Frontora
DOI: 10.70945/f.v04i02.0032
eISSN: 3143-8695 Vol. 4, No. 2, 2026
ARTICLE | OPEN ACCESS

Financial and Technological Challenges in Sustainable Energy Infrastructure

Proggo Choudhury[1]*

[1] *Department of Master of Business Administration, North South University, Dhaka, Bangladesh.*

***Correspondence:**
Proggo Choudhury
Email: proggoc@gmail.com

How to cite this article:
Choudhury, P. (2026) Financial and Technological Challenges in Sustainable Energy Infrastructure. *Frontora. 4*(2), 1-7.

Article History:
Received: 15 July 2026
Accepted: 22 September 2026
Published: 31 October 2026

Peer Review Process:
This article was evaluated through a rigorous double-blind peer review process. The identities of both authors and reviewers remained fully concealed. At least two independent experts assessed the manuscript for originality, accuracy, and its relevance to the journal's academic scope.

ABSTRACT

The sustainable energy infrastructure has influenced global energy networks, where the emphasis is on renewable energy implementation, grid modernization, energy storage, and digital transformation. The speed of this change is determined not only by technological challenges but more so by financial constraints. This review focuses on essential financial and technological challenges regarding sustainable energy infrastructure, with regard to investment volumes, investment risks, renewable energy integration, energy storage, smart grid development, digitalization, and infrastructure resilience. The authors apply a systematic review of peer-reviewed articles, global energy reports, and governmental studies for the identification of common barriers, emerging solutions, and important directions of research with regard to different economic and geographical contexts. A review of the evidence shows that finance remains a key barrier to adoption. It is predicted that clean-energy investment needs will rise by around 40% by 2030 from current levels. Apart from that, an insufficient level of energy storage capacity as well as cybersecurity threats and its lack of specialized skills constitute hurdles to clean energy use. There are some positive signs – technologies such as digital energy management, AI, advanced batteries, or smart-grid offer possibilities for making systems more efficient and flexible. In general, prosperity of the clean energy transformation demands finance and technological innovations, supportive policies, and infrastructure planning.

Keywords: Sustainable Energy Infrastructure, Renewable Energy Finance, Energy Transition, Smart Grids, Energy Storage.

© The Author(s) 2026. Open Access. This article is licensed under a Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/), which permits use, sharing, adaptation, distribution, and reproduction in any medium, provided appropriate credit is given to the original author(s) and source. Published by American Science Press LLC, USA; Editorial Office: Cambria Scholars Ltd, UK. (http://frontora.cspub.co.uk).

INTRODUCTION

Sustainable energy infrastructure has become an important part of the global strategy designed to reduce greenhouse gas emissions and to promote energy security and sustainable economic development [1]. Rising energy consumption and demand, threats posed by climate issues, technical developments, and transformation of energy markets have made countries reconsider their traditional energy systems based on fossil-fuel energy generation [2]. Sustainable energy infrastructure involves renewable energy generation technologies, energy transmission and distribution networks, energy storage technologies, smart grids, and energy efficiency systems [3]. The transition of these interconnected elements is vital to creating more reliable energy systems with low carbon emissions [4]. Nonetheless, this transition entails a great deal of complicated challenges associated with finance, technology, institutional infrastructures, and operations, with their magnitude differing considerably from one country/region to another [5, 6]. The financial capacity plays an important role in developing sustainable energy infrastructures, especially at the beginning [7]. It requires significant financial investments to build renewable energy plants, new electricity transmission networks, storage systems, and implement modern digital technologies in the process of generating electricity [8]. Despite the fact that prices for some of the technologies are becoming more competitive, project developers still do not know what prices for electricity and interests they will have to deal with in the long run, what policies will be implemented by the government, what permissions will be needed, what kinds of exchange rates will exist in the future [9]. All these factors will determine the cost of capital and the feasibility of projects in financial terms. Such challenges pose a problem in developing countries where capital is unavailable and expensive, borrowing is complicated and involves many consequences, and institutional capability is low [10].

