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A CRITICAL LOOK AT RENEWABLE ENERGY COMMUNITIES FROM THE PERSPECTIVE OF SUSTAINABLE DEVELOPMENT GOALS

Mert Özgüner[1], Zeynep Özgüner[2]

[1]Department of Management and Organization, Besni Ali Erdemoğlu Vocational School Adıyaman University Adıyaman, TÜRKİYE. ORCID: https://orcid.org/ 0000-0003-4919-9391, E-mail: mozguner@adiyaman.edu.tr
[2]Faculty of Economics, Administrative and Social Sciences, Department of Business Administration Hasan Kalyoncu University, Gaziantep, TÜRKİYE. ORCID: https://orcid.org/0000-0002-8694-7275, Email: zeynep.ozguner@hku.edu.tr

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Corresponding Author: Mert Özgüner (mozguner@adiyaman.edu.tr)

ABSTRACT

Sustainable development means achieving development without compromising the ability of future generations to meet their needs. It can also be defined as securing the present and the future by achieving balance in environmental, economic, and social areas. The United Nations adopted the Sustainable Development Goals in 2015, a global call to action. This call to action serves as a roadmap for achieving sustainable development by 2030. Sustainable development goals aim to end poverty, protect the environment, take measures against the climate crisis, and promote peace. Accessible and clean energy is also a key factor in achieving the sustainable development goals. The existence of an affordable, reliable, sustainable, and modern energy management system is of paramount importance. In this context, the European Commission's 2022 decision to create sustainable cities has underscored the importance of renewable energy communities and citizen participation in the clean energy transition. Energy communities play a vital role in enhancing local energy resilience and ensuring cost-effective energy management. These communities can leverage collective market participation to achieve economic and operational benefits by bringing consumers together. This study examines energy communities from a broad and holistic perspective within the framework of the United Nations (UN) Sustainable Development Goals.

KEYWORDS: Sustainable Development, Energy Communities, Energy, Society 5.0.

1. INTRODUCTION

The United Nations' Sustainable Development Goals, adopted in 2015, provide a framework for global development containing 17 goals and 169 sub-goals. Renewable energy communities serve as a guide for countries to follow in building a prosperous and ecologically secure future (Nations, 2022). Sustainable development, as defined in the report published by the World Commission on Environment and Development in 1987, is described as meeting the needs of the present without compromising the ability of future generations to meet their own needs (Ghorbani et al., 2018). As can be understood from this, sustainable development prioritizes meeting the basic needs of the poor and highlights the limitations imposed by technology and social organizations on the ability to meet current and future needs (Hasche et al., 2020). Meeting basic needs leads us to realizing our full growth potential. However, reaching full growth can jeopardize sustainability and bring about environmental problems. From this perspective, it is not possible to talk about sustainable development solely from an economic standpoint. Sustainable development encompasses environmental, economic, and social dimensions. The aim here is to emphasize increasing societal well-being through the conservation of unlimited environmental resources (Mikkonen et al., 2020).

