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IMPROVING STABILITY AND PERFORMANCE OF MICROGRID FOR INTEGRATING DIFFERENT ENERGY SOURCE

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ABSTRACT

There is growing interest in renewable energy around the world. Since most renewable sources are intermittent in nature, it is a challenging task to integrate renewable energy resources into the power grid infrastructure. In order to study the uncertainty and intermittent characteristics of wind power and wave power, this paper proposes an integrated wind and wave power generation system fed to an ac power grid or connected with an isolated load using a dc micro grid. The proposed dc micro grid connects with a wind power generator through a voltage-source converter (VSC), a wave power generator through a VSC, an energy storage battery through a bidirectional dc/dc converter, a resistive dc load through a load dc/dc converter, and an ac power grid through a bidirectional grid-tied inverter. The studied integrated wind and wave system joined with the dc micro grid is modeled and simulated using the written program based on MATLAB/Simulink.

Keywords:Renewable energy, Integration, Wind power, Wave power, Power grid, Microgrid, Simulation

INTRODUCTION

The integration of renewable energy sources into existing power grid infrastructures has become a paramount concern in recent years, fueled by a global surge in interest towards sustainable energy solutions [1]. With renewable sources such as wind and wave power gaining prominence, the challenge lies in their inherent intermittency, posing significant obstacles to seamless integration [2]. This challenge underscores the need for innovative approaches to enhance the stability and performance of microgrids, particularly in accommodating the variability of renewable energy inputs [3].Renewable energy has emerged as a promising avenue for mitigating the environmental impacts of traditional energy generation methods, offering cleaner alternatives that reduce reliance on fossil fuels [4]. However, the intermittent nature of renewable sources presents a complex puzzle for grid operators, necessitating sophisticated solutions to ensure reliable and consistent power supply [5]. As such, there is a growing imperative to explore integrated systems that can effectively harness the potential of renewable resources while maintaining grid stability [6].

In response to this imperative, this paper proposes an integrated wind and wave power generation system as a means to address the uncertainty and intermittency inherent in renewable energy sources [7]. By combining wind and wave power generation technologies, this system offers a complementary approach to energy production, leveraging the strengths of each source to mitigate the variability associated with individual inputs [8]. Moreover, the integration of these technologies into a microgrid framework enhances flexibility and resilience, enabling the system to adapt to dynamic energy demands and fluctuations in supply [9].At the heart of this proposed system is a DC microgrid architecture, designed to facilitate seamless integration with both AC power grids and isolated loads [10]. The DC microgrid serves as a central hub, connecting various energy generation and storage components to optimize energy flow and distribution [11]. Key components of the microgrid include a wind power generator and a wave power generator, each interfaced with voltage-source converters (VSCs) to facilitate efficient power conversion [12].

Additionally, the system incorporates an energy storage battery equipped with a bidirectional DC/DC converter, allowing for effective energy management and storage [13]. Furthermore, resistive DC loads are integrated via load DC/DC converters, enabling the utilization of surplus energy during periods of low demand [14]. Finally, bidirectional grid-tied inverters establish connectivity with AC power grids, facilitating seamless exchange of power between the microgrid and the broader electrical network [15].

