Article | Received 11 December 2024; Accepted 19 March 2025; Published 26 March 2025
https://doi.org/10.55092/rse20250002

En-communiting: framing renewable energy communities as territorial asset for environmental and social well-being

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Highlights:

- Introduces the concept of *en-communiting* to describe the dynamic social process through which communities coalesce around shared energy practices.
- Develops a 7-point analytical framework and applies it to four diverse case studies of renewable energy communities.
- Reveals how renewable energy communities act as territorial assets, enhancing eco-welfare by integrating environmental sustainability with social well-being.

Abstract: Renewable Energy Communities (RECs) are increasingly recognized as key actors in the energy transition, promoting decentralized governance, social inclusion, and environmental sustainability. The article introduces the concept of *en-communiting* to describe the dynamic social process through which communities coalesce around shared energy practices, fostering collective agency, trust, and participatory governance. Grounded in the eco-welfare paradigm, *en-communiting* highlights the role of RECs as territorial assets that integrate renewable energy with social well-being. To systematically assess these dynamics, the article shapes a 7-point analytical framework and applies it in a comparative analysis of four case studies across different socio-economic and geographical contexts. The findings reveal that while RECs hold significant potential for fostering energy democracy and community resilience, their actual impact is shaped by structural barriers, governance models, and community engagement dynamics. The conclusion highlights the discrepancy between the envisioned potential of the *en-communiting* process and its actual capacity to drive transformative change, emphasizing the need for targeted strategies to bridge this gap and strengthen the role of RECs in fostering a just and inclusive energy transition.

Keywords: renewable energy communities; eco-welfare; *en-communiting*; urban energy transition; energy territorial assets

1. Introduction

The energy sector has undergone significant changes due to global trends, that have reshaped it both physically, in terms of infrastructures, and at governance level [1]. As Barnes [2] observes, the first macro trend is Decarbonization, a key pillar of the energy transition promoted by national and global policies. Institutions have responded by implementing renewable energy policies, launching public awareness campaigns, offering economic incentives, and enforcing stricter climate regulations to reduce greenhouse gas emissions and encourage public engagement with sustainable practices. The second major trend is Digitization, driven by the so-called ICT revolution, which began in the 1970s. This technological shift has opened new pathways for citizens to engage with energy systems and markets. Tools such as smart meters, energy demand response systems, and distributed clean energy generation technologies have significantly expanded participation opportunities [3], enabling what Marres [4] calls "material participation" in energy management. These developments allow citizens to directly influence energy management and decision-making through digital platforms and technological mediation. Movements such as *Fridays for Future* and the *Gilets Jaunes* illustrate how digital tools can amplify public engagement in energy and climate debates [3]. The third major trend is Decentralization, which challenges traditional centralized energy systems historically controlled by nation-states. Decentralization has enabled more localized approaches to energy production, consumption, and distribution, fostering the growth of energy cooperatives, municipally owned energy infrastructures, and Renewable Energy Communities (RECs) [5–7]. These large-scale transformations have been further intensified by the energy crisis triggered by the war in Ukraine [8] catalyzing a dual dynamic. On one hand, they have heightened interest and awareness of ecological and climate challenges within scientific communities, prompting a more critical examination of environmental issues [9]. On the other hand, they have increased public pressure for green-oriented policies, spurring research on renewable energy sources and energy transitions [10,11], and driving technological innovations to address these urgent concerns.

These advancements have played a key role in the development of renewable energy sources (solar, thermal, photovoltaic, wind, biomass, geothermal, hydrogen, etc.…) [12] allowing a rethought and potentially a restructuration of the energy system itself. At various level: at the Production level, they enable more decentralized and widespread renewable energy generation; at the Consumption level, improvements in the reliability, durability, safety, and affordability of renewable energy sources accelerate the shift toward full electrification; at the Energy Supply level, the market is diversifying with the entry of exclusively clean energy providers; and at the Storage level, despite the high costs associated with lithium battery development, significant progress is being made [1].

