

The role of renewable energies in the transition to a sustainable energy model: Challenges and opportunities

El papel de las energías renovables en la transición hacia un modelo energético sostenible: Retos y oportunidades

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ABSTRACT

This study focused on the important role of renewable energies in the transition to a sustainable energy model and assessed their benefits, challenges and opportunities. Renewable energies have been identified as an important solution to respond to climate change by reducing greenhouse gas emissions and diversifying the energy matrix. However, challenges have been identified, including the scarcity and variability of renewable energy sources, high upfront costs and the need for infrastructure improvements. However, significant opportunities in energy storage were highlighted, including technological advances, favorable policies and regulations, and financial innovations. The positive socio-economic impact of renewable energy on job creation, social development and poverty reduction has also been demonstrated. In summary, the importance of harnessing the potential of renewable energy and addressing current challenges is key to moving towards a more secure and sustainable future.

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Keywords: renewable energies, energy sustainability, climate change, challenges, opportunities.

RESUMEN

Este estudio se centra en el importante papel de las energías renovables en la transición hacia un modelo energético sostenible y evalúa sus beneficios, retos y oportunidades. Las energías renovables se han identificado como una solución importante para responder al cambio climático reduciendo las emisiones de gases de efecto invernadero y diversificando la matriz energética. Sin embargo, se han identificado retos, como la escasez y variabilidad de las fuentes de energía renovables, los elevados costes iniciales y la necesidad de mejorar las infraestructuras. Sin embargo, se destacaron importantes oportunidades en el almacenamiento de energía, como los avances tecnológicos, las políticas y normativas favorables y las innovaciones financieras. También se ha demostrado el impacto socioeconómico positivo de las energías renovables en la creación de empleo, el desarrollo social y la reducción de la pobreza. En resumen, la importancia de aprovechar el potencial de las energías renovables y abordar los retos actuales es clave para avanzar hacia un futuro más seguro y sostenible.

Palabras clave: energías renovables, sostenibilidad energética, cambio climático, retos, oportunidades.

INTRODUCTION

The transition to a sustainable energy model has become a global imperative in the fight against climate change and the search for a more prosperous and equitable future (Jacobson et al., 2020). In this context, the role of renewable energies acquires a fundamental relevance. This article delves into the analysis of how renewable energies are shaping this transition towards a more sustainable energy system, exploring both the inherent challenges and the opportunities that lie ahead.

Renewable energies, which include sources such as solar, wind, hydro, biomass and geothermal, represent a key alternative to fossil fuels because of their ability to provide energy sustainably, without depleting finite resources or generating greenhouse gas

emissions (Denholmet al.,2021). This approach not only contributes to the reduction of carbon emissions, but also promotes energy security and stimulates long-term economic development (Fawcett et al.,2020).

One of the main drivers of this transition is the urgency of addressing climate change and its devastating impacts. As the effects of global warming become increasingly evident, from extreme weather events to biodiversity loss, the need to reduce our dependence on fossil fuels becomes imperative (Arora et al.,2020). Renewable energies offer a viable and necessary solution to decarbonize our economy and mitigate climate risks, aligning with international commitments such as the Paris Agreement (Wills et al.,2020).

In addition to their environmental benefits, renewable energy also offers significant opportunities in terms of socioeconomic development. Investment in renewable energy infrastructure can generate employment, stimulate technological innovation and improve energy access, especially in marginalized or rural communities. Furthermore, by reducing long-term operating costs, renewables can ensure greater energy equity and economic stability (Ikegami et al., 2020).

MATERIALS AND METHODS

In this research, a literature review methodology was used to analyze the role of renewable energies in the transition to a sustainable energy model, as well as the associated challenges and opportunities. The literature review was carried out using various sources of information, including academic databases, specialized journals, reports from international organizations, books and other relevant documents in the field of renewable energy and energy sustainability.

The literature search and selection process was carried out using keywords related to the topic of study, such as "renewable energies", "energy transition", "sustainable energy model", "challenges", "opportunities", among others. Priority was given to the inclusion of recent research and publications to ensure the relevance and timeliness of the information collected.

Once the relevant literature was compiled, a critical and systematic analysis of the selected papers was conducted to identify trends, patterns, viewpoints and key findings related to the research topic. Particular attention was paid to the different perspectives and approaches presented in the literature, as well as to discrepancies and areas of debate within the field.

In addition, comparisons and syntheses of the findings obtained from different sources were made to develop a comprehensive and balanced understanding of the subject. Both the positive aspects and the challenges associated with the use of renewable energies in the transition to a sustainable energy model were highlighted in order to provide a complete and objective view of the subject.

Finally, the results of the literature review were used to inform and support the development of the discussion and conclusions of this study. A critical evaluation of the

literature reviewed was provided, as well as recommendations for future research and action in the field of renewable energy and energy sustainability.