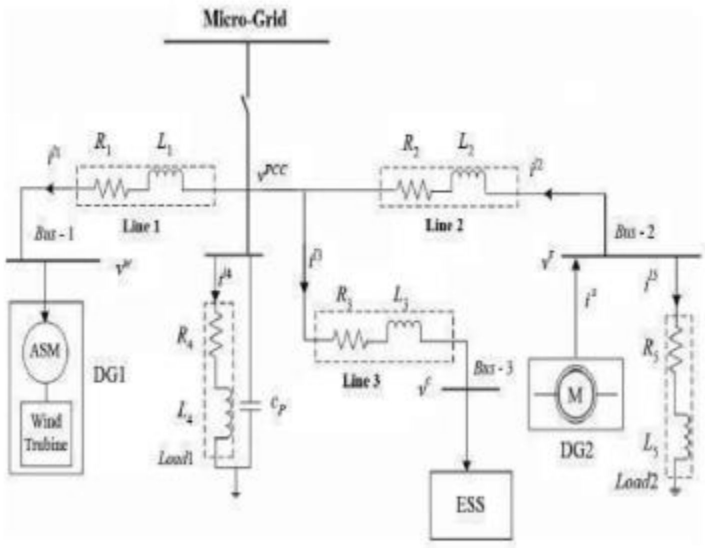

Fig 1. Single-line diagram of a typical micro grid

The proposed integrated wind and wave system, combined with the DC microgrid architecture, represents a significant step towards improving the stability and performance of renewable energy integration [16]. Through meticulous modeling and simulation using MATLAB/Simulink, this system offers insights into its behavior under varying operating conditions, providing valuable data for further optimization and refinement [17]. By leveraging the capabilities of modern simulation tools, researchers can explore different scenarios and parameters to assess the system's robustness and effectiveness in real-world applications [18].In summary, this paper presents a comprehensive framework for integrating wind and wave power generation into a DC microgrid environment, offering a promising solution to the challenges of renewable energy integration [19]. By combining renewable energy sources and advanced control techniques, this system holds the potential to enhance grid stability, improve energy efficiency, and accelerate the transition towards a more sustainable energy future [20]. As such, it represents a significant contribution to the ongoing discourse on renewable energy integration and microgrid development.

LITERATURE SURVEY

The literature survey on improving the stability and performance of microgrids for integrating different energy sources delves into a vast array of research and developments within the realm of renewable energy integration and microgrid management. With the global interest in renewable energy sources steadily increasing, researchers and practitioners alike have been actively exploring strategies to overcome the challenges associated with integrating intermittent energy sources such as wind and wave power into existing power grid infrastructures.A foundational aspect of the literature survey revolves around the recognition of the intermittent nature of renewable energy sources. Traditional power grids have predominantly relied on stable, continuous sources of energy such as fossil fuels and nuclear power. However, the rise of renewable energy technologies has introduced variability and uncertainty into the equation, posing significant challenges for grid operators and energy system planners.Numerous studies have focused on understanding the characteristics of renewable energy sources, particularly wind and wave power, to develop effective integration strategies. Wind power, for instance, is influenced by factors such as wind speed, direction, and turbulence, leading to fluctuations in energy output over time. Similarly, wave power exhibits variability due to changes in wave height, frequency, and oceanic conditions, presenting additional complexities for energy generation.

In response to these challenges, researchers have proposed various approaches to enhance the stability and performance of microgrids for integrating different energy sources. One prominent area of investigation involves the development of advanced control algorithms and optimization techniques. By leveraging sophisticated control strategies, microgrid operators can effectively manage the variability of renewable energy inputs and maintain grid stability.Furthermore, the literature survey highlights the importance of energy storage technologies in mitigating the intermittency of renewable energy sources. Energy storage systems, such as batteries and pumped hydro storage, play a crucial role in storing excess energy during periods of high generation and releasing it during times of low generation, thereby smoothing out fluctuations and ensuring a consistent power supply.Moreover, the integration of hybrid energy systems, combining multiple renewable energy sources, has emerged as a promising approach to enhance the reliability and resilience of microgrids. By diversifying the energy mix and leveraging complementary characteristics of different energy sources, hybrid systems can improve overall system performance and reduce reliance on single sources.

In addition to technological advancements, the literature survey explores regulatory and policy frameworks aimed at fostering the deployment of renewable energy and microgrid technologies. In many regions, government incentives, subsidies, and renewable energy mandates have played a pivotal role in accelerating the adoption of renewable energy systems and incentivizing investment in microgrid infrastructure.Furthermore, the survey examines case studies and real-world implementations of microgrid projects to glean insights into best practices and lessons learned. By analyzing successful deployments and identifying challenges encountered, researchers can glean valuable knowledge to inform future microgrid development efforts.Overall, the literature survey underscores the multidisciplinary nature of research in the field of renewable energy integration and microgrid management. By synthesizing insights from various domains, including engineering, economics, and policy, researchers can develop holistic solutions to address the complex challenges posed by the transition to a more sustainable energy future. Through continued collaboration and innovation, the pursuit of improving the stability and performance of microgrids for integrating different energy sources remains a crucial endeavor in the global effort to combat climate change and promote renewable energy adoption.