However, as the world transitions from fossil fuels to renewable energy, technological advancements alone cannot address the complexities of this shift. Scholars have increasingly examined its societal implications, including how these shifts influence public engagement and governance. Researches have explored how Energy Democracy fosters inclusive decision-making processes [13,14] and how the concept of Energy Citizenship emphasizes the active role of individuals in shaping energy policies and practices [15,16]. The global urgency to mitigate climate change, combined with the need to address energy poverty and ensure equitable access to resources, has indeed shifted the focus toward participatory and decentralized energy solutions. Renewable Energy Communities (RECs), that are citizen-led, decentralized and organized initiatives managing renewable energy systems, have thus

gained recognition as transformative actors able to link environmental sustainability with social equity, responding to territorial energy needs in a more inclusive and sustainable manner. Although the term REC is relatively new, the underlying principles – collective ownership, decentralized energy production, and community-driven governance – have historical precedents. Examples include Danish wind cooperatives that emerged in the 1970s, the German Bürgerenergiegenossenschaften (citizen energy cooperatives), and the Italian cooperative energy model, which has roots in early 20th-century mutual aid societies and rural electrification cooperatives.

Today, RECs align with the European Union's vision outlined in the *Clean Energy for all Europeans Package* and directives such as RED II (2018/2001) [17] and IEM (2019/944) [18], which promote energy transition as a socially inclusive and territorially rooted process. While no single definition of RECs exists, the European Community describes them as citizen-led collective energy actions that can take various legal forms (e.g., associations, cooperatives, partnerships, non-profit organizations, or small/medium-sized enterprises). RECs may include households, businesses, and local authorities, that equip themselves with the necessary infrastructure to produce, consume, and share renewable energy. Their core objectives include sustainable development, social inclusion, energy poverty reduction and ensuring access to energy for basic needs [19]. To analyze these dynamics, we adopt an *eco-welfare* framework [20–22], a paradigm that bridges environmental sustainability and social well-being, positioning RECs within broader societal goals. From this perspective, RECs become a tool that redefines energy as a common good, a model of citizen-led energy governance that integrates environmental sustainability with social equity and well-being, while fostering resilience, participation, and social cohesion [21,23].

In this context, the concept of *en-communiting* is introduced to describe the dynamic process of community creation around renewable energy production and consumption. This neologism draws from established theories of commons [24], social capital [25], community-building [26] collective agency [27,28], social innovation [29] and energy democracy [30]. It captures how communities come together around energy challenges, emphasizing how localized social cohesion – characterized by trust and reciprocity – and resilience – rooted in territorial embeddedness – emerge within these communities. It also highlights the role of participatory governance in shaping energy transitions.

Unlike traditional analyses of RECs, that primarily focus on technical or economic benefits, *en-communiting* shifts the focus on the social processes that underpin the formation and operation of RECs [31]. Specifically, it explores how shared energy practices contribute to building collective identity, strengthening reciprocal relations and enhancing localized resilience. By doing so, it contributes to the eco-welfare discourse, demonstrating that RECs generate not only environmental and economic benefits but also social well-being and equity. While RECs are formal organizational entities that enable renewable energy production and distribution, *en-communiting* captures the informal social dynamics through which communities are built and sustained around these activities. It examines how collective agency and social cohesion are cultivated through shared energy practices, offering a deeper understanding of community dynamics within RECs.

The article addresses three key research questions: 1) How do RECs, through the process of *en-communiting*, act as territorial assets in addressing socio-environmental challenges? 2) What social mechanisms within the *en-communiting* process enhance community participation and governance in

energy transitions? 3) How does the process of *en-communiting* within RECs contribute to the broader framework of eco-welfare?

The paper is structured as follows: section 2 presents the theoretical framework proposing the eco-welfare paradigm and the novel concept of *en-communiting*; section 3 discusses the methodological approach; section 4 presents the four selected case studies and applies a seven-point framework of analysis; section 5 discusses the cases in the framework of the research questions.

