ISSN: 2584-2706 DOI: https://doi.org/10.67317/IJMSRT26JUL046

The Role of Renewable Energy Integration in Achieving Carbon Neutrality and Climate Change Mitigation: A Systematic Review

*Mohammed Abdalghafoor
*Corresponding Author

Abstract
The shift to renewable energy has emerged as a key approach to carbon neutrality and reducing the negative effects of climate change. This systematic review aims to review the literature on renewable energy integration for decarbonization efforts in the last five years (2021-2026). The review centers on renewable energy technologies, energy transition pathways, policy frameworks, technological innovation and sectoral strategies to reduce GHGs emissions and promote sustainable development.
The studies reviewed have repeatedly shown that the combination of renewable energy and energy efficiency measures, smart energy systems, supportive policies and technological innovation has a significant effect on speeding up the transition towards carbon neutrality. But there are still obstacles including financing shortfalls, policy uncertainties, intermittent renewable energy supply, etc. that prevent the widespread deployment. The results indicate that synergies between policy measures, investments in clean technologies and collaboration across sectors are important for strengthening climate resilience and for the long-term sustainability objectives.

Keywords
Renewable energy integration; Carbon neutrality; Climate change mitigation; Energy transition; Sustainable development; Decarbonization.

Introduction

Climate change is one of the most critical issues facing the world in the twenty-first century, and the increase in greenhouse gas (GHG) emissions is driving up global warming, environmental degradation, biodiversity loss, and extreme weather events. These ecological changes pose a serious threat to ecosystems, economic development, human health, and social stability, and is why carbon neutrality is emerging as a long-term development goal for governments, industries and international bodies (Chen et al., 2022; Wei et al., 2022). Carbon neutrality signifies achieving balance between the carbon emissions and removal by implementing carbon emission reduction, renewable energy generation, technological advancement, and carbon sequestration programs (Al Khaffaf et al., 2024; Wang et al., 2025). This has led to the implementation of ambitious carbon neutrality targets and the development of comprehensive climate policies and energy transition strategies in many countries aimed at decreasing fossil fuel dependency and increasing the use of cleaner energy sources (Ahmad et al., 2025; Pawłowski & Rydzewski, 2024).
Integration of renewable energy has become one of the most promising strategies for both lowering carbon emissions and enabling the transition to a low carbon energy system. Renewable energies, such as solar, wind, hydropower, geothermal, and biomass, offer viable solutions for electricity generation, transportation, industrial use, and domestic consumption that help mitigate the negative environmental impacts of fossil fuels and reduce greenhouse gas emissions (Zhao et al., 2022; Halkos & Aslanidis, 2024). As renewables grow in prevalence, they yield positive impacts on energy security, resource efficiency, air pollution, and economic development through green innovation and job creation, as well as climate change mitigation (Ansarinasab, 2025; Stancu et al., 2025). Renewable

energy has become a fundamental part of national and international decarbonization strategies as technological advances have increased the efficiency and lowered the cost of using renewable energy in recent years (Agyekum & Ali, 2025).

However, the carbon neutral transition is not limited to increasing the amount of renewable energy generation. To integrate renewable energy into the electrical grid, various complementary technologies must be developed, including energy efficiency, electrification of transport and industry, smart grid modernization, digital energy management systems, energy storage technologies, hydrogen production and carbon capture, utilization and storage (CCUS) technologies (Chen et al., 2022; Wang et al., 2025). Recent studies highlight the need for these technologies to be part of systematic policy packages that provide incentives for investments, innovation, regulatory uniformity, and inter-sectoral collaboration to ensure optimal emissions reductions and timely climate action (Yang & Lo, 2024; Wei et al., 2022). Additionally, the adoption of renewables has gained greater significance in the context of supply chains, manufacturing systems, and urban infrastructure, where it plays a vital role in establishing environmental resilience and ensuring economy-wide decarbonisation (Guntuka et al., 2024; Carreira & Ferreira, 2025).

While significant advances have been made in developing renewable energy, there are still many barriers to achieving global carbon neutrality goals. Even though some nations have already embarked on the transition to a low carbon economy, technical issues like the intermittent production of renewable energies, power grid instability, lack of energy storage capacity and aging infrastructure still impose major restrictions in many countries (Zhao et al, 2022; Halkos & Aslanidis, 2024). In addition to the obstacles already mentioned, the energy transition is further complicated by economic challenges, such as high initial investment costs, financing disparities, and technological disparities among regions, especially in developing economies (Ansarinasab, 2025; Kong et al., 2022). Moreover, the slow roll-out of RE and low effectiveness of climate mitigation efforts can be attributed to inconsistent policy implementation, institutional weaknesses, supply chain vulnerabilities, and low public acceptance (Mukherjee et al., 2024; Guntuka et al., 2024).