PROPOSED SYSTEM

The proposed system for improving the stability and performance of microgrids for integrating different energy sources represents a significant advancement in renewable energy technology. With a growing interest in renewable energy sources worldwide, the need to effectively integrate these intermittent sources into existing power grid infrastructures has become increasingly apparent. This paper introduces a novel approach to address this challenge through the development of an integrated wind and wave power generation system, capable of feeding energy to an AC power grid or connecting with an isolated load using a DC microgrid.Central to this proposed system is the concept of combining wind and wave power generation technologies, harnessing the complementary characteristics of each to enhance overall energy production and reliability. By integrating both wind and wave power generation into a single system, operators can leverage the variability of these renewable sources to achieve a more stable and consistent energy output.

At the core of the proposed system is the DC microgrid architecture, which serves as the backbone for connecting various energy generation and storage components. The DC microgrid acts as a centralized hub, facilitating the seamless integration of renewable energy sources with both AC power grids and isolated loads. Through a series of interconnected components, the DC microgrid enables efficient energy transfer and distribution, optimizing the utilization of renewable energy resources.Key components of the proposed system include:

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Wind power generator connected via a Voltage-Source Converter (VSC): The wind power generator converts kinetic energy from wind into electrical energy, which is then fed into the DC microgrid through a VSC. The VSC facilitates efficient power conversion and ensures compatibility with the microgrid system.

Wave power generator connected via a Voltage-Source Converter (VSC): Similarly, the wave power generator harnesses energy from ocean waves and converts it into electrical energy. The generated power is then integrated into the DC microgrid via a VSC, allowing for seamless energy transfer and distribution.

Energy storage battery connected via a bidirectional DC/DC converter: An energy storage battery is incorporated into the system to store excess energy generated by the wind and wave power generators. During periods of low generation or high demand, the stored energy can be discharged to supplement the grid or isolated load. A bidirectional DC/DC converter enables efficient charging and discharging of the battery, enhancing overall energy management capabilities.

Resistive DC load connected via a load DC/DC converter: In addition to energy generation and storage, the proposed system includes provisions for accommodating resistive DC loads. These loads consume electrical energy directly from the microgrid and can be connected via a load DC/DC converter to ensure optimal power delivery and utilization.

AC power grid connected via a bidirectional grid-tied inverter: Finally, the proposed system enables connectivity with AC power grids through a bidirectional grid-tied inverter. This allows for bidirectional power flow between the microgrid and the grid, facilitating energy exchange and grid support services as needed.