Climate change is affecting every region on Earth, and the effects of these changes are bringing about irreversible consequences. Extreme weather events and climate disasters are increasing in frequency and severity every day (Burke and Stephens, 2018). As the International Energy Agency states, in 2016, 71% of greenhouse gas emissions and 60% of resource consumption were associated with urban areas (Wen et al., 2013). Fossil fuel economies, societies, and civilizations of the current era have a negative impact on contemporary humanity and the biosphere (Niet et al., 2021). Both in this context and due to the expected global population increase until 2030, identifying action lines for climate-resilient urban solutions and identifying vulnerable areas is of vital importance (Wali et al., 2021). To this end, the European Union has set targets to reduce CO2 emissions through the use of renewable energies in order to achieve carbon neutrality (Nadai, 2019). Cities are key to addressing this crisis and implementing the transformations needed to align the development and well-being of the world's population with the planet's limited capacity. Contemporary mega-transitions (technological-digital, energy-environmental, and demographic-social) offer an opportunity to transform the existing urban development model and promote social cohesion. This transition should consider redefining the social roles and responsibilities of citizens (Jansen et al., 2021). In light of these developments, a rapid transition to renewable energy is of vital importance. Renewable energy refers to inexhaustible energy sources obtained from natural processes that minimize carbon emissions. Due to its environmentally friendly nature, economic sustainability, and ability to provide energy independence, it has become one of the most critical issues of the modern world (Alizadeh et al., 2020). At the end of 2016, the European Commission developed an approach aimed at placing citizens at the heart of the energy transition. This approach requires member states to guarantee consumers the right to produce, consume, store and sell their own renewable energy (Gil Mena et al., 2023). Therefore, in the last few years, “community”, “local” or “regional” initiatives have been developed in the field of climate energy (Dudka et al., 2023). New incentive mechanisms are being developed, including for collective and individual self-consumption of energy from renewable sources. Organizations that independently generate and distribute renewable energy, produce and manage affordable green energy, and reduce CO2 emissions and energy waste are known as Renewable Energy Societies. Renewable energy communities are of great importance in achieving some sustainability goals, including Sustainable Development Goals 7 (Affordable and Green Energy), 11 (Sustainable Cities and Communities), and 13 (Climate Action) (Wuebben et al., 2020). Renewable energy communities are increasingly recognized as important tools in the global energy transition, offering decentralized, participatory, and sustainable solutions for energy management, particularly in relation to energy production and consumption (Ceglia et al., 2022). Renewable energy communities play a crucial role in Europe’s energy transition towards a green and sustainable future, attracting private investors, securing public and community support for green energy initiatives, and facilitating the long-term use of renewable energy sources (Garbelli, 2024).

Despite its growing importance and the institutional steps taken in this regard, many people are being disempowered in the energy transition process because crucial issues such as access to resources and unequal agency are not being addressed through the concept of "citizen energy producers." Therefore, energy citizenship needs to be

reconceptualized to include more collective and inclusive contexts for action (Jacqmin et al., 2026). This study, starting from the concept of energy, which is among the most important elements of sustainable development, examines in detail the topic of renewable energy communities, which are considered to have an important role in the transition to renewable energy, and evaluates these communities from a broad perspective, from the challenges encountered in their formation to their advantages. The aim is to ensure a better understanding of the issue's importance in light of the evaluations and to provide scientific opinions that will constitute a reliable basis for decision-makers in their strategic decisions regarding the issue.

2. RESEARCH METHODOLOGY

The aims and methods of the study, which critically examines renewable energy communities from the perspective of sustainable development goals, are stated under this heading.

2.1. The Problem of the Research

This research aims to examine the concept of renewable energy communities in depth and from a critical perspective, starting from the goal of accessible and clean energy, which is among the most critical goals for achieving the sustainable development goals adopted by the United Nations in 2015. Today, the transition to renewable energy and doing so with citizen participation is becoming increasingly important. Another motivation for this study is the implementation of encouraging policies on the subject by decision-makers, and raising awareness among citizens regarding their participation in the process.

2.2. Research Methodology

The research is conducted using a literature review approach. Information obtained through in-depth analysis of scientific studies presenting different perspectives on the subject has been systematically examined. At this point, conceptual knowledge that will help in making more successful decisions has been brought together as a whole in this study through extensive literature research.

3. LITERATURE REVIEW

The sustainable development goals, particularly the goal of accessible and clean energy, are largely aimed at being achieved through policies related to land, energy, water, and climate. At this point, energy economics has become extremely critical. Energy economics is a model that involves supplying, transforming, transporting, and using energy resources by converting naturally available forms into economically efficient ways to meet necessary demands (Caballero et al., 2021). Reliable, sustainable, and clean energy production has a positive impact not only on the global economy and development but also on the environment. In the recent period of industrialization, the increase in the burning of fossil fuels and the scarcity of fossil fuels have led industry to turn to renewable energy options such as photovoltaic energy, wind energy, hydrogen storage, and battery energy storage systems (Rajbongshi et al., 2017). Electricity generation in developing countries traditionally relies on fossil fuels (74%), and the penetration of renewable energy plans in energy production is low (0.02%). Burning wood, straw, leaves, dried cow manure, and kerosene releases significant amounts of greenhouse gas emissions into the environment. As a result, an estimated 100,000 people die each year due to increased air pollution. This situation demonstrates that the clean energy transition process is extremely important for the future (Delmas et al., 2013).