Technological complexity is yet another significant challenge. Solar and wind energy must be regarded as unstable

necessitating the need for the creation of more flexible infrastructures designed to adjust to the discrepancies in electricity supply and needs. Old electricity grids were usually built with the notion of centralized electric production and planned flow of electricity [11]. However, recently, systems have begun to embrace decentralized sources of renewable energy, storage capacities in the form of batteries, electric vehicles, and producers-consumers of electricity. In order to connect the new components to the existing infrastructure, modernization of the electricity transmission and distribution systems, implementation of advanced control mechanisms, and development of flexible electricity markets are necessary [5]. The absence of proper grid upgrades can cause congestion, curtailment, and reliability issues as renewable deployment rises. As a result, energy storage has gained significance in sustainable infrastructure planning. The storage mechanisms like batteries can bring flexibility by allocating power from periods of surplus supply to periods with a high demand [12]. On the other hand, however, storage technologies face various difficulties related to costs, degradation, availability of resources, management, safety, and recycling. Moreover, the appropriateness of particular storage technology also depends on the scale of projects, duration, region of implementation, and market design [13].

METHODOLOGY

This study used a framework of literature review to analyze financial and technological issues linked to sustainable energy infrastructures. Important peer-reviewed studies, international energy reports, policy papers, and organizational publications were reviewed to gain academic, technical, and policy observations. The authors focused their study on the literature discussing renewable energy investments, financing energy transition, modernization of grids, energy storage, digitalization, smart grid technologies, and resilience of the infrastructure [14]. The searches used combinations of words, for instance, sustainable energy infrastructure, renewable energy finance, energy investments, grid integration, energy storage, smart grid technologies, digital energy, technological barriers, and energy transition. The selection of works has been done depending on their relevance to financial, technological, and operational aspects of sustainable infrastructure. Recent literature has been preferred to bring new technology and funding advancements although significant prior investigations have been left intact to create the theoretical basis of the investigation [15]. Studies that deal with infrastructure-oriented sustainability issues only to a small extent have been ignored. The collected pieces of evidence were synthesized into five main topics and themes including barriers and limitations in financing and investment; integration of renewable energy; energy storage and flexibility; digitalization and security; funding and innovation pathways. Comparative analysis was later employed to determine reoccurring limitations, solutions, and research priorities in varied countries and regions [3, 16].

RESULTS AND DISCUSSION

Financial Constraints and Investment Barriers

Among the most important factors affecting the formation of green energy infrastructure. The development of this sector requires investments made in various interconnected parts, such as renewable energy generation plants, transmission facilities, grids, storage facilities as well as charging infrastructure, digital services, and energy efficiency technologies [17]. However, unlike traditional infrastructure development, green investments often require modernizing multiple components at once, which means higher capital demand and big importance of financial management. Despite promising positive performance of renewable-energy technologies, high-interest rates or scarcity of financing may deter investors from funding the projects. This is especially essential for developing countries since investors in those regions may face significant political, regulatory, currency, and market risks [18]. Indeed, the same technology can have very different investment conditions in various nations. Regulatory uncertainty further complicates the process by raising doubts in investors' minds. Any modifications in the renewable-energy incentives, electricity tariffs, taxes, land-use regulations, and procurement mechanisms lead to a change in expected revenues [19]. The long-lasting nature of the projects makes it necessary for investors to evaluate the policies over a prolonged period. Additionally, delays in obtaining permits and grid connections raise investment costs and contribute to delay in revenues. The constant changes of the currency result in another financial problem for the countries that depend on imported machinery or financing in foreign currency [9]. A drop in the value of the national currency makes the cost of equipment, servicing the debt, and project development higher. Moreover, smaller developers may face even more problems since they have the fewer ways to avoid financial risks [20].



