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Review

Individual and community catalysts for Renewable Energy Communities (RECs) development

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This review examines factors catalyzing citizens' participation in Renewable Energy Communities (RECs), crucial for sustainable energy transitions. We analyze the interplay of individual and community elements promoting involvement in these collective projects. Individual drivers include pro-environmental values, economic incentives, desire for energy autonomy, and technical knowledge. Community factors encompass social cohesion, local identity, effective leadership, inclusive governance, and supportive policies. The synergy between these factors drives REC development. Challenges remain in ensuring accessibility, sustaining participation, and scaling successful models. Further research is needed on participation dynamics over time, cross-cultural comparisons, innovative financing, and digital technologies' role. Understanding and enhancing these catalyzing factors can unlock the potential of community-driven energy solutions to address climate change while promoting sustainable and equitable energy future.

Addresses

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Corresponding author: Mannarini, Terri (terri.mannarini@unisalento.it)**Keywords**

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Introduction

Renewable Energy Communities (RECs) have emerged as a pivotal model in the pursuit of decarbonization goals and sustainable energy transitions [1,2]. These are local initiatives where citizens, social entrepreneurs, and public authorities jointly own and manage renewable energy projects, sharing both the costs and benefits of clean energy production and consumption [3,4]. In RECs, community members can act as both producers

and consumers (“prosumers”) of renewable energy, working together to generate, distribute, and use clean energy at the local level. This collective approach emphasizes decentralization and active participation, marking a significant shift from traditional centralized energy systems.

The REC model goes beyond mere technological implementation; it represents a paradigm shift in how energy is produced, distributed, and consumed. This shift not only addresses environmental concerns but also has the potential to reshape social dynamics and economic structures at the local level [5]. Through shared ownership and democratic governance, RECs enable communities to take control of their energy future while contributing to broader sustainability goals.

As the urgency of addressing climate change intensifies, understanding the factors that drive citizen involvement in RECs becomes crucial for policymakers, researchers, and practitioners alike [6,7]. This paper aims to take stock of the current research on the individual and community factors that act as catalysts for citizens participation in renewable energy communities (main concepts are summarized in [Figure 1](#)). Understanding these factors is crucial not only for the success of individual REC projects but also for the wider adoption of this model as a key component of energy transition strategies. By examining these drivers, we can gain insights into how to foster and sustain citizen engagement in local energy initiatives, ultimately contributing to broader sustainability goals [5,8].

Additionally, RECs are a way to connect people to the natural ecosystem, not only as individuals, but also as collectives. They serve as an example of practices that build connectedness between communities and nature by creating a sense of shared ownership and responsibility.

This review examines two distinct but related aspects of REC development. First, we analyze individual-level factors that predict citizen participation in existing RECs, including psychological, economic, and social determinants. Second, we examine community-level characteristics that influence both the likelihood of REC formation and their subsequent success, ranging from social cohesion to institutional support. By examining these complementary perspectives, we aim to

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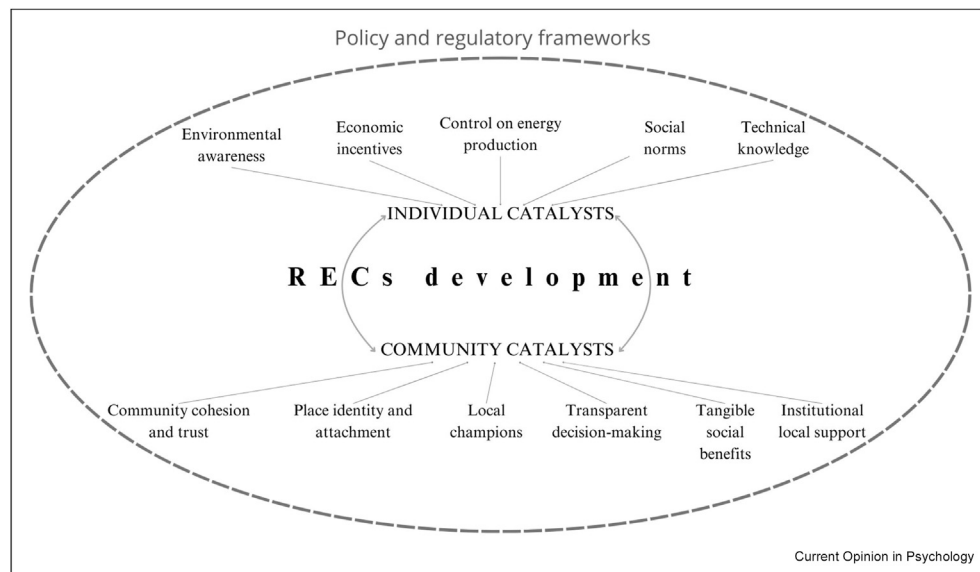
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Figure 1



Summary of the main concepts discussed in the review.

provide a comprehensive understanding of what drives REC development and sustainability.

Individual catalysts

A consistent finding across studies is the significant role of pro-environmental attitudes and values in motivating participation in RECs [9–11]. Individuals with higher levels of environmental awareness, ecological citizenship and biospheric values, as well as people with stronger environmental commitment and concerns about climate change, are more likely to engage in community energy projects [3,12–15]. Participants' commitment to the environment varies: some are driven by a strong sense of environmental responsibility, others by a general awareness and desire to contribute.

While environmental concerns are crucial, economic incentives also play a substantial role in attracting participants to RECs [1,16]. The prospect of reduced energy costs, financial returns on investments, and energy price stability often serves as a powerful motivator [17,18]. However, it is important to note that economic factors rarely act in isolation; they often complement environmental motivations [9,19]. RECs offer diverse economic benefits. These include potential long-term savings on energy bills, opportunities for local investments with financial returns, and contributions to local economic development. By creating jobs and keeping energy spending local, RECs can provide multiple economic incentives for community participation.

Participation in RECs can be driven by a desire for greater control over energy production and consumption [20,21]. The opportunity to become an active “prosumer” (both producer and consumer of energy) appeals to individuals who seek autonomy from traditional energy systems [14,22]. This sense of empowerment and agency in the energy transition process can be a strong catalyst for involvement [23,24]. The empowerment derived from REC participation extends beyond energy-related decisions; it can foster a broader sense of civic engagement and community self-reliance.

Finally, technical knowledge about renewable energy systems and energy management can facilitate participation in RECs [2,31]. However, a lack of such knowledge is not necessarily a barrier if the community provides opportunities for learning and skill development [32,33]. In fact, the prospect of acquiring new skills and knowledge can itself be a motivating factor for some individuals [15,34]. RECs can serve as platforms for community learning and skill-sharing, further enhancing their appeal to potential participants.

Beyond the individual level, interpersonal factors also play a crucial role in promoting citizen participation in RECs. In particular, social networks and social norms act as a link between individual and community level factors [25,26]. Studies have shown that people are more likely to participate in RECs when they perceive it as a socially desirable action within their close circle [27,28]. Peer examples and social learning processes can significantly

impact decision-making regarding REC participation [29,30], highlighting how individual choices are embedded in broader social contexts.

Community catalysts

The success of RECs depends on two distinct sets of community-level factors: (1) characteristics of the local community that facilitate REC development, and (2) structural features of the RECs themselves that promote their sustainability. We examine both dimensions to provide a comprehensive understanding of community-level catalysts.

Local community characteristics

Strong social ties and a sense of community cohesion have been identified as critical factors in the success of RECs [2,35]. Communities with pre-existing social networks and high levels of trust among members are more likely to initiate and sustain energy projects [23,25]. Trust in local institutions and community leaders also plays a crucial role in fostering participation [31,36].

A strong sense of local identity and place attachment can serve as catalysts for REC participation [10,37]. Energy projects framed as benefiting the local community and enhancing its resilience are more likely to gain support [34,38]. This factor underscores the importance of aligning REC initiatives with local values and identities [27,30]. RECs can contribute to strengthening local identity by becoming symbols of community achievement and self-reliance. Some communities have incorporated local cultural elements or historical references into their REC projects, creating a unique narrative that resonates with residents.

The presence of respected community members who advocate for and lead REC initiatives can significantly boost participation [8,9]. These “local champions” often possess a combination of technical knowledge, social capital, and leadership skills that help to mobilize community resources and support [18,39]. Effective local champions come from diverse backgrounds. They might be community leaders, local business owners, educators, or simply passionate residents. Their credibility often stems from their deep understanding of local context and their ability to bridge different community interests. Supporting and empowering these champions through training, networking opportunities, and resources can be a valuable strategy for fostering REC development.

Finally, the presence of supportive local policies and regulatory frameworks can significantly facilitate REC development [3,13]. Municipalities that actively promote community energy initiatives through policy

incentives, simplified permitting processes, or direct support can create an enabling environment for citizen participation [24,41]. Supportive policies can take many forms. Some local governments have incorporated RECs into their climate action plans or set specific targets for community-owned renewable energy. Others have created dedicated offices or staff positions to support community energy initiatives. Financial support mechanisms, such as low-interest loans or grant programs, can also be crucial in overcoming initial barriers to REC development.

REC organizational features

Building and maintaining trust is an ongoing process in RECs. Transparent communication, inclusive decision-making processes, and fair distribution of benefits are key to fostering trust. Some successful RECs have implemented regular community meetings, open-book financial practices, and clear grievance mechanisms to ensure accountability and maintain community support.

RECs that adopt inclusive and transparent decision-making processes are more likely to attract and retain participants [17,26]. Collaborative governance models that allow for meaningful citizen input and shared ownership of projects can enhance legitimacy and foster a sense of collective responsibility [33,40]. Various models of collaborative governance have been implemented in successful RECs. These range from direct democracy approaches where all major decisions are put to a community vote, to representative systems with elected boards and regular consultations. Some RECs have experimented with innovative methods such as participatory budgeting for allocating project benefits or used digital platforms to facilitate ongoing community input.