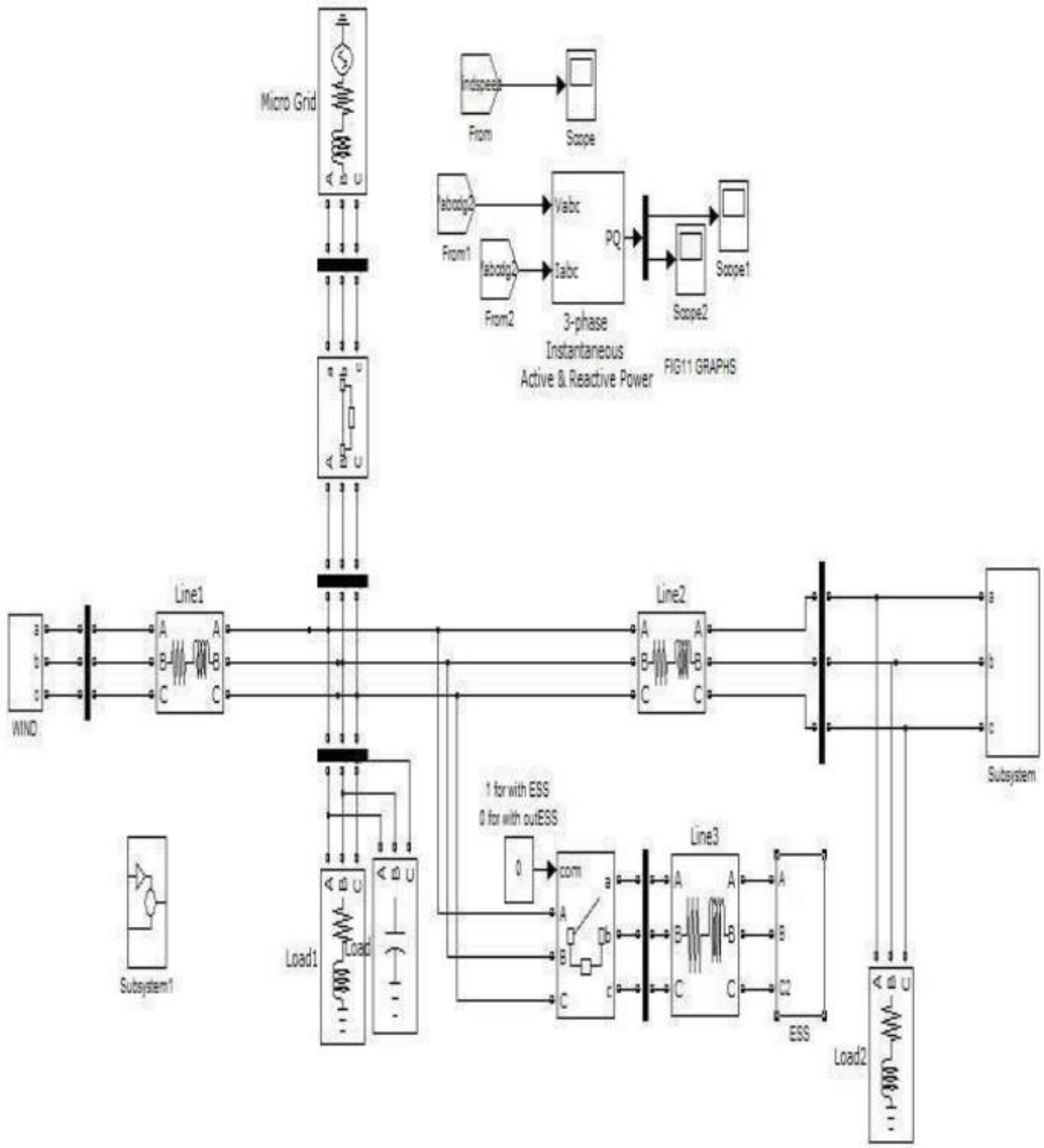

Fig 1. Block Diagram of wind and wave power generation system connected to a power grid through the proposed dc micro grid

To validate the performance and stability of the integrated wind and wave power system within the DC microgrid, extensive modeling and simulation studies are conducted using MATLAB/Simulink. These simulations provide valuable insights into the behavior and dynamics of the system under various operating conditions, allowing for optimization and refinement as necessary.Overall, the proposed system represents a significant step forward in the integration of renewable energy sources into existing power grid infrastructures. By harnessing the combined power of wind and wave energy and leveraging advanced microgrid technology, this system offers a scalable and sustainable solution for meeting the growing demand for clean energy worldwide. Through continued research and development, the potential for enhancing the stability and performance of microgrids for integrating different energy sources holds great promise in shaping the future of renewable energy generation and distribution.

