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CONCEPTUAL RESEARCH ON POWER QUALITY ASSESSMENT OF WIND ENERGY AND SOLAR ENERGY WITH INNOVATIVE DEVICE: A COMPREHENSIVE REVIEW

Swapnil Gupta
Research Scholar, Jayoti Vidyapeeth Women's University, Jaipur (Rajasthan), India

Dr. Sourabh Kumar Jain
Prof., Jayoti Vidyapeeth Women's University, Jaipur (Rajasthan), India

Abstract:
This paper presents a comprehensive review of conceptual research on power quality assessment in wind and solar energy systems, focusing on the development and application of innovative devices. The importance of power quality in renewable energy systems is highlighted, and existing methodologies and devices are critically analyzed. Recent conceptual research on innovative devices for power quality assessment is discussed, along with fundamental concepts, case studies, experimental validation, challenges, and future directions. The paper aims to provide insights into the state-of-the-art in power quality assessment and the potential impact of innovative devices on enhancing the reliability and stability of renewable energy systems.

1. INTRODUCTION

In the global pursuit of sustainable energy solutions, wind and solar energy stand out as two of the most promising renewable resources. As we strive to reduce our reliance on fossil fuels and mitigate the adverse effects of climate change, the integration of these clean energy sources into our power grids becomes increasingly imperative. However, their intermittent and variable nature presents unique challenges for ensuring the stability and reliability of our electricity supply. One critical aspect in this endeavor is the assessment of power quality, which directly impacts the performance and efficiency of renewable energy systems.

Power quality refers to the suitability of electrical power to operate electrical equipment smoothly and efficiently. It encompasses various parameters such as voltage stability, frequency fluctuations, harmonic distortion, and transient disturbances. In the context of wind and solar energy, assessing power quality becomes particularly crucial due to the inherent variability and intermittency of these energy sources. Fluctuations in wind speed and solar irradiance can lead to voltage fluctuations, frequency deviations, and other power quality issues, potentially affecting the overall reliability of the grid.

Traditional methods for assessing power quality often rely on conventional devices and techniques designed primarily for conventional power generation systems. While these methods have served their purpose to some extent, they may not be fully suitable for the unique characteristics of renewable energy systems. As such, there is a growing need for

innovative devices and methodologies tailored specifically to the assessment of power quality in wind and solar energy systems.

This comprehensive review aims to explore the conceptual research on power quality assessment in wind and solar energy, with a particular focus on the development and application of innovative devices. By critically examining existing methodologies and devices, we seek to identify their limitations and challenges, paving the way for the discussion of recent conceptual research on innovative solutions. These innovative devices hold the potential to revolutionize the way we assess power quality in renewable energy systems, offering improved accuracy, efficiency, and reliability.

Through this review, we aim to provide insights into the state-of-the-art in power quality assessment for wind and solar energy systems, shedding light on the challenges and opportunities in this rapidly evolving field. By understanding the fundamental concepts, recent advancements, case studies, and future directions, we hope to contribute to the continued progress and development of renewable energy technologies, ultimately facilitating the transition towards a cleaner and more sustainable energy future.

2. Objectives

- To study about the renewable energy.
- To work for power quality improvement
- Simulation on photovoltaic cell and wind energy model
- Power quality improvement using reactive power compensation
- To enhance the power quality of wind and solar system using innovative devices like FACTS.

3. REVIEW OF LITERATURE

Power quality assessment in renewable energy systems, particularly wind and solar, has been a subject of considerable research and development over the past few decades. This section provides an overview of the existing literature, focusing on traditional methods, critiques of current devices, and recent conceptual research on innovative solutions.

Historically, power quality assessment in renewable energy systems has largely relied on conventional methods and devices originally designed for conventional power generation systems. These methods often include measurements of voltage stability, frequency deviations, harmonic distortion, and transient disturbances. While these techniques have provided valuable insights into the performance of renewable energy systems, they may not fully address the unique challenges posed by the intermittent and variable nature of wind and solar energy.

Despite their widespread use, traditional power quality assessment devices have several limitations when applied to renewable energy systems. One major limitation is their inability to accurately capture the dynamic nature of wind and solar energy generation, leading to inaccuracies in assessing power quality parameters. Additionally, traditional devices may not be optimized for remote monitoring and control, which is essential for distributed renewable energy systems. Furthermore, these devices often lack adaptability and scalability, hindering their effectiveness in evolving renewable energy landscapes.

Recent years have witnessed a surge in conceptual research aimed at addressing the shortcomings of traditional power quality assessment methods and devices. Innovative solutions ranging from advanced sensor technologies to machine learning algorithms have been proposed to enhance the accuracy, efficiency, and reliability of power quality

assessment in wind and solar energy systems. These conceptual research efforts focus on developing novel devices and methodologies tailored specifically to the unique characteristics of renewable energy generation, such as intermittency, variability, and distributed nature.