When the benefits of RECs are tangible and visible within the community, participation is likely to increase [6,32]. This can include improvements in local infrastructure, job creation, or community development projects funded by energy revenues [5,27]. Demonstrating clear social benefits at the local level helps to build support and sustain long-term engagement [29,30].

It is crucial to recognize that individual and community factors do not function in isolation but rather interact in intricate and multifaceted ways [23,42]. This complex interplay necessitates an ecological approach as the most appropriate framework for analyzing REC processes and outcomes. To illustrate, strong community cohesion has the potential to amplify individual motivations, while tangible local benefits can reinforce personal environmental values [11,42]. A comprehensive understanding of these dynamic interactions is

fundamental to the development of efficacious strategies aimed at promoting and sustaining REC participation [6,16].

The synergy between individual and community factors can create powerful momentum for REC development. For instance, when individuals with strong environmental values come together in a community with a strong sense of local identity, the resulting REC project can become a source of collective pride and further strengthen community bonds. Similarly, the economic benefits experienced by early adopters can shift social norms, encouraging broader participation over time.

Conclusion

The analysis of factors catalyzing participation in Renewable Energy Communities (RECs) reveals a complex interplay of individual and community elements [2,23]. The multifaceted nature of RECs is mirrored in the diverse catalysts for citizen participation. Regarding individual factors, the literature review suggests that fostering environmental education and awareness could be a key strategy in promoting REC participation [14,42]. Capacity building within communities can be achieved through workshops, training sessions, and hands-on involvement in energy projects. At the community level, parallel objectives can be pursued by actions aimed at structuring economic incentives aligned with community values, facilitating inclusive and transparent decision-making processes, and nurturing and empowering local champions who drive initiatives [3,9,14,29].

The literature on community resilience [43,44] demonstrates that local resources play a vital role in fostering sustainable community development. Local champions can play a crucial role in mobilizing internal resources in response to both local and global challenges [45], ultimately supporting RECs. These champions act as powerful motivators in community contexts, triggering capacity-building processes that foster psychological empowerment [46], thereby enhancing citizens' sense of control and critical awareness.

It is imperative to acknowledge that no universal approach exists for fostering REC participation. Strategies must be tailored to local contexts and evolve with changing community needs and global energy landscapes [24,31]. The success of RECs hinges on their ability to balance individual motivations with collective benefits, fostering a sense of shared ownership and responsibility for local energy transitions.

Despite the identified catalyzing factors, challenges persist in fostering widespread REC development. These include: 1) ensuring accessibility for all community segments, including low-income households and

marginalized groups [22,24]; 2) sustaining participation beyond initial enthusiasm, particularly in the face of technical or financial challenges [34,36]; 3) translating successful models from small communities to larger urban contexts or across diverse cultural settings [21,31]; and 4) aligning local REC initiatives with broader national and international energy policies [3,13].

To address these challenges, future research should prioritize longitudinal studies examining the evolution of participation motivations [11,20]. Furthermore, conducting comparative analyses across diverse cultural and policy contexts is essential to identify transferable success factors [24,25], thereby facilitating the development of more adaptable REC models for effective implementation in varied settings. Scholars should also investigate innovative financing mechanisms to reduce entry barriers for a broader participant spectrum [1,37], exploring the potential of crowdfunding, community bonds, or partnerships with ethical finance institutions. Moreover, it is imperative to examine the role of digital technologies in enhancing participation and community energy management [16,41], with particular emphasis on the potential of smart grids, blockchain for energy trading, and digital platforms for community engagement—areas that warrant extensive exploration.

In conclusion, RECs represent not merely a technological shift, but a social innovation in energy production and consumption [21,27]. By enhancing our understanding of participation catalysts, we can unlock the full potential of community-driven energy solutions to address climate change and energy sustainability. The path towards a sustainable energy future involves both empowering communities and individuals and transforming energy infrastructure [16,41]. By leveraging human capital, organizational resources, and social capital [47], RECs can generate a self-reinforcing cycle of empowerment and sustainable development.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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- * of special interest
- ** of outstanding interest

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Further information on references of particular interest

1. This study identifies key factors influencing the acceptance and adoption of renewable energy community solutions, focusing on prosumer psychology. It highlights the importance of environmental attitudes, social norms, and perceived behavioral control.
3. The study analyzes the role of thermal energy communities in Germany's heating transition. It identifies factors such as social cohesion, institutional support, and environmental awareness as crucial for the success of these initiatives.
19. The study examines factors influencing idle resource-sharing behaviors in low-carbon communities. It highlights the importance of social norms, perceived benefits, and trust in the community.
20. Compares residents' motivations for participating in renewable energy communities across different innovation segments. It emphasizes that beyond innovativeness, factors such as economic and environmental benefits are crucial.
30. Explores why bottom-up approaches are more acceptable than top-down in energy communities. It highlights the importance of collective psychological ownership and place-technology fit.