Detailed Analysis of Wind as an Energy Source for Achieving Sustainable Energy Generation

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Abstract. Currently, the world's energy system is shifting towards sustainability in an attempt to reduce environmental impacts of climate change and ensure energy security. The article states a discourse on different mechanical progressions as well as arrangement measures aimed at addressing these challenges counting progressed determining devices, energy capacity innovations, and grid framework updates. The details about the wind energy system installations across the world and its potential output is being discussed that gives insight about how wind energy systems can be beneficial at different sites. The economic and natural challenges are provided that will make the decision-making process about the capacity to which dependency on wind energy can be made. The wind energy system installations need a thorough research and funding from the various institutions for its more reliable and efficient working. The various researches, investment, and commitment from governments, communities, and other sectors are basic to opening wind energy's full potential and realizing its assurance as a energy proving source feeding power to the grid.

Keyword-: Renewable energy, wind turbines, sustainability, fossil fuels, grid instability, secure energy, power generation.

1 Introduction

The demand for energy in the world today exceeds the capacity of available generation which makes it important that Future energy needs to be met efficiently and affordably. this is the key reason why When implementing energy solutions, the usage of renewable energy sources

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ought to come first. Renewable energy sources include biomass, geothermal resources, solar, hydropower, wind, and ocean energy, among other natural resources that can be converted into clean, useable energy. In addition to being a crucial part of renewable energy, wind energy has a number of benefits, such as being affordable, dependable, and eco-friendly. Electricity is currently produced using it. Given the great potential of wind, it is imperative to research wind energy consumption [1]. With a broadly available resource and zero-cost fuel as well as exceptionally low life-cycle pollutant emissions, wind energy has the potential to be a primary contributor to the growing clean energy needs of the global community. Tapping the potential terawatts of wind energy that could drive the economic realization of these forecasts and subsequently moving from hundreds of terawatt-hours per year to petawatt-hours per year from wind and solar resources could provide an array of further economic and environmental benefits to both local and global communities [2] [3]. This work has selected wind energy because it is the most affordable renewable energy technology and therefore ideal for emerging economies to execute and manufacture. Alternatively, in addition to this option, the technology has been fully implemented in many industrial economies, including Denmark, Spain, Germany. Although the big emerging markets, for instance, China and India, are active in developing this technology, other emerging markets, specifically the smaller ones, are still immature. Consequently, examining the effects of environmental regulations on wind energy creation can assist decision-makers and builders in more precisely rethinking how regulatory simplification can increase RE growth conserving heightened environmental protection measures [5]. In this paper we discussed about the wind energy, its significance in renewable energy sources, its contribution towards sustainable development, impact on communities, opportunities, and its technological advancements.

2 Understanding Wind Energy and its Significance

Sustainable energy frameworks always incorporate the major portion of worldwide wind control. Fossil fuel-finding options to manage climate change and ensure energy security have driven the disclosure of wind energy, which is considered an elective source due to its replenishable character and environmentally friendly over all others [6]. Wind power is tackled by taking advantage of moving to discuss mass and changing it into power by implying wind turbines. These devices work through their edges getting rotated by constrain applied on them by wind, which in turn pivots a generator for the generation of electric power [7]. The significance of this kind of power lies in that it may be utilized in essentially reducing GHGs, dependence on non-renewable fossil fuels, and guaranteeing self-sufficiency in power supply. Traditional strategies utilized to create power from coal or oil regularly cause pollution and emissions of GHGs [8]. Other than that, sources of wind energy are all over, so the generation of power can be done anyplace with a low fear of natural impacts leading to a rise in adaptability against unforeseen freezing out. Bringing down the cost of wind energy and making it more competitive in comparison with traditional sources of power generation have been made conceivable by innovative progressions and economies of scale [9].

