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REVIEW ON FUZZY LOGIC BASED WIND GRID SYSTEM TO IMPROVE POWER QUALITY

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***Abstract*— The significance of producing electricity from renewable energy sources (RESs) is growing as the global energy demand rises. One of the main RESs is wind power, which has the potential to greatly enhance the world's supply of electricity. To use wind energy effectively and economically, the utility grid must be integrated due to its fluctuating and unpredictable nature. Due to the variable power output, adding wind-generated energy to the grid may result in problems with power quality, demanding adherence to the IEC-61400 standard's electrical performance requirements. This research suggests employing fuzzy controllers to integrate wind energy systems and enhance grid quality of electricity in order to resolve this issue.**

The quality of the electricity generated when connected to the grid can be affected by variations in the production of energy from renewable sources, such as wind power. The operational efficiency of the wind turbine and power quality are determined based on observations and adherence to the IEC-61400 standard, which considers electricity quality measurements like "active" and "reactive" "electric power", "voltage sag", "voltage swell", "flickers", "harmonics", and "the electrical behaviour of the switching operations". The proposed approach aims to reduce simulated MATLAB/SIMULINK power quality difficulties by improving the source profile using a fuzzy-based controller. The study studies and compares the results generated both with and without the use of the fuzzy controller in order to judge the effectiveness of the latter.

Keywords- power quality, fuzzy logic, wind energy.

I. INTRODUCTION

When producing, transferring, and dispersing wind power, it's critical to evaluate power quality concerns such voltage sag, swells, flickers, and harmonics. Wind turbines, however, have the potential to interfere with the transmission network. An induction generator that is directly linked to the grid is a typical way to run a wind-generating system. Cost-effective, effective, and long-lasting induction generators are available. However, induction generators need reactive power for the process of magnetization, and fluctuations in the active power generated by wind can have a big influence on the generator's terminal voltage and absorbed reactive power.

In order to limit excess power output under typical operating conditions, wind energy systems require a sophisticated control approach. A system to store energy in batteries could be needed to take into account the changes created by electricity-generating turbines in situations when grid outages are becoming more frequent. To increase the quality of power, technical regulation of the electricity level connected to commercial wind turbines is advised.

II. LITERATURE REVIEW

In their paper, Mouna Rekik, Lotfi Krichen, and Achraf Abdelkafi emphasise the difficulties that the imbalance between the generation and consumption of wind power poses for the electrical grid's long-term stability. This imbalance results in wind power's unpredictability and intermittent behaviour. To solve this problem, they provide a novel control approach that concentrates on the dynamics of a wind farm made up of permanent magnet synchronised generators (PMSG) and N-Aerogenerators.

Without using a storage device, their major goal is to maintain equilibrium between the power generated by the wind farm and the electricity needed by the consumers. Their suggested control structure has two hierarchical levels. Controlling the manager of the wind turbine, which is in charge of guaranteeing a balance of energy and steady electrical power generated by the wind farm, is the first approach. For the slave wind turbines, which are intended to generate as much power as possible, the second technique is local control.

In a research study, the authors used MATLAB/Simulink simulations to show that their suggested control approach for wind farms using N-Aerogenerators and permanent magnet synchronous generators (PMSG) produces power in a smooth manner and is more resilient than other currently available methods over a range of wind speeds and requirements for power.

In a separate study, Dr. N. Rathina Prabha, C. Kanmani, and R. Bhavani identified many power quality (PQ) issues that might occur when wind farms are connected to the electrical grid, including voltage sag, swell, flicker, and harmonics. The main causes of these PQ issues, with voltage sag accounting for up to 70% of the issues, are the non-linear loads that are prevalent in commercial and industrial settings. The authors propose a novel fuzzy-Logic-Controller (FLC)-based control approach for the Unified Power Quality Conditioner (UPQC), a specialist device that addresses voltage swings and current harmonics, which could enhance functionality. The based classification-controlled UPQC mitigates voltage sag and current harmonics more successfully and effectively than the conventional PI-controlled UPQC. The suggested approach has been shown to produce high-quality power and improve the dependability of energy produced from renewable sources linked to the grid, according to the simulation results and control system effectiveness evaluation. This paper emphasises the need of addressing PQ issues and the potential benefits of UPQC with fuzzy control in wind power systems.

In comparison to solar or tidal energy, the writers B. Avudai Lakshmi and R. Karpagam emphasise wind energy conversion as being more affordable. Power quality issues include harmonics, voltage dips, swells, nonlinear loads, and single-phase failures can affect wind farms. The researchers suggest adopting STATCOM as an equilibrium system to lessen these problems. In order to produce or consume reactive and real power, STATCOM combines a static synchronous power source with a correspond-connected static reactive compensator. An apparatus known as a Proportional Resonant (PR) controller is used to assess the compensator's performance. The complete system has been simulated by the authors using MATLAB/SIMULINK. According to the simulation's results, STATCOM can successfully reduce harmonics and enhance the voltage profile in a connected to “the grid wind energy conversion system”. A connected to the grid wind energy conversion system's electrical voltage profile and harmonic reduction are affected by the STATCOM, as shown by the computer's model.

