# Innovative Control Approaches for Efficient Power Management in Hybrid Renewable Energy Resource Microgrids

[1]Rubini.B, [2] Saloni Bansal, [3] Dhiraj Jadhav, [4] Dr.K.K.Senthilkumar, [5] Dr.R.Dhilipkumar, [6] Dr. Avinash M. Pawar, [7]Dr.V.Vivek

[1]*Vels Institute of Science Technology and Advanced Studies, Pallavaram,Chennai, India.*
[2] *Department of Electronics & Communication Engineering, GLA University, Mathura, saloni.bansal@gla.ac.in*
[3] *Department of Computer Engineering,Vishwakarma Institute of Technology Pune India dhiraj.jadhav@vit.edu*
[4] *Associate Professor,Department of ECE,Prince Shri Venkateshwara Padmavathy Engineering College, Chennai - 127.,k.k.senthilkumar_ece@psvpec.in*
[5] *Asso Professor,Department of ECE,New Prince Shri Bhavani College of Engineering and Technology Chennai-600073,Tamil nadu,India,dhilip.r@newprinceshribhavani.com*
[6] *Bharati Vidyapeeth's college of Engineering for women, Pune avinash.m.pawar@bharatividyapeeth.edu*
[7]*AAA College of Engineering and Technology, Sivakasi, Tamil Nadu, India - 626005 vivekmsucse@gmail.com*

Abstract: Hybrid renewable energy resource (RER) microgrids offer a sustainable solution to integrating multiple energy sources like solar and wind into modern power systems. However, managing the intermittent nature of these resources presents significant challenges in maintaining stable and efficient power distribution. This study explores innovative control approaches for optimizing power management in hybrid RER microgrids. By utilizing advanced algorithms, including real-time optimization and machine learning techniques, the proposed framework ensures efficient energy distribution, reduces dependency on the grid, and enhances system stability. The research focuses on integrating these control strategies to balance energy supply and demand while maximizing the utilization of renewable energy sources. Simulation results demonstrate the effectiveness of the proposed methods in improving system efficiency and reliability under varying environmental conditions, contributing to the broader adoption of hybrid RER microgrids.

Keywords: Hybrid renewable energy, power management, control strategies, energy optimization, microgrids

## 1. Introduction

[1] *rubini.se@velsuniv.ac.in*

The pressing need to cut carbon emissions and slow down climate change is what is driving the world's shift to renewable energy sources like solar and wind. Although renewable energy offers a viable substitute for fossil fuels, sustaining a steady and dependable energy supply is hampered by its inherent variability. Grid operators face a significant challenge in balancing the real-time energy supply and demand due to the intermittent nature of solar and wind generation, which is impacted by weather patterns and time of day. In order to provide a more regular and dependable power supply, hybrid renewable energy resource (RER) microgrids—which combine several renewable sources with energy storage systems—have emerged as a viable solution to these problems. Hybrid RER microgrid power flow management is challenging, nevertheless, since it calls for optimizing renewable energy utilization while lowering dependency on the main grid and maintaining system stability. This paper investigates novel control approaches to improve hybrid RER microgrid power management. The goal of the project is to maximize the utilization of renewable energy sources, lower operating costs, and increase the efficiency of energy distribution by utilizing sophisticated control techniques like machine learning and real-time optimization. By adapting to changes in energy availability in real time, these adaptive control mechanisms make sure the microgrid runs effectively and consistently. The suggested techniques provide important new information for creating more intelligent, sustainable microgrids that can supply the increasing demand for clean energy in an environmentally friendly future.

