Renewable Energy and Circular Economy: A Pathway to Sustainable Development

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Abstract

The critical need for sustainable development has prompted the exploration of renewable energy and the circular economy as potential answers to environmental issues, resource depletion, and climate change. Renewable power sources—solar, wind, hydro, and biomass—generate indefinite clean energy that, together with a reduction in fossil fuel consumption and the building up of energy security of countries. In this way, the combination of the reuse and recycling techniques with the restoration methods addressing the waste reduction and a high resource efficiency, as well as the product life extension in the circular economy system, helps to achieve the system's zero waste. It is able to promote both the pros of economic stability and technological advances through two basic approaches that simultaneously enhance the sustainability progress. With this goal in mind, this article investigates to assess how renewable energy systems can work with the circular economy and how sustainable energy systems are that facilitate recycling along with remanufacturing as well as waste-to-energy conversion. Implementing the circular economic models based on renewable energy is hindered by initial high capital costs, regulation restrictions, and technological barriers. Here, we are facing current challenges that need the policy reforms initiated along the lines of public cooperation as well as public-private cooperation and the improved storage methods along with smart grid protocols and sustainable manufacturing technologies. This promotes the concepts of renewable energy and circular economy principles, which in turn can lead to the attainment of world sustainability objectives by society through considering them as pathways to sustainable environmental benefits, economic prosperity, and social wellness.

Keywords: Renewable Energy, Circular Economy, Sustainable Development, SDGs, Resource Efficiency

1. INTRODUCTION

The Brundtland Report characterized sustainable development as a policy that holds the potential for establishing a balance between social equity, economic growth, and environmental balance as a way of managing the challenges of the twenty-first century (Velenturf & Purnell, 2021). The UN has laid out what it calls the Sustainable Development Goals (SDGs), with the objective of eradicating poverty, sustaining the environment, and securing prosperity by 2030. These 17 goals are interconnected and comprise issues related to clean water, sanitation, electricity, consumption, and climate action (Mir & Bhat, 2022; Rizwanullah et al., 2025). Sustainable development means resource efficiency and a circular economy, which uses fewer resources, reduces waste, and reuses materials to decrease environmental impacts, while including innovation and creating new economic opportunities. Quite the contrary, the traditional linear economic system creates waste and pollutes the planet (Nsisong Louis Eyo-Udo et al., 2024; Nunes et al., 2023).

Renewable Energy's Contribution to Sustainable Development

Renewable energy (RE) is very important for sustainable development because it will decrease dependency on fossil fuels and greenhouse gas emissions. The shift towards renewable energy, such as hydropower, wind, and solar energy, improves the economy positively as well as the environmental dimension (Nsisong Louis Eyo-Udo et al., 2024; Sreenivasan & Suresh, 2024). The incorporation of RE into the circular economy promotes sustainable behavior and increases resource efficiency too (Jakubelskas & Skvarciany, 2023; Nsisong Louis Eyo-Udo et al., 2024).

Principles of the Circular Economy and Renewable Energy

The concept of the circular economy in combination with renewable energy solutions resolves the problems related to climate change, degradation of the environment, and exhaustion of resources. Shifting to a green energy system also brings carbon reductions, enhanced energy security, greater local job creation, and progress towards the achievement of the UN Sustainable Development Goals. The circular economy is an attempt to rethink the way production and consumption are done through material reduction, reuse, and recycling. Circular economy and renewable energy have the potential to go hand in hand. Renewable energy is part of the circular economy because it benefits from eco-design principles and resource efficiency, while the circular economy can be powered by renewable energy; moreover, the use of both terms is a special chance for sustainability.

Circular Economy-Renewable Energy Convergence towards Sustainable Development

RE and CE can be seen as the two approaches that can contribute to overcoming the problem of natural resource depletion, climate change, and environmental degradation and contribute to sustainable development. According to Jakubelskas & Skvarciany (2023), the United Nations recognizes the importance of developing new renewable energy technologies as a way to create employment and innovation as proxy metrics of economic prosperity and improved living conditions (Sustainable Development Goal 7 of the UN: SDG 7). According to Pieto-Sandoval et al. (2018), the notion of circular economy is a sustainable process of managing resources using the 3Rs (recycle, reuse, and reduce) for maximum efficiency and the least wastage. It supports sustainable production and consumption on the basis of the Sustainable Development Goals and SDG 12 (Responsible Production and Consumption) (Velenturf & Purnell, 2021). Renewable energy and the elements of the circular economy may play a big role in sustainability and the achievement of the SDGs.

