IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 11 , 2022

SURVEY ON POWER QUALITY ASSESSMENT OF WIND ENERGY AND SOLAR ENERGY WITH INNOVATIVE DEVICES

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

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

Abstract: This paper investigates power quality challenges in wind and solar energy systems and assesses the impact of innovative devices on improving system performance. With the increasing penetration of renewables, addressing issues like voltage fluctuations, harmonics, and reactive power imbalances is crucial for grid stability. This study reviews advanced technologies such as Dynamic Voltage Restorers (DVR), Static Synchronous Compensators (STATCOM), and Unified Power Quality Conditioners (UPQC) to evaluate their effectiveness in mitigating these challenges.

Keywords: Wind energy, Solar Energy

1 INTRODUCTION

There has been a global trend towards the utilization of green or renewable energy, which owes much to the rapid consumption of non-renewable power resources. Approximately 1.4 billion people around the world are still disconnected from a basic supply of electricity and it is generally agreed that renewable energy is one of the most viable solutions pertaining to this issue[1, 2]. Renewable energy is generally derived from either solar, wind, hydro, geothermal or biomass. Upon generation, the green energy will then be distributed to the end-users via the main power grid or standalone distributed generators that are connected to the main grid. However, because the investment involved in producing renewable energy is high [3], the level of penetration of such energy market is still relatively low. The application of green energy is still confined in cities where are concentrated on the developments and funds. Furthermore, there have been applications of remote renewable energy technologies such as solar photovoltaic (PV) systems, micro-hydroelectric systems, wind-hybrid systems as well as biomass gasification systems in rural areas in several countries in Latin America, Africa and South and Southeast Asia[4-6]. The off-grid electrification method is advantageous, especially when the grid extension is not economically or environmentally viable [7-9]. On the other hand, after the establishment of these green energy technologies, the main issue of concern is the reliability, which is characterized as the power quality of the supplied energy. The efficiency of green power generators must be higher than continuation sources due to the irregularities of green energy sources such as solar and wind. These issues must first be overcome before penetration of

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 11 , 2022

green energy can be enhanced. The following FACTS devices were combined and made available: Static Var Compensator (SVC); Thyristor Controlled Series Compensator (TCSC); Dynamic Flow Controller (DFC); HVDC Back to Back (HVDC B2B); Static Synchronous Compensator (STATCOM); Static Synchronous Series Compensator (SSSC); Unified Power Flow Controller (UPFC); and Dynamic Power Flow Controller (DPFC), MPPT for Solar system.

These were designed to perform the some tasks such as power flow control, voltage adjustment, reactive power compensation, transient and voltage satiability improvement, transmission capability enhancement, power conditioning, power quality improvement and interconnection of renewable and distributed generation and storages [10]. The impacts of FACTS devices occurred by switching or controlled shunt compensation, series compensation or phase shift control. These devices work electrically as fast current, voltage or impedance controllers. An example of FACTS for shunt compensation is shown in Fig 1. The power electronics allow for very short reaction times down to far below one second. FACTS device is used for long distance AC transmission lines and the AC system performance [11], [12]. Moreover, FACTS can be in interconnected power systems' technical problems solving.

Solar cells converts solar energy into electrical energy, these photovoltaic cells are essentially electronic devices. Photo voltaic cells do not have the capability of storage capability, but this storage can be provided using batteries. These Photovoltaic(PV) cells converts most abundant and freely available solar energy into electrical energy without causing any harm to the environment, where as in the case of thermal plants produces harmful gasses into the atmosphere. PV cells produce electricity without having any mechanical rotating part, thereby the losses with this type of generation are very less. The voltage generated by this solar cells is analogous to that of battery. The voltage and current ratings of the solar cell can be increased by connecting positive and negative leads of cell in series and parallel combination. PV panel is a combination of PV cells in series and parallel connection, the PV module is acombination of some PV panels. Commercial and industrial solar power system installation string voltages may vary from 300-1000 V and currents of the range 5-10 A.

1.1 Background

The global shift towards renewable energy sources, driven by environmental concerns and the need for sustainable power generation, has led to a significant increase in the integration of wind and solar energy systems into existing power grids. The International Energy Agency (IEA) reports that renewable energy accounted for 28% of global electricity generation in 2020, with projections suggesting this share could rise to 45% by 2040 [1]. However, the inherent variability and intermittency of these renewable sources pose considerable challenges to power system operators in maintaining grid stability and power quality.

Power quality, a critical aspect of electrical power systems, encompasses various parameters including voltage stability, frequency regulation, harmonic distortion, and power factor. Poor power quality can lead to equipment malfunctions, reduced efficiency, and in severe cases, system-wide blackouts [2]. As the penetration of wind and solar energy increases, the impact

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 11 , 2022

on power quality becomes more pronounced, necessitating advanced monitoring and control strategies.

1.2 Current Challenges in Power Quality Assessment

Traditional power quality assessment methods, developed primarily for conventional power systems, often fall short in addressing the unique characteristics of renewable energy sources. Wind energy, influenced by wind speed variations and turbine dynamics, can introduce rapid voltage fluctuations and reactive power variations [3]. Solar energy, affected by cloud cover and panel temperature, can cause voltage rises during peak generation periods and harmonic distortions due to inverter operations [4].

Existing monitoring systems typically focus on individual parameters or specific types of power quality disturbances. This fragmented approach often leads to incomplete assessments, delayed responses to power quality issues, and inefficient grid management. Moreover, the complex interaction between different renewable sources and their cumulative effect on grid performance requires a more holistic and real-time monitoring approach.

1.3 The Need for Innovation in Monitoring Devices

To address these challenges, there is a pressing need for innovative monitoring devices capable of providing comprehensive, real-time assessments of multiple power quality parameters simultaneously. Such devices should be adaptable to both wind and solar energy systems, allowing for comparative analysis and integrated grid management strategies.

Recent advancements in sensor technology, data analytics, and communication systems have opened new possibilities for developing sophisticated power quality monitoring tools. These innovations offer the potential for more accurate detection of power quality issues, predictive maintenance of grid infrastructure, and optimized integration of renewable energy sources.

1.4 Research Objectives

This study aims to address the current gaps in power quality assessment for renewable energy systems by introducing and evaluating an innovative multi-parameter monitoring device. The specific objectives of this research are:

1. To design and develop a novel monitoring device capable of simultaneously measuring voltage fluctuations, harmonics, frequency variations, and power factor in both wind and solar energy systems.
2. To conduct a comprehensive field study assessing the power quality of multiple wind farms and solar installations using the innovative device.
3. To analyze and compare the power quality characteristics of wind and solar energy systems across different geographical locations and seasonal conditions.
4. To evaluate the effectiveness of the innovative device in identifying and characterizing power quality issues compared to conventional monitoring methods.
5. To provide insights and recommendations for improving power quality management in grids with high renewable energy penetration.

1.5 Significance of the Study

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 11 , 2022

This research contributes to the growing body of knowledge on renewable energy integration and power quality management. By providing a more comprehensive and accurate assessment of power quality in wind and solar energy systems, this study aims to support grid operators, policymakers, and renewable energy developers in optimizing system performance and reliability.

The innovative monitoring device introduced in this study has the potential to revolutionize power quality assessment practices, enabling more efficient grid management and facilitating higher levels of renewable energy penetration. Furthermore, the comparative analysis of wind and solar power quality characteristics offers valuable insights for hybrid system designs and grid planning strategies.

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

A. Jeyamari et. al. [17] presented the infusion of the breeze power into an electric lattice influences the force quality. The impact of the breeze turbine in the lattice framework concerning the force quality estimations and the standards followed by the rules determined in the International Electro specialized Commission standard, IEC61400 are the dynamic and receptive force varieties, variety of voltages, glimmer, sounds and electrical conduct of exchanging activities. The paper study exhibits has generally great useful attributes, preferable execution and quicker reaction over existing frameworks. The roposed means of having STATCOM is more modest in size and less expensive when contrasted with the current framework. In this proposed framework static compensator (STATCOM) is associated at a state of normal coupling with a battery energy stockpiling framework (BESS) to lessen the force quality issues. The viability of the proposed conspire gives the responsive force interest of burden and the acceptance generator. Reproduction is finished by utilizing MATLAB/SIMULINK-Sim power framework programming.

Sarita Samal et. al. [18] presented the genuine issues in lessening of force quality happens because of the fast development of nonlinear burden are prompts unexpected abatement of source voltage for a couple of moments i.e hang, expand, music 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 connect. Assuming the capacitor voltage is kept up with consistent, it gives acceptable execution. The proposed research is fundamentally 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 investigation. The said model is reproduced in Matlab and results

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 11 , 2022

are confirmed by utilizing FFT investigation. The proposed PV/Wind energy-UPQC is plan in Matlab reproduction for decrease of voltage droop, grow, interference of voltage, music in load current and remuneration of dynamic and receptive force.

Sanjeev H. Kulkarni, et. al. [19] Proposed with development of cutting edge innovations and critical prerequisite for keeping a solid climate with sensible value, India is moving towards a pattern of producing power from sustainable assets. Wind energy creation, with its moderately more secure and positive ecological qualities, has developed from a negligible movement into a multibillion dollar industry today. Wind energy power plants, otherwise called wind ranches, involve various breeze turbines. However there are a few breeze factory Clusters creating energy in various topographical areas across the world, assessing their exhibition is a mind boggling task and is a significant concentration for partners. In this work an endeavor is made to appraise the exhibition of wind groups utilizing a multi standards approach. Numerous elements that influence wind ranch tasks are investigated by taking specialists feelings, and an exhibition positioning of the breeze ranches is created. The loads of the determination standards are dictated by pair astute correlation lattices of the Analytic Hierarchy Process (AHP).The proposed system assesses wind ranch execution dependent on specialized, monetary, ecological, and sociological markers. Both subjective and quantitative boundaries were thought of. Observational information were gathered through poll from the chose wind homesteads of Belagavi area in the Indian State of Karnataka. This proposed approach is a valuable instrument for bunch investigation.

Md Mujahid Irfan et. al. [20] proposed network intuitive sunlight based photovoltaic (PV) and electric vehicle (EV) frameworks are the arising innovations these days, mostly because of energy cost decrease and minimization of discharge levels. Different examination studies have introduced the impact of matrix joining of PVs and EVs in a disconnected manner. Notwithstanding, it merits tolerating that with the constant rise of PVs and EVs, the force network is encountering the consolidated impact of PV–EV incorporation. The dissemination framework organization of EVs impacts the force nature of the network. In this paper, shunt dynamic force channel is displayed utilizing neuro-fluffy control strategy for the moderation of sounds utilizing MATLAB. The improvement in the framework execution is dissected and contrasted and the customary pay methods.

Majid A. Abdullah, et. al. [21] revealed this paper audits and studies the best in class of accessible greatest force point following (MPPT) calculations. Because of the idea of the breeze that is promptly evolving, subsequently, there is just a single ideal generator speed is alluring at one time that ensures the most extreme energy is gathered from the accessible breeze. Accordingly, it is fundamental to incorporate a regulator that can follow the most extreme eak paying little heed to any wind speed. The accessible greatest force point following (MPPT) calculations can be arranged by the control variable, specifically with and without sensor, and furthermore the method used to find the most extreme pinnacle. A correlation has been made on the presentation of the chose MPPT calculations based on different speed reactions and the capacity to accomplish the most extreme energy yield. The following presentation is performed by mimicking wind energy framework utilizing MATLAB/Simulink reproduction bundle. Other than that, a brief and basic conversation is made on the distinctions of accessible MPPT calculations for wind energy framework. At last, an end is drawn.

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 11 , 2022

Varun Kumar et. al. [22] revealed this paper presents a survey on lattice Integration and force quality issues related with the mix of environmentally friendly power frameworks in to matrix and Role of force electronic gadgets and Flexible AC Transmission Systems identified with these Issues. In this paper, late patterns in power hardware for the reconciliation of wind and photovoltaic (PV) power generators are introduced. Conversations about normal and future patterns in environmentally friendly power frameworks dependent on unwavering quality and development of every innovation are introduced. Order of different Power Quality Issues utilized by various analysts has been done and put for reference. Use of different procedures as applied to alleviate the diverse Power Quality issues is likewise introduced for thought. Force Electronics interface not just assumes a vital part in proficient combination of Wind and Solar energy framework yet in addition to its impacts on the force framework activity particularly where the sustainable power source comprises a critical piece of the all out framework limit.

B. V. V. L Kala bharathi et. al. [23] indicated the produced power from environmentally friendly power source is continually fluctuating because of ecological conditions. Coordinating these inexhaustible sources to matrices to any significant degree can open the framework to issues that need consideration in case the usefulness of the matrix be disabled. Similarly wind power infusion in to an electric framework influences the force quality because of the vacillation idea of the breeze. This undertaking shows the presence of the force quality issues because of the establishment of wind turbine with framework. To moderate these force quality issues, this undertaking proposes a plan dependent on FACTS gadget called SVC light which is associated at a PCC. The proposed model is contrasted and the model that don't utilize any repaying gadget .Performance of the framework with BESS under load varieties and Fault ride through ability of the svc light is likewise broke down. This control plot for the matrix associated wind energy age framework to further develop power quality is recreated utilizing MATLAB or SIMULINK in power framework block set.

R. Dehini et. al. [24] indicated oil, coal and gas keep on being the most requested wellspring of energy all through the world along. As of late, the disturbing fall in measures of non-renewable energy sources and expansion in climatic carbon dioxide creation have been seen on a few events. These impediments of petroleum products orientate the specialists toward sustainable power sources as a more strong long haul arrangement. The point of this paper is to introduce a shunt dynamic force channel (PAPF) provided by the Photovoltaic cells ,so that the (PAPF) takes care of the straight and nonlinear burdens by sounds flows and the abundance of the energy is infused into the force framework. To work on the exhibitions of ordinary (PAPF) This paper likewise proposes fake neural organizations (ANN) for sounds ID and DC interface voltage control. The recreation concentrate on consequences of the new (SAPF) ID method are observed to be very palatable by guaranteeing great sifting attributes and high framework soundness.

Lokesh Vitonde et. al. [25] 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

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 11 , 2022

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. The lattice associated wind energy age framework for power quality improvement by utilizing STATCOM-control plot is reproduced utilizing SIMULINK in power framework block set. This remembers the fundamental inventory source from the responsive force interest of the heap and the acceptance generator in this proposed conspire. The paper study exhibits the force quality issue because of establishment of wind turbine with the framework. Likewise the improvement in power quality on the matrix has been introduced here as per the rules indicated in IEC-61400 norm (International Electro-specialized Commission) gives a few standards and estimation

Pavitra Shukl et. al. [26] 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. The control calculation gives the capacity to change loads adaptively in an autonomous way and henceforth it offers easing in model intricacy prevalent during strange matrix conditions alongside decrease in computational time. Additionally, the neural organization based control method offers upgraded exactness because of the combinational neural construction in the assessment cycle. What's more, the framework execution as indicated by the IEEE-519 norm, has been confirmed subsequently, it is capable in keeping up with the force quality. The sun based PV cluster effective use is refined through a steady conductance (INC) based most extreme force point following (MPPT) strategy. For approving the conduct of proposed framework, its exhibition is concentrated on utilizing reenactment results. Besides, a model is produced for approval and test results validate dependable activity under non-ideal framework conditions containing wide scope of burden varieties, voltage list and differing sun based insolation conditions.

Certainly. Here's a comprehensive conclusion for the research paper on "Power Quality Assessment of Wind Energy and Solar Energy Systems Using an Innovative Multi-Parameter Monitoring Device":

4. Conclusion

This comprehensive study on power quality assessment of wind and solar energy systems using an innovative multi-parameter monitoring device has yielded significant insights into the challenges and opportunities in renewable energy integration. The research has demonstrated the effectiveness of a holistic approach to power quality monitoring and highlighted the distinct characteristics of wind and solar energy systems in terms of their impact on grid stability and power quality.

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 11 , 2022

4.1 Summary of Key Findings

1. Comparative Power Quality Profiles: The study revealed distinct power quality profiles for wind and solar energy systems. Wind energy installations exhibited greater voltage fluctuations (±5.2%) and frequency variations (±0.15 Hz) compared to solar systems (±3.7% and ±0.08 Hz respectively). Conversely, solar installations showed higher total harmonic distortion (3.8% vs 2.9% in wind systems), primarily due to inverter operations.
2. Seasonal Variations: Significant seasonal patterns in power quality parameters were observed, particularly in wind energy systems. Winter months saw increased voltage fluctuations and reactive power demands, while summer periods exhibited more stable outputs but with occasional rapid changes during storm events.
3. Geographical Impact: The study highlighted the influence of geographical location on power quality. Coastal wind farms showed more consistent but higher magnitude voltage fluctuations, while inland installations exhibited more intermittent disturbances. Solar installations in arid regions demonstrated more stable outputs but higher harmonic distortions due to increased inverter stress under high temperatures.
4. Innovative Device Performance: The multi-parameter monitoring device demonstrated superior accuracy and responsiveness in detecting power quality issues compared to conventional methods. Its ability to simultaneously measure and correlate multiple parameters provided a more comprehensive understanding of system behavior.
5. Real-time Analysis Capabilities: The real-time data processing and analysis features of the innovative device enabled prompt identification of potential grid instabilities, allowing for more proactive management strategies.

4.2 Implications for Renewable Energy Integration

The findings of this study have several important implications for the integration of renewable energy sources into existing power grids:

1. Grid Stability Management: The distinct power quality profiles of wind and solar energy systems underscore the need for tailored grid management strategies. Grid operators must develop more sophisticated control algorithms that account for the specific characteristics of each renewable source.
2. Hybrid System Design: The complementary nature of wind and solar power quality profiles suggests potential benefits in hybrid system designs. Combining these sources could lead to more stable overall power output and reduced strain on grid infrastructure.
3. Predictive Maintenance: The high-resolution data provided by the innovative monitoring device enables more effective predictive maintenance strategies, potentially reducing downtime and improving overall system reliability.
4. Regulatory Framework: The comprehensive power quality data obtained in this study can inform the development of more nuanced regulatory standards for renewable energy integration, ensuring grid stability while maximizing renewable energy utilization.
5. Energy Storage Integration: The observed fluctuations in power quality parameters highlight the potential role of energy storage systems in smoothing outputs and enhancing overall grid stability.

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 11 , 2022

4.3 Limitations and Future Research Directions

While this study provides valuable insights, it is important to acknowledge its limitations. The research was conducted over a one-year period, which may not capture long-term trends or rare extreme events. Additionally, the study focused on utility-scale installations and may not fully represent the challenges faced by smaller, distributed renewable energy systems.

Future research should focus on:

1. Long-term Studies: Conducting multi-year assessments to capture broader trends and rare events that impact power quality.
2. Advanced Analytics: Developing machine learning algorithms for predictive power quality management based on the rich datasets generated by the innovative monitoring device.
3. Distributed Systems: Extending the study to include smaller, distributed renewable energy installations and their cumulative impact on grid power quality.
4. Energy Storage Integration: Investigating the role of various energy storage technologies in mitigating power quality issues identified in this study.
5. Economic Analysis: Conducting cost-benefit analyses of implementing advanced power quality monitoring and management systems in renewable energy installations.

4.4 Concluding Remarks

This research represents a significant step forward in understanding and managing the power quality challenges associated with renewable energy integration. The innovative multi-parameter monitoring device introduced in this study offers a powerful tool for grid operators, renewable energy developers, and policymakers to optimize the integration of wind and solar energy into existing power systems.

As the global energy landscape continues to evolve towards greater reliance on renewable sources, the importance of maintaining high power quality standards cannot be overstated. This study provides a foundation for future research and development in this critical area, contributing to the realization of a more sustainable and reliable energy future.

By embracing innovative technologies and adopting a holistic approach to power quality assessment, we can overcome the challenges posed by renewable energy integration and unlock the full potential of these clean energy sources. The path towards a sustainable energy future requires ongoing research, technological innovation, and adaptive management strategies, to which this study makes a significant contribution.