## 1.1 Background

The development of renewable technologies such as solar and wind power has increased due to the growing need for more sustainable and cleaner forms of energy. In order to solve the global climate catastrophe and reduce greenhouse gas emissions, these technologies are essential. The problem of intermittency with renewable energy sources, however, stems from the fact that their production is heavily reliant on elements like the state of the weather, the time of day, and seasonal variations. It is challenging to integrate renewable energy into conventional power grids because of this inherent fluctuation because these systems are typically built to handle continuous and predictable production from fossil fuels. Hybrid renewable energy resource (RER) microgrids have arisen as a solution to this problem. To produce a more steady and dependable power supply, these systems combine a variety of renewable energy sources, like solar and wind, with traditional energy storage technologies, like batteries. Local generation and consumption are made possible by hybrid RER microgrids, which also minimize transmission losses and dependency on centralized power grids. Microgrids can operate in standalone or grid-connected modes, which gives them flexibility and makes them appropriate for both remote and urban applications. Hybrid RER microgrids have several advantages, but managing the variable nature of renewable energy effectively calls for sophisticated control systems. Because renewable energy is unpredictable, it is necessary to make decisions quickly in order to maximize system performance and maintain a balance between energy supply, storage, and demand. Because renewable energy sources are dynamic, traditional control systems frequently struggle to keep up. This emphasizes the necessity of creative control schemes that make use of cutting-edge technology such as artificial intelligence (AI), machine learning, and real-time optimization algorithms. These instruments can aid in the microgrid's ability to anticipate energy patterns, optimize energy distribution, and adjust quickly to changing circumstances.

New developments in artificial intelligence and optimization technologies have made it

possible to develop smarter control systems that can dynamically regulate power flows in hybrid microgrids. These solutions guarantee grid stability in a variety of environmental circumstances, encourage more economical use of renewable resources, and lessen dependency on backup power sources. Hybrid RER microgrids can increase the use of renewable energy, reduce energy losses, and boost overall system efficiency by implementing clever control mechanisms.
The goal of this project is to create and apply cutting-edge control schemes for hybrid RER microgrid power management. The main objective is to investigate how these novel control strategies might improve system dependability, optimize energy distribution, and lower operating costs to enable a wider integration of hybrid renewable energy systems into contemporary power grids.

## 2. Literature Review

One of the main areas of focus in the search for sustainable energy solutions is the integration of renewable energy resources into microgrids. Microgrids are a useful tool for controlling distributed energy production, particularly when it comes to renewable energy sources like wind and solar power. Advanced energy management and control systems for hybrid renewable energy microgrids have been extensively studied in a number of studies, with the main goal being to increase system dependability, efficiency, and responsiveness to fluctuating energy availability. A suggested approach highlights the use of green energy in hybrid microgrids and stresses how crucial it is to smoothly integrate renewable energy sources while preserving energy security and system stability [1]. Another analysis delves into the latest developments in hybrid microgrids, focusing on techniques for planning and controlling energy supplies. It highlights issues such as the intermittent nature of renewable resources and the necessity of effective energy management systems [2].
Subsequent research endeavors offer a thorough examination of power management tactics inside hybrid energy systems, assessing diverse control methodologies and their efficaciousness in optimizing energy fluxes for microgrids that are connected to the grid and those that are isolated [3]. The importance of real-time data in effectively controlling power generation and distribution is highlighted by research into real-time stochastic power management systems [4]. The integration of electric vehicles into hybrid renewable energy systems is a crucial aspect, since suggested approaches have been shown to enhance system efficiency and energy usage [5]. In order to maintain system stability, a different study on active and reactive power management focuses on balancing power generation and demand by including storage devices [6].
The most recent developments in energy management system (EMS) technologies are reviewed, highlighting the critical role that intelligent EMS solutions play in decentralized energy management [7]. Moreover, the future of optimized microgrids is examined, with an emphasis on control strategies and optimization techniques intended to improve reliability and efficiency when using renewable energy [8]. Furthermore, a thorough analysis of power management techniques for distributed energy resources in microgrids has been conducted, providing insight into the best ways to operate these systems and the new directions that are being pursued to enhance their dependability and performance [9]. In order to ensure resilience and flexibility, a real-time energy management and control system for microgrids based on renewable energy has finally been suggested [10]. Its main goal is to manage energy flows in both grid-connected and islanded modes.
To sum up, research on energy management and control techniques for hybrid renewable

energy microgrids has advanced significantly. The significance of intelligent control systems, effective resource planning, and real-time optimization in managing decentralized energy systems is highlighted by these research. However, more study is required to increase the scalability, affordability, and long-term sustainability of these systems, particularly as renewable energy sources are being included into international power grids.

### 2.1 Problem Statement

The increasing incorporation of renewable energy sources such as wind and solar into contemporary power systems poses notable obstacles because of these supplies' inherent fluctuations and sporadic nature. In contrast to conventional energy generation, the production of renewable electricity is highly dependent on external factors like the weather and the time of day, which can lead to unanticipated variations in the availability of energy. Maintaining a steady and reliable power supply is made more challenging by these swings, especially in hybrid renewable energy microgrids that integrate several energy sources. Particularly when renewable output is low, current energy management systems frequently fail to effectively balance power generation, energy storage, and distribution. This highlights the requirement for sophisticated control schemes that can maximize the use of renewable energy in hybrid microgrids, improve grid stability, and optimize power flow.

### 2.2 Research Gap

Energy management solutions for hybrid renewable energy systems have come a long way, but many of the present methods are not flexible enough to adjust to changes in renewable energy generation in real time. The inability of most conventional control systems to adapt to the erratic and fluctuating nature of renewable energy supplies is due to their static character or heavy reliance on predetermined models. Furthermore, there is still a dearth of study on how to best coordinate several renewable energy sources inside a single microgrid, especially when it comes to storage management and real-time power delivery. The lack of knowledge on these systems' long-term economic viability and environmental effects is another significant gap. Moreover, there remains a deficiency of scalable solutions that are applicable in a variety of energy settings. This emphasizes the necessity of creative and clever control schemes that can raise the hybrid renewable energy microgrids' efficiency, scalability, and dependability.

### 2.3 Objectives

With the goal of maximizing power management in hybrid renewable energy resource (RER) microgrids, this work develops sophisticated control algorithms. The primary goal is to create sophisticated algorithms that can adjust to changes in energy supply and demand instantly, allowing for effective power flow control. The second goal is to combine efficient energy storage technologies with renewable energy sources to increase system stability and reduce operating expenses. Maximizing the utilization of renewable energy resources will lessen dependency on non-renewable electricity and increase the sustainability of microgrid operations, which brings us to our third and final goal. By fulfilling these objectives, the study hopes to support hybrid RER microgrids' wider acceptance and their function in the future of sustainable energy.

## 3. Methodology

**Traditional Grid:** Energy travels in a straight line from big, centralized power plants to final users in a conventional grid system. Typically, these facilities consist of conventional power plants, like gas-fired, nuclear, and coal-fired units. High-voltage transmission lines carry the electricity produced in these plants over great distances to regional substations, where it is stepped down to lower voltages before being distributed to residences, commercial buildings, and industrial facilities. The electricity in this paradigm only flows in one direction, from the generator to the user, and neither distributed energy resources nor renewable energy technologies are integrated. Despite its long history of dependability, this system is neither flexible enough to support distributed generation, nor is it capable of handling two-way energy flows, which are necessary to integrate renewable energy sources into contemporary power networks.

**Smart Grid/Future Grid Enabling High DG Integration:** The smart grid is a development of the conventional grid that integrates distributed generation (DG) sources such as fuel cells, microturbines, solar, and wind through the use of cutting edge technologies. The smart grid, in contrast to conventional systems, decentralizes power generation, allowing energy to be produced closer to its point of consumption. This technology allows for two-way power flows, in which users who use technologies like rooftop solar panels to create extra power can also sell their energy back to the grid. Higher energy efficiency and system reliability are the outcomes of this bidirectional flow, which enhances energy generation, transmission, and distribution. Utilizing Power Line Communication (PLC) and Information and Communication Technology (ICT), which offer real-time energy flow monitoring and control to ensure optimal grid functioning, is essential to this transition.

**Distributed Generation Technologies and Storage Support:** The capacity of the smart grid to incorporate various distributed generation (DG) technologies, including fuel cells, wind turbines, solar photovoltaics, micro-turbines, and combined heat and power (CHP) plants, is a crucial characteristic. Local energy generation is made possible by these technologies, which also lower transmission losses and stabilize the system during spikes in demand. Batteries and other energy storage devices are essential for counteracting the sporadic nature of renewable energy. When renewable generation is low, like at night or during periods of low wind, excess energy produced during times of high renewable output, like noon solar maxima, can be stored in batteries and released. By doing this, the unpredictability of renewable energy sources is reduced and a steady and dependable power supply is guaranteed.

**Microgrid and Multi-Microgrid Systems:** To increase grid flexibility and dependability, the smart grid architecture also includes multi-microgrid (Multi-MG) systems and microgrids. A microgrid is a small-scale energy system that combines dispersed energy sources and can function both separately and in tandem with the larger grid. Microgrids use energy storage devices and renewable energy systems to deliver more dependable and sustainable power. In order to improve resilience and the system's capacity to handle variations in energy supply and demand, numerous microgrids are coordinated. These systems are particularly useful in areas that are vulnerable to power outages or in isolated, off-grid locations since they can operate independently to provide constant power supply.

**Advanced Metering Infrastructure and Consumer Empowerment:** Advanced Metering Infrastructure (AMI) deployment is a vital part of the smart grid. AMI offers real-time insights into energy consumption using smart meters and data analytics, empowering users to better monitor and control their energy use. Demand response programs, which enable users to modify their energy usage during periods of high demand in response to pricing signals or grid circumstances, are also supported by this technology. Furthermore, AMI gives customers the power to produce, store, and resell extra energy to the grid via gadgets like smart homes and electric cars (EVs). Customers and the grid engage in a two-way exchange that improves overall energy efficiency and encourages the adoption of renewable energy sources more widely.

**Virtual Power Plants and Grid Integration:** Virtual Power Plants (VPPs), which combine dispersed energy resources like solar panels, wind turbines, and energy storage systems into a single, coordinated entity, are a component of the smart grid. By reducing supply unpredictability and offering crucial services like load balancing and frequency regulation, VPPs enhance grid operations. This method makes it possible to manage distributed energy resources effectively, which supports grid stability—especially in areas where renewable energy is widely used. The grid is guaranteed to function well even in the presence of variable energy sources because to the integration of dispersed generation, intelligent control systems, and sophisticated metering.

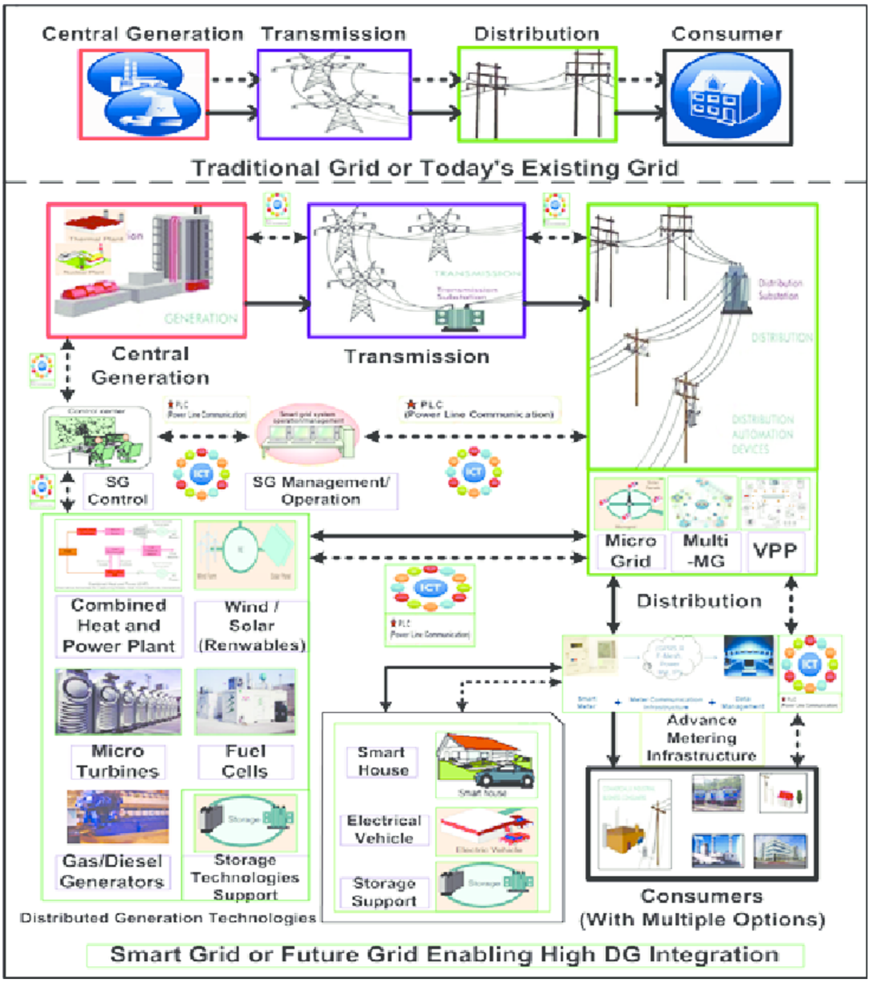


Figure 1 Proposed Methodology

### 3.1 Smart Grid Algorithm for Distributed Generation (DG) Integration

The algorithm focuses on optimizing the flow of energy across various distributed energy resources such as solar panels, wind turbines, fuel cells, and energy storage systems. It begins by balancing power generation from both renewable and conventional sources, ensuring that the total generation meets the energy demand. The algorithm incorporates advanced transmission and distribution management, where communication systems like Power Line Communication (PLC) and Information and Communication Technology (ICT) are used to monitor and control power flow in real-time. The integration of microgrids and Virtual Power Plants (VPP) enables smaller, decentralized grids to function independently or as part of the larger grid, further enhancing system flexibility. Through Advanced Metering Infrastructure (AMI) and demand response mechanisms, the algorithm optimizes energy usage by adjusting consumption based on supply conditions. It also incorporates energy storage systems and electric vehicles, utilizing them to store excess energy and provide power during peak demand. At the consumer level, smart homes and electric vehicles play a key role in demand-side management, where appliances and devices adjust their energy usage based on price signals and grid conditions. This algorithm ensures efficient, reliable, and sustainable energy distribution in the modern smart grid.

Generation Dispatch Algorithm:

$$P_{total} = P_{renewable} + P_{conventional} + P_{storage} \quad (1)$$

Transmission System Load Balancing:

$$P_{transmission(t)} = \sum P_{sources(t)} - \sum P_{losses(t)} \quad (2)$$

Distribution Automation and Microgrids

$$P_{microgrid(t)} = P_{generation(t)} - P_{demand(t)} \quad (3)$$

Demand Response Algorithm:

$If\ (P\_demand(t) > P\_available(t))$:

$$Reduce_{Consumption(t)} = \Delta P \quad (4)$$

Energy Storage Algorithm:

$If\ (P\_generation(t) > P\_demand(t))$:

$Charge\_Storage(t) = P\_excess$

$Else\ If\ (P\_generation(t) < P\_demand(t))$:

$$Discharge_{Storage(t)} = P_{shortfall} \quad (5)$$

## 4. Results and Discussion

The figures present the simulated performance of a hybrid renewable energy resource (RER) microgrid system over a 24-hour period, showcasing power demand, renewable energy usage, battery status, and grid power utilization. Each graph highlights the interactions between different components of the microgrid system, particularly focusing on the balance between renewable energy generation, energy storage, and demand.

**Power Demand:** The power demand curve illustrates the energy requirements of the system over the day. The demand follows a typical pattern, with lower demand during early morning hours and peaks around midday and evening. This is representative of a standard residential or industrial load profile where demand is higher during working hours and decreases at night. Understanding this demand pattern is essential for optimizing power flow and ensuring that the energy supply meets the consumption needs without relying heavily on external grid power.

**Renewable Energy Usage (Solar and Wind):** The second plot shows the usage of solar and wind energy over time. The solar energy contribution peaks during midday, reflecting the availability of sunlight, while wind energy shows fluctuating availability throughout the day due to varying wind speeds. The solar used curve (in blue) is concentrated around daylight hours, aligning with expected solar energy production. The wind used curve (in green) fluctuates more, as wind energy is less predictable and more variable. Both renewable sources complement each other in meeting the energy demand. However, there are instances when renewable energy is insufficient to meet the demand, which necessitates battery or grid power support.

**Battery Status:** The battery status graph tracks the energy stored in the battery over the 24-hour period. The battery begins the day with a partial charge, and its charge increases during periods of excess renewable energy generation, particularly during peak solar hours. As solar generation decreases in the evening, the stored battery energy is gradually used to meet the demand. The battery discharges during hours of low renewable generation, helping to maintain a continuous power supply. The plot shows a gradual decrease in battery charge after evening demand peaks, indicating the effective use of stored energy to cover the energy gap when renewable energy is insufficient.

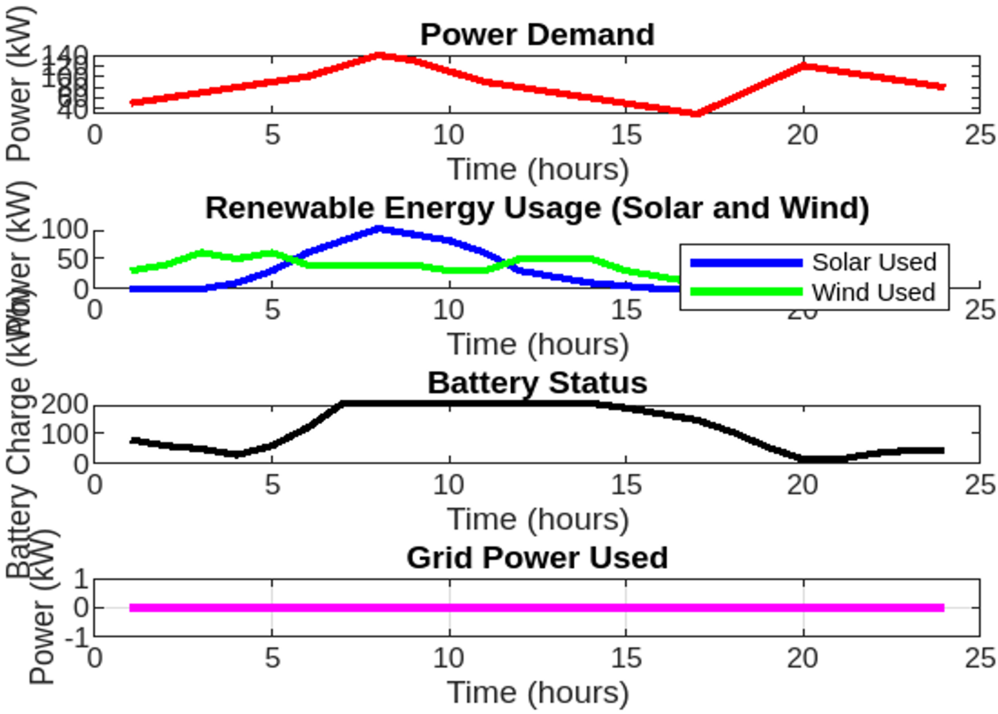


Figure.2 Performance of a hybrid renewable energy resource (RER)

**Grid Power Used:** The final graph depicts the grid power used throughout the day. Interestingly, the grid power usage remains constant at a low level, indicating that the microgrid system is largely self-sufficient in meeting energy demand through a combination of renewable energy sources and battery storage. This minimal reliance on grid power suggests that the system is effectively managing power flow, utilizing renewable energy when available, and drawing from the battery during periods of shortfall. The consistent use of grid power could indicate a minimal baseline power requirement that the system meets to maintain grid stability or provide a fail-safe backup during peak demand periods.

### 4.1 Discussion

The results highlight the effectiveness of the hybrid renewable energy microgrid system in balancing energy demand with available resources. Solar and wind energy contributions fluctuate, but through the use of energy storage, the system can maintain a reliable power supply throughout the day. The battery plays a crucial role in storing excess energy during periods of high generation and discharging when renewable energy is low, reducing the need to draw significant power from the grid. The minimal grid usage observed in the results further demonstrates the potential of such systems to operate independently and efficiently, particularly in areas with variable renewable energy availability.

Overall, the integration of renewable energy sources, battery storage, and intelligent energy management strategies within the microgrid demonstrates the viability of reducing dependency on conventional grid power. The use of real-time control strategies to manage power flow between solar, wind, and storage ensures optimal performance, even with fluctuating renewable energy inputs. The system can significantly contribute to enhancing energy efficiency, lowering costs, and supporting a more sustainable energy infrastructure.

## 5. Conclusion and Future Scope

The results of this study demonstrate that hybrid renewable energy resource (RER) microgrid systems are highly effective in managing power flow, reducing grid dependency, and optimizing the use of renewable energy. By integrating solar, wind, and battery storage, the system successfully balances the fluctuating availability of renewable energy sources with energy demand throughout the day. The battery plays a crucial role in storing excess energy during peak renewable generation periods and supplying energy during low renewable production hours, thus ensuring continuous power supply. Minimal reliance on grid power highlights the efficiency of such systems in maintaining self-sufficiency, which is critical for achieving sustainable energy goals.

Looking ahead, there are several areas where hybrid RER microgrid systems can be further enhanced. Future research could focus on improving forecasting models for renewable energy generation and demand to optimize power management more effectively. Additionally, incorporating other renewable sources like hydroelectric or geothermal energy could increase system resilience. Exploring advanced grid integration techniques, such as demand response strategies, would also enhance the system's ability to balance supply and demand. Finally, detailed economic and environmental analyses could provide valuable insights into the long-term benefits and challenges of widespread implementation.

## References

1. Naji Alhasnawi, Bilal, Basil H. Jasim, and M. Dolores Esteban. "A new robust energy management and control strategy for a hybrid microgrid system based on green energy." *Sustainability* 12, no. 14 (2020): 5724.
2. Barik, Amar Kumar, Smriti Jaiswal, and Dulal Chandra Das. "Recent trends and development in hybrid microgrid: a review on energy resource planning and control." *International Journal of Sustainable Energy* 41, no. 4 (2022): 308-322.
3. Kumar, G. R., D. Sattianadan, and K. J. I. J. O. E. Vijayakumar. "A survey on power management strategies of hybrid energy systems in microgrid." *International Journal of Electrical & Computer Engineering (2088-8708)* 10, no. 2 (2020).
4. Ciupageanu, Dana-Alexandra, Linda Barelli, and Gheorghe Lazaroiu. "Real-time stochastic power management strategies in hybrid renewable energy systems: A review of key applications and perspectives." *Electric Power Systems Research* 187 (2020): 106497.
5. Mohamed, Naoui, Flah Aymen, Ziad M. Ali, Ahmed F. Zobaa, and Shady HE Abdel Aleem. "Efficient power management strategy of electric vehicles based hybrid renewable energy." *Sustainability* 13, no. 13 (2021): 7351.
6. Anjaiah, Kanche, P. K. Dash, Ranjeeta Bisoi, Snehamoy Dhar, and S. P. Mishra. "A new approach for active and reactive power management in renewable based hybrid microgrid considering storage devices." *Applied Energy* 367 (2024): 123429.
7. Vuddanti, Sandeep, and Surender Reddy Salkuti. "Review of energy management system approaches in microgrids." *Energies* 14, no. 17 (2021): 5459.
8. Kiehbadroudinezhad, Mohammadali, Adel Merabet, Ahmed G. Abo-Khalil, Tareq Salameh, and Chaouki Ghenai. "Intelligent and optimized microgrids for future