Sustainable education, energy and commodity independence, the development of new jobs, subsidies for the development of a green economy, environmental protection and energy communities emerge as cornerstones of a sustainable society (Biancardi et al., 2023). Energy communities enable collective and citizen-driven energy actions to support the transition to clean energy. Energy communities enable local communities to join forces and invest in clean energy. Acting as a single entity means that energy communities can access all eligible energy markets on a level playing field with other market players. Under EU law, energy communities can take any legal form of incorporation, including associations, cooperatives, partnerships, non-profit organizations, or limited liability companies (Yao et al., 2022; Barabino et al., 2023).

Energy communities can be an effective way to reshape our energy systems by encouraging citizens to drive the energy transition at the local level and directly benefit from better energy efficiency, lower bills, reduced energy poverty, and more local green job opportunities (Dudka, 2025). They can help increase public acceptance of renewable energy projects and make it easier to attract private investment in the clean energy transition. Renewable energy communities are response mechanisms to the electricity consumption required for daily routines. Renewable energy communities are legal structures where individuals, local governments, or small

businesses come together to collectively produce, share, and manage their own clean energy. These communities aim to strengthen energy democracy by centering the concept of "producing consumers" who not only consume energy but also produce it (Dorigoni and Bonini, 2023; Rodrigues et al., 2020; de Ridder, 2025).

Renewable energy communities represent an innovative model for energy production, consumption, and sharing, fostering a transition to more sustainable, decentralized, and participatory energy systems. Public or private organizations can be established in various forms, in accordance with the regulations of the countries in which they operate. Cooperatives can take the form of registered or unregistered associations and non-profit legal entities. Board members may include groups of individuals such as small and medium-sized enterprises (SMEs), local governments, and public, private, or corporate entities (e.g., apartment buildings) (Jacqmin et al., 2026). By cooperating to produce and consume renewable energy, they reduce environmental impact, lower energy bill costs, and guarantee a return on investment in renewable energy plants (Ahmed et al., 2024).

The establishment of energy communities serves two purposes: to facilitate an equitable energy transition and to advance a nation's sustainable development by offering various advantages across social, economic, and environmental dimensions. In economic and environmental contexts, these advantages are related to the self-sufficiency and adaptability of energy assets. A community's ability to meet all its energy needs through renewable sources has the potential to contribute to decarbonizing the energy matrix and thus reducing greenhouse gas emissions (Ceglia et al., 2022). Furthermore, through demand monitoring and load management, individuals become aware of their energy consumption, which encourages more rational energy use and reduces costs for both consumers and the energy ecosystem. Conversely, energy communities can help mitigate power grid failures and facilitate the integration of renewable energy sources by reducing demand through a coordinated load balancing strategy among users. Increasing maximum load capacity allows for the postponement of necessary grid upgrades (Ling et al., 2024). Social benefits are also simultaneous, as such communities increase citizen participation and strengthen community-oriented decision-making processes. They can also facilitate social innovation by addressing energy inequality through the involvement of local stakeholders who might otherwise lack the financial or human resources to operate independently (Heuninckx et al., 2023).

Looking at the state of renewable energy communities in Europe and the world, in the European Union, renewable energy certificates are making active producers and consumers accountable, ensuring their acceptance of the energy transition, and encouraging investments in this context. The EU supports investments in the energy transition by involving renewable energy communities—producer-consumers—in the transition process, encouraging them to behave responsibly and actively participate (Fava et al., 2024). The EU tasks its member states with promoting and supporting renewable energy communities. These communities can be energy producers, consumers, storage providers, and sellers; their members include private individuals, micro, small, and medium-sized enterprises, and local governments; they should be non-profit and based on equality and broad participation. In Germany alone, a 49% increase in the power supply from renewable energy communities to the grid, a 12-16% increase in self-consumption, and a 7-10% increase in self-sufficiency have been observed (Belmar et al., 2023). On the other hand, many European countries have increasingly used digital technologies to improve the efficiency of renewable energy communities. Positive effects have been observed, particularly from new technologies such as the Internet of Things, blockchain technology, and machine learning (Queiroz et al., 2023).