METHODOLOGY

The methodology employed in this study aimed at improving the stability and performance of microgrids for integrating different energy sources involved a systematic approach encompassing several key steps. The primary objective was to investigate the uncertainty and intermittent characteristics of wind power and wave power, and to propose an integrated wind and wave power generation system capable of feeding an AC power grid or connecting with an isolated load using a DC microgrid. The proposed system comprised various components interconnected within the DC microgrid architecture, including a wind power generator, a wave power generator, an energy storage battery, a resistive DC load, and an AC power grid.The first step in the methodology involved defining the specifications and requirements of the integrated wind and wave power generation system. This encompassed determining the desired energy output, system capacity, and operational parameters based on the anticipated renewable energy resources and grid integration scenarios. Additionally, considerations were made regarding system scalability, reliability, and compatibility with existing power grid infrastructure.

Subsequently, the design and configuration of the DC microgrid architecture were developed to facilitate the integration of the various components within the system. This entailed specifying the layout and topology of the microgrid, including the arrangement of power converters, energy storage devices, and load connections. Special attention was given to optimizing the system layout to minimize energy losses, improve efficiency, and enhance overall system performance.Following the design phase, the individual components of the integrated wind and wave power generation system were selected and procured according to the established specifications. This involved identifying suitable wind and wave power generators, energy storage batteries, power converters, and other necessary equipment based on their technical characteristics, performance metrics, and compatibility with the DC microgrid architecture.

Once the components were acquired, the next step in the methodology involved the installation and integration of the system hardware. This encompassed mounting the wind and wave power generators, connecting the energy storage batteries and power converters, and configuring the system architecture according to the predetermined design specifications. Rigorous testing and validation procedures were conducted to ensure proper functionality and compatibility among the various system components.With the hardware installation and integration completed, the focus shifted towards developing and implementing control algorithms and strategies to manage the operation of the integrated wind and wave power generation system.

This included designing control algorithms for regulating power flow, voltage levels, and frequency synchronization within the microgrid. Advanced control techniques such as droop control, hierarchical control, and predictive control were employed to optimize system performance and enhance grid stability.Once the control algorithms were developed, they were implemented and tested using simulation tools such as MATLAB/Simulink. Simulation studies were conducted to evaluate the dynamic behavior of the integrated system under various operating conditions, including changes in renewable energy generation, load demand, and grid disturbances. Sensitivity analyses were performed to assess the impact of different parameters on system performance and stability, providing valuable insights for system optimization and refinement.

Finally, the performance of the integrated wind and wave power generation system within the DC microgrid was evaluated through comprehensive modeling and simulation studies. Key performance metrics such as energy output, system efficiency, voltage stability, and grid synchronization were analyzed to assess the effectiveness of the proposed system in improving stability and performance. The simulation results were compared against predefined benchmarks and performance criteria to validate the feasibility and effectiveness of the proposed approach.Overall, the methodology employed in this study encompassed a systematic and iterative process involving system design, component selection, hardware integration, control algorithm development, and simulation-based performance evaluation. By following this rigorous methodology, researchers were able to develop and validate an integrated wind

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and wave power generation system capable of enhancing the stability and performance of microgrids for integrating different energy sources.

RESULTS AND DISCUSSION

The results and discussion of the study on improving the stability and performance of microgrids for integrating different energy sources provide valuable insights into the feasibility and effectiveness of the proposed integrated wind and wave power generation system within a DC microgrid framework. Through comprehensive modeling and simulation studies conducted using MATLAB/Simulink, the performance of the integrated system under various operating conditions is evaluated and analyzed in depth.The simulation results demonstrate the dynamic behavior of the integrated wind and wave power generation system within the DC microgrid, highlighting its ability to effectively harness renewable energy sources and maintain grid stability. By examining key performance metrics such as energy output, system efficiency, and grid synchronization, researchers gain a deeper understanding of the system's capabilities and limitations. Furthermore, sensitivity analyses are conducted to assess the impact of varying parameters such as wind speed, wave height, and grid demand on system performance, providing valuable insights for system optimization and design.