2. Theoretical framework

2.1. Eco-Welfare: integrating sustainability and social well-being

The attention of scholars towards the connections between environmental concerns and the sustainability of welfare systems has increased as the climate crisis has gotten worse [20–22]. According to them there are interdependencies between the environmental crisis and the fiscal crisis of the state that make them inseparable crises exacerbating one another's instability and complexity; their interconnection lies in a vicious cycle: environmental degradation undermines the economic foundations of the welfare state, while a weakened welfare state amplifies social inequalities that, in turn, accelerate ecological harm. Addressing these crises requires moving beyond growth-dependent models and exploring Eco-welfare solutions that balance ecological and social imperatives [32]. It is a modality that challenges the paradigm to which we are accustomed, that is, that of continuous economic growth; in fact, in Western countries the dominant welfare model is closely linked to economic growth, even if capitalism has led to an unsustainable consumption of environmental resources [33]. Adopting the eco-welfare perspective means combining respect for environmental limits with the development of social rights, means designing environmental measures that do not unfairly affect the most vulnerable groups in society, or social protection measures that do not take into account environmental deterioration [34,35]. Decarbonization in this sense, assumes a social dimension because reducing carbon emissions through renewable energy sources lowers health costs, creates new jobs in areas like photovoltaic panel installation and energy network management, and decreases dependence on fossil fuels [36]. These shifts also contribute to reducing social and economic inequalities by ensuring the fair distribution of green technology benefits. To achieve these outcomes eco-social policies – that integrate environmental and social objectives – are necessary [20,21], such as energy justice policies that ensure fair access to clean energy and targeted incentives for adopting renewable energy technologies (i.e. subsidies for installing renewable energy systems in low-income households, or social housing to alleviate energy poverty and promote equitable access to clean energy solutions). Nonetheless, these actions ought to prioritize pre-distribution strategies above traditional redistribution policies [20,21,37]. While redistribution seeks to correct disparities retrospectively dealing with them only after they occur, pre-distribution tackles inequalities at their source by influencing the processes of wealth creation and resource access. This can be achieved through measures such as: establishing adequate minimum wages and fair labor contracts, ensuring equitable access to essential resources like education, healthcare, and vocational training, implementing progressive fiscal policies that reduce inequalities through fair taxation of wealth, investing in sustainable public infrastructure (including public transport, social housing, and renewable energy systems as essential public services). Such pre-distribution approaches not only lower living costs but also enhance overall quality of life, creating a more equitable and sustainable society. In particular,

the pre-distribution policies promote the decoupling of economic growth and the provision of well-being, thus ensuring that people's well-being does not depend solely on GDP growth. Indeed, through pre-distributive investments, it is possible to create a more equitable and sustainable society where well-being is guaranteed by equal access to resources and opportunities, independently of economic growth dynamics [38].

In the context of energy systems, this approach facilitates the transition from centralized, fossil-fuel-based infrastructures to decentralized renewable networks managed collectively, allowing to achieve 1) environmental sustainability, reducing greenhouse gas emissions through renewable energy use; 2) social inclusivity, ensuring equitable access to clean energy, particularly for vulnerable populations; 3) economic resilience, strengthening local economies through the creation of green jobs and energy cost savings. In this sense the Walker & Devine-Wright [39] concept of "place-based energy systems," resonates with eco-welfare principles by emphasizing the integration of local social and ecological contexts into energy governance. This localized approach is crucial for addressing territorial disparities, particularly in regions facing socio-economic marginalization.

2.2. En-communiting: creating community around energy issue as territorial assets

A particularly relevant field of application of eco-welfare policies lies in addressing energy poverty, a domain that highlights the interdependences between social and environmental sustainability and provide a unique opportunity for preventive and pre-distributive measures to reduce inequalities while fostering equitable access to renewable energy resources. Within this context, and from an energy justice perspective [40,41] community-based energy initiatives emerge as a potentially powerful tool. Energy, in this perspective, is not merely viewed as an economic or ecological asset but, more crucially, as a social relation, framed as a common good rather than as a private commodity [23]. This approach extends beyond linking energy production with consumption and beyond reaffirming the responsibility of energy consumers; it questions the opportunity of active citizenship and participatory democracy offered by RECs [42]. At the same time, communities with their intrinsic qualities, such as a shared sense of identity, shared places, values, visions, and interests, solidarity, and the capacity for collective action and resilience, are ideal settings for exploring alternative approaches to energy production, distribution, and consumption, both technologically and in terms of organizational structures and daily practices [43]. Since the early 2000s, communities have increasingly been recognized as the most suitable arenas for addressing climate change, advancing sustainability, and fostering renewable energy development [44,45]. Combining energy – envisioned as a space for active citizenship and collaborative democracy – with community – understood as a platform for collective climate action – creates a democratic space for fostering an energy culture, as Pellizzoni [43] notes. The Energy of Communities is exactly the transformative potential of collective action in the energy sector; community energy initiatives enable communities to assume significant ownership or control over energy system, generating substantial benefits not only for direct participants but also for the broader community [43]. These benefits include the promotion of renewable energy development, reductions in energy consumption, and broader socio-environmental impacts such as enhanced social cohesion, empowerment, local economic development, and social innovation. As highlighted by a substantial body of literature [39,46–49], these efforts reflect the broader capacity of community energy projects to reshape not only energy systems but also the social fabric of the communities involved. In this sense, RECs become spaces where citizens can become active

agents of the energy transition [23]. By leveraging local resources, networks, and knowledge, RECs act as territorial assets that generate socio-environmental benefits [7,19]. This conceptualization aligns with Lefebvre's [50] notion of the Right to the City, which advocates for the democratization of urban spaces and the collective reappropriation of resources. Harvey [51] expands this idea by framing territorial assets as counterpoints to the privatization and commodification of common goods. The territorial nature of RECs ensures that solutions are tailored to specific cultural, economic, and ecological realities [52]. By embedding renewable energy systems within local contexts, RECs act as vital responses to the socio-ecological pressures of urbanization and globalization, contributing to regional sustainability while fostering social and environmental resilience.

Within this framework, the *en-communiting* neologism is deliberately constructed and here introduced to describe the dynamic and ongoing process of building community ('communiting' as a verb) around shared energy practices and systems. The prefix 'en-' denotes enabling or fostering, highlighting the proactive and participatory nature of this process [31].

While novel, it draws on established theories of commons [53], social capital [25], community-building [26] collective agency [27,28], social innovation [29] and energy democracy [24], capturing how communities come together around energy challenges. Inspired by Ostrom's work on the commons [53], *en-communiting* reflects how community energy initiatives can function as locally governed common-pool resources, emphasizing shared ownership, democratic decision-making, and equitable benefit distribution. This perspective aligns with participatory governance frameworks, such as Fung and Wright's [30] concept of Empowered Participatory Governance, which highlights citizen-driven decision-making and collective problem-solving in local contexts. The concept also extends the RECs discourse by focusing on micro-level social interactions that drive collective energy governance, offering a sociological perspective that positions RECs as social innovations fostering eco-welfare through the integration of environmental sustainability with social cohesion and equity [54]. This interpretation resonates with Moulaert et al.'s understanding of grassroots social innovation [29], wherein community-led initiatives address exclusion while generating new forms of solidarity and governance. Informed by Putnam's notion of social capital [25], *en-communiting* emphasizes the trust, reciprocity, and networks that facilitate collective action within RECs. It also draws from community-building frameworks [26], which highlight the importance of shared experiences and common goals in fostering resilient social ties. Similarly, the concept of collective agency [27,28] underlines how communities mobilize resources and knowledge to co-create energy solutions, ensuring that decision-making processes are inclusive and participatory.

Unlike related concepts such as 'energy citizenship', which emphasize civic participation and political agency in energy transitions, *en-communiting* highlights the relational and social dynamics within RECs. It illustrates how collective identity and localized social capital are cultivated through shared energy practices, thus enriching the understanding of community governance in energy transitions. This perspective aligns with the energy democracy framework proposed by Burke and Stephens [24] which advocate for democratic control over energy systems through local, community-led initiatives. For example, in RECs, members often participate in regular meetings, share knowledge on energy-saving practices, and collectively make decisions about energy production and distribution. This active involvement not only ensures more democratic governance but also strengthens social bonds, trust, and a shared sense of purpose within the community. Thus *en-communiting* emphasizes these

everyday interactions and collaborative efforts, showing that the strength of RECs lies in their capacity to build resilient, engaged communities through shared energy initiatives.

In this perspective, RECs are more than functional entities, are social hubs able to enhance local agency and territorial resilience, while providing socio-environmental benefits, such as lowering pollutant emissions, improving air quality, encouraging sustainable lifestyles, educating communities about the role of renewable energy in addressing climate change, and reducing energy poverty through affordable access to renewable energy. Additionally, these programs boost participatory governance, promote innovation and the creation of local jobs, increase knowledge of energy inequities, and build technical and managerial skills [48,55,56]. Key components of *en-communiting* process include:

I) *Collective Agency*, i.e. the ability of communities to make decisions about energy production, distribution, and consumption.
II) *Trust and Reciprocity*, since relationships are formed through participatory governance models, which foster social cohesion [25].
III) *Territorial Embeddedness*, that indicates the alignment of energy initiatives with local cultural, social, and ecological dynamics [51].

While these three components capture the core of the *en-communiting* process, for a more structured assessment, the study develops a 7-point analytical framework (see section 3), which expands on these principles by integrating additional dimensions relevant to the governance, technological, and socio-environmental impact of RECs.

Beyond these core components, the success of RECs depends on a broader set of enabling conditions that facilitate long-term community engagement and project sustainability. *en-communiting* underscores the importance of *community buy-in* for RECs success highlighting the need for active local community support and engagement as noted by Walker & Devine-Wright [39]. Without a strong sense of ownership, localized energy projects are less likely to achieve their sustainability and inclