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Dual energy management system using solar pv and wind energy with the utilization of microgrid

Soniya yadav[1], Mrs. hansa jha[2], Dr. mithilesh singh[3]

[1]soniya yadav:M tech Scholler
[2]Mrs Hansa Jha: Assistant professor
[3]Dr.mithilesh singh: Professor, Dept. of Electrical Engineering,shri rawatpura sarkar university Raipur Chhattisgarh ,India

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Abstract –*India has rapidly emerged as a global leader in renewable energy, driven by ambitious targets and substantial investments. The country's renewable energy capacity has seen significant growth , particularly solar photovaltaic (pv)and wind energy sectors. As of 2023, india has target to achieve 500GW of renewable energy capacity by 2030. aiming to reduce its carbon footprint and meet increasing energy demands sustainably. This paper reviews the advancement in india's solar PV, wind energy and microgrid system, highlighting their importance and integration into the energy landscape.*

Key Words: solar panel, wind energy, microgrid, photovoltaic cell.

1.INTRODUCTION

India's renewable energy sector has experienced rapid growth with significant investments and ambitious targets driving the expansion of solar photovaltaic (PV) and wind energy capacities [1],this captures the essence of india's renewable energy landscape, emphasizing the growth potential, and strategic efforts in this sector [2].the primary objective of deploying renewable energy in india is to advance economics development, improve energy security , and mitigateclimate change , supported by strong government policies and foreign investments. This paper present singnificant achievements, prospects, challenges, and opportunities in the renewable energy sector, providing insights for policymakers and stakeholders.

1.1 Solar PV Energy

The Jawaharlal Nehru national solar mission (JNNSM), examining its impact on india's power sector reforms, barriers dismantled , remaining challenges and high level apporches to enhance policy implementations [3]. Key initiatives like the national solar mission have propelled india's solar capacitive to over 60 GW analyzes JNNSM within india's power sector reforms, examining dismantled and remaining barriers , policy implementations challenges and high level approaches based on global best practice to address these challenges .[4]. The deployment of solar PV panels ranges form large utility scale solar parks to small rooftop installations , contributing to energy security and reducing dependency on fossil fuel [5].

1.2 Wind Energy

india's wind energy sector is the fourth largest in the world, with substantial onshore and offshore wind potential, india's wind energy potential using advanced wind distribution methods and artifial intelligence for onshore, offshore and nearshore locations highlightning significant seasonal variations and optimal periods for wind power4 generation . high potential offshore wind sites along the Indian coast have been identified , with an estimate gross technical potential of 3941 GW , excluding environmentally sensitive areas. [5,6,7]. Favourable policies and technological advancement have helped reduce the cost of wind energy production, with the installed wind capacity surpassing 30 GW [8].

2. Importance of Microgrid systems

Microgrid system are gaining increasing importance in india's energy landscape due to their potential to ensure energy access and enhance sustainability [10]. These system are particularly beneficial in remote and rural areas where extending the main grid is economically or technically unfeasible [11].

2.1 Ensuring Energy Access

Microgrid can provide reliable and uninterrupted power to off-grid and underserved communities, enhancing the quality of life and supporting economic development [12]. By incorporating renewable energy sources such as solar and wind, microgrids help in reducing the reliance on diesel generators and other polluting energy sources [13].

2.2 Sustainability and Resilience

Microgrids contribute to sustainability by integrating renewable energy sources, reducing greenhouse gas emissions and environmental impact[14,15][14]. They also enhance grid resilience by providing backup power during outages and natural disasters, ensuring countinuous energy supply [15][16].

2.3 Hybrid Solar PV wind systems in india

Hybrid system PV and wind generation systems are becoming particularly attractive solutions for stand-alone applications in india. By combining solar and wind energy sources, these system can offer better reliability and become more economical , enhancing the overall economy and reliability of renewable power generation [17].

2.4 Solar electricity Generation

Solar electricity generation in india predominantly uses photovoltaics (PV). efficiency improvements in PV technologies have significantly enhanced solar power generation capabilities [18].

2.5 Global Wind Report

The global wind report of 2012 indicated an annual market growth of around 10% wit5yh wind turbines classified into horizontal axis (HAWT) and vertical-axis (VAWT0) types [19].

3. Hybrid Solar –Wind System Classification

Hybrid solar-wind system can be classified into grid connected and stand alone types. Optimization techniques play a crucial role efficiently utilizing these system [20].

