924, 2021.

[14] B. Sabir, V. K. Rawat, M. Faizan, and M. Tahir, "Analysis of generated harmonics in DFIG driven by wind turbine during linear and non-linear load", International Conference on Computer Communication and Informatics (ICCCI), pp. 1-7, 2021.

[15] Z. WANG and W. WU, "Coordinated control method for DFIG-Based wind farm to provide primary frequency regulation service", IEEE Power & Energy Society General Meeting (PESGM), pp. 1-1, 2020.

[16] B. S. Goud, P. S. Varma, B. L. Rao, M. S. K. Reddy, A. Pandian, and C. R. Reddy, "Cuckoo search optimization-based MPPT for integrated DFIG-wind energy system", International Conference on Decision Aid Sciences and Application (DASA), pp. 636-639,2020.

[17] E. Hamatwi and P. Barendse, "Condition monitoring and fault diagnosis of stator and rotor interturn winding faults in a DFIG-based wind turbine system: A Review", International SAUPEC/Rob Mech/PRASA Conference, pp. 1-6, 2020.

[18] R. A. de Oliveira, C. Chen, M. H. J. Bollen, and R. Chouhy Leborgne, "Short-term distortion and protection operation in DFIG-based wind parks during voltage dips", IEEE PES Innovative Smart Grid Technologies Europe (ISGT-Europe), pp. 819-823, 2020.

[19] T. Zhang et al., "Improved continuous fault ride through control strategy of DFIG-based wind turbine during commutation failure in the LCC-HVDC Transmission System", in IEEE Transactions on Power Electronics, vol. 36, no. 1, pp. 459-473, 2021.

[20] Nirmala.G, Suresh Kumar. P, "A novel bat optimized run length networks (BORN) for an efficient classification of breast cancer", Journal of Ambient Intelligence and Humanized Computing, 12(5), pp. 4797–4808.2021.

[21] P.Suresh Kumar, S.Meenakshi, Performance Analysis of FPGA based implementation of FFT architecture with pruning algorithm for industrial applications, Int. J. Adv. Sci. Eng. 7: 2. 1770-1775 (2020).

[22] P.Suresh Kumar, S.Meenakshi, A.Venkatesh, Performance Analysis of High Voltage Intelligent Supervisory Systems Using Neural Networks, Int. J. Adv. Sci. Eng. Vol.6 No.4 1525-1532 (2020).

[23] S.Meenakshi, P.SureshKumar, S.Ramsanjay, Soft computing techniques based digital adoptive controllers with Intelligent system for switched reluctance motor,Int. J. Adv. Sci. Eng. 7: 1. 1614-1624 (2020)

https://doi.org/10.37896/pd91.4/91478

[24] P. Suresh Kumar,G. Nirmala,S. Manimegalai,H. Arulvedi, Performance Enhancement of Cognitive Radio Networks Using SINR-Based Cooperative Beamforming, Int. J. Adv. Sci. Eng. 8: 3. 2260-2267 (2022)

[25] G Kanagaraj and P Suresh Kumar, Pulmonary Tumor Detection by virtue of GLCM, Journal of Scientific & Industrial Research, Vol. 79, pp. 132–134, (2020).

[26] Nirmala.G, P.Suresh Kumar, Deep Convolution Neural network for breast mass classification from management, Biosc. Biotech. Res.Comm, 13(13), 203-208 (2020).\

[27] G. Nirmala P. Suresh Kumar, A novel bat optimized run length networks (BORN) for an efficient classification of breast cancer, Journal of Ambient Intelligence and Humanized Computing volume 12, 4797–4808 (2021).

[28] Suresh Kumar, P., Nirmala, G., Manimegalai, S., Arulvedi, H. 2022. Performance Enhancement of Cognitive Radio Networks Using SINR-Based Cooperative Beamforming, Int. J. Adv. Sci. Eng. 8 (3) 2260-2267.

[29] T. Zhang et al., “Improved continuous fault ride through control strategy of DFIG-based wind turbine during commutation failure in the LCC-HVDC Transmission System”, in IEEE Transactions on Power Electronics, vol. 36, no. 1, pp. 459-473, 2021.