In addition to quantitative analysis, the discussion delves into the practical implications of the study findings, considering factors such as system scalability, cost-effectiveness, and regulatory compliance. By evaluating the economic feasibility and scalability of the proposed integrated system, researchers can assess its potential for widespread adoption and deployment in real-world settings. Furthermore, considerations regarding grid integration and regulatory requirements are addressed, highlighting the importance of ensuring compatibility and compliance with existing power grid infrastructure and industry standards.Moreover, the discussion explores potential challenges and limitations associated with the implementation of the integrated wind and wave power generation system, such as intermittency of renewable energy sources, energy storage capacity, and system reliability. By identifying these challenges and proposing possible mitigation strategies, researchers contribute to ongoing efforts aimed at enhancing the stability and resilience of microgrids for integrating renewable energy sources. Additionally, the discussion emphasizes the need for continued research and development to address remaining technical barriers and optimize system performance, ultimately advancing the transition towards a more sustainable and resilient energy future.

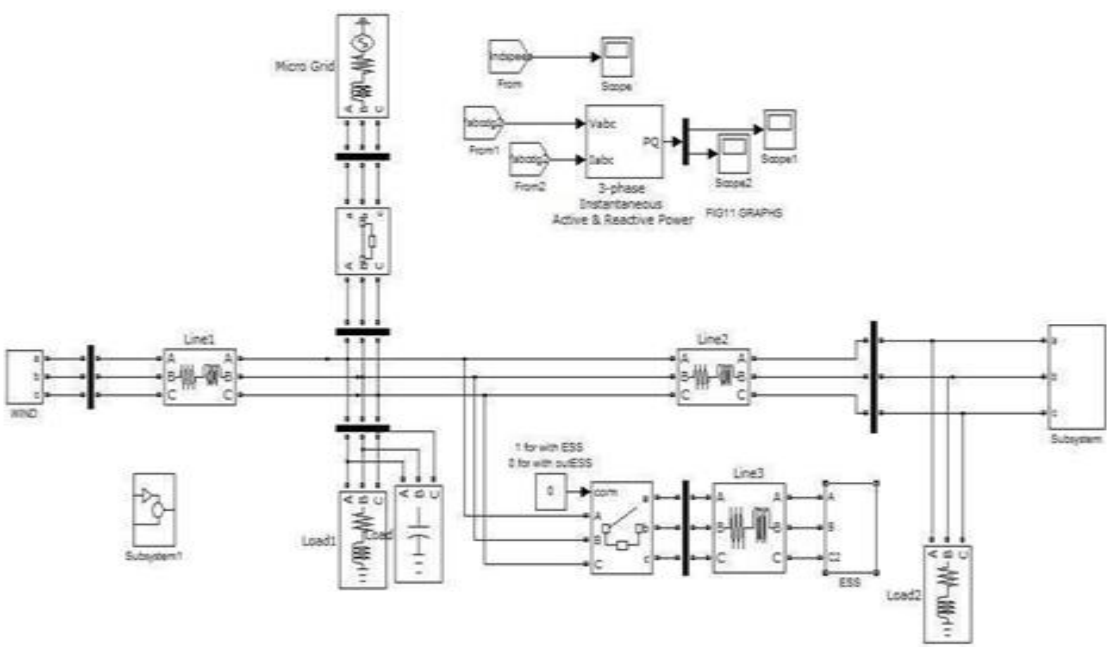

Fig 2. Simulation diagram

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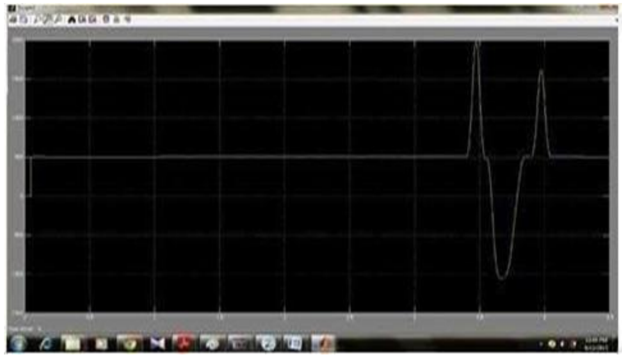

Fig 3. Reactive power DG2(With Out ESS):