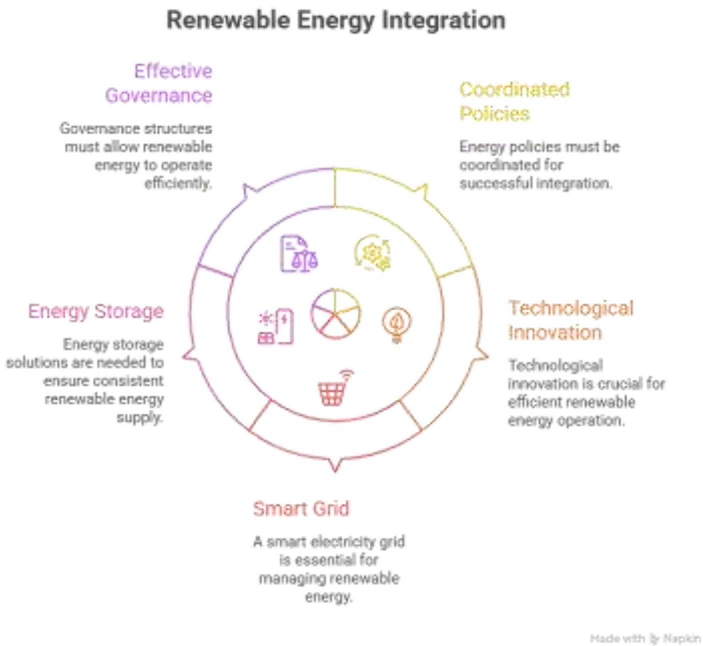
The higher complexity of the carbon neutrality challenge has spurred a considerable amount of research on renewable energy technologies, policy instruments, technological innovation and pathway analysis to integrated decarbonisation of various sectors. Recent systematic and scientometric reviews show that, to achieve the goal of carbon neutrality, coordinated efforts must be carried out involving governments, industries, researchers, financial institutions, and local communities to incentivize the uptake of clean energy, while at the same time achieving environmental, economic and social goals (Ahmad et al., 2025; Kyriakopoulos & Sebos, 2023). Furthermore, technological innovation, environmental management systems and international cooperation have been recognized as key factors to promote long-term climate neutrality and sustainable development (Ikram & Es-sadki, 2026; Agyekum & Ali, 2025).

There is a need to draw conclusions from current evidence on the contribution of integration of renewables to climate change mitigation, given the growing amount of literature on renewable energy and carbon neutrality. Hence, this systematic literature review aims to review the most recent studies published from 2021 to 2026 to investigate the contribution of integrating renewable energy sources towards carbon neutrality. Among others, the review considers renewable energy technologies, policy frameworks, technological innovations, sectoral decarbonization strategies, implementation challenges and opportunities for the speed up of global transition to sustainable, low-carbon and climate-resilient energy systems.

Literature Review

The growing need to tackle climate change has made the integration of renewable energy an important route to carbon neutrality and GHG (greenhouse gas) reduction. Carbon neutrality is achieved by balancing carbon emission with carbon removal by implementing widespread renewable energy technologies and improving energy efficiency and low carbon policies (Chen et al., 2022; Al Khaffaf et al., 2024). There is growing evidence that renewable energy sources like solar, wind, hydropower, geothermal and biomass energy can play a crucial role in the transition away from fossil fuel energy systems, because they have less environmental impact and are sustainable. In addition, Ahmad et al. (2025) noted that the transition to renewable energy is among the most prominent research topics in the world due to its impact on carbon emission reduction and its importance for achieving sustainable economic growth.

Figure 1. Key Components of Renewable Energy Integration for Achieving Carbon Neutrality and Climate Change Mitigation



There are several studies that stress that integration of renewable energies is more than just a matter of increasing renewables' electricity generation. The key factors for successful integration of renewable energy sources include coordinated energy policies, technological innovation, smart electricity grid, energy storage and effective governance structures that allow renewable energy sources to operate efficiently in the existing energy system (Yang & Lo, 2024; Wei et al., 2022). The benefits of the green energy pathways are not limited to emissions reductions, but also include energy security, less reliance on imported fossil fuels and energy resilience in the face of potential future energy crises, as suggested by Halkos and Aslanidis (2024). Likewise, Ansarinasab (2025) states that the transition to renewable energy contributes to numerous SDGs by enabling access to clean energy, environmental sustainability and inclusive economic growth.