3.1 Bridge to india

India's wind-solar hybrid (WSH) project capacity is poised to grow significantly by 2025,driven by demand for form green power and the promises of grater transmission efficiency and lower costs [21].

3.2 Utility Scale Solar Segment

In the utility-scale solar segment, India added about 8GW of new capacity in FY2023, with notable installations in rajasthan, tamil nadu, and maharastra. The rooftop solar segment saw a slight increase, with gujrat leading in installations [22].

3.3 optimization

Combining solar PV and wind system enhances energy output but requires optimization . AI techniques like fuzzy logic and genetic algorithms are emerging as effective alternatives. Optimization in renewable energy system . recent perspectives explores various optimization techniques to enhance the efficiency and predictability of renewable energy system, covering applications from large-scale power forecasting to small-scale DG sizing and siting [23,24,25,26,27,28,29].

3.4 Comprehensive Review of existing Literature

India's renewable energy sector, focusing on solar PV, wind energy, and microgrids, lacks comprehensive studies on microgrid challenges, integration of multiple sources, economics benefits, technological innovations, policy frameworks, and social impacts [23][30].

3.5 Comparisons of methodology

a systematic review was conducted using databases like Scopus, web of science, IEEE Xplore, and google scholar. Inclusion criteria covered recent advancements, policy analyses, and case studies in india [24][31].

Table -1: Overview of Energy Access and Sustainability Methodologies

Methodology	Description	Benefits	Challenges
Energy Access	Reliable power to off-grid and underserved communities.	Uninterrupted power Economic development Reduced diesel use	High initial costs Technical feasibility Maintenance
Sustainability and Resilience	Integrates renewables to reduce emissions and enhance grid resilience.	Lower emissions Environmental sustainability Grid resilience	Grid integration Intermittent sources Setup costs

Methodology	Description	Benefits	Challenges
Hybrid PV-Wind Systems	Combines solar and wind for better reliability and economy.	Increased reliability Cost-effective Better efficiency	Technical complexity Initial costs Optimization needs
Optimization Techniques	Uses AI to enhance energy output and performance.	Optimized output Improved performance Effective use of renewables	Algorithm complexity Continuous monitoring High computational needs

4. CONCLUSIONS

India's commitment to renewable energy is evident through its significant advancements in solar PV, wind energy, and the adoption of microgrid sytems. These efforts are pivotal in achieving the country's ambitious targets of 500GW renewable capacity by 2030 . continued research and optimization are required to address the existing gaps and challenges, facilitating the efficient utilization of renewable energy source and supporting india's transition to a sustainable energy future .

REFERENCES

1. Charles Rajesh Kumar J, Majid MA. Renewable energy for sustainable development in India: Current status, future prospects, challenges, employment, and investment opportunities. Energy, Sustainability and Society 10 2020.

2. Kumar A, Kumar K, Kaushik N, Sharma S, Mishra S. Renewable energy in India: Current status and future potentials. Renewable and Sustainable Energy Reviews 14 2010 2434– 2442.

3. Avinash Kshitij KM. 5. Case of India. CSIR-National Institute of Science Communication and Policy Research (NIScPR)1.

4. Shrimali G, Rohra S. India's solar mission: A review. Renewable and Sustainable Energy Reviews 2012; 16: 6317–6332.

5. Kashish Shah. India Is Home to the World's Largest Utility-Scale Solar Installations. Institute for Energy Economics and Financial Analysis 2020;

6. Krishnamoorthy R, Udhayakumar K, Raju K, Elavarasan RM, Mihet-Popa L. An assessment of onshore and offshorewind energy potential in india using moth flame optimization. Energies (Basel) 2020; 13.

7. Chaurasiya PK, Warudkar V, Ahmed S. Wind energy development and policy in India: A review. Energy Strategy Reviews 2019; 24: 342–357.

8. International Renewable Energy Agency. Future of wind: deployment, investment, technology, grid integration and socio-economic aspects. .

9. Us Salam I, Yousif M, Numan M, Billah M. Addressing the Challenge of Climate Change: The Role of Microgrids in Fostering a Sustainable Future - A Comprehensive Review. Renewable Energy Focus 48 2024.

10. Khatun E, Hossain M, Ali M, Halim M. A Review on Microgrids for Remote Areas Electrification- Technical and Economical Perspective. International Journal of Robotics and Control Systems 2023; 3: 627–642.

11. Sharma S, Sood Y. Microgrids: A Review of Status, Technologies, Software Tools, and Issues in Indian Power Market Microgrids: A Review of Status, Technologies, Software Tools, and Issues in Indian Power Market. IETE Technical Review 2020; 39.