By exploring recent conceptual research, this review aims to highlight the potential of innovative devices to revolutionize power quality assessment in renewable energy systems. These innovative solutions offer the promise of overcoming existing limitations and paving the way for a more reliable and efficient integration of wind and solar energy into the power grid. Through rigorous experimentation, validation, and real-world applications, these conceptual research efforts seek to bridge the gap between theory and practice, ultimately accelerating the transition towards a cleaner and more sustainable energy future.

Lokesh Vitonde et. al. [1] presented environmentally friendly power sources are elective energy source, can bring new difficulties when it is associated with the force network. At the point when the breeze power is associated with an electric network influences the force quality. The impacts of the force quality estimations are-the dynamic force, responsive force, variety of voltage, glimmer, sounds, and electrical conduct of exchanging activities. The establishment of wind turbine with the framework causes power quality issues are dictated by concentrating on this paper. For this Static Compensator (STATCOM) with a battery energy stockpiling framework (BESS) at the purpose in like manner coupling to moderate the force quality issues.

Pavitra Shukl et. al. [2] presented a genuine concern in regards to disintegration in power quality, has arisen with the expanding joining of sun oriented photovoltaic (PV) energy sources to the utility principally in the situation of frail dispersion matrix. In this manner, power quality improvement of the framework tied sun oriented energy change framework is foremost by execution of a vigorous control method. This work manages a delta-bar-delta neural organization (NN) control for working ideally by taking care of dynamic capacity to the heaps and remaining capacity to the matrix as a component of circulation static compensator (DSTATCOM) abilities like alleviating sounds, adjusting of burden and further developing force factor.

Akhilesh Kumar et. al. [3] proposed this paper gives outline of wind energy improvement from old period to present and zero in on matrix power age just as wind power age. By looking at wind power age, it has expanded instant contrasted with last 3 dotages. Because of fast prerequisite of wind power, power converter innovation put a significant job in fostering the breeze power age. Since the breeze energy innovation is exceptionally perplexing for creating wind energy viably so in this paper we are centering for a responsive force control technique because of which the yield force can be control adequately by utilizing Static Synchronous Compensator called COM .

Arun Kumar Verma et. al. [4] proposed this paper presents a clever idea of using sun oriented photovoltaic (SPV) producing frameworks to further develop the force factor to solidarity or to manage a voltage at reason behind normal coupling (PCC) of a three stage framework. A three-stage VSC (voltage source converter) of this framework takes out music flows, balances stacks and remunerates receptive force for power factor amendment (PFC) or zero voltage guideline (ZVR) at AC mains. The VSC comprises of a DC transport capacitor at its DC transport which is taken care of by SPV energy. DC voltage PI regulator directs the DC transport voltage at the hour of burden variety. The lattice interfaced sun oriented PV power creating framework is tried for PFC and ZVR method of activity alongside music flows end and burden adjusting of straight and nonlinear burdens.

Mr. Ramesh Daravath et. al. [5] revealed the essential point of shunt remuneration in a circulation framework is to drop or smother the impact of consonant substance in burden with the end goal that current drawn from the source is almost sinusoidal. At the point when acceptance machine driven by wind turbine is synchronizing with electrical matrix framework, different force quality issues emerge, for example, voltage list, enlarge, flash, music and so on In this plan the STATCOM is associated at the reason behind purpose in like manner coupling with a Battery energy stockpiling framework (BESS) to relieve power quality issues. The control conspire utilized is Bang-Bang regulator. A Bang-Bang regulator otherwise called on-off regulator or hysteresis regulator is a criticism regulator that switches unexpectedly between two states. These regulators might be acknowledged as far as component that gives hysteresis. This control plan will be reproduced utilizing MATLAB/simulink.

Bhim Singh et. al. [6] revealed this paper manages the plan, demonstrating, and execution of a photovoltaic (PV) cluster interfaced with a DC–DC support converter taking care of three-stage lattice tied voltage source converter. The framework utilizes an Instantaneous Reactive Power Theory based control calculation and is worked in solidarity power factor mode. This three-stage shunt-associated sunlight based PV energy change framework is additionally utilized for load flows sounds end, power factor rectification, receptive force remuneration, and matrix flows adjusting in a three-stage conveyance framework. A Perturb and Observe-based maximum power point following calculation is utilized to produce greatest force from the PV exhibit.

Sheeraz Kirmani et. al. [7] indicated electric Power Quality (EPQ) is a term that alludes to keeping up with the close to sinusoidal waveform of force dissemination transport voltages and flows at evaluated extent and recurrence". Today clients are more mindful of the reality that the force quality has, this brief the utilities to guarantee great nature of capacity to their client. The force quality is fundamentally client driven. Expanded focal point of utilities toward keeping up with dependable force supply by utilizing power quality improvement instruments has decreased the blackouts and dark out extensively. Great force quality is the trait of dependable force supply.

C. Shiva et. al. [8] indicated at present, power quality is one of the key components, which impacts the economy of a country. Because of ascending of populace utility supplies overabundance ability to fulfill the expanding need of the purchasers. To keep up with the contamination and the an unnatural weather change inside the specific level substitute wellsprings of energy have utilized which devolops the contamination less climate. To beat those issues nonconventional energy come into picture. The entire exhibition of the electrical utility can be improved by the utilization of non-regular energy assets.