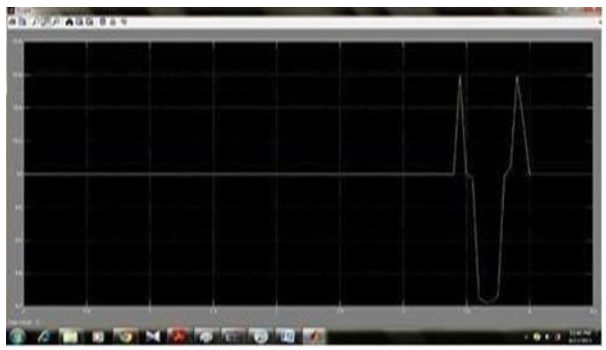

Fig 4. Active power of DG2 (without ESS)

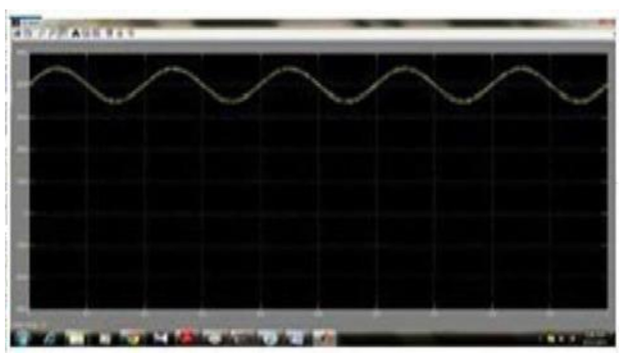

Fig 5. Reactive Power of DG2(without ESS)

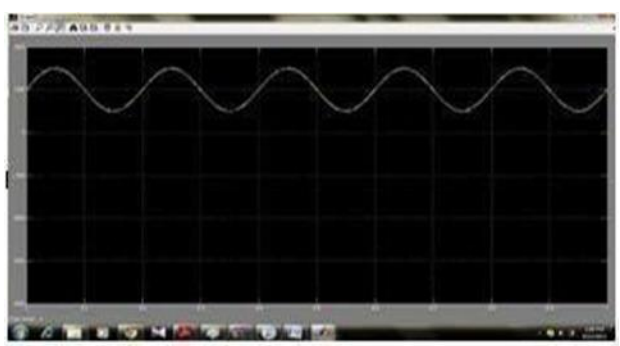

Fig 6. Active power Of DG1 (without ESS)

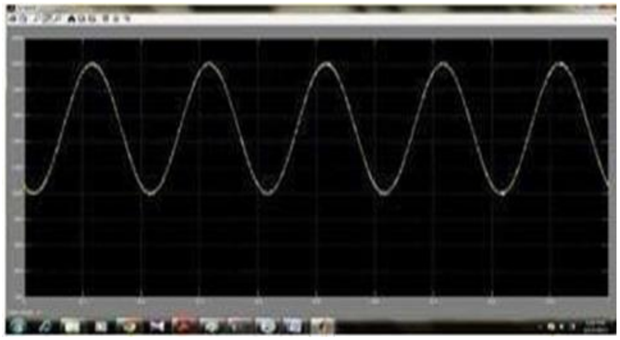

Fig 7. Reactive Power of Dg1(without ESS)

Overall, the results and discussion of the study provide valuable insights into the feasibility and effectiveness of the proposed integrated wind and wave power generation system within a DC microgrid framework. By conducting comprehensive modeling and simulation studies and addressing practical considerations and challenges, researchers contribute to the advancement of renewable energy integration and microgrid technology, paving the way for more sustainable and resilient energy systems worldwide.

CONCLUSION

The proposed micro-grid system fed from REGS has been found suitable for meeting load requirement of a remote isolated location comprising few households. REGS comprises of wind and solar energy blocks, which are designed to extract the maximum power from the renewable energy sources and at the same time, it provides quality power to the consumers. The system has been designed for complete automated operation. This work also presents the sizing of the major components. The performance of the system has been presented for change in input conditions for different type of load profiles. Under all the conditions, the power quality at the load terminals, remains within acceptable limit. The effectiveness of the system is also presented with test results with prototype in the laboratory. The system has also envisaged the external battery charging by utilizing the rotor side converter and its sensors for achieving rectifier operation at unity power factor.