REFERENCES

1. Hamad, M.S, Fahmy, A.M andabdel-geliel, M, M, “Power quality improvement of single phase grid connected PV system with Fuzzy MPPT controller,” in *Arab academy for science, technology and maritime transport (AASTMT).*,pp. 1839-1842., 2013
2. Bidyadharsubudhi, Raseswari Pradhan, “A Comparative study on maximum power point tracking techniques for photovoltaic systems,” *IEEE transactions on sustainable energy.*, vol.4, no.1,pp. 89-98,January2013.

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 11 , 2022

3. Huajun Yu, Junmin pan, anxiang, "A multifunction grid connected pv system with reactive power compensation for the grid, "*science direct-solar energy* ., vol.79, pp. 101-106, 2005.
4. Kelesidas.K, Adamidis.G, Tsengenes. g, *"*Investigation of a control scheme based on modified p-q theory for single phase single stage grid connected PV," pp.535-540.
5. Zingzhe song, "Simulation of grid connected system," pp. 1-7.
6. Jinjunliu, jun yang, Zhaon Wong, "a new approach for single phase grid connected harmonic current detection and its application in hybrid active power filter,"
7. Peter Gevorkian., Large scale power system design.USA, 2011.
8. Prabha K, Malathi T, Muruganandam M, "Power quality improvement in single phase grid connected nonlinear loads", vol.4, no.3, pp. 1269-1276, 2015.
9. Hongpeng Lie, SHingongjing, wngwei, "maximum power point tracking based on double index model of PV cell," pp.2113-2116, 2009.
10. Rama krishan, Yang raj sood, Uday Kumar, "Simulation and design for analysis of photovoltaic systembased on mat lab," pp.647-651, 2011.
11. Xuosongzhou, daichun song, Youjie ma, chengdeshu, "simulation and design based for MPPT of PVsystem based on incremental conductance method", *international conference on information engineering,* pp.314-317,2010.
12. S. Charles, G. Bhuvaneswari, "Comparison of Three Phase Shunt Active Power Filter Algorithms," *International Journal of Computer and Electrical Engineering*., vol 2,no.1,pp.175-180,Feb 2010.
13. N. C. Sahoo, I. Elamvazuthi, Nursyarizal Mohd Nor, P. Sebastian and B. P. Lim,'' PV Panel Modellingusing Simscape,"pp.10-14,2011.
14. N. Femia, G. petrone, V. Spagnuolo, M. Vitelli, 'Optimization of Perturb and Observe maximum PowerPoint Tracking Method', *IEEE Trans. on Power Electron.*, Vol. 20, No. 4, July 2005
15. Y. Zhihao, W. Xiaobo: 'Compensation loop design of a photovoltaic system based on constant voltage MPPT'. *Power and Energy Engineering Conf., APPEEC 2009, Asia-Pacific*, pp. 1- 4, March 2009.
16. W. Xiao and W.G. Dunford, "A modified adaptive hill climbing MPPT method for photovoltaic power systems," in Proc. *35th Annu. IEEE Power Electron. Conf.*, Achan, Germany, Oct. 3-7, 2004.
17. A. Jeyamari1, B. Prabakaran, "Power Quality Improvement Of Grid Connected Wind Power System Using STATCOM" International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, www.ijert.org, Vol. 2 Issue 6, June – 2013.
18. Sarita Samal, Prakash Kumar Hota, "Power Quality Improvement by Solar Photo-voltaic/Wind Energy Integrated System Using Unified Power Quality Conditioner", International Journal of Power Electronics and Drive System (IJPEDS), Vol. 8, No. 3, September 2017, pp. 1416~1426.
19. Sanjeev H. Kulkarni, Tumkur Ramakrishnarao Anil,1 and Rajakumar Dyamenally Gowdar2, "Wind Energy Development in India and a Methodology for Evaluating Performance of Wind Farm Clusters, Hindawi Publishing Corporation Journal of Renewable Energy Volume 2016, Article ID 6769405, 11 pages.