Technological progress has also helped propel the penetration of renewable energies into the energy mix. Wang et al. (2025) point out that renewable energy technologies, hydrogen energy, battery storage systems and carbon capture technologies are complementary solutions to carbon neutrality. Similarly, Agyekum and Ali (2025) notes that ongoing advancements in digital technologies, AI, and smart energy management can greatly enhance the efficiency of renewable energy systems and their reliability. These innovations not only allow for increased renewable energy penetration, but also help to tackle some of the operational concerns of variable renewable energy.

Table 1. Summary of Selected Literature on Renewable Energy Integration and Carbon Neutrality

Authors	Study Focus	Major Findings
Chen et al. (2022)	Strategiesfor carbon neutrality	Renewable energy, energy efficiency, and carbon capture technologies are fundamental for achieving net-zero emissions.
Zhao et al. (2022)	Renewable energy transition	Renewable energy deployment significantly reduces greenhouse gas emissions and supports carbon neutrality targets.

ISSN: 2584-2706 DOI: https://doi.org/10.67317/IJMSRT26JUL046

Wei et al. (2022)	Carbon neutrality policies	Strong governance and policy frameworks accelerate renewable energy adoption and decarbonization.
Yang and Lo (2024)	Renewable energy andenergy efficiency policies	Cross-sector policy integration improves renewable energy implementation and climate mitigation.
Halkos and Aslanidis (2024)	Greenenergy pathways	Renewable energy enhances energy security, environmental sustainability, and low-carbon development.
Wang et al. (2025)	Decarbonization technologies	Hydrogen, renewable energy, energy storage, and carbon capture technologies provide integrated pathways toward carbon neutrality.
Ansarinasab (2025)	Renewable energy transition within the SDGs	Renewable energy supports sustainable development but faces financial, technological, and infrastructure challenges.
Guntuka et al. (2024)	Climate-neutral supply chains	Cross-sector collaboration and renewable energy integration strengthen sustainable supply chains and reduce lifecycle emissions.

In general, the literature copiously confirms that the integration of renewable energy is one of the most promising solutions to reach carbon neutrality and mitigate the climate change. The examined studies show that the combination of the deployment of renewable energy sources and supportive policies, technological innovation, environmental management systems and coordinated sectoral action can significantly reduce carbon emissions while increasing environmental resilience (Kyriakopoulos & Sebos, 2023; Ikram & Es-sadki, 2026). However, further investment and international cooperation, along with policy stability, is needed to address current technical, financial and institutional challenges and accelerate global transition to sustainable low-carbon energy systems.

Methodology

A systematic literature review (SLR) was used to review the role of integration of RE in making the energy sector carbon neutral and how it helps in mitigating climate change. A systematic review was selected because it can identify, evaluate and synthesize existing scientific evidence, and with a transparent and structured review process, can minimize bias. This approach has been widely used in research focused on carbon neutrality (Chen et al., 2022), transitioning to renewable energy (Ahmad et al., 2025), climate resilience (Carreira & Ferreira, 2025), and sustainable development.

Peer reviewed journal articles published in the period 2021-2026 were identified for the review, to ensure that the evidence was up to date with recent developments in renewable energy integration, carbon neutrality policy, technological innovation, and climate mitigation strategies. Research papers directly related to renewable energy, decarbonisation technologies, climate neutrally, environmental sustainability and energy transition were only taken into account for participation. All literature selected for this review were the references cited for this review only, so that the scope of the review is consistent and the results are synthesized from literature that has a significant relevance and quality (Al Khaffaf et al., 2024; Wang et al., 2025).

Table 2. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Publication Type	Peer-reviewed journal articles and book chapters	Conference abstracts, editorials, dissertations, reports
Publication Period	2021–2026	Studies published before 2021
Language	English	Non-English publications
Research Focus	Renewable energy, carbon neutrality, climate change mitigation, energy transition, sustainable development	Studies unrelated to renewable energy integration or carbon neutrality
Source Selection	Only the references provided for this systematic review	Additional references outside the provided list