Wind turbines are a basic innovation to tackle wind energy for electrical power generation. These turbines contain a few fundamental parts counting rotor edges, nacelle, and tower. Rotor edges are made from either fiberglass or carbon composites that will proficiently capture the motor energy from the wind [10]. On the top part of a columnar structure called a turbine, this is often where one finds a generator as well as other basic components like a gearbox. Hence, maximizing on energy generation; since it stands in a way that supports the turbine while raising its rotor edges so that they can capture higher wind speeds [11]. When airflow interacts with these rotor edges, they turn in this manner causing the associated shaft with the rotor to turn it. The rotational energy is changed over into electrical power by a

generator that passes it through to the network for dispersion purposes [12]. Changing wind into electric power has numerous points of interest and advantages over conventional fossil fuel-based power generation. Wind control is sustainable and maintained by nature since it depends on the wind which is a nearly boundless asset in nature to produce power [13]. Unlike fossil fuels that have restricted supplies and contribute to natural problems due to extraction and burning, wind energy has very limited carbon footprints once turbines are introduced. Furthermore, wind power is a domestic source of energy in many nations leading to a reduction in the reliance on imported oil and expanded security in the field of energy [14]. Wind energy makes a difference by expanding power generation sources, stabilizing power markets, and constraining financial exposure to unstable fuel prices [15]. Wind power may be a feasible arrangement that meets the growing need for power while moderating natural concerns and advancing energy security. Fig 1 shows a significance of wind energy. Table 1 contains the top 10 wind farms.

Table 1. Top 10 wind farms in the world with their energy production capacity

State of farm	Name of the Wind farm	Location/Country	Power capacity in MW
Texas	Horse Hollow Wind Energy Centre	USA	735.5
Cumbria	Walney Extension Offshore Wind	UK	659
Tamil Nadu	Muppandal Wind Farm	India	1500
Rajasthan	Jaisalmer Wind Park	India	1600
California	Alta Wind Energy Centre	USA	1548
Texas	Capricorn Ridge Wind Farm	USA	662.5
Kent Essex	London Array Offshore Wind Farm	UK	630
Gansu	Jiuquan Wind Power Base	China	20
Texas	Roscoe Wind Farm	USA	781.5
Arlington	Shepherds Flat Wind Farm	USA	845

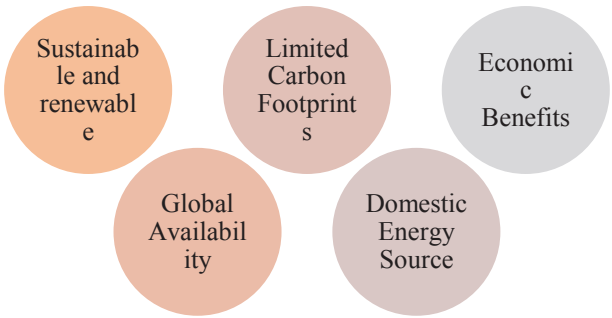

Fig. 1. Significance of wind energy

3 Wind Energy's Contribution to Sustainable Development

Wind energy power plays a central part in advancing sustainable development around the world. Wind power contributes to natural preservation, social imbalance, and financial well-being by adjusting to sustainability goals. One of the key ways in which wind energy helps economic improvement is by giving clean renewable power and reducing GHG emissions which minimize climate change [16]. Wind power makes a difference by uprooting fossil fuel-based power generation to control air pollution, well-being, and maintaining the environment. Other than that, wind energy projects as community engagement and discussions to social acknowledgment as well as cooperation within the alter over to renewable energy [17]. Financially, wind energy offers an extent of benefits that support sustainable development. One of the major financial points of interest in wind power is its potential for work creation and nearby economic support. Wind energy projects require skilled labour in, development, operation, and supporting works in both rural and urban areas [18]. The new wind farms may lead to the development of unused supply chains, businesses, and infrastructure consequently giving a boost to the territorial economy. Localized generation of wind power moreover brings down reliance on imported fuels and improves energy security [19].