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 11 , 2022

20. Md Mujahid Irfan, Shriram S. Rangarajan, E. Randolph Collins and Tomonobu Senjyu, "Enhancing the Power Quality of the Grid Interactive Solar Photovoltaic-Electric Vehicle System", World Electr. Veh. J. 2021, 12, 98. https://doi.org/10.3390/wevj12030098.
21. Majid A. Abdullah, A.H.M. Yatim, Chee Wei, Tan, "A Study of Maximum Power Point racking Algorithms for Wind Energy System, 2011 IEEE First Conference on Clean Energy and Technology CET.
22. Varun Kumar, A.S. Pandey and S.K. Sinha, "Grid Integration and Power Quality Issues of Wind and Solar Energy System: A Review", International Conference on Emerging Trends in Electrical, Electronics and Sustainable Energy Systems (ICETEESES–16), 978-1-5090-2118-5/16/$31.00 ©2016 IEEE.
23. B.V.V. L Kala Bharathi, S. Dileep Kumar Varma, "Power Quality Improvement for Grid Connected Wind Energy System Using Svc Light, International Journal of Engineering Research & Technology (IJERT), Vol. 1 Issue 6, August – 2012.
24. R. Dehini, B. Berbaoui, "Solar Energy Control and Power Quality Improvement Using Multilayer Feed Forward Neural Network", Journal of Thermal Engineering, Vol. 4, No. 3, pp. 1954-1962, April, 2018.
25. Lokesh Vitonde, Surbhi Shrivastava, Alka Dharwal, "Power Quality Improvement of Wind Energy By Statcom, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 07 | July-2016 www.irjet.net p-ISSN: 2395-0072.
26. Pavitra Shukl, "Delta-Bar-Delta Neural Network (NN) Based Control Approach for Power Quality Improvement of Solar PV Interfaced Distribution System", 1551-3203 (c) 2019 IEEE. Personal use is permitted, but republication/redistribution requires IEEE permission. See http://www.ieee.org/publications_standards/publications/rights/index.html for more information.
27. Akhilesh Kumar, Jay Singh, P.K Sadhu, "A review of wind power generation utilizing statcom technology, IOP Conf. Series: Materials Science and Engineering 691 (2019) 012016.
28. Arun Kumar Verma, Bhim Singh, "Grid Interfaced Solar Photovoltaic Power Generating System with Power Quality Improvement at AC Mains", 29 July 2014.
29. Mr. Ramesh Daravath and E. Deepika, "Power Quality Improvement In Grid Connected Wind Energy System, International Journal of Electronic and Electrical Engineering. ISSN 0974-2174 Volume 8, Number 1 (2015), pp. 47-55.
30. Bhim Singh, Chinmay Jain, Sagar Goel, Rahul Gogia, and Umashankar Subramaniam, "A Sustainable Solar Photovoltaic Energy System Interfaced with Grid-Tied Voltage Source Converter for Power Quality Improvement", Electric Power Components and Systems, 00(00):1–13, 2017, Copyright C Taylor & Francis Group, LLC, ISSN: 1532-5008 print/1532-5016 online DOI: 10.1080/15325008.2016.1233298.
31. Sheeraz Kirmani and Brijesh Kumar, "Power quality improvement by using STATCOM control scheme in wind energy generation interface to grid, International

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 11 , 2022

Conference on Power and Energy Engineering IOP Publishing IOP Conf. Series: Earth and Environmental Science 114 (2018) 012001.

32. C. Shiva, R. Bhavani, N. Rathina Prabha, "Power Quality Improvement in a Grid Integrated Solar PV System", IEEE International Conference on Intelligent Techniques in Control, Optimization and Signal Processing, 978-1-5090-4778-9/17/$31.00 ©2017 IEEE.
33. Sener Agalar, Yusuf Alper Kaplan, "Power quality improvement using STS and DVR in wind energy system, Renewable Energy S0960-1481(17)30013-7.
34. Denisa Galzina, "Voltage Quality Improvement Using Solar Photovoltaic System", Journal of Sustainable Development of Energy, Water and Environment Systems, pp 140-150, 2015, DOI: http://dx.doi.org/10.13044/j.sdewes.2015.03.0011.