Because microgrids may provide a solution to the most serious problems facing the power generating and transmission business, academics have recently been interested in them. Microgrids are capable of producing high-quality electricity and sustainable energy. In the present research, the researchers model and evaluate a straightforward microgrid system made up of two diesel generators and a wind energy conversion system (WECS) based on a doubly fed induction generator (DFIG). There are several places where loads are linked to the system, and when loads fluctuate and the DFIG turbine torque varies, the voltage profile of the electrical power system deteriorates. To improve the electric current characteristics of the system, the researchers used a “vector control technique” with compensating for reactive power applied to the “grid-side converter” (GSC). In order to decouple the reactive and active power of the DFIG, they have also used a stator fluctuation-oriented vector control approach to regulate the rotor-side converter (RSC) of the WECS. The results of the research imply that the usage of FACTS devices in systems that generate electricity from renewable sources may be reduced or abolished while system efficiency is maintained or improved.

An improved power quality conditioner (IPQC) has been developed by K. Lakshmi Ganesh, G. Satyanarayana, G. Ranjith Kumar, and N.V. Prasad. It employs a straightforward approach based on FFT analysis to estimate the reference compensation current. The improved IPQC works well when the surroundings is rapidly changing and may now be utilised with balanced, unbalanced, and fluctuating loads. However, an auto-tuned active power filter can beat its rivals in terms of “harmonic reduction”, reactive electrical compensation, and “power factor enhancement”. Conventional filters might not be enough in such circumstances. Total Harmonic Distortion (THD) may be efficiently maintained within IEEE-519 guidelines with the help of the suggested assault rifle-tuned shunt active filter. Hybrid fuzzy logic controllers are used in the method, which has been fully tested for a variety of loads, to enhance the unpredictable behaviour of the IPQC. The power system network's transient responsiveness has been greatly enhanced and the network's adaptability has been increased by the use of a combination of fuzzy controllers.

The rising problem of distortions of harmonics in the power system brought on by loads that are not linear has been discovered by Lotfi Krichen and Mouna Rekik. The authors suggested a control method that makes use of shunt active filters driven by a bladed wind generator to solve this issue. This method regulates the distributed generator interface converters on wind turbines to ensure acceptable voltage quality at the “point of common coupling” (PCC), while compensating for the currents of harmonics and reactive power generated by non-linear loads. The suggested method was modelled in MATLAB, and the simulation results show that the wind turbine can perform as a reliable active power filter and power factor correction device, lowering distortions caused by harmonics and improving the power factor of the electrical network.

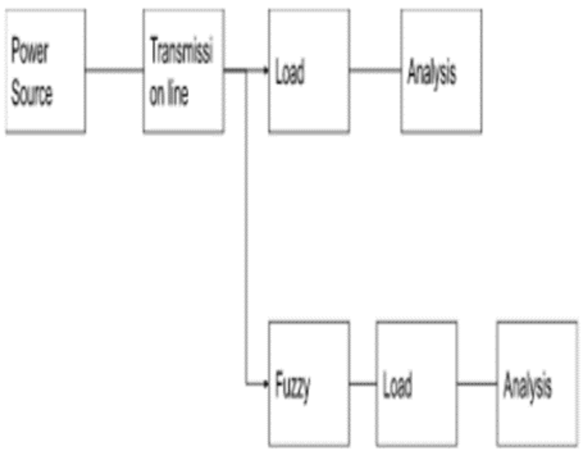
In order to reduce copper loss, the work by Kang-IK Ha and Kahyun Lee suggests innovative control approaches for a wind energy conversion system with a DFIG. The stator and grid-side converter currents are regulated to preserve unity power factor in the traditional method, which connects the stator electrically to the grid and the rotating part through a pair of back-to-back converter. This approach, however, might not be energy-efficient. In order to reduce losses, the authors suggest a minimum copper loss (MCL) operation that identifies the current through the rotor instructions that produce the optimal torque and horsepower characteristics. The anticipated converter current needs come from the configuration-side converter, which provides reactive electrical power to make up for the grid's factor of electricity. In order to manage the “power factor”, “speed”, and dc-link voltage of the system for MCL operation, the suggested approach modifies the “d-q rotor currents” and “d-axis converter current”. Through simulations accomplished under various operating situations, the suggested control system's viability and MCL tracking capability are illustrated.

The power quality of wind turbines and variations in power output brought on by changes in wind speed are investigated by Kececioglu et al. According to IEEE 519-1992 standards, they assess a variety of electrical performance metrics, such as voltage, current, active power, reactive power, perceived power, and harmonics. Over the course of three months, the research continually examines these variables, collecting knowledge on active, reactive, and apparent electrical power values, average current and voltage harmonics, and RMS voltage and current measurements. The investigators want to learn more about the characteristics of wind turbine electricity quality and how wind speed variations affect power production.

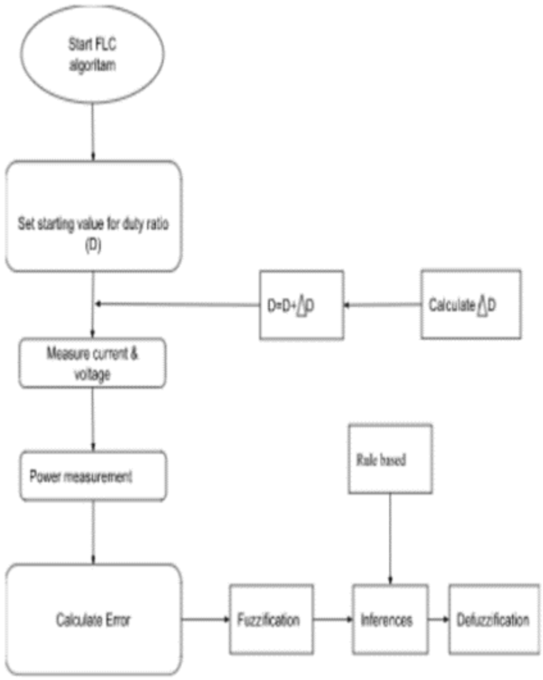
III. METHODOLOGY

The authors of this study suggested a wind energy generation system that is linked to the grid and makes use of a fuzzy logic controller (FLC) to enhance power quality. Total harmonic distortion (THD) decreased as a result of the FLC-based strategy, showing improvements in system efficiency. Since the FLC technique mixes expert knowledge into fuzzy rules to achieve control objectives, it has the advantage of not requiring elaborate mathematical representations of the system. Additionally, the FLC is capable of handling erratic or noisy data, making it appropriate for application in non-linear and unpredictable contexts where conventional control techniques would not succeed. The voltage error (V) and change in error (E) are two inputs that the FLC voltage regulation circuit receives. By contrasting the proposed FLC system with systems that don't use the FLC methodology, the study assessed the effectiveness of the FLC system.

Block Diagram



Flow Chart



IV. SYSTEM REQUIREMENT

Hardware Requirement:

Processor: Intel Core i7- 8th Gen

Installed memory (RAM): 4.00GB

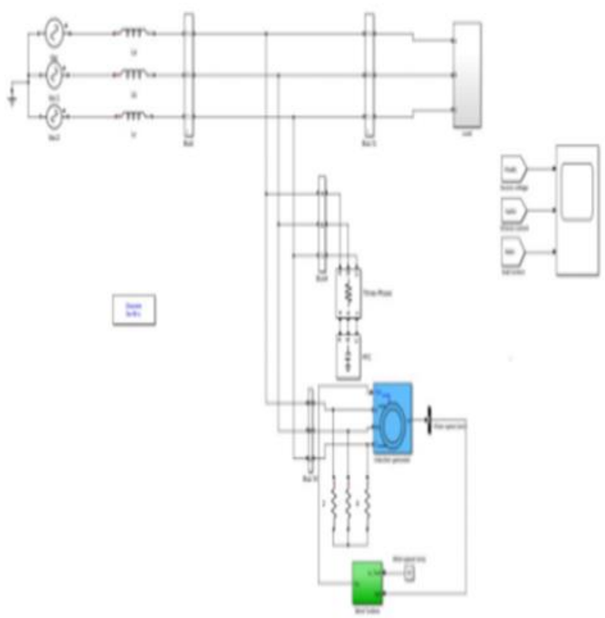
System Type: 64-bit Operating System

Software Requirement:

Matlab Software

V. RESULT

The paper shows a grid-connected wind energy generation system that improves power quality by means of a fuzzy logic controller (FLC). By contrasting the system's performance with and without the controller, the efficacy of the suggested FLC-based strategy is assessed. In order to achieve control objectives, the FLC technique combines expert knowledge with fuzzy rules; this eliminates the need for intricate mathematical models of the system. It is also ideal for usage in non-linear and unpredictable contexts where standard control approaches fail since it can tolerate noisy or erroneous data. The voltage error (V) and change in error (E) are the two inputs that the FLC voltage regulator requires. The outcomes demonstrate that the FLC-based strategy has led to a decrease in total harmonic distortion (THD), suggesting enhanced system performance.



VI. CONCLUSION

In this study, it was suggested that power quality problems be resolved by using wind energy systems with fuzzy logic controllers. To assess the performance of the suggested system, two systems—one with a fuzzy controller and the other without—were compared.

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