The advancement of wind farms can create many job opportunities through an arrangement of rent installments incomes to landowners including government bodies resulting from charges collected on property among other money-related agreements. These earnings may be reinvested into a few community development activities produced with charged dollars so that they can afterward develop into greater projects inside the community to improve infrastructure, and contributing to social welfare and quality of life of the society [20]. Freeing the wind control can help in ranging country economies depending intensely on agriculture or extractive businesses. This thus will present modern income sources and financial stability. Wind energy's natural and financial advantages support more extensive points of assuring economic advancement goals as summarized in the United Nations Sustainable Development Agenda [21]. It is the reason that wind power is crucial for a more reasonable future with less harmful effects on nature through empowering renewable energy arrangements, minimizing greenhouse gas emissions, moving forward with social inclusion, and supporting sustainable growth [22]. In relation to this, it is obvious that wind energy empowers sustainable development goals to be accomplished by playing its portion in numerous divisions of natural conservation. Wind power's clean and renewable source reduces climate change by lowering the dependence on fossil fuels and GHGs emissions. Wind energy is additionally helping preserve natural resources and protecting biological systems by diminishing the air pollution and water pollution that come with conventional forms of generating power. Wind power makes a difference in advancing sustainable biological systems characterized by negligible natural degradation and improved biodiversity, subsequently ensuring a quality future for the next generations [23]. Through financial transformation and environmental supportability, wind energy projects have far-reaching suggestions for local communities. Decision-making processes for these projects frequently include inhabitants subsequently promoting community engagement, strengthening, and cohesion in society [24]. This makes wind farms owned by the community empower individuals to take an interest effectively as they travel from one frame of energy to another hence controlling their assets locally [25]. In this manner, wind energy activities improve social capital arrangement through policy cooperation that guarantees people's sense of pride and ownership this makes them versatile in connection to long-term sustainable improvements. Fig 2 shows the process of wind energy generation from wind turbines. Table

2, a comparison between wind energy and fossil fuels it shows wind energy's sustainability [35].

Table 2. Comparison on wind energy with fossil fuels

Comparative Variables	Wind Energy	Fossil Fuels
Physical/ Environmental contributing factors		
Area of Land Required	Large and open space	Comparatively smaller land for plants
Requirement of infrastructure	Turbines and power station establishment	Full pipelines and refinery construction
Facility of Water consumption	Not necessary	Water facility is crucial for cooling process in plants
Decommissioning process requirement	Parts are easy to dismantle and transoport	complex
Impact on production if climate changes	Effected by wind speed	No effect
Type of source of energy	renewable	Non-renewable
Effects on the environment	no emissions/ environmentally friendly	High green house gases released
Energy associated comparison		
Power output	Variable depending on the speed of wind	steady
Dependency on grid	Grid dependent	Not grid dependent
Reliability	Comparatively less due to wind availability	Highly stable
Storage system	Backup is required	Not necessary
Energy independence	Self-reliant	Depends on fossil fuel availability
Economic aspect		
Dependency on fuel	Fuel required is free and abundant	Fuel will deplete
Cost of operation after setup	Low	high
Cost of power generated	Initial set is high but later it is economic	Price of fuel effects the generation cost
Extraction process	Easily available	Mining and refining is required