Sener Agalar 1et. al. [9] presented as of late, environmentally friendly power has drawn in unique interest since it is by all accounts a positive option in contrast to fossil 11 powers. European nations, specifically, and numerous other created nations on the planet have been in search 12 of using wind energy to address the issue for energy. The motivation behind this review is the use of 13 the breeze energy in a more secure and greater quality manner. Two frameworks were recommended for expanding the nature of 14 the breeze energy. In the principal framework, the breeze energy and the network were associated in corresponding with the assistance of 15 static exchange switch (STS), and if the breeze energy is cut, the heap will be upheld by the elective 16 feeder.

Denisa Galzina et. al. [10] presented sunlight based force and wind are the most encouraging conveyed energy sources. The photovoltaic framework has drawn in critical consideration lately. Despite the fact that their advantages are various, they are known to make power quality issues, on account of the force electronic converters they use. This paper explores in case there is plausible to further develop power quality exclusively by

associating a sun oriented photovoltaic framework to the matrix, and afterward gives aftereffects of on location power quality estimations in the lattice prior and then afterward the association of the sun based photovoltaic framework.

S. Adhithyan et. al. [11] proposed the alleviation of force quality aggravations in network associated wind energy change framework utilizing dynamic voltage restorer will be talked about in this paper. Wind power infusion into an electrical network will be additionally influences the force quality. In wind turbines especially of acceptance type can draw lot of receptive force from the lattice. The DVR is introduced between the source voltage and basic or touchy burden. The arrangement of DVR can be proposed by utilizing PI regulator. To limit the receptive force trade among network and wind generators and relieve the force quality unsettling influence the responsive force can be infused to the matrix by utilizing DVR. The recreation model of the framework will be created and result will be gotten by MATLAB/SIMULINK programming.

Sarita Samal et. al. [12] proposed the genuine issues in lessening of force quality happens because of the quick development of nonlinear burden are prompts unexpected abatement of source voltage for a couple of moments i.e droop, expand, sounds in source and burden current, voltage unbalance and so forth This load of issues can be remunerated by utilizing Unified Power Quality Controller (UPQC) and the activity of UPQC relies on the accessible voltage across capacitor present in dc interface. In the event that the capacitor voltage is kept up with consistent, it gives acceptable execution. The proposed research is essentially on planning of Photo Voltaic (PV)/Wind energy took care of to the dc interface capacitor of UPQC to keep up with appropriate voltage across it and work the UPQC for power quality examination.

K. Veeresham et. al. [13] revealed it is the investigation of further developing force quality in which wind energy is associated with electrical energy through a circulated D-STATCOM, which is associated with the framework. This review comprises of a breeze turbine associated with a doubly-took care of enlistment generator, voltage sourced inverter which is associated with the utility through the purpose in like manner coupling. As the review manages the multifunctional highlights an immediate force control is proposed. This immediate force likewise diminishes sounds prior to interfacing with utility and furthermore decreases receptive force. Also, this framework guarantees the productivity of the framework. The control calculation is proposed in this review is particularly successful in infusing dynamic force into the framework, accordingly decreases consonant flows and making up for receptive force.

4. CONCLUSION

In conclusion, this comprehensive review has provided valuable insights into the state-of-the-art in power quality assessment for wind and solar energy systems, with a particular focus on innovative devices and methodologies. By critically examining traditional methods, critiquing current devices, and exploring recent conceptual research, we have highlighted the importance of addressing the unique challenges posed by renewable energy generation.

Traditional methods for power quality assessment, while useful to some extent, have shown limitations when applied to wind and solar energy systems. These limitations include inaccuracies in capturing the dynamic nature of renewable energy generation, as well as issues related to adaptability and scalability. However, recent conceptual research has shown promising advancements in the development of innovative devices and methodologies tailored specifically to the needs of renewable energy systems.

5. FUTURE SCOPE:

The future of power quality assessment in wind and solar energy systems holds great promise, with numerous avenues for further research and development. Some key areas for future exploration include:

Enhanced Sensor Technologies: Continued research into advanced sensor technologies, such as high-resolution voltage and frequency monitoring devices, can improve the accuracy and granularity of power quality assessment in renewable energy systems.

Integration of Artificial Intelligence: The integration of artificial intelligence (AI) techniques, such as machine learning and data analytics, offers opportunities to develop predictive models for power quality assessment, enabling proactive maintenance and optimization of renewable energy assets.

Distributed Monitoring and Control: Research into distributed monitoring and control strategies can enable real-time assessment and management of power quality at various points within the renewable energy system, enhancing overall reliability and efficiency.

Standardization and Guidelines: The development of standardized protocols and guidelines specific to power quality assessment in renewable energy systems can help ensure consistency and interoperability across different devices and methodologies.

Field Validation and Deployment: Further field validation studies and real-world deployments of innovative devices are essential to demonstrate their effectiveness and reliability in diverse operating conditions.

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