Figure 1: Financial Constraints and Investment Barriers

Renewable-Energy Integration and Grid Modernization

Renewable energy is generating new technical needs for contemporary electricity networks. Both solar and wind energy can lessen the use of fossil fuels, however, their rapid changes make it harder to balance supply and demand on a constant basis [21]. Modernization of electricity networks is necessary therefore. Traditional electrical grids were created mainly for centralized electricity generation and expected flows of power in one direction, while the new energy systems include distributed wind and solar electricity producers, battery storages, electric vehicles as well as proactive energy consumers [22]. These changes prompt the need for modern monitoring solutions, new automated control systems, and flexible management for electricity networks. If transmission capacity is limited, it may restrict the deployment of renewable energy sources as key resources are usually sited away from major towns, hence increasing congestion and curtailment risk [23]. Advanced forecasting techniques that use machine-learning can optimize predictive power for renewable energy generation and scheduling. Also, using energy storage, demand response, flexible generation, and regional interconnections can increase flexibility. Therefore, putting more renewable sources into use should be coupled with a synchronized investment into transmission and distribution, forecasting systems, digital control systems, and skills [24].

Energy Storage and System Flexibility

The significance of energy storage has grown in recent times in terms of reconciling the disparities between renewable energy production and electricity consumption as presented in Figure 2. Renewable solar power only operates during the daytime, which is especially problematic with electric consumption that remains high even during the night [25]. The use of energy storage allows to transfer excess electricity to the time of higher consumption, minimizing losses caused by renewable energy curtailment and optimizing the flexibility of the electricity grid. The benefit of battery storage systems lies in their modularity, speed of reaction, and the ability to be used on different scales. They can provide frequency regulation, peak shaving, renewable energy integration, and backup power [26, 27]. Nonetheless, the existing barriers for implementation of battery energy storage solutions are high capital prices, battery deterioration, thermal management, availability of materials, and requirements for dismantling systems after reaching their lifetime. Other technologies, such as pumped-storage hydropower, flow batteries, thermal storage, and hydrogen, provide solutions for a applications that require large-scale or long-duration storage. However, challenges persist in areas such as efficiency and costs [28]. In addition, electricity-market design affects investment in storage due to the effect of inadequate compensation for flexibility services on project funding. Similarly, the demand for critical minerals draws attention to the importance of recycling in resource management [22]. Hence, it is clear that planning for the future should consider both short- and long-duration storage and include flexible demand, association with the grid, forecasting, the availability of supportive market mechanisms, and lifecycle-based investments [29].