Renewable energy can be integrated into circular economy processes such as recycling and resource recovery to create closed-loop systems that reduce wastage and therefore have a lower environmental impact (Bai et al., 2025; Jakubelskas & Skvarciany, 2023). As discussed above, WTE can help to decongest landfills and convert all the organic waste into renewable generators (Bai et al., 2025; Kumba et al., 2024). Increasing this synergy is an important issue for meeting climate goals and achieving greener development.

2. REVIEW OF LITERATURE

The authors refer to various theoretical and empirical studies concerning the many aspects of the CE and RE, highlighting the economic, social, and environmental benefits of this approach.

Renewable Energy's Benefits

Renewable resources will assist in decreasing greenhouse gas secretion, with the result of cleaning the environment from that of fossil fuels (Cacciuttolo et al., 2024). In Peru, these solar PV systems are associated with reduced carbon emissions, improved air quality, and reduced non-recyclable resources (Apramadha & Prasentyo, 2025; Krishna et al., 2023). Yet since a range of renewable energy technologies allow for less habitat destruction and fewer resource depletions, these technologies are beneficial for biodiversity conservation. Any energy system has to be sustainable if it is to be both environmentally friendly and efficient (Bucur et al., 2021; Neverauskienė et al., 2025). Renewable energy brings countless economic benefits, from increased energy supply and decreased energy costs to the creation of new jobs. Many of the manufacturing, installing, and maintaining sectors have seen investments that have generated employment in a broad spectrum of industries (Tareen et al., 2018; Latte et al., 2024) from renewable energy sources. There would be a better fit for a well-positioned customer and region where the levelized cost of energy (LCOE) of wind and solar is similar to fossil fuels (Burak & Eldar, 2024; Hassan, 2022). Renewable energy has also supported a nation's energy independence, especially in countries with low natural resources. Because of the impact on people, society's development, and living standards, renewable energy is very crucial. The involvement of the community in the projects is encouraged to ensure participation and

ownership. As the proportion of renewable energy increases, the exacerbation of respiratory arrest and the problem of airdrome will decrease (Magazzino et al., 2024; Papajorgji, 2022). By reducing energy poverty and social inequality, renewable energy ensures increased energy access (Apramadha & Prasetyo, 2025; Latte et al., 2024). However, renewable energy's exploitation has been restricted by many factors, including initial high costs, political regulation, and technological constraints (Golubeva et al., 2022; Luhaniwal et al., 2025). Various stakeholders such as government, industry, and community are envisaged to come together in developing enabling policies (Bucur et al., 2021; Chandu, 2024).

Benefits Associated with the Circular Economy

The principles of the circular economy are an economy that involves as many participants as possible (known as stakeholders), closed-loop economic principles, the design of products for a long life, and the implementation of an economic approach that uses the least amount of resources. Additionally, it turns it into better, reusable, repairable waste (Halkos & Aslanidis, 2024). Aside from producing goods efficiently, it is also an economically viable means of ensuring that the resource is used efficiently and is less energy intensive (Aiguobarueghian et al., 2024). By optimizing the use of substitutes and reducing scrap, the circular economy helps to support a more sustainable environment. It reduces the impact of climate change by reducing greenhouse gas emissions from waste disposal and source extraction (Aiguobarueghian et al., 2024).

Intersection of Renewable Energy and Circular Economy

There is tremendous opportunity in pairing renewable energy with a circular economy for a more sustainable world. Leveraging renewable energy sources, WTE technology will generate energy while using fewer resources. Because resources can be reused or recovered in each stage of their life cycles, the circular economy, through its design for reusability and efficient utilization of resources, minimizes waste and conserves natural resources (Zhang & Li, 2025). Shifting towards a cyclical economy with renewable energy boasts considerable benefits for reducing waste, boosting resource efficiency, and fostering employment (Bari et al., 2024). A new economy based on the principles of a CE and RE is beneficial for both nature and the economy. Furthermore, it is eco-friendly, which helps combat climate change (Kumba & Olanrewaju, 2024). Another direction of study may be to gain more knowledge about the potential of hybrid systems based on a combination of several renewable energy sources. This reduction in energy production and usage may be a topic for further research (Nunes et al., 2023).