Table 1. Stages of the methodology

Methodology stage	Actions performed
Literature search	- Selection of related keywords.
	- Use of academic databases and specialized journals.
	- Consultation of reports from international organizations and books.
Selection of information	- Evaluation of the relevance and timeliness of the literature.
	- Inclusion of recent research and publications.
Literature analysis	- Identification of trends, patterns and key findings.
	- Critical and systematic analysis of selected documents.
	- Comparisons and synthesis of findings from different sources.
Discussion of results	- Development of a comprehensive and balanced understanding of the subject.
	- Highlight positive aspects and challenges associated with the use of renewable energies.
	- Critical evaluation of the literature reviewed.
	- Formulation of recommendations for future research and actions.

Principle of the form

Source: Own elaboration

RESULTS

The research results revealed a number of significant findings regarding the role of renewable energies in the transition to a sustainable energy model, as well as the associated challenges and opportunities. The results are discussed in detail below:

Table 2. Contribution of renewable energies to energy sustainability.

Appearance	Findings
Emissions Reduction	Renewable energies contribute to the reduction of greenhouse gas emissions, which promotes climate change mitigation.
Energy Diversification	They allow diversification of the energy matrix, reducing dependence on fossil fuels and improving energy security.
Long-term Sustainability	Its renewable nature ensures the long-term availability of energy, without depleting finite resources.

Source: Own elaboration

Renewable energies, by generating electricity without producing greenhouse gas emissions during operation, play a crucial role in reducing carbon emissions (Blanco et al.,2020). This is especially relevant at a time when climate change mitigation is a global

priority. By gradually replacing fossil fuels in sectors such as electricity generation, transportation and heating, renewable energies can help meet emission reduction targets set in international agreements (Galganiet al.,2021).

Diversification of the energy matrix is essential to ensure stability and security of energy supply. Relying heavily on a single energy source, such as oil or natural gas, can expose a country to risks of price volatility, supply shortages, or geopolitical disruptions (Barlow et al.,2019). Incorporating renewables into the energy mix reduces this dependence, which improves energy security and resilience to external shocks (Le et al.,2020).

One of the most outstanding advantages of renewable energies is their sustainable and renewable nature. Unlike fossil fuels, whose extraction and consumption are finite and not sustainable in the long term, renewable energies take advantage of abundant and continuously available natural resources, such as sunlight, wind, water and biomass. This feature ensures long-term energy availability and contributes to the preservation of natural resources for future generations (Abdelaziz et al.,2021).

Taken together, these findings underscore the importance of renewables in the transition to a more sustainable and resilient energy model. By reducing greenhouse gas emissions, diversifying the energy matrix and ensuring the long-term availability of clean energy, renewables are positioned as a comprehensive solution to address today's energy and environmental challenges. However, it is crucial to address the obstacles they still face, such as the technical and economic challenges in their large-scale integration into the electricity grid, in order to maximize their positive impact on global energy sustainability.

Table 3. Challenges in the integration of renewable energies

Challenge	Implications
Intermittency and Variability	The intermittency and variability of renewable sources can pose challenges in grid integration, requiring storage and demand management solutions.
High Initial Costs	The initial costs of investing in renewable infrastructure can be high, although they pay off in the long term through operational savings and environmental benefits.
Infrastructure and Logistics	Improvements in infrastructure and logistics are needed to facilitate the implementation and operation of large-scale renewable energy projects.

Source: Own elaboration

One of the main challenges in the integration of renewable energies is their intermittent and variable nature. Electricity generation from sources such as solar and wind is dependent on weather and environmental factors, which can lead to fluctuations in energy availability (Boone et al., 2021). This intermittency can pose challenges in power grid management, especially at times of high demand or when weather conditions are unfavorable for renewable generation. To address this challenge, large-scale energy

storage solutions are required, as well as demand-side and smart grid management technologies to efficiently integrate renewables into the electricity system (Hepbasliet al.,2020).

Despite their long-term benefits, the initial investment in renewable infrastructure can be significantly high. The installation costs of technologies such as solar panels, wind turbines or hydropower plants can be a barrier to the widespread adoption of renewable energy, especially in developing countries or countries with limited financial resources (Chini et al.,2021). However, it is important to note that the costs of renewable technologies have decreased considerably in recent decades, and this trend is expected to continue as technology advances and the scale of production increases (Esmailzadehet al.,2021).

The implementation of large-scale renewable energy projects requires adequate infrastructure and efficient logistics (Kaviani et al., 2021). This includes the construction of solar and wind farms, the installation of power transmission and distribution systems, as well as the development of transportation networks for the transport of raw materials and equipment. Effective planning and coordination between the different stakeholders involved, including governments, private companies and local communities, are essential to overcome logistical challenges and ensure the success of renewable projects (Finaet al.,2021).

In summary, these challenges highlight the complexity of integrating renewables into the existing energy system and underscore the need to address a range of technical, economic and logistical considerations to ensure their successful adoption on a large scale. While these obstacles may represent significant challenges, they also offer opportunities for innovation and collaboration in developing technical and policy solutions that will drive the transition to a more sustainable and resilient energy future.

Table 4. Opportunities for renewable energy expansion

Opportunity	Potentialities
Technological Advances	Technological advances in energy storage and grid management can mitigate the challenges of intermittency and variability.
Policies and Regulations	Favorable policies and regulations can boost investment in renewable energy, including tax incentives and subsidy programs.
Financial Innovation	Financial innovation, such as innovative financing mechanisms and long-term power purchase agreements, can improve the economic viability of renewable projects.