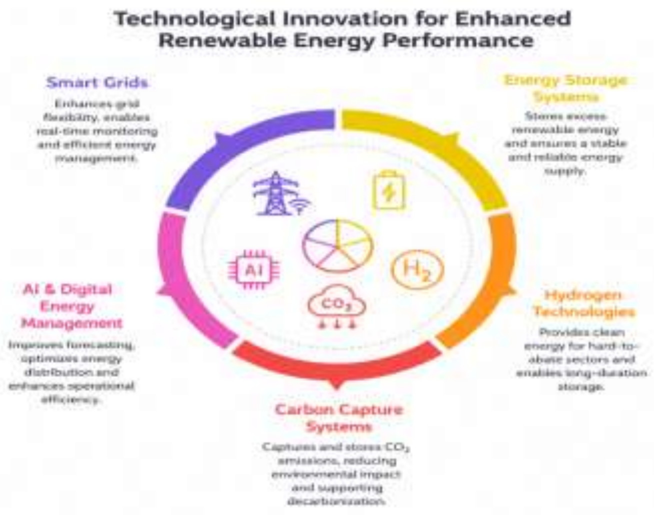
Volume 4 / Issue 7 / July 2026 International Journal of Modern Science and Research Technology
ISSN: 2584-2706 DOI: https://doi.org/10.67317/IJMSRT26JUL046

To enhance the reliability of the review, only peer-reviewed publications with clear relevance to the research topic were included. The synthesis was restricted to studies that were not related to renewable energy integration or carbon neutrality. The results were then grouped thematically, which enabled the determination of the consensus, emerging trends, gaps in research and practical implications presented in the literature selected (Mukherjee et al., 2024; Ikram & Es-sadki, 2026).
The inclusion and exclusion criteria shown in **Table 2** ensured that the review remained focused on recent, relevant, and high-quality evidence directly addressing renewable energy integration and carbon neutrality.

Table 3. Data Extraction and Thematic Analysis Framework

Theme	Information Extracted	Purpose of Analysis
Renewable Energy Technologies	Solar, wind, hydropower, biomass, geothermal, hydrogen	Assess technological contributions to carbon neutrality
Policyand Governance	Climate policies, renewable energy regulations, carbon neutrality strategies	Examine policy support for renewable energy integration
Technological Innovation	Smart grids, energy storage, digital technologies, carbon capture	Evaluate innovation supporting decarbonization
Implementation Challenges	Financial, technical, infrastructure, institutional barriers	Identify factors limiting renewable energy deployment
ClimateChange Mitigation	Emission reduction strategies, sustainability outcomes	Assess renewable energy contribution to climate mitigation
Future Directions	Research gaps, policy recommendations, emerging technologies	Identify opportunities for improving carbon neutrality pathways

Selected studies from the literature published between 2021 and 2026 were analysed for the contribution of renewable energy integration for achieving carbon neutrality and climate change mitigation. The results indicate that there is a wide agreement that renewable energy is now a key pillar of the global decarbonization strategy because it is a solution that is able to reduce GHG emissions, increase energy efficiency and contributes to sustainable development. In all the literature that was reviewed, integration of renewable energy sources was always linked with reduced fossil fuel reliance, better energy security, and improved resilience to climate change risks (Chen et al., 2022; Al Khaffaf et al., 2024; Ahmad et al., 2025). The results also show that the implementation of carbon neutrality would necessitate a multi-sectoral collaboration with the deployment of renewable energy and technology development and a policy framework.



The review also emphasises the role of technological innovation in enhancing the performance of renewable energy and in speeding up carbon neutrality. Complementary technologies, such as smart grids, energy storage, hydrogen, AI and digital energy management and carbon capture systems, are identified as technologies that boost the reliability and reduce intermittency challenges associated with renewables in several studies (Agyekum & Ali, 2025; Wang et al., 2025). These technologies provide greater flexibility to the grid, optimize energy distribution and enable the significant integration of renewable energy into modern electricity systems. Moreover, the costs of renewable energy have steadily fallen over the years, a trend that is further driven by constant technological improvements, making renewable energy more competitive than conventional fossil fuels (Halkos & Aslanidis, 2024).

Table 4. Summary of Major Findings from the Reviewed Studies

Theme	Key Findings	Supporting References
Renewable Energy Integration	Renewable energy is the primary driver of carbon neutrality and significantly reduces greenhouse gas emissions.	Chen et al. (2022); Zhao et al. (2022); Al Khaffaf et al. (2024)
Renewable Energy Technologies	Solar, wind, hydropower, biomass, and geothermal energy improve energy security and environmental sustainability.	Halkos & Aslanidis (2024); Ansarinasab (2025)
Technological Innovation	Smart grids, energy storage, hydrogen technologies, AI, and carbon capture improve renewable energy efficiency and reliability.	Wang et al. (2025); Agyekum & Ali (2025)
Policyand Governance	Strong policy frameworks, financial incentives, and international cooperation accelerate energy transition.	Wei et al. (2022); Yang & Lo (2024); Pawłowski & Rydzewski (2024)
Cross-Sector Decarbonization	Renewable energy integration across transportation, industry, supply chains, and buildings reduces lifecycle carbon emissions.	Guntuka et al. (2024); Dewasiri & Joshi (2025); Carreira & Ferreira (2025)
Major Challenges	Infrastructure limitations, intermittency, financing constraints, and policy inconsistencies hinder renewable energy deployment.	Kong et al. (2022); Mukherjee et al. (2024); Ansarinasab (2025)

Another focal point that appeared frequently in the literature reviewed was policy and governance. Stable policy and regulatory environments, financial incentives, carbon neutrality policies, and long-term governmental commitment are key elements to enabling renewable energy integration (Wei et al., 2022). Yang and Lo (2024) show that synergistic energy-efficiency and renewable energy policies are effective in enhancing carbon reductions in the electricity, transport, and industrial energy sectors. Likewise, Pawłowski and Rydzewski (2024) stress the importance of effective policy coordination, including public involvement and international collaboration, to speed up the transition to carbon-neutral economies.

While all these good news, a series of barriers that still limit the integration of renewable energies are identified in all the studies reviewed. The technical challenges e.g., renewables intermittency, lack of electricity storage, aging transmission system, and grid instability, are among the major obstacles to mass deployment (Zhao et al., 2022). High costs of capital investment and differential access to clean energy financing are formidable challenges in the developing world (Ansarinasab, 2025; Kong et al., 2022). The effectiveness of renewable energy implementation is also hindered by institutional challenges such as inconsistent regulations, governance gaps and lack of collaboration among stakeholders, which is also a significant obstacle to achieving carbon neutrality (Mukherjee et al., 2024; Guntuka et al., 2024).

Discussion

The results of the systematic review show that integration with renewable energy is a key approach in reaching carbon neutrality and the mitigation of climate change. In the literature that was reviewed, there is high consensus that shifting from fossil fuel based energy systems to renewable energy sources is leading to key reductions in greenhouse gas (GHG) emissions along with enhanced environmental sustainability and energy security. The result is consistent with Chen et al. (2022) who concluded that the three key elements that constitute a successful carbon-neutral society are renewable energy deployment, energy efficiency and carbon capture technologies. Likewise, Al Khaffaf et al. (2024) noted that the integration of renewable energy into various sectors is crucial for achieving carbon emissions reduction and sustainable economic growth.

The review also suggests that renewable energy integration is not only about electricity generation and it needs to take place in an entire system transformation. Among the different renewable energy sources, solar, wind, hydropower, geothermal, and biomass energy have become the most popular renewable technologies because they can be used to supplement fossil fuels for electricity generation with minimal environmental impact (Zhao et al., 2022; Halkos & Aslanidis, 2024). Despite this, the reviewed studies all indicate that renewable energy alone is not enough to reach a carbon neutral state without other measures, such as energy efficiency, smart grids, battery storage systems, hydrogen technologies, and carbon capture, utilization, and storage (CCUS) (Wang et al., 2025). These technologies complement each other, making the grid more flexible, the system more reliable and helping to overcome the intermittency issues of renewable electricity production.

A second key finding is that policy and governance are essential to speeding up renewable energy integration. The literature reviewed shows consistent conclusions that countries with strong renewable energy policies, financial policies and long-term climate policy have achieved higher carbon neutrality outcomes than countries with more disperse policy frameworks (Wei et al., 2022; Yang & Lo, 2024). Government policies such as carbon pricing, renewable energy subsidies, investment incentives, and environmental policies put in place make it easy to use clean energy and incentivize private sector participation. Pawłowski and Rydzewski (2024) also emphasized the need to combine all three aspects of governance – climate mitigation, public participation and energy security – in order to create sustainable approaches to implementing carbon neutrality policies. Similarly, Ahmad et al. (2025) found that policy consistency and international cooperation are key themes of research in recent literature on carbon neutrality, which are crucial for long-term decarbonization.

Integration across sectors was another important issue that was prevalent across the literature examined. The use of renewable energy is becoming more widespread than just power generation and is spreading into areas such as transport, production, building construction, supply chain, agriculture and industry. Guntuka et al. (2024) showed that renewable energy can help lower carbon emissions throughout the supply chain and improve the environmental performance of industrial operations. Likewise, Dewasiri and Joshi (2025) highlighted the importance of renewable energy in enabling a climate-neutral development by making transport, communication and urban infrastructure more sustainable. The results suggest that a coordinated effort in all economic sectors is needed to achieve carbon neutrality instead of sector-specific efforts in the energy sector.