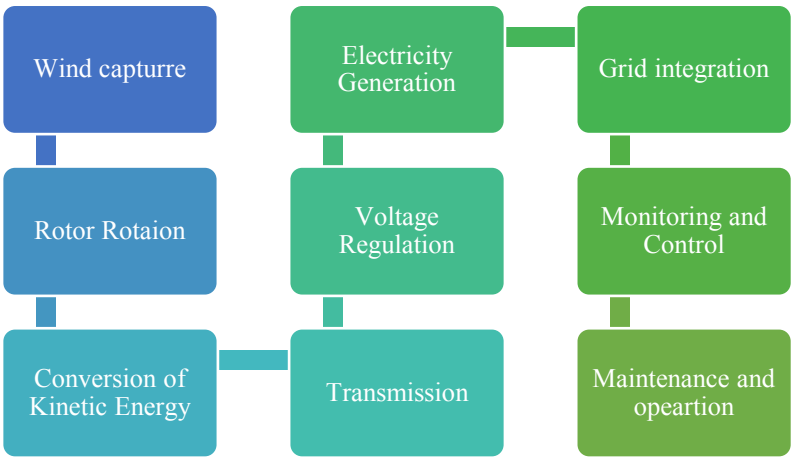

Fig. 2. Process of wind energy generation from wind turbines

4 Opportunities, Difficulties, and Progress in Wind Energy Integration

Transitioning to a more sustainable and flexible future for energy overcomes a few challenges and opportunities within the course of coordinating wind energy into pre-existing power systems. Fluctuations or variations in power generation and grid uncertainty are a few of them [26]. Wind turbines don't have the capacity to generate power as per necessity like other traditional sources that can generate power on a persistent premise. Unlike conventional sources of power plants wind turbines depend on wind accessibility, which makes their output uncertain and variable. Hence, it causes operational challenges for grid operators in order to maintain supply and request at any given time to preserve the reliability and integrity of the system. In order to address intermittency challenges and grid integration, notable technological improvements have been developed over a long period of time [27]. One way is by utilizing cutting-edge determining tools coupled with predictive analytics to take action on the accuracy of wind energy. Utilizing weather information, machine learning algorithms as well as computational models provides network administrators more authority and anticipates changes in wind energy generation while optimizing dispatches from other innovative sources is essential to compensate for irregularities [28-32].

The intermittency issue can be solved by coordinating unique energy capacity advancements such as batteries and pumped hydro storage into the grid [33]. During the period when there's more wind power being produced than required, energy can be stored as electricity in these advances to be released later when demand exceeds supply. The adaptability and strength of power systems must be necessary to progress through a better grid infrastructure and keen grid advances which are principal for retaining expanded levels of wind power infiltration [34]. This implies that productive transmission and distribution of wind-generated power over different geographical areas will require updating the transmission systems, including building unused high-voltage transmission lines and building up grid-scale renewable energy storage offices [35-37]. Besides, the utilization of demand response programs, deployment of grid-edge innovation systems along appropriation of energy administration frameworks permits the customer to adjust their utilization patterns after a move in accessibility or generation from the wind farm this advances both stability in terms of electrical supply as

well as ensuring lower costs on managing things with sources containing different forms of energies [38].

For the continued advancement of technology-related solutions, policies and incentives are important in advancing wind energy development and its integration into existing power systems [39]. Within the frame of renewable energy targets, feed-in taxes, and tax incentives, governments can raise wind energy infrastructure investment and rush its deployment [40]. Promote assurance in all administrative adjustments and mechanisms like capacity markets and renewable portfolio guidelines would ensure that wind energy makers get reasonable payment for their projects which is able to draw in private capital to promote competition within the market [41-44]. Such collaborative activities among government organizations, industry players, and research institutions in a sense, offer aid in sharing best practices but drive innovations other than tending to boundaries to the integration of wind power into the national grid [45]. Wind energy integration is full of troubles but it still remains an opportunity for progress and growth forward. Technological advancements, supportive approaches as well as concerted efforts have made it possible to move towards a cleaner future that's driven by wind power [46-48].

Table 3. Concise overview of the challenges, solutions, progress related to the integration of wind energy

Challenges	**Solutions**	**Progress**	**Reference**
Fluctuations in power generation	Advanced forecasting tools Integration of weather data Optimization of dispatches from renewables	Improved accuracy in wind forecasting Enhanced grid stability	[49]
Grid uncertainty	Energy storage integration Grid upgrades Transmission system enhancements	Enhanced grid flexibility Smoother wind energy integration	[50]
Policy and incentives	Renewable energy targets Fair compensation mechanisms Collaborative efforts	Accelerated wind energy deployment Increased investment	[51], [52]
Growth opportunities	Technological advancements Supportive policies Continued research	Progress towards sustainable energy future	[53],[54],[55]

5 Conclusion

In review of wind energy power concludes by showing the needs, important role in current energy scenarios and its sustainability goals. The significance and effects are summarized in key points:

- Wind power is a sustainable and renewable source of energy that brings down the emissions of greenhouse gases and can also reduce the harmful effects that are caused by

the traditional source of energy generation. It can happen that as much as we use these renewable sources we can move towards climate change and achieve an environmentally friendly future.

- We can easily raise our energy security by using the wind resources of nations that have abundant amounts of wind and decrease the reliance on fossil fuels. These sources have the benefit of decentralizing and domestically producing which makes it constant in terms of supply. So by this method and investing in wind infrastructure we can reduce the risk of geopolitical instability and stabilize the fuel cost by producing these sources.
- Wind Energy Sources and its projects offer a variety of job opportunities in the market including development, financial, and production. By the establishment of wind farms, research, development centers, and renewable energy plants, wind energy infrastructure projects raise the growth of that area and support the business in that community helping to move forward green economy.
- When it comes to creating wind power there are a few particular challenges that will emerge when looking to optimize the capability and immovable quality of wind power so it is vital to form innovations towards wind turbines, frameworks integration, and energy storage. Within the field of wind power, the basic fundamental for investments is to empower strong frameworks of renewable energy and its components.
- In other words, wind energy could be a feasible arrangement that has financial practicality while profiting society. In the event that we are able to take advantage of its solid focuses and address the challenges confronting it through advancement and arrangement making; at that point, it can act as a turning point towards a cleaner future where thriving will be more evident in the view of future..

References

1. Olabi, A. G., Khaled Obaideen, Mohammad Ali Abdelkareem, Maryam Nooman AlMallahi, Nabila Shehata, Abdul Hai Alami, Ayman Mdallal, Asma Ali Murah Hassan, and Enas Taha Sayed. "Wind energy contribution to the sustainable development goals: case study on London array." Sustainability 15, 5 (2023): 4641.
2. Veers, Paul, Katherine Dykes, Eric Lantz, Stephan Barth, Carlo L. Bottasso, Ola Carlson, Andrew Clifton et al. "Grand challenges in the science of wind energy." Science 366, no. 6464 (2019): eaau2027.
3. Elkjær, Lene Gjørtler, Maja Horst, and Sophie Nyborg. "Identities, innovation, and governance: A systematic review of co-creation in wind energy transitions." Energy Research & Social Science 71 (2021): 101834.
4. Friebe, Christian A., Paschen von Flotow, and Florian A. Täube. "Exploring technology diffusion in emerging markets–the role of public policy for wind energy." Energy Policy 70 (2014): 217-226.
5. Kumar, K. U., Babu, P., Basavapoornima, C., Praveena, R., Rani, D. S., & Jayasankar, C. K. (2022). Spectroscopic properties of Nd3+-doped boro-bismuth glasses for laser applications. Physica B: Condensed Matter, 646, 414327.
6. Schumacher, Kim, and Zhuoxiang Yang. "The determinants of wind energy growth in the United States: Drivers and barriers to state-level development." Renewable and Sustainable Energy Reviews 97 (2018): 1-13.
7. Debnath, Binoy, Md Shihab Shakur, Md Tanvir Siraj, ABM Mainul Bari, and Abu Reza Md Towfiqul Islam. "Analyzing the factors influencing the wind energy adoption in Bangladesh: A pathway to sustainability for emerging economies." Energy Strategy Reviews 50 (2023): 101265.

8. Lakshmi, L., Reddy, M. P., Santhaiah, C., & Reddy, U. J. (2021). Smart phishing detection in web pages using supervised deep learning classification and optimization technique ADAM. Wireless Personal Communications, 118(4), 3549-3564.
9. Spandana, K., & Rao, V. S. (2018). Internet of Things (Iot) Based smart water quality monitoring system. International Journal of Engineering and Technology (UAE), 7(3), 259-262.
10. Schaffarczyk, Alois Peter. Introduction to wind turbine aerodynamics. Springer Nature, 2020.
11. Nazir, Muhammad Shahzad, Ali Jafer Mahdi, Muhammad Bilal, Hafiz M. Sohail, Nisar Ali, and Hafiz MN Iqbal. "Environmental impact and pollution-related challenges of renewable wind energy paradigm–a review." Science of the Total Environment 683 (2019): 436-444.
12. Indira, D. N. V. S. L. S., Ganiya, R. K., Ashok Babu, P., Xavier, A., Kavisankar, L., Hemalatha, S., ... & Yeshitla, A. (2022). Improved artificial neural network with state order dataset estimation for brain cancer cell diagnosis. BioMed Research International, 2022.
13. Jaidass, N., Moorthi, C. K., Babu, A. M., & Babu, M. R. (2018). Luminescence properties of Dy3+ doped lithium zinc borosilicate glasses for photonic applications. Heliyon, 4(3).
14. Hirth, Lion, and Simon Müller. "System-friendly wind power: How advanced wind turbine design can increase the economic value of electricity generated through wind power." Energy Economics 56 (2016): 51-63.
15. Bošnjaković, Mladen, Marko Katinić, Robert Santa, and Dejan Marić. "Wind turbine technology trends." Applied Sciences 12, no. 17 (2022): 8653.
16. Tong, Colin, and Colin Tong. "Advanced Materials Enable Renewable Wind Energy Capture and Generation." Introduction to Materials for Advanced Energy Systems (2019): 379-444.
17. Chaudhuri, Anudipta, Rajkanya Datta, Muthuselvan Praveen Kumar, João Paulo Davim, and Sumit Pramanik. "Energy conversion strategies for wind energy system: Electrical, mechanical and material aspects." Materials 15, no. 3 (2022): 1232.
18. Yue, L., Jayapal, M., Cheng, X., Zhang, T., Chen, J., Ma, X., ... & Zhang, W. (2020). Highly dispersed ultra-small nano Sn-SnSb nanoparticles anchored on N-doped graphene sheets as high performance anode for sodium ion batteries. Applied Surface Science, 512, 145686.
19. Chudy-Laskowska, Katarzyna, and Tomasz Pisula. "An Analysis of the Use of Energy from Conventional Fossil Fuels and Green Renewable Energy in the Context of the European Union's Planned Energy Transformation." Energies 15, no. 19 (2022): 7369.
20. Goud, J. S., Srilatha, P., Kumar, R. V., Kumar, K. T., Khan, U., Raizah, Z., ... & Galal, A. M. (2022). Role of ternary hybrid nanofluid in the thermal distribution of a dovetail fin with the internal generation of heat. Case Studies in Thermal Engineering, 35, 102113.
21. Amin, Muhammad, Hamad Hussain Shah, Anaiz Gul Fareed, Wasim Ullah Khan, Eunhyea Chung, Adeel Zia, Zia Ur Rahman Farooqi, and Chaehyeon Lee. "Hydrogen production through renewable and non-renewable energy processes and their impact on climate change." International journal of hydrogen energy 47, no. 77 (2022): 33112-33134.
22. Ramprasad, P., Basavapoornima, C., Depuru, S. R., & Jayasankar, C. K. (2022). Spectral investigations of Nd3+: Ba (PO3) 2+ La2O3 glasses for infrared laser gain media applications. Optical Materials, 129, 112482.
23. Naresh, M., & Munaswamy, P. (2019). Smart agriculture system using IoT technology. International journal of recent technology and engineering, 7(5), 98-102.

24. Peszko, Grzegorz, Dominique Van Der Mensbrugghe, Alexander Golub, John Ward, Cor Marijs, Anne Schopp, John Rogers, and Amelia Midgley. Diversification and cooperation in a decarbonizing world: climate strategies for fossil fuel-dependent countries. World Bank Publications, 2020.
25. Al-Shetwi, Ali Q. "Sustainable development of renewable energy integrated power sector: Trends, environmental impacts, and recent challenges." Science of The Total Environment 822 (2022): 153645.
26. Bhukya, M. N., Kota, V. R., & Depuru, S. R. (2019). A simple, efficient, and novel standalone photovoltaic inverter configuration with reduced harmonic distortion. IEEE access, 7, 43831-43845.
27. Jami, Anahita AN, and Philip R. Walsh. "The role of public participation in identifying stakeholder synergies in wind power project development: The case study of Ontario, Canada." Renewable energy 68 (2014): 194-202.
28. Kumar, Mahesh. "Social, economic, and environmental impacts of renewable energy resources." Wind solar hybrid renewable energy system 1 (2020).
29. Maradin, Dario. "Advantages and disadvantages of renewable energy sources utilization." International Journal of Energy Economics and Policy 11, no. 3 (2021): 176-183.
30. Patil, S., & Anandhi, R. J. (2020). Diversity based self-adaptive clusters using PSO clustering for crime data. International Journal of Information Technology, 12(2), 319-327.
31. Leiren, Merethe Dotterud, Stine Aakre, Kristin Linnerud, Tom Erik Julsrud, Maria-Rosaria Di Nucci, and Michael Krug. "Community acceptance of wind energy developments: Experience from wind energy scarce regions in Europe." Sustainability 12, no. 5 (2020): 1754.
32. Elum, Zelda Anne, and Abiodun Suleiman Momodu. "Climate change mitigation and renewable energy for sustainable development in Nigeria: A discourse approach." Renewable and sustainable energy reviews 76 (2017): 72-80.
33. Akshatha, S., Sreenivasa, S., Parashuram, L., Alharthi, F. A., & Rao, T. M. C. (2021). Microwave assisted green synthesis of p-type Co3O4@ Mesoporous carbon spheres for simultaneous degradation of dyes and photocatalytic hydrogen evolution reaction. Materials Science in Semiconductor Processing, 121, 105432
34. Kamran, Muhammad, Muhammad Rayyan Fazal, and Muhammad Mudassar. "Towards empowerment of the renewable energy sector in Pakistan for sustainable energy evolution: SWOT analysis." Renewable Energy 146 (2020): 543-558.
35. Daaboul, Jessica, Patrick Moriarty, and Damon Honnery. "Net green energy potential of solar photovoltaic and wind energy generation systems." Journal of Cleaner Production 415 (2023): 137806.
36. Suji Prasad, S. J., Thangatamilan, M., Suresh, M., Panchal, H., Rajan, C. A., Sagana, C., ... & Sadasivuni, K. K. (2022). An efficient LoRa-based smart agriculture management and monitoring system using wireless sensor networks. International Journal of Ambient Energy, 43(1), 5447-5450.
37. Armeni, Chiara. "Participation in environmental decision-making: Reflecting on planning and community benefits for major wind farms." Journal of Environmental Law 28, no. 3 (2016): 415-441.
38. Kontogianni, Alexandra, Ch Tourkolias, Michalis Skourtos, and Dimitrios Damigos. "Planning globally, protesting locally: Patterns in community perceptions towards the installation of wind farms." Renewable Energy 66 (2014): 170-177.
39. Karuppusamy, L., Ravi, J., Dabbu, M., & Lakshmanan, S. (2022). Chronological salp swarm algorithm based deep belief network for intrusion detection in cloud using fuzzy

entropy. International Journal of Numerical Modelling: Electronic Networks, Devices and Fields, 35(1), e2948.