supply power from renewable energy resources: A review." *Energies* 15, no. 9 (2022): 3359.
9. Rangu, Seshu Kumar, Phani Raghav Lolla, Koteswara Raju Dhenuvakonda, and Arvind R. Singh. "Recent trends in power management strategies for optimal operation of distributed energy resources in microgrids: A comprehensive review." *International Journal of Energy Research* 44, no. 13 (2020): 9889-9911.
10. Worku, Muhammed Y., Mohamed A. Hassan, and Mohamed A. Abido. "Real time energy management and control of renewable energy based microgrid in grid connected and island modes." *Energies* 12, no. 2 (2019): 276.
11. Improving image steganalyser performance through curvelet transform denoising, J Hemalatha, MKK Devi, S Geetha, Cluster Computing 22 (5), 11821-11839, 2018.
12. Stego Detection: Image Steganalysis Using a Novel Hidden Stego Visual Geometry Group–Based CNN Classification. Hemalatha J, Bala Subramanian Chokkalingam, Vivek V, Sekar Mohan. Journal of Applied Security Research, Taylor &Francis.August 2022.
13. Data Hiding Using PVD and Improving Security Using RSA Hemalatha.J., Aditya Kumar Sahu., Balasubramanina.C. Journal of Applied Security Research, Taylor & Francis. July 2021.
14. Enhancing the JPEG image steganography security by RSA and attaining high payload using advanced DCT replacement method and modified quantisation table, J Hemalatha, MKK Devi, S Geetha, International Journal of Business Intelligence and Data Mining 14 (1-2), 138-154, 2019.
15. "A interval valued intuitionistic fuzzy multi criteria decision making MA Ranjithkumar, J Boobalan, LG Atlas, P Sudhakar, RS Kumar E3S Web of Conferences 376, 01114"
16. "Applications of some modified open sets in r-neighbourhood spaces with ideals S Tharmar, A Nagarajan, E Rajesh, T Thanigasalam, R Senthilkumar E3S Web of Conferences 376, 01111"
17. "RELATION BETWEEN RESOLVING SET AND DOMINATING SETS IN VARIOUS GRAPHS DLF JANA, LTT GUNASEKAR, R GANDHI, RS KUMAR Advances and Application of Mathematical Sciences 21 (7), 3795-3803"
18. Rengarajan A.; Kumar R.; Sakhare N.N.; Thangarasu N.; Mahalakshmi V.; Bhimanpallewar R.N.,(2023),"Measuring the Impact of Machine Learning on Real-Time Data Analysis",2023 3rd International Conference on Smart Generation Computing, Communication and Networking, SMART GENCON 2023,Vol.,no.,pp.-.doi:10.1109/SMARTGENCON60755.2023.10442946
19. Mondal D.; Thangarasu N.; Preetha M.; Ingle Y.S.; Saxena A.; Kumar J.R.R.,(2023),"Investigating the Effectiveness of Internet Key Exchange (IKE) Protocol in Wireless Network Security",2023 3rd International Conference on Smart Generation Computing, Communication and Networking, SMART GENCON 2023,Vol.,no.,pp.-.doi:10.1109/SMARTGENCON60755.2023.10441857
20. Murari K.; Balaji N.V.; Hemalatha S.; Bagade J.V.; Kannagi A.; Sakhare N.N.,(2023),"An Investigation into the Effectiveness of Different Methodologies in Enhancing Genetic Algorithm Performance",2023 3rd International Conference on Smart Generation Computing, Communication and Networking, SMART GENCON 2023,Vol.,no.,pp.-.doi:10.1109/SMARTGENCON60755.2023.10442363

21. Rampal S.; Shreenidhi H.S.; Shrivastava M.; Singh A.P.; Reena R.; Kumar S.D.,(2023),"Exploring the Use of Machine Learning Techniques for Enhancing Real-Time Data Access",2023 3rd International Conference on Smart Generation Computing, Communication and Networking, SMART GENCON 2023,Vol.,no.,pp.-.doi:10.1109/SMARTGENCON60755.2023.10442815
22. Yuvaraj K.; Balakumar P.; Kadam P.S.; Mishra P.; Raja Kumar J.R.; Verma A.,(2023),"Assessing the Validity of Automated Data Analysis Methods Based on Artificial Intelligence",2023 3rd International Conference on Smart Generation Computing, Communication and Networking, SMART GENCON 2023,Vol.,no.,pp.-.doi:10.1109/SMARTGENCON60755.2023.10442308
23. Pragathi, B., and P. Ramu. "Authentication Technique for Safeguarding Privacy in Smart Grid Settings." E3S Web of Conferences. Vol. 540. EDP Sciences, 2024.
24. Pragathi, Bellamkonda, Deepak Kumar Nayak, and Ramesh Chandra Poonia. "Lorentzian adaptive filter for controlling shunt compensator to mitigate power quality problems of solar PV interconnected with grid." International Journal of Intelligent Information and Database Systems 13.2-4 (2020): 491-506.
25. Pragathi, Bellamkonda, et al. "Evaluation and analysis of soft computing techniques for grid connected photo voltaic system to enhance power quality issues." Journal of Electrical Engineering & Technology 16 (2021): 1833-1840.