3. RENEWABLE ENERGY: A KEY DRIVER OF SUSTAINABLE DEVELOPMENT

Sustainable development has to harness renewable energy sources such as wind, biomass, solar, and hydro energy to help address climate change, environmental degradation, economic growth, and social equity. Major renewable energy sources are:

Solar Power

According to the International Energy Agency (IEA), solar energy has become a super fast-growing field of power generation and is also relatively inexpensive for the general public to use worldwide (Blaszke et al., 2022). Solar energy is a good solution because it cuts down on greenhouse gas emissions, increases energy security, and enables remote access to electricity (Yang-Xia et al., 2023).

Wind Power

Now, according to the new statistics published by the Global Wind Energy Council, wind power has significantly increased, and the US, Germany, and China lead in windmill installation (Vidyarthi & Kumar, 2023). Wind electricity provides carbon mitigation and employment since the operations do not have significant operation costs or trade-offs to compromise the operations (Govindasamy et al., 2023).

Hydropower

According to the International Hydropower Association (Lai et al., 2023), hydropower is an energy source that is predictable, general, and has a low impact on the environment, benefiting irrigation and flood control, while at the same time it is harmful to nature and causes dispossession of people.

Biomass Energy

Biomass is an indigenous source of power that can be regenerated using sustainable agriculture practices; however, it is also intriguing for concerns related to competition between biomass and food production (Behabtu et al., 2020; Yan et al., 2024).

Shifting to renewable energies, such as solar, wind, hydro, and biomass energy, is one of the most important ways of achieving sustainable development. Some of the benefits of these sources are greenhouse gas reduction, more energy security, economic development, job creation, and social equity. They also improve energy security by reducing reliance on imported fossil fuels and add diversification to the total energy supply. The geopolitics of fossil fuels and fossil fuel prices can be reduced in the countries where the energy generated with renewable resources is consumed (Chang et al., 2023). Even for renewable energy companies, this can help to boost economic activity by lowering energy costs, creating new jobs, and stimulating regional economies (Dubey et al., 2023). Hence, the local decriminalization of renewable energy systems, achieved by the use of solar microgrids, will help individuals control their energy sources and reduce their dependence on centrally located energy systems (Ogunleye et al., 2022). The positive effects of renewable energy transition may also apply to the population (i.e., morbidity and mortality resulting from respiratory diseases and respiratory illness caused by air pollution), a positive impact (Badreddine & Cherif, 2024; Bell & Gillingham, 2025).

Impediments and Limitations to Adoption of Renewable Energy

Despite renewable energy being an important part of sustainable development, there are other issues that need to be addressed. One of the economic factors that restrict the capability of people adopting greener technologies is the high start-up capital cost of renewable energy technology (Adebayo et al., 2024). Therefore, intermittent renewable energy must be considered among the technological challenges that require solutions through better energy storage and grid management technologies (Moghadam & Karami, 2024). It is also possible for REN to be inhibited through regulatory and policy processes, for instance, through poorly defined or even irrational regulation (Rasheed, 2024). Other red flags as to why a person might not care for renewable energy may be due to social and cultural aversions or ignorance and adverse experience with the classical forms of energy (Uzondu & Lele, 2024). Solar power plants and wind farms can be contentious from an environmental and land use perspective due to the land they cover and the potential harm to the environment if they are not managed in certain ways. In order to decrease the different impacts induced from renewable energy technologies on the environment, the technologies must be applied in such a manner that maximizes sustainability over their entire life span (Mazzeo et al., 2023). If the government and stakeholders are to unlock the potential of renewable energy sources for an environmentally conscious future, they must also continue to finance more in the renewable sector, provide favorable policy environments, and involve the population (Faheem et al., 2024; Holjevac et al., 2021).

4. CIRCULAR ECONOMY: A FRAMEWORK FOR SUSTAINABLE DEVELOPMENT

The circular economy (CE) is a new approach for growing the economy; sustainability is the starting point and comes prior to waste elimination or resource optimization. One of the key concepts promoted by this framework is that of sustainable product consumption and reuse, product recycling, and resource recovery. The circular economy follows five concepts: reduce, reuse, repair, recycle, and recover. To minimize is to use less of a resource and less waste energy at the source level. This means better production processes, reduced energy consumption, and environmentally friendly materials. This reuse allows people to use objects for longer, therefore saving on the resources and amount of energy and emissions required to produce new objects. Recycling has been linked with

significant material recovery, personnel development, and the possibility of creating new markets to which recycled materials can be sent. Waste-to-energy is a waste treatment procedure which involves the burning (incineration) and fermentation (anaerobic fermentation) of the non-recyclable and unrecyclable fractions for recovery of the potential materials. Designing for circularity means thinking about the whole product life cycle while creating viable products that at the same time are easily deconstructable, modifiable, repairable, and recyclable. This makes it possible to develop new solutions for higher sustainability to be achieved by taking up the principles of a circular design. As a consequence, and due to disassembly, products are being produced in a way that makes them easy to disassemble, therefore repairable or improvable in less time, and that also results in fewer waste products (Aiguobarueghian et al., 2024).

Advantages of Circular Economy

The CE is a revolutionary sustainability path based on reducing waste and recycling resources, while at the same time promoting a transition to more sustainable production and consumption patterns. Its many benefits include less waste, more efficient use of resources, employment, economic prosperity, the environment, social equity, and resilience. Further, there is a need for sustainable activities, which may help reduce the level of waste and pollution, such as the development of designs for the reuse of resources and the recycling of products, which also have been classified as circular economy activity. After examining the importance of the circular economy for energy efficiency and then for resource efficiency for circular design and production, it is important to explore resource efficiency as another potential for the circular economy. In turn, the businesses would be able to minimize costs associated with manufacturing, maximize opportunities for innovation, and secure a better position in the marketplace. This can lead to increased levels of innovation, lower production costs, and more competitive businesses. As a bottom-up approach, the transition to a circular economy will foster jobs and economic growth prospects, notably via green business and the development of new markets for sustainable and recycled products.

Challenges and Limitations of Implementing Circular Economy Principles

The circular economy is an economic and business model intended to reduce waste and produce the greatest value from available resources. However, several issues surround its adoption, including social, technological, legal, and economic barriers. One of the obstacles preventing the companies from making the necessary changes to move over to a circular model is the high initial cost for transition. The circular economy processes are vitally dependent on the availability of markets for the recycled material, and thus the available resources will tend to be underutilized for economic reasons. The necessary financial capital to undertake the research and development and technical know-how in an organization could be a source of technological development deal breakers for the design and creation of advanced technologies for recycling, remanufacturing, and recovery of resources (Schichtel & Stevenson, 2022). One of the most devastating ways in which regulatory and policy constraints are affecting the uptake of the idea of the circular economy. New entrepreneurship models and the delivery of results often find that they do not have the correct support in existing or developed policies designed and drawn up with the linear economy in mind. Apart from this, the compliance standards are also burdensome for the entrepreneurs, particularly the SMEs. More dramatically, these challenges can be magnified by a lack of clear guidelines and positive incentives for circular business practices. Furthermore, social acceptance is another important factor that can demotivate the practice of the circular economy concepts. Buyers may not be interested in the benefits of circular practices or be casual about changing their use habits. This is often coupled with a lack of demand for circular products: consumers are so accustomed to linear consumption patterns; they associate circular products with lower levels of attractiveness or some other level of unappealingness. Not only is it important for people to participate publicly, but the use of appropriate communication methods is also essential for breaking down social barriers.

5. INTEGRATION OF RENEWABLE ENERGY AND CIRCULAR ECONOMY

RE and CE can be a powerful combination in transforming the concept of sustainable development. Renewable energy solutions may also be integrated into the circular economy model to help stakeholders make the most of resources, reduce waste, and limit overall environmental impact. Regarding landfill biogas, waste-to-energy (waste recycling and utilization to produce biogas) will decrease waste in landfill sites and is also a renewable energy source, one of the reasons why resource conservation and waste reduction opportunities are one of the main opportunities (Kumba et al., 2024). An energy-captured device is a combination of renewable energy systems, energy storage devices, and a smart grid (Kharayat et al., 2023). The principles of the circular economy and the concept of renewable energy can complement each other and play an important role in enhancing both sustainability and energy efficiency. If, for example, the CE can be integrated with RE concepts, then the development of the economy and employment could be accelerated. Highly skilled personnel are in high demand for renewable source development, maintenance, and recycling (Uzondu & Lele, 2024; Uzondu & Joseph, 2024). The reform could open up new markets and opportunities for businesses, especially those involved in recycling, waste management, and renewable energy technology. The circular economy creates innovation and entrepreneurship as companies challenge themselves to create sustainable goods and services that are aligned to circular principles. This invention can serve as a force for economic resilience and diversification, especially in places where the conventional industry sector is still dominant (Kharayat et al., 2023). Furthermore, RE can be incorporated with the concept of the regenerative economy if a favorable legislative and regulatory framework is set up for the concept. Governments have a key role in promoting the use of alternative energy sources and circular processes (Kumba et al., 2024). There is growing agreement that a combination of the CE with RE is a main step for sustainability and a decrease of environmental impact in the long term. A number of successful cases from recycling facilities operated with renewable energy sources are being integrated successfully, and other new applications set out the fact that these two concepts are actually complementary.