40. Sandhu, Mamatha, and Tilak Thakur. "Issues, challenges, causes, impacts and utilization of renewable energy sources-grid integration." International Journal of Engineering Research and Applications 4, no. 3 (2014): 636-643.
41. Medina, Carlos, C. Ríos M. Ana, and Guadalupe González. "Transmission grids to foster high penetration of large-scale variable renewable energy sources–A review of challenges, problems, and solutions." International Journal of Renewable Energy Research (IJRER) 12, no. 1 (2022): 146-169.
42. Ibrahim, Muhammad Sohail, Wei Dong, and Qiang Yang. "Machine learning driven smart electric power systems: Current trends and new perspectives." Applied Energy 272 (2020): 115237.
43. Ramkumar, M., Babu, C. G., Kumar, K. V., Hepsiba, D., Manjunathan, A., & Kumar, R. S. (2021, March). ECG cardiac arrhythmias classification using DWT, ICA and MLP neural networks. In Journal of Physics: Conference Series (Vol. 1831, No. 1, p. 012015). IOP Publishing.
44. Amiryar, Mustafa E., and Keith R. Pullen. "A review of flywheel energy storage system technologies and their applications." Applied Sciences 7, no. 3 (2017): 286.
45. Jisha, P. K., Naik, R., Prashantha, S. C., Nagabhushana, H., Sharma, S. C., Nagaswarupa, H. P., ... & Premkumar, H. B. (2015). Facile combustion synthesized orthorhombic GdAlO3: Eu3+ nanophosphors: Structural and photoluminescence properties for WLEDs. Journal of Luminescence, 163, 47-54.
46. Farivar, Glen G., William Manalastas, Hossein Dehghani Tafti, Salvador Ceballos, Alain Sanchez-Ruiz, Emma C. Lovell, Georgios Konstantinou, Christopher D. Townsend, Madhavi Srinivasan, and Josep Pou. "Grid-connected energy storage systems: State-of-the-art and emerging technologies." Proceedings of the IEEE 111, no. 4 (2022): 397-420.
47. Feng, Cheng, Yi Wang, Qixin Chen, Yi Ding, Goran Strbac, and Chongqing Kang. "Smart grid encounters edge computing: Opportunities and applications." Advances in Applied Energy 1 (2021): 100006.
48. Ramakrishna, G., Naik, R., Nagabhushana, H., Basavaraj, R. B., Prashantha, S. C., Sharma, S. C., & Anantharaju, K. S. (2016). White light emission and energy transfer (Dy3+→ Eu3+) in combustion synthesized YSO: Dy3+, Eu3+ nanophosphors. Optik, 127(5), 2939-2945.
49. Abolhosseini, Shahrouz, and Almas Heshmati. "The main support mechanisms to finance renewable energy development." Renewable and Sustainable Energy Reviews 40 (2014): 876-885.
50. Akshatha, S., Sreenivasa, S., Parashuram, L., Kumar, V. U., Sharma, S. C., Nagabhushana, H., ... & Maiyalagan, T. (2019). Synergistic effect of hybrid Ce3+/Ce4+ doped Bi2O3 nano-sphere photocatalyst for enhanced photocatalytic degradation of alizarin red S dye and its NUV excited photoluminescence studies. Journal of Environmental Chemical Engineering, 7(3), 103053.
51. Polzin, Friedemann, Florian Egli, Bjarne Steffen, and Tobias S. Schmidt. "How do policies mobilize private finance for renewable energy?—A systematic review with an investor perspective." Applied Energy 236 (2019): 1249-1268.
52. Naik, R., Prashantha, S. C., Nagabhushana, H., Sharma, S. C., Nagaswarupa, H. P., Anantharaju, K. S., ... & Girish, K. M. (2015). A single phase, red emissive Mg2SiO4: Sm3+ nanophosphor prepared via rapid propellant combustion route. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 140, 516-523.

53. Solman, Helena, Mattijs Smits, Bas van Vliet, and Simon Bush. "Co-production in the wind energy sector: A systematic literature review of public engagement beyond invited stakeholder participation." Energy Research & Social Science 72 (2021): 101876.
54. Naik, R., Prashantha, S. C., & Nagabhushana, H. (2017). Effect of Li+ codoping on structural and luminescent properties of Mg2SiO4: RE3+ (RE= Eu, Tb) nanophosphors for displays and eccrine latent fingerprint detection. Optical Materials, 72, 295-304.
55. Wolniak, Radosław, and Bożena Skotnicka-Zasadzień. "Development of Wind Energy in EU Countries as an Alternative Resource to Fossil Fuels in the Years 2016–2022." Resources 12, no. 8 (2023): 96.