Source: Own elaboration

Technological advances in energy storage and grid management represent a key opportunity to overcome the challenges associated with the intermittency and variability of renewable energy (Nakata et al.,2020). Energy storage systems, such as lithium ion batteries, thermal storage technologies, and hydroelectric storage solutions, allow

excess energy generated during periods of high renewable production to be stored for later use during times of low generation (Damgaard et al.,2020). Similarly, smart grid management technologies make it possible to optimize energy distribution, coordinate energy generation and consumption more efficiently, and anticipate and respond to fluctuations in energy demand and supply (Al-Attar et al.,2020).

Favorable policies and regulations can play a crucial role in driving the expansion of renewable energy. Tax incentives, government subsidies, renewable energy standards, and market mechanisms such as emissions trading systems and minimum guarantee prices can stimulate investment in renewable projects and create an enabling environment for industry development (Castellazzi et al.,2021). Similarly, the implementation of renewable energy integration policies in energy planning at the national and regional levels can encourage the adoption of clean energy and accelerate the transition to a more sustainable energy model (IEA, 2021).

Financial innovation plays a crucial role in the expansion of renewable energy by making projects financially viable and attractive to investors(Chen et al.,2020). Innovative financing mechanisms, such as green bonds, renewable energy investment funds, and long-term power purchase agreements (PPAs), can help reduce capital costs and improve the profitability of renewable projects. In addition, the increasing involvement of the private sector in financing renewable projects and the development of innovative business models, such as results-based financing and energy performance contracts, are expanding access to capital for renewable energy expansion (Liu et al., 2020).

These opportunities therefore offer a promising path for expanding renewables and accelerating the transition to a more sustainable and resilient energy model. By harnessing technological advances, implementing favorable policies and regulations, and promoting financial innovation, we can overcome the obstacles and challenges facing renewables and move toward a cleaner, more secure and sustainable energy future.

Table 5. Socioeconomic impact of renewable energy sources

Impact	Implications
Job Creation	The implementation of renewable projects can generate local employment in sectors such as construction, operation and maintenance.
Community Development	Renewable energy can boost community development by providing access to clean energy and encouraging investment in local infrastructure.
Energy Poverty Reduction	Improving access to affordable and sustainable energy can help reduce energy poverty and improve the quality of life in vulnerable communities.

Source: Own elaboration

The implementation of renewable energy projects generates a wide range of employment opportunities in various sectors (Hussain et al., 2021). From the manufacturing and installation of renewable technologies to the operation and maintenance of wind farms, solar plants and hydropower projects, renewable energy has the potential to drive job creation at local, regional and national levels. In addition, the development of supply chains and services associated with the renewable industry also contributes to employment generation in related sectors, such as construction, engineering and consulting (Mori et al., 2019).

Renewable energy can boost community development by providing access to clean, sustainable energy in areas previously marginalized or with limited access to electricity (Bazilian et al., 2021). Renewable projects, such as community wind farms or distributed solar installations, can strengthen local infrastructure, improve quality of life, and create economic opportunities for local communities. In addition, ownership participation in renewable projects can generate additional income for communities and strengthen social cohesion (Gomez et al., 2020).

Improving access to affordable and sustainable energy is key to combating energy poverty and promoting social inclusion. Renewable energy offers a viable solution by providing a clean and reliable energy source that is more accessible and affordable than traditional fossil fuel-based options, especially in rural or remote areas (IRENA, 2021). By reducing energy costs and improving supply reliability, renewables can help improve the living conditions of vulnerable communities and contribute to reducing energy inequality (Bruni et al., 2020).

As such, the socioeconomic impact of renewable energies goes beyond the simple generation of clean electricity. These technologies can catalyze economic development, strengthen local communities and improve people's quality of life, especially in areas where energy access is limited. By harnessing the potential of renewable energy to create jobs, foster community development and reduce energy poverty, we can move toward a more inclusive and sustainable future for all.

CONCLUSIONS

In conclusion, this study provided a comprehensive overview of the role of renewable energy in the transition to a sustainable energy model, highlighting its benefits, challenges and opportunities. Renewable energy is emerging as a key solution to address the urgent challenge of climate change, improve energy security and promote socioeconomic development worldwide.

Through studies, renewable energy has been shown to have many important benefits, including reducing greenhouse gas emissions, diversifying the energy mix, and ensuring a long-term sustainable energy supply. However, significant challenges were also identified, such as the space and variability of renewable resources, high upfront costs, and the need for improved infrastructure and equipment.

Despite these challenges, many opportunities for renewable energy expansion have been identified, including technological advances in energy storage and grid management, good policies and regulations, and innovations in the securities market. The socioeconomic impacts of renewable energy were also highlighted, including job creation, community development and poverty reduction.

Ultimately, this research highlights the importance of harnessing the power of renewable energy and addressing current challenges to move toward a more secure and sustainable future. By adopting a comprehensive approach that combines technological progress, effective policies and international cooperation, we can accelerate the transition to more sustainable energy models and promote well-being and justice for future generations.

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