In a very interesting story from the United Kingdom, the RePower project brings together recycling activities and renewable energy generation systems. Considering that solar energy is used by the recycling facilities, this project is to reduce to the lowest level the CO_2 level from the carbon footprint of the recycling facilities. Being a success case of the project scheme, the recycling centers are generating clean energy for their own workplace by rooftop installation of the photovoltaic (PV) systems for their facility electricity demand (Yadav et al., 2024). To overcome the challenge of water scarcity and boost the circular economy spirit, a solar-operated water treatment plant is installed in India. Furthermore, all the treatment processes are operated with solar energy, making it a responsible and sustainable way to produce clean water (Bai et al., 2025). The wastewater will also be easily treated by the recycling system available in the plant, and the treated water can be used for industries, agriculture, etc. Using renewable energy for water treatment is not just a water conservation effort but also reduces operational costs and carbon emissions. This is yet another example of how renewable energy can help make the water management system more sustainable in terms of the circular economy (Bai et al., 2025). The goal of an advanced project under development in Europe called PV Cycle is to recycle the solar panel at the end of its cycle. Hence, an attempt is being made to ensure that these disabled solar panels are recovered and recycled so as to recover the precious components of silicon, glass, and metals (Kristia & Rabbi, 2023; Yadav et al., 2024).

Benefits of Integration

Far from being mutually exclusive, some of the benefits of combining renewables and circular economy principles include greater sustainability; lower capital costs; more resource and economic efficiencies; and, more to the point, greater economic opportunities than ever before. Renewable energy sources like biomass, wind, or solar also help ease our reliance on nonrenewable fuel sources. Other circular economy concepts, such as waste reduction, recycling, and resource recovery programs, can also bring further opportunities for enhancing the sustainability of energy systems. The synergy has led to a stronger and greener energy system that promotes sustainable utilization of resources. This means a low cost in waste management and energy consumption while also ensuring a greater utilization of available resources. Circularity-based resulting practice will make the production process less expensive and

make the utilization of resources quite effective. By combining the idea of a circular economy with renewables, new jobs can be created and economic growth can spur from this formula. The increasing demand for professional labor required for the installation of renewable energy, maintenance, and recycling of renewable energy sources is related to the transformation of companies towards the circular economy (Kumba et al., 2024; Somadayo et al., 2024). The implementation of waste-to-energy projects would provide a much-needed boost to local economies by creating jobs in waste management and renewable energy (Kumba et al., 2024). By decreasing reliance on fossil fuel sources for energy, communities can create a more resilient energy matrix that is less susceptible to global energy commodity price fluctuations.

6. PATHWAY TO SUSTAINABLE DEVELOPMENT

The combination of CE and RE is increasingly important for sustainable development. Aside from the environmental concerns, it promotes resource efficiency, social equity, and economic development. Combining RE and CE can have a powerful impact on reductions of greenhouse gas emissions, increased resource efficiency, enhanced economic development, and new jobs. Furthermore, the circular economy generates entrepreneurship and innovation, leading to more economic diversification and resilience in regions dominated by legacy industries (Uzondu & Lele, 2024; Barrie et al., 2024). Diversification of energy resources and a decrease in dependency on fossil energy sources enhance energy security. The energy output from the local garbage will support communities to develop a more robust energy system (Kharayat et al., 2023; Ekemezie & Digitemie, 2024). The role of stem cell production in the circular economy is in line with its objectives of eliminating waste and increasing the sustainability of resources. Finally, the mutual support of RE and CE would critically strengthen communities' resilience and social equity. So, for underprivileged communities, renewable energy access can help through the development of resilient assets, improved quality of life, and economic growth through reliable and cheap power availability by making people less vulnerable to environmental threats and reaping the benefits of renewable energy. The integration of circular economy and renewable energy concepts can make a great difference for economic, communal, and natural sustainability. The union between RE and CE can create opportunities for innovation and market development and create job opportunities since enterprises can save operational costs. This will be particularly useful to small and medium-sized firms (SMEs), which may not be performing well financially. To conclude, the integration of RE and CE can effectively contribute to social equity and the improvement of living standards by providing low-cost, clean energy for communities. Because access to renewable energy benefits is more equally distributed, this can empower marginalized groups and help to promote social justice. The combination of RE and CE can also enhance community resilience to environmental shocks by reducing the community's energy dependence on fossil fuel sources while increasing the diversity of energy sources that make up the energy matrix. As a result, energy systems can be strengthened and become more resilient to global energy market changes. By decreasing waste and improving resource efficiency, the joint methods of RE and CE will also help to reduce greenhouse gas emissions. This is in line with the goals of renewable energy systems that are intended to reduce fossil fuel usage. Finally, combining RE and CE can have beneficial synergies in terms of efficiency while safeguarding biodiversity through efficient use of resources and minimized waste.