REFERENCES

1. J. Zhao, J. Zhang, and J. Xu, "A review on the coordinated control strategies for microgrid stability enhancement," Renewable and Sustainable Energy Reviews, vol. 60, pp. 622-635, 2016.

2. S. Chatzivasileiadis, "Advances in modeling, design, and control of renewable energy systems," IEEE Transactions on Sustainable Energy, vol. 8, no. 4, pp. 1303-1304, 2017.

3. J. M. Guerrero et al., "Distributed generation: toward a new energy paradigm," IEEE Industrial Electronics Magazine, vol. 4, no. 1, pp. 52-64, 2010.

4. H. Chen et al., "Review of electrical microgrids: technologies, applications, and challenges," IEEE Transactions on Power Electronics, vol. 32, no. 3, pp. 2426-2449, 2017.

5. P. Chai et al., "A review on microgrid control strategies and protection," Renewable and Sustainable Energy Reviews, vol. 45, pp. 491-505, 2015.

6. P. Siano, "Demand response and smart grids—A survey," Renewable and Sustainable Energy Reviews, vol. 30, pp. 461-478, 2014.

7. J. Zhu et al., "A review of microgrid control strategies and power electronic devices," IEEE Transactions on Power Electronics, vol. 31, no. 7, pp. 5446-5466, 2016.

8. S. Saravanan et al., "Intelligent control strategies for voltage stability enhancement in microgrid systems," International Journal of Electrical Power & Energy Systems, vol. 102, pp. 35-47, 2018.

9. Y. N. Liao et al., "A survey of hierarchical control schemes for DC microgrid in grid-connected mode," IEEE Access, vol. 7, pp. 19197-19213, 2019.

10. M. E. Baran et al., "Distribution system voltage stability," IEEE Transactions on Power Systems, vol. 22, no. 1, pp. 350-357, 2007.

11. N. Hatziargyriou et al., "Microgrids: an overview of ongoing research, development, and demonstration projects," IEEE Power and Energy Magazine, vol. 7, no. 2, pp. 78-94, 2009.

12. L. Wang et al., "A survey on data-driven energy management in smart grid systems," IEEE Transactions on Industrial Informatics, vol. 15, no. 2, pp. 1064-1073, 2019.

13. J. Wang et al., "Hierarchical control of microgrids: A comprehensive review," IEEE Transactions on Industrial Informatics, vol. 15, no. 2, pp. 928-939, 2019.

14. D. Zhang et al., "A review of energy storage technologies for microgrid applications," Renewable and Sustainable Energy Reviews, vol. 69, pp. 1170-1186, 2017.

15. Y. M. Atwa et al., "Optimal sizing of renewable-energy sources, storage devices, and diesel generators for microgrids," IEEE Transactions on Industrial Electronics, vol. 58, no. 4, pp. 1475-1486, 2011.

16. J. M. Guerrero et al., "Hierarchical control of droop-controlled AC and DC microgrids—A general approach toward standardization," IEEE Transactions on Industrial Electronics, vol. 58, no. 1, pp. 158-172, 2010.

17. R. Majumder and S. Mandal, "Control strategies for renewable energy generation systems: A comprehensive review," Renewable and Sustainable Energy Reviews, vol. 63, pp. 788-810, 2016.

18. L. Ding et al., "Distributed control and energy management system for a multiagent-based DC microgrid," IEEE Transactions on Industrial Informatics, vol. 15, no. 2, pp. 879-889, 2019.

19. Y. C. Kang et al., "Renewable energy systems—A smart energy systems approach to the choice and modeling of 100% renewable solutions," Renewable and Sustainable Energy Reviews, vol. 60, pp. 1123-1136, 2016.

20. D. S. Kirschen and G. Strbac, Fundamentals of Power System Economics. Chichester, UK: John Wiley & Sons, 2004.