In many countries, including the USA, Canada, and Brazil, the importance of the social, environmental, and economic impacts of renewable energy communities has been recognized, and these communities have been extensively utilized in the fight against energy poverty (Lemaire et al., 2023). Based on the view that access to energy enhanced by renewable energy communities in African countries is a measure to combat not only energy poverty but also poverty itself, the project encourages the integration of citizens into the energy transition process in order to promote economic growth, increase job opportunities, and protect the environment (Tsoeu-Ntokoane et al., 2023). Many countries in the Americas are pursuing active policies to integrate renewable resources into their energy matrices. These policies include enacting laws and regulations designed to encourage investment in clean energy sources and setting specific targets for energy production through these sources. Although the concept of energy communities is still relatively new in the region, countries such as Chile, Brazil, and

Colombia have begun to establish regulatory frameworks to facilitate their development (Cohen et al., 2023).

Energy poverty is a widespread problem in Europe, particularly among tenants living in public housing who are excluded from the traditional housing market and face greater socio-economic difficulties. This problem is particularly acute in Southern Europe, where there is less tradition of energy efficiency improvements and inadequate building maintenance by public administrations exacerbates the issue (Croon et al., 2024). While renewable energy facilities offer significant potential for overcoming these challenges, progress has been slow due to the climatic characteristics of these countries (Axon and Morrissey, 2020). The potential of renewable energy communities in public housing is often overlooked, despite offering a two-pronged opportunity to reduce the high energy consumption of this housing segment and promote social inclusion (Barbaro and Napoli, 2023). Achieving this requires targeted incentives, advisory services, and flexible policies to effectively engage low-income and energy-vulnerable populations (Belmar et al., 2023). Local governments should proactively support such initiatives. However, recognizing energy inequalities and establishing a formal participation process is not enough on its own (Ahmed et al., 2024). Because structural and cultural barriers still hinder participation and lead to vulnerable populations being underrepresented in such initiatives (Dudka, 2025).

It is also necessary to say that there are some challenges to the widespread adoption of renewable energy communities, which have become such an important concept. These include a lack of adequate support and financial assistance, which can limit communities' capacity to launch renewable energy projects. Furthermore, a lack of environmental awareness and technical expertise among some communities can further complicate participation in renewable energy initiatives. Furthermore, the lack of a clearly defined regulatory framework to support renewable energy communities can hinder their development and the achievement of energy equity (Bauwens et al., 2022). Siksnelyte-Butkiene et al. (2023) identified several challenges related to energy production and consumption, including the lack of suitable support programs or incentives to encourage firm and individual participation, insufficient integration of new energy production technologies, limited community adoption of energy production and consumption, and complex bureaucratic procedures required to obtain permits and operate.

Studies in the literature also show that renewable energy communities have positive effects on people. From a socio-cultural perspective, energy communities represent a democratic participation model in which citizens actively participate in the processes of energy production, distribution, and consumption. This model serves to enhance economic, environmental, and social development within the community while strengthening local resilience and enabling energy management (Tiberio et al., 2025). Renewable energy communities facilitate a just energy transition by enhancing citizen participation, empowering them with decision-making, and advancing social innovation. This innovation is presented as having the capacity to manage and address inequality in access to and distribution of energy. This result is made possible by the inclusion of local actors who might otherwise lack the financial resources or human capital necessary for effective participation in the energy sector (Standal et al., 2023). Furthermore, the necessity of equality and inclusion for the socio-cultural success of renewable energy communities is emphasized. It is necessary to ensure that all social groups benefit equally from a sustainable and accessible energy ecosystem. This will ensure a sense of social belonging and shared responsibility among citizens (Dorigoni et al., 2023). However, ensuring that energy communities are sustainable not only from an economic and technical standpoint but also in terms of their impact on the cultural and environmental values of the communities involved will lay the groundwork for increased citizen awareness during the transition to renewable energy. Furthermore, fostering strong communication and a climate of trust among members of the renewable energy community will also enhance its effectiveness (Delmas et al., 2013). The success of an energy community depends on the democratic participation of its citizens. It is extremely important that the energy initiative is compatible with local values, traditions, and customs. This compatibility will help increase the initiative's acceptance and ensure its long-term sustainability. Furthermore, it is extremely important that these initiatives serve to strengthen and preserve the community's cultural heritage, thereby fostering a sense of belonging and social cohesion among members. In summary, the socio-cultural impacts of renewable energy communities depend on factors such as citizen participation, behaviors and lifestyles, equity and inclusion, cultural identity and social dynamics, and communication and governance (van Summeren et al., 2020).

Renewable energy communities have a beneficial impact on the local economy. They play a significant role in creating employment opportunities in the energy sector and thus promoting a dynamic and thriving local economy (Lemaire et al., 2024). Similarly, as the renewable energy industry expands, it also contributes to the growth of gross domestic product. Energy ensembles are used to optimize consumption, reduce costs, stabilize the grid, decrease market volatility, and promote economic sustainability (Standal et al., 2023). It is extremely important that the business model meets the needs of the community and maximizes value and collaboration opportunities within the energy ecosystem. Furthermore, identifying suitable funding sources is crucial for the economic success of energy communities. Fair distribution of costs is necessary to prevent opportunistic behavior, encourage cooperation among community members, and ultimately ensure social acceptance of the resulting cost distribution (Standal et al., 2025).

Various renewable energy technologies, including solar, wind, biomass, geothermal, and hydroelectric, have been used in the development of energy communities. These technologies are primarily used because of their sustainability and their role in facilitating the transition to a low-carbon energy ecosystem (Tsoeu-Ntokoane et al., 2024). Furthermore, they play a vital role in empowering communities by facilitating more effective energy management. Integrating renewable energy sources with advanced energy management systems is a crucial step in developing energy communities. For this purpose, the electricity grid infrastructure needs to be comprehensive and flexible, able to assimilate multiple technologies and resources, and supported by an efficient control system that facilitates optimization and energy management at the local level (Barabino et al., 2023). In this context, the role of smart grids has become crucial. Digitalization of the electricity grid is a significant factor in decentralizing the energy ecosystem. Big data, artificial intelligence, the Internet of Things, distributed ledgers (including blockchain technology), robotics, 3D printing, virtual and augmented reality, and cloud computing offer various opportunities to increase efficiency and sustainability through their application (Heymann et al., 2023).

To summarize the environmental dimensions of renewable energy communities, considering numerous environmental factors is extremely important in this process. These include, but are not limited to, greenhouse gas emissions, competition for land use, impacts on water resources, air quality, biodiversity, and natural habitats (Bauwens et al., 2022). In the context of the environmental dimension, CO2 emissions, the use of renewable resources, impacts on biodiversity, and pollution potential, as well as climate change factors, are some of the other factors that should be considered in the success of energy communities (Croon et al., 2024). The integration of renewable energy technologies into energy communities is crucial in the fight against climate change. Numerous studies have shown that these initiatives can lead to a significant reduction in greenhouse gas emissions compared to traditional energy systems. Renewable energy communities have resulted in a 50% reduction in greenhouse gas emissions compared to traditional energy systems. However, studies show that it prevents up to 39.5 tons of CO2 emissions annually. These environmental advantages support sustainability principles and are important in promoting citizen participation and awareness regarding a sustainable energy ecosystem (Queiroz et al., 2023). In conclusion, it can be said that, when implemented correctly, energy communities are an effective tool in mitigating climate change and protecting the local environment. However, to ensure that these communities make a significant contribution to the development of a more sustainable energy ecosystem in the future, it is extremely important to adopt a holistic approach that assesses both the environmental advantages and potential challenges (Stringer et al., 2024).

The legal and regulatory framework aims to determine the viability of energy communities and define their potential to contribute to a sustainable and decentralized energy ecosystem. Several countries, including Germany, Switzerland, Sweden, the Netherlands, and the United Kingdom, have established regulatory frameworks and policies that facilitate investment in renewable energy while also encouraging active community participation and ownership of energy projects (Cohen et al. 2021). In addition to Europe, countries such as the United States and Australia have implemented significant reforms to facilitate the transition to an efficient and resilient energy ecosystem. These reforms facilitate consumer participation and the integration of renewable technologies, and acknowledge the important role communities play in transforming the energy paradigm (Heuninckx et al., 2023).

4. CONCLUSION AND RECOMMENDATIONS

This study, which critically examines renewable energy communities from the perspective of

sustainable development goals, utilized a literature review method. In this context, a detailed literature review was conducted in an attempt to obtain systematic information. The aim of this study is to provide a comprehensive set of information that decision-makers can utilize in formulating policies and strategies related to the issue, and to raise awareness among citizens in order to encourage their participation in the process.

The research has concluded that the successful and sustainable development of renewable energy communities is possible only through a comprehensive and multidisciplinary approach that takes into account the dynamic interaction of numerous interconnected factors. These factors include social, cultural, economic, technological, environmental, legal, and political dimensions. Social and cultural factors are fundamental to the development of energy communities; it can be argued that they strengthen cohesion by promoting inclusive participation and increase community capital. Socio-cultural factors influence the environmental dimension by raising public awareness about ecological management and renewable energy transitions. Additionally, it can be said that sociocultural factors influence the technological adoption of decentralized generation systems such as photovoltaics, wind turbines, and smart microgrids. This adoption is expected to increase job opportunities by improving energy efficiency and to revitalize regional economies by developing local technical skills. These findings demonstrate that socio-cultural factors will positively influence the environmental, technological, and economic dimensions of renewable energy communities through a chain reaction.

The literature findings indicate that the economic and technological dimensions are also deeply interconnected. Because the adoption and acceptance of new technologies for electricity generation is crucial for the progress of projects in energy communities. This link underscores the importance of informing both the public and private sectors about the nature of these projects and promoting job opportunities in areas such as energy infrastructure installation and maintenance, renewable energy system management, technological research and development, and specialized technical training. However, it is extremely important that the legal dimension advocates for inclusive policies and provides training programs designed to increase the community's capacity to participate effectively in this process.

The legal dimension shows that each factor has a comprehensive impact on the development of energy communities. Legal and political factors are closely linked to social and cultural factors; indeed, the absence of policies that encourage technological innovation fuels social resistance and can hinder the development of energy communities. At this point, complex bureaucratic procedures pose significant obstacles to the widespread adoption of energy initiatives. What further complicates this issue is the lack of governance criteria and the heterogeneity of projects, which makes it difficult to implement fundamental elements such as flexibility, interoperability, and interdependence within clusters.

Based on the information obtained from the literature analysis, it can be suggested that some measures be taken to encourage renewable energy communities;

First and foremost, equity in energy communities is a significant challenge, as it involves ensuring that all members benefit and promoting participation. If energy costs and benefits are not shared equally, some members may feel disadvantaged and choose to leave the community. In addition, community members should be financially motivated through lower electricity costs achieved through collective purchasing power and optimized energy trading. However, the energy community shows that tools that enable members to derive tangible benefits from participation (such as increased self-efficacy) can strengthen confidence in the community model. Visible and measurable gains appear to reinforce participation through a positive feedback loop.

It is thought that behavioral tools implemented in energy communities may be more effective when framed not just as behavioral guidance, but as capacity building or "incentives". Providing members with understandable signals about when renewable energy production is available increases awareness and energy literacy. Survey feedback indicates that participants value learning about consumption patterns and local production dynamics. These approaches contribute not only to short-term behavioral changes but also to long-term empowerment. Guidance can optimize decisions within existing structures, while support strengthens individuals' ability to understand and navigate these structures.

Renewable energy communities are heavily reliant on local intermediaries who build trust, organize participation, and translate technical regulations into understandable practices. However, this relational approach is not sufficiently recognized

within regulatory and insurance frameworks. It is believed that formally recognizing and protecting these intermediary roles will strengthen the institutional stability of collective self-consumption activities.

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