While these positive changes are welcome, the review outlines key ongoing issues that still hinder the integration of renewables. Renewable energy reliability is still impacted by technical challenges like energy storage, transmission infrastructure and intermittency (Zhao et al., 2022). However, financial difficulties, such as the cost of investment and access to financing, continue to be significant hurdles, especially in developing nations where renewable energy systems are still being established (Ansarinasab, 2025; Kong et al., 2022). In addition, the delays in renewable energy implementation and the ineffectiveness of policies are often attributed to institutional weaknesses in the development and execution of renewable energy projects, as well as to inconsistent regulatory frameworks and limited stakeholder collaboration (Mukherjee et al., 2024). To overcome these obstacles, governing arrangements need to be strengthened, more money must be invested, new technologies must be developed, and international collaboration is needed.

The results also indicate that the integration of renewable energies not only paves the way for achieving carbon neutrality but also enhances overall environmental resilience and sustainable development. The use of renewable energy decreases pollution, enhances public health, increases energy independence and supports green economic growth. Carreira and Ferreira (2025) noted that the combination of sustainable governance and climate adaptation with renewable energy strategies contributes to environmental resilience. Similarly Kyriakopoulos and Sebos (2023) found that there is a dual benefit of both mitigation and adaptation measures being combined to enhance the overall effectiveness of climate policy and enhance resilience against future climate risks. Furthermore, Ikram and Es-sadki (2026) showed that the implementation of environmental management systems (EMS) like ISO 14001 further enhances organizational commitment to reducing carbon footprint by fostering a continuous improvement process for the environment and optimizing the use of resources.

Conclusion

The integration of renewable energies is a key part of the global process to reach the carbon neutrality and climate change mitigation goals. This systematic review was conducted to collect and synthesize the most recent literature published between 2021 and 2026, and results were consistent, revealing that renewable energy technologies such as solar, wind, hydropower, geothermal and biomass make significant contributions to the reduction of GHGs and transition to low-carbon energy systems. The review also shows that energy efficiency, technological innovation, smart energy systems, and policy support are the key factors for integrating renewable energy (Chen et al., 2022; Al Khaffaf et al., 2024; Wang et al., 2025).

The results also reveal that carbon neutrality would require cross-sectoral actions along the electricity generation, transportation, industry, buildings and supply chains. To promote and scale up the adoption of clean energy, several factors are crucial, including effective governance frameworks, investments in renewable energy infrastructure, technological innovation, and international cooperation, which can help address challenges like infrastructure limitations, financing constraints, and policy inconsistencies (Wei et al., 2022; Yang & Lo, 2024; Ahmad et al., 2025). Moreover, low carbon energy systems can be greatly improved in terms of efficiency and reliability by combining renewable energy with other new technologies, including smart grids, energy storage systems, hydrogen technologies and carbon capture.

Overall, the integration of renewable energy is a promising and sustainable way to combat climate change and support environmental protection, energy security, and sustainable economic growth. Investing in clean energy technologies and improving policy enforcement and implementation, as well as enhanced collaboration between governments, industry and researchers will be essential to make a greater contribution to global carbon neutrality and long-term climate resilience. Future studies could be expanded to include the creation of new renewable energy technologies and help tackle regional energy inequalities in the adoption of renewable energy, while also optimizing energy storage solutions.

References

1. Al Khaffaf, I., Tamimi, A., & Ahmed, V. (2024). Pathways to carbon neutrality: A review of strategies and technologies across sectors. Energies, 17(23), 6129. **https://doi.org/10.3390/en17236129**
2. Ahmad, H., Yaqub, M., & Lee, S. H. (2025). Global trends in carbon neutrality: a scientometric review on energy transition challenges, practices, policies, and opportunities. Environment, Development and Sustainability, 1-26. https://doi.org/10.1007/s10668-025-06507-7
3. Ansarinasab, M. (2025). The role of renewable energy transition in achieving carbon neutrality within the SDG framework: challenges, and prospects. Gondwana Research. https://doi.org/10.1016/j.gr.2025.11.022
4. Stancu, A., Popescu, C., Panait, M., Rădulescu, I. G., Brezoi, A. G., & Voica, M. C. (2025). Pathways to Carbon Neutrality: Innovations in Climate Action and Sustainable Energy. Sustainability, 17(24), 11240. **https://doi.org/10.3390/su172411240**
5. Chen, L., Msigwa, G., Yang, M., Osman, A. I., Fawzy, S., Rooney, D. W., & Yap, P. S. (2022). Strategies to achieve a carbon neutral society: a review. Environmental chemistry letters, 20(4), 2277-2310. https://doi.org/10.1007/s10311-022-01435-8
6. Lobus, N. V., Knyazeva, M. A., Popova, A. F., & Kulikovskiy, M. S. (2023). Carbon footprint reduction and climate change mitigation: A review of the approaches, technologies, and implementation challenges. C, 9(4), 120. **https://doi.org/10.3390/c9040120**

7. Yang, Y., & Lo, K. (2024). China's renewable energy and energy efficiency policies toward carbon neutrality: A systematic cross-sectoral review. Energy & Environment, 35(1), 491-509. https://doi.org/10.1177/0958305X231167472
8. Kyriakopoulos, G. L., & Sebos, I. (2023). Enhancing climate neutrality and resilience through coordinated climate action: review of the synergies between mitigation and adaptation actions. Climate, 11(5), 105. **https://doi.org/10.3390/cli11050105**
9. Guntuka, L., Mukandwal, P. S., Aktas, E., & Paluvadi, V. S. K. (2024). From carbon-neutral to climate-neutral supply chains: a multidisciplinary review and research agenda. The International Journal of Logistics Management, 35(3), 916-942. https://doi.org/10.1108/IJLM-03-2023-0116
10. Carreira, H., & Ferreira, J. J. (2025). Environmental resilience and carbon neutrality: a systematic and integrative review. Management of Environmental Quality: An International Journal, 1-29. https://doi.org/10.1108/MEQ-06-2025-0404
11. Ikram, M., & Es-sadki, J. (2026). ISO 14001, Carbon Neutrality, and the Sustainable Development Goals: A Bibliometric and Systematic Review of Environmental Management Systems. Corporate Social Responsibility and Environmental Management. **https://doi.org/10.1002/csr.70820**
12. Pawłowski, A., & Rydzewski, P. (2024). Pathways to carbon neutrality: Integrating energy strategies, policy, and public perception in the face of climate change—a global perspective. Energies, 17(23), 5867. **https://doi.org/10.3390/en17235867**
13. Wei, Y. M., Chen, K., Kang, J. N., Chen, W., Wang, X. Y., & Zhang, X. (2022). Policy and management of carbon peaking and carbon neutrality: A literature review. Engineering, 14, 52-63. https://doi.org/10.1016/j.eng.2021.12.018
14. Agyekum, E. B., & Ali, E. B. (2025). Impact of technological innovation on carbon neutrality-systematic and bibliometric review of two decades of research. Carbon Research, 4(1), 30. https://doi.org/10.1007/s44246-025-00197-6
15. Wang, Z., Sun, Y., Kong, H., & Xia-Bauer, C. (2025). An in-depth review of key technologies and pathways to carbon neutrality: classification and assessment of decarbonization technologies. Carbon Neutrality, 4(1), 15. https://doi.org/10.1007/s43979-025-00129-8
16. Zhao, F., Bai, F., Liu, X., & Liu, Z. (2022). A review on renewable energy transition under China's carbon neutrality target. Sustainability, 14(22), 15006. **https://doi.org/10.3390/su142215006**
17. Dewasiri, N. J., & Joshi, A. (2025). Advancing Climate Neutrality Through Sustainable Human Systems: Transforming Transport, Energy, and Communication in South Asia. In Climate Neutrality Through Smart Eco-Innovation and Environmental Sustainability (pp. 227-242). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-83250-5_14
18. Halkos, G. E., & Aslanidis, P. S. C. (2024). Green energy pathways towards carbon neutrality. Environmental and Resource Economics, 87(6), 1473-1496. https://doi.org/10.1007/s10640-024-00856-z
19. Mukherjee, S., Baral, M. M., Singh, R. K., Chittipaka, V., & Kamble, S. S. (2024). Achieving carbon neutrality for the improvement of the business performance: a systematic literature review and future research directions. International Journal of Productivity and Performance Management, 73(8), 2385-2413. https://doi.org/10.1108/IJPPM-07-2023-0332
20. Kong, C., Zhang, J., Ntarmah, A. H., Kong, Y., & Zhao, H. (2022). Carbon neutrality in the Middle East and North Africa: the roles of renewable energy, economic growth, and government effectiveness. International Journal of Environmental Research and Public Health, 19(17), 10676. **https://doi.org/10.3390/ijerph191710676**
21. Zulkarnayeen, A. S. M., & Akib, S. M. (2026). Global Renewable Energy Transition Toward Carbon Neutrality: Technological Advances, Policy Drivers, and Socioeconomic Implications. Pacific Journal of Advanced Engineering Innovations, 3(1), 28-38. https://doi.org/10.70818/pjaei.v03i01.0206
22. Nilsson, A., Mentis, D., Korkovelos, A., & Otwani, J. (2021). A GIS-based approach to estimate electricity requirements for small-scale groundwater irrigation. ISPRS International Journal of Geo-Information, 10(11), 780. **https://doi.org/10.3390/ijgi10110780**
23. Shahzad, A., Gabriel, H. F., Haider, S., Mubeen, A., & Siddiqui, M. J. (2018). Development of a flood forecasting system using IFAS: a case study of scarcely gauged Jhelum and Chenab river basins. Arabian Journal of Geosciences, 11(14), 383. https://doi.org/10.1007/s12517-018-3737-6

24. Fawzy, S., Osman, A. I., Doran, J., & Rooney, D. W. (2020). Strategies for mitigation of climate change:areview. Environmental Chemistry Letters, 18(6), 2069-2094. https://doi.org/10.1007/s10311-020-01059-w
25. Qamruzzaman, M., & Karim, S. (2024). RETRACTED: Unveiling the synergy: Green finance, technological innovation, green energy, and carbon neutrality. Plos one, 19(10), e0308170. https://doi.org/10.1371/journal.pone.0308170
26. Sen, G., Chau, H. W., Tariq, M. A. U. R., Muttil, N., & Ng, A. W. (2021). Achieving sustainability and carbon neutrality in higher education institutions: A review. Sustainability, 14(1), 222. **https://doi.org/10.3390/su14010222**
27. Rawat, D., Yadav, A. K., & Dubey, K. (2026). Social and Economic Impacts of Carbon Neutrality: Impacts and Implications. In Forestry for a Carbon-Neutral and Sustainable Future: A Scientific Perspective (pp. 559-579). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-032-06427-1_23
28. Dewasiri, N. J., Gangodawilage, D., & Singh, R. (2025). Pathways to Climate Neutrality: Integrating Sustainability in Transport, Energy, and Communication for the Indo-Pacific Region. In Climate Neutrality and Sustainable Ecosystems: Practical Approaches to Addressing Global Warming (pp. 95-114). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-96-7181-6_6
29. Usman, B. M., Johl, S. K., & Khan, P. A. (2025). Enhancing energy sector sustainability through robust green governance mechanisms for carbon neutrality. Discover Sustainability, 6(1), 216. https://doi.org/10.1007/s43621-025-01064-5
30. Kassem, M. A., & Moscariello, A. (2025). Geothermal energy: A sustainable and cost-effective alternative for clean energy production and climate change mitigation. Sustainable Futures, 10, 101247. https://doi.org/10.1016/j.sftr.2025.101247
31. Yan, X., Wang, L., Fang, M., & Hu, J. (2022). How can industrial parks achieve carbon neutrality? Literature review and research prospect based on the CiteSpace knowledge map. Sustainability, 15(1), 372. **https://doi.org/10.3390/su15010372**
32. Law, Y. Y., & Liang, X. (2026). National strategies to achieve carbon neutrality in the energy sector of ASEAN member countries. Environment, Development and Sustainability, 1-28. https://doi.org/10.1007/s10668-026-07700-y
33. Olekanma, O., Rodrigo, L. S., Adu, D. A., & Gahir, B. (2024). Small-and medium-sized enterprises' carbon footprint reduction initiatives as a catalyst for green jobs: A systematic review and comprehensive business strategy agenda. Business Strategy and the Environment, 33(7), 6911-6939. **https://doi.org/10.1002/bse.3846**
34. Cervantes Puma, G. C., Salles, A., & Bragança, L. (2024). Nexus between urban circular economies and sustainable development goals: a systematic literature review. Sustainability, 16(6), 2500. **https://doi.org/10.3390/su16062500**
35. Muhmad, S. N., Cheema, S., Mohamad Ariff, A., Nik Him, N. F., & Muhmad, S. N. (2024). Systematic literature review and bibliometric analysis of green finance and renewable energy development. Sustainable Development, 32(6), 7342-7355. **https://doi.org/10.1002/sd.3093**