12. Valencia F, Billi M, Urquiza A. Overcoming energy poverty through micro-grids: An integrated framework for resilient, participatory sociotechnical transitions. Energy Res Soc Sci 2021; 75: 102030.

13. Harrold DJB, Cao J, Fan Z. Renewable energy integration and microgrid energy trading using multi-agent deep reinforcement learning. Appl Energy 2022; 318.

14. Parag Y, Ainspan M. Sustainable microgrids: Economic, environmental and social costs and benefits of microgrid deployment. Energy for Sustainable Development 2019; 52: 72–81.

15. Järventausta P, Peltonen L, Valta J, Uski S, Aalto P. Microgrids: Impact on the Development of Sustainable Electric Energy Systems. In: 2021: 905–915.

16. Hamidieh M, Ghassemi M. Microgrids and Resilience: A Review. IEEE Access 2022; 10: 106059–106080.

17. Parveen N. A Review on Hybrid Solar PV and Wind Energy System. International Research Journal of Engineering and Technology 2008; 1222.

18. Kumari S, Bhende A, Pandit A, Rayalu S. Efficiency enhancement of photovoltaic panel by heat harvesting techniques. Energy for Sustainable Development 2023; 73: 303–314.

19. Global Wind RepoRt AnnuAl m Ark et updAt e 2012. .

20. Habib MA, Said SAM, El-Hadidy MA, Al-Zaharna I. Optimization procedure of a hybrid photovoltaic wind energy system. Energy 1999; 24: 919–929.

21. Bridge to IndiaI. INDIA CORPORATE RENEWABLE BRIEF. 2023.

22. https://pib.gov.in/newsite/PrintRelease.aspx. Ministry of New and Renewable Energy organises 'Global Wind Day 2024' event with a central theme of "Pawan-Urja: Powering the Future of India. .

23. Lujano-Rojas JM, Dufo-López R, Bernal-Agustín JL, Osório GJ, Catalão JPS. Chapter 8 - Optimum Design of Small-Scale Stand-Alone Hybrid Renewable Energy Systems. In: Erdinç O, editor. Optimization in

Renewable Energy Systems. Boston: Butterworth-Heinemann, 2017: 279–306.

24. Arabali A, Ghofrani M, Bassett JB, Pham M, Moeini-Aghtaei M. Chapter 7 - Optimum Sizing and Siting of Renewable-Energy-based DG Units in Distribution Systems. In: Erdinç O, editor. Optimization in Renewable Energy Systems. Boston: Butterworth-Heinemann, 2017: 233–277.

25. Torbaghan SS, Gibescu M. Chapter 6 - Optimum Transmission System Expansion Offshore Considering Renewable Energy Sources. In: Erdinç O, editor. Optimization in Renewable Energy Systems. Boston: Butterworth-Heinemann, 2017: 177–231.

26. Taşcıkaraoğlu A. Chapter 5 - Impacts of Accurate Renewable Power Forecasting on Optimum Operation of Power System. In: Erdinç O, editor. Optimization in Renewable Energy Systems. Boston: Butterworth-Heinemann, 2017: 159–175.

27. Dai T. Chapter 4 - Optimum Bidding of Renewable Energy System Owners in Electricity Markets. In: Erdinç O, editor. Optimization in Renewable Energy Systems. Boston: Butterworth-Heinemann, 2017: 117–158.

28. Santos SF, Fitiwi DZ, Shafie-khah M, Bizuayehu AW, Catalão JPS. Chapter 1 - Introduction to Renewable Energy Systems. In: Erdinç O, editor. Optimization in Renewable Energy Systems. Boston: Butterworth-Heinemann, 2017: 1–26.

29. Eren Y, Küçükdemiral İB, Üstoğlu İ. Chapter 2 - Introduction to Optimization. In: Erdinç O, editor. Optimization in Renewable Energy Systems. Boston: Butterworth-Heinemann, 2017: 27–74.

30. Elavarasan RM, Shafiullah G, Padmanaban S et al. A Comprehensive Review on Renewable Energy Development, Challenges, and Policies of Leading Indian States with an International Perspective. IEEE Access 8 2020 74432–74457.

31. Odilova S, Sharipova Z, Azam S. Investing in the Future: A Systematic Literature Review on Renewable Energy and its Impact on Financial Returns. International Journal of Energy Economics and Policy 2023; 13: 329–337.