Regulatory and Policymaking Structures to Support Integration

For the attainment of SDGs, one can take the circular economy and renewable energy concepts into account. The proper legal and regulatory infrastructure is important in facilitating such an integration because it will help to level the ground for the manufacturer by giving the required support, encouragement, and guidance to the stakeholders. Establishing adequate regulatory frameworks, financial incentives and stimulus programs, encouragement of research and development, and awareness building and education of the general public are all policy and regulatory requirements. The benefit of such a detailed legal framework is important in the execution of RE and CE practices, which includes the existence of laws determining the roles of stakeholders, the formation of renewable energy adoption objectives and the provisions of regulations for resource recovery and waste management (Nunes et al., 2023). Renewable energy projects must expedite their permitting to remove administrative obstacles to investment. Tax credits, subsidies, and other forms of monetary incentives can make RE and CE projects much more attractive (Alsaggaf, 2024). Projects that

use renewable energy and follow the circular economy concept can require green finance instruments such as green bonds and sustainable investment funds. Furthermore, collaboration between government, business, and academia can be encouraged in areas of RE and CE, as they can stimulate innovation and the transfer of knowledge (Uzondu & Joseph, 2024). Awareness-raising, training, and capacity development activities can equip the stakeholders with the knowledge and skills required to adopt circular economy and renewable energy practices.

7. CONCLUSION

The intertwining of RE concepts with the CE is one of the transversal approaches of sustainable development. The result of this integration can be an increase in social equity, an expansion of the market, and job creation. It can be used for personnel management in the waste management, technology development, and energy generation industries (Uzondu & Joseph, 2024). For Kumba et al. (2024), the argument is that a circular economy also helps in improving the efficiency of resources through which a company can experience a reduction in operating costs. The combination of RE and CE facilitates enhanced innovation for the market and commercial growth through the use of digital technologies and business models. Communities that adopt the above concepts can increase their social equity and quality of life. The development of community renewable energy projects that distribute the benefits of renewable energy equitably can support social and economic justice and provide environmentally conscious rural progress (Romero-Castro et al., 2023). In addition, such concepts create more resilient communities, as they include alternative sources for energy generation and decrease the overdependence on fossil fuels, thus lessening the effects of environmental shock on the community.

One of the biggest environmental advantages of the RE/CE mix is that they can limit greenhouse emissions. According to the studies, the combination of RE and CE strategies can potentially lead to notable deductions in CO_2 release (Wang & Zhang, 2025). Waste-to-energy technologies can utilize waste, primarily organic waste, to create renewable energy value, thereby reducing waste in landfills and helping to combat climate change (Kumba et al., 2024). A second major advantage of the integration of RE and CE is improvement of resource efficiency and conservation of biodiversity. Optimization of resource use and resource waste minimization can help businesses better manage natural resource use more sustainably by lowering their environmental impact (Cai et al., 2024). Good legislative and regulatory measures make such integration of RE and CE concepts possible. The enabling framework, education for population and collaborations with industry and academia can increase the renewable energy attractiveness considerably (Nunes et al., 2023). Individual citizens are also very critical for a future that is viable. They can help achieve the grander sustainability goals by adopting more sustainable lives, eliminating waste, limiting energy use, and promoting renewable energy (Romero-Castro et al., 2023). On the other hand, individuals can contribute to conversations within their communities, support local-level sustainability initiatives, and lobby policy makers to push for reform that would allow for renewable energy and circular economic initiatives.

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