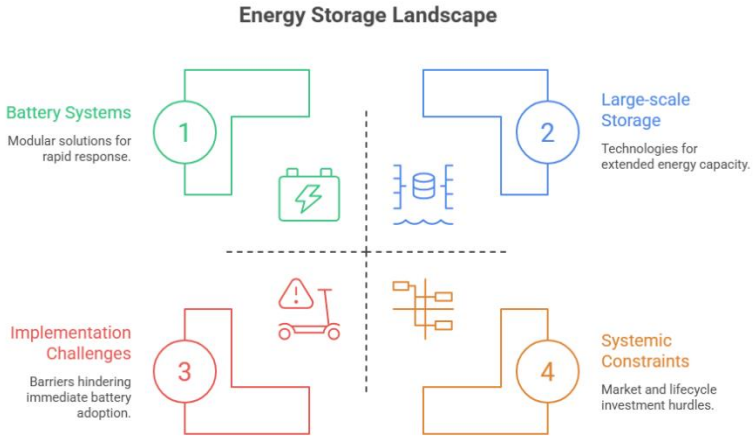


Figure 2: Energy Storage and System Flexibility

Digitalization, Smart Grids, and Cybersecurity

Sustainable energy infrastructure is being revolutionized by digitalization, using tools such as smart grids, modern metering technologies, automation systems, and data-based energy systems as presented in Table 1. New solutions promote the functioning of electric networks and make it easier to bring renewable sources into operation [30]. AI and machine learning will boost the performance of demand forecasting, renewable energy estimation, predictive maintenance, and energy storage. As per the International Energy Agency, some positive effects of digitalization on energy-system operation are possible if the implementation is good and the necessary infrastructure is in place [31]. Cybersecurity is becoming a very big issue because energy systems connected to each other are more vulnerable to digital threats. At the same time, poor-quality data and incompatible technologies are preventing smart energy management solutions from being used [33, 33]. The International Energy Agency reported that cyberattacks against the energy sector increased by over 50% in 2022 compared to 2020 and this stresses the importance of digital futureproofing. In order to solve this problem, it is necessary to adopt secure communication protocols and standards, foster workforce development and introduce proper data governance [34-37]. That means cyber security should be included in the planning process of the energy infrastructure.

Table 1: Digitalization, Smart Grids, and Cybersecurity in Sustainable Energy Systems

Component	Benefits and challenges	Recommended measures
Smart grids and automation	Improve grid efficiency and renewable energy integration [30]	Modernize grid infrastructure
AI and machine learning	Enhance demand forecasting, renewable energy prediction, and predictive maintenance	Develop reliable data-driven systems
Digital energy management	Improves operational performance when adequate infrastructure is available [24]	Ensure appropriate infrastructure and implementation
Cybersecurity	Interconnected systems increase exposure to cyberattacks	Strengthen cyber protection and risk assessment
Data quality and interoperability	Poor-quality data and incompatible technologies hinder smart energy management [31]	Establish data standards and compatible technologies
Cyberattack prevention	Energy-sector cyberattacks increased by over 50% in 2022 compared with 2020	Adopt secure communication protocols and continuous monitoring
Institutional capacity	Effective digitalization requires skilled personnel and reliable data governance [17–22]	Provide workforce training and strengthen data governance
Integrated infrastructure planning	Cybersecurity must be considered alongside energy-system development	Incorporate security into infrastructure design

Emerging Financing Mechanisms and Technological Pathways

Designing and implementing sustainable energy infrastructure involves technological progress, as well as the need for financial resources. Public funds are vital, but the mobilization of private capital is crucial in scaling renewable generation technologies, upgrading electrical grids, and constructing energy storage facilities. Such tools as green bonds, blended finance, concessional loans, and guarantees serve to lower investment risk and increase project feasibility [38, 39]. The increasing popularity of green finance mechanisms confirms that the need for financing

environmentally friendly infrastructure projects is growing rapidly [40]. Investment conditions can be enhanced by development banks and governments using risk-sharing tools, provision of technical support and long-term investments [41]. New technologies such as advanced batteries, intelligent networks, artificial intelligence, and green hydrogen technologies facilitate increasing efficiency and flexibility of the system, but their implementation requires financing of technological research, demonstration projects, professionals, and technology transfer. Cooperation of the governments, universities, electric companies, and private companies can consolidate local competencies and reduce dependence on technology [42-44].

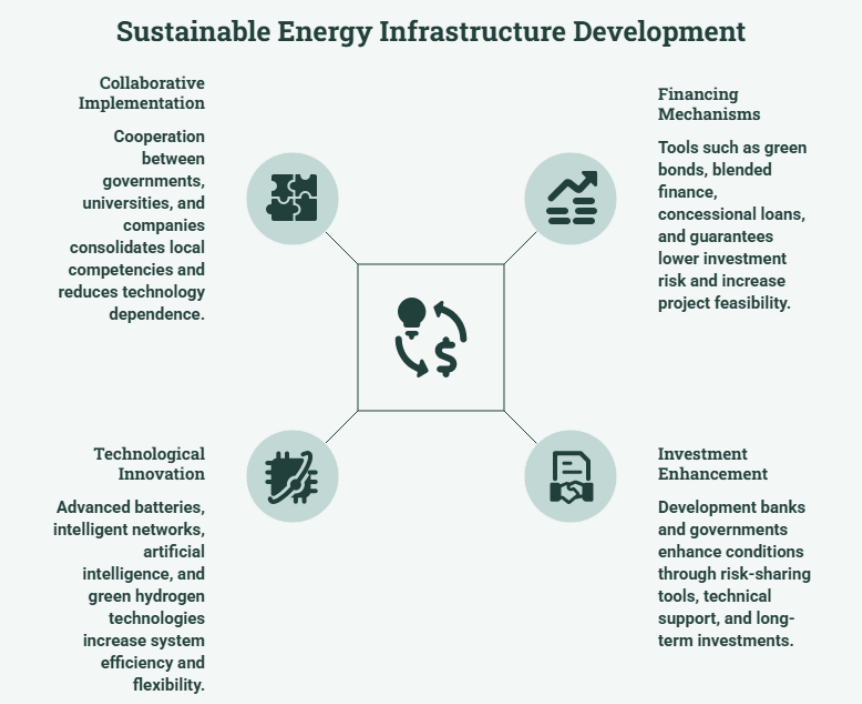


Figure 3: Emerging Financing Mechanisms and Technological Pathways

CONCLUSION

The development of sustainable energy infrastructure faces two major obstacles which combine financial barriers with technological limitations to block its path toward creating a low-carbon stable and dependable energy system. The development of infrastructure projects faces major obstacles because they require large initial capital investments while dealing with intense financial risks and unpredictable government regulations and foreign exchange risks and insufficient affordable funding options in emerging markets. The system encounters multiple technological obstacles because renewable power sources create unstable output and the grid operates at its maximum capacity and storage facilities reach their limits and digital systems encounter security threats and there exists a shortage of skilled workers. The review demonstrates that financial and technological challenges should not be addressed independently. However, innovations in financial instruments such as green bonds, blended finance, concessional financing, guaranteeing, and public-private partnerships can be used to improve the investment climate, whereas innovations such as smart grids, storage, AI, and forecast can increase the flexibility and efficiency of energy systems. However, all those innovations would be not sufficient without stability in policies, cybersecurity, skilled human capital, technological transfer, and right institutions' coordination. It is necessary that the future strategies would be developed on a comprehensive basis combining finance, technologies, governance, and planning.

Author Contributions

P. C. contributed to the conceptualization, literature review, investigation, and synthesis of relevant literature. P. C. prepared the original manuscript, critically reviewed and edited the manuscript, and approved the final version for publication.

REFERENCES

1. Falcone, P. M. (2023). Sustainable energy policies in developing countries: a review of challenges and opportunities. *Energies*, *16*(18), 6682. https://doi.org/10.3390/en16186682
2. Di Castelnuovo, M., & Biancardi, A. (2020). The future of energy infrastructure: Challenges and opportunities arising from the R-evolution of the energy sector. *Disruption in the Infrastructure Sector: Challenges and Opportunities for Developers, Investors and Asset*

Managers, 5-52. https://doi.org/10.1007/978-3-030-44667-3_2
3. Al Imon, K. A., Robbani, M. S., Chowdhury, B. S., Arthey, A. G., Ahmed, N., & Amin, N. (2025, December). Lightweight Kalman Filtering for Battery Pack SOC Estimation: A Bar-Delta Approach. In *2025 28th International Conference on Computer and Information Technology (ICCIT)* (pp. 4555-4560). IEEE. https://doi.org/10.1109/iccit68739.2025.11491411
4. Taghizadeh-Hesary, F., & Yoshino, N. (2020). Sustainable solutions for green financing and investment in renewable energy projects. *Energies*, *13*(4), 788. https://doi.org/10.3390/en13040788
5. Li, H., Peng, W., Adumene, S., & Yazdi, M. (2023). Attention towards energy infrastructures: Challenges and solutions. *Intelligent reliability and maintainability of energy infrastructure assets*, 137-148. https://doi.org/10.1007/978-3-031-29962-9_9
6. Al Imon, K. A., Chowdhury, B. S., Robbani, M. S., Rahman, M. A., Ahmed, N., & Anonto, H. Z. (2025, November). Advanced nonlinear state estimation of degrading battery systems via unscented Kalman filtering. In *2025 IEEE PES Conference on Innovative Smart Grid Technologies-Middle East (ISGT Middle East)* (pp. 1-5). IEEE. https://doi.org/10.1109/isgtmiddleeast65737.2025.11314288
7. Li, H., Peng, W., Adumene, S., & Yazdi, M. (2023). Attention towards energy infrastructures: Challenges and solutions. *Intelligent reliability and maintainability of energy infrastructure assets*, 137-148. https://doi.org/10.1007/978-3-031-29962-9_9
8. Pandey, V. (2020). Energy infrastructure for sustainable development. In *Affordable and clean energy* (pp. 1-13). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-71057-0_77-1
9. Howlader, M. N., Chowdhury, S., Al Imon, K. A., Khan, G. J., Mehedi, M. K. H., Rabbi, M. F., ... & Al Zami Alif, S. (2026). Design and implementation of a low-cost IoT-enabled dual-axis photovoltaic tracking system with experimental and simulation-based validation. *Journal of Electrical Systems and Information Technology*, *13*(1), 44. https://doi.org/10.1186/s43067-026-00351-z
10. Globa, S. B., Vasiljev, E. P., Berezovaya, V. V., & Zyablikov, D. V. (2023). Risks and financial barriers to the implementation of sustainable infrastructure investment projects in the housing sector. In *Smart Green Innovations in Industry 4.0 for Climate Change Risk Management* (pp. 239-245). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-28457-1_25
11. Nauman, M., Naheed, R., & Khan, J. (2024). Navigating sustainable horizons: exploring the dynamics of financial stability, green growth, renewable energy, technological innovation, financial inclusion, and soft infrastructure in shaping sustainable development. *Environmental Science and Pollution Research*, *31*(20), 29939-29956. https://doi.org/10.1007/s11356-024-33202-3
12. Tasnia, R., & Hossain, M. S. (2026). Investment barriers and financing solutions for critical energy infrastructure projects. Pacific Journal of Advanced Engineering Innovations, 3(1), 89–96. https://doi.org/10.70818/pjaei.v03i01.0246
13. Mhlanga, D. (2021). Artificial intelligence in the industry 4.0, and its impact on poverty, innovation, infrastructure development, and the sustainable development goals: Lessons from emerging economies? *Sustainability*, *13*(11), 5788. https://doi.org/10.3390/su13115788
14. Kumar. J, C. R., & Majid, M. A. (2020). Renewable energy for sustainable development in India: current status, future prospects, challenges, employment, and investment opportunities. *Energy, Sustainability and Society*, *10*(1), 2.https://doi.org/10.1186/s13705-019-0232-1
15. Hossain, M. S., Patel, U., & Chadni, F. H. (2024). Key Factors Affecting High-Voltage Insulation Performance: Evidence from Environmental Contamination, Partial Discharge, and Preventive Maintenance. *Applied IT & Engineering*, *2*(1), 1-16. https://doi.org/10.25163/engineering.2110771
16. Fu, C., Lu, L., & Pirabi, M. (2023). Advancing green finance: a review of sustainable development. Digital Economy and Sustainable Development, 1(1). https://doi.org/10.1007/s44265-023-00020-3
17. Serban, A. C., & Lytras, M. D. (2020). Artificial intelligence for smart renewable energy sector in Europe—Smart energy infrastructures for next generation smart cities. IEEE Access, 8, 77364–77377. https://doi.org/10.1109/access.2020.2990123
18. Hossain, M. S., & Rahman, M. A. (2022). Integration of solar thermal energy and solar electricity generation for sustainable power production. Central Asian Journal of Theoretical and Applied Science. https://doi.org/10.51699/cajotas.v3i5.1696
19. Wu, J., & Tran, N. K. (2018). Application of Blockchain Technology in Sustainable Energy Systems: An Overview. Sustainability, 10(9), 3067. https://doi.org/10.3390/su10093067
20. Thacker, S., Adshead, D., Fay, M., Hallegatte, S., Harvey, M., Meller, H., O'Regan, N., Rozenberg, J., Watkins, G., & Hall, J. W. (2019). Infrastructure for sustainable development. Nature Sustainability, 2(4), 324–331. https://doi.org/10.1038/s41893-019-0256-8
21. Ullah, M. S., Hossain, M. S., & Ullah, S. M. E. (2025). Wireless power transfer adoption in smart renewable energy networks: A quantitative study of awareness, perceived benefits, technical barriers, and renewable integration. Energy Environment and Economy, 3(1), 1–13. https://doi.org/10.25163/energy.3110770
22. Stafford-Smith, M., Griggs, D., Gaffney, O., Ullah, F., Reyers, B., Kanie, N., ... & O'Connell, D. (2017). Integration: the key to implementing the Sustainable Development Goals. *Sustainability science*, *12*(6), 911-919. https://doi.org/10.1007/s11625-016-0383-3
23. Strielkowski, W., Civín, L., Tarkhanova, E., Tvaronavičienė, M., & Petrenko, Y. (2021). Renewable energy in the

sustainable development of electrical power sector: A review. *Energies*, *14*(24), 8240. https://doi.org/10.3390/en14248240
24. Rahman, M. A., & Hossain, M. S. (2021). Intelligent Optimisation for Power System Stability: A Comparative Expert-Survey Analysis of Artificial Neural Networks, Particle Swarm Optimisation, Genetic Algorithms, Fuzzy Logic, and Hybrid AI Approaches. *Journal of Primeasia*, *2*(1), 1-16. https://doi.org/10.25163/primeasia.2110773
25. Gielen, D., Boshell, F., & Saygin, D. (2016). Climate and energy challenges for materials science. *Nature materials*, *15*(2), 117-120.. https://doi.org/10.1038/nmat4545
26. Rodić, L., & Wilson, D. (2017). Resolving governance issues to achieve priority sustainable development goals related to solid waste management in developing countries. Sustainability, 9(3), 404. https://doi.org/10.3390/su9030404
27. Newaz, A. A. H., Al Imon, K. A., Jahan, R., & Tanvir, I. K. (2022). Advanced Motor Design and Optimization for High-Efficiency Industrial Applications. Metallurgical and Materials Engineering, 28(4), 697-713.
28. Georgeson, L., & Maslin, M. (2018). Putting the United Nations Sustainable Development Goals into practice: A review of implementation, monitoring, and finance. Geo Geography and Environment, 5(1). https://doi.org/10.1002/geo2.49
29. Azhgaliyeva, D., Kapoor, A., & Liu, Y. (2019). Green bonds for financing renewable energy and energy efficiency in South-East Asia: a review of policies. Journal of Sustainable Finance & Investment, 10(2), 113–140. https://doi.org/10.1080/20430795.2019.1704160
30. Hossain, A., Oyebode, D., Imon, K. a. A., Faisal, S. M. W., & Vayyala, R. (2025). Analyzing how MIS can optimize the distribution of energy in smart grids, focusing on data-driven decision-making processes. Journal of Smart Internet of Things, 2025(1), 31–42. https://doi.org/10.2478/jsiot-2025-0004
31. Khan, S. A. R., Godil, D. I., Jabbour, C. J. C., Shujaat, S., Razzaq, A., & Yu, Z. (2025). Green data analytics, blockchain technology for sustainable development, and sustainable supply chain practices: evidence from small and medium enterprises. *Annals of Operations Research*, *350*(2), 603-627. https://doi.org/10.1007/s10479-021-04275-x
32. Carley, S., & Konisky, D. M. (2020). The justice and equity implications of the clean energy transition. Nature Energy, 5(8), 569–577. https://doi.org/10.1038/s41560-020-0641-6
33. Rasoulinezhad, E., & Taghizadeh-Hesary, F. (2022). Role of green finance in improving energy efficiency and renewable energy development. Energy Efficiency, 15(2), 14. https://doi.org/10.1007/s12053-022-10021-4
34. Arner, D. W., Buckley, R. P., Zetzsche, D. A., & Veidt, R. (2020). Sustainability, FinTech and Financial Inclusion. *European Business Organization Law Review*, *21*(1), 7–35. https://doi.org/10.1007/s40804-020-00183-y
35. Palomares, I., Martínez-Cámara, E., Montes, R., García-Moral, P., Chiachio, M., Chiachio, J., ... & Herrera, F. (2021). A panoramic view and swot analysis of artificial intelligence for achieving the sustainable development goals by 2030: progress and prospects. *Applied Intelligence*, *51*(9), 6497-6527. https://doi.org/10.1007/s10489-021-02264-y
36. Gayen, D., Chatterjee, R., & Roy, S. (2023). A review on environmental impacts of renewable energy for sustainable development. *International Journal of Environmental Science and Technology*, *21*(5), 5285–5310. https://doi.org/10.1007/s13762-023-05380-z
37. Leal Filho, W., Tripathi, S. K., Andrade Guerra, J. B. S. O. D., Giné-Garriga, R., Orlovic Lovren, V., & Willats, J. (2019). Using the sustainable development goals towards a better understanding of sustainability challenges. *International Journal of Sustainable Development & World Ecology*, *26*(2), 179-190.. https://doi.org/10.1080/13504509.2018.1505674
38. Fuso Nerini, F., Tomei, J., To, L. S., Bisaga, I., Parikh, P., Black, M., ... & Mulugetta, Y. (2018). Mapping synergies and trade-offs between energy and the Sustainable Development Goals. *Nature Energy*, *3*(1), 10-15. https://doi.org/10.1038/s41560-017-0036-5
39. Sachs, J. D., Schmidt-Traub, G., Mazzucato, M., Messner, D., Nakicenovic, N., & Rockström, J. (2019). Six transformations to achieve the sustainable development goals. *Nature sustainability*, *2*(9), 805-814. https://doi.org/10.1038/s41893-019-0352-9
40. He, X., Khan, S., Ozturk, I., & Murshed, M. (2023). The role of renewable energy investment in tackling climate change concerns: Environmental policies for achieving SDG-13. *Sustainable Development*, *31*(3), 1888-1901. https://doi.org/10.1002/sd.2491.
41. Tusar, T. (2026). AI-Driven Decision Support Systems for Infrastructure Management: A Systematic Review. *Pacific Journal of Advanced Engineering Innovations*, *3*(1), 69-77.
42. Rashid, L. (2019). Entrepreneurship Education and Sustainable Development Goals: A literature Review and a Closer Look at Fragile States and Technology-Enabled Approaches. *Sustainability*, *11*(19), 5343. https://doi.org/10.3390/su11195343
43. Truby, J. (2020). Governing Artificial Intelligence to benefit the UN Sustainable Development Goals. *Sustainable Development*, *28*(4), 946–959. https://doi.org/10.1002/sd.2048
44. Endris, E., & Kassegn, A. (2022). The role of micro, small and medium enterprises (MSMEs) to the sustainable development of sub-Saharan Africa and its challenges: a systematic review of evidence from Ethiopia. *Journal of Innovation and Entrepreneurship*, *11*(1), 20. https://doi.org/10.1186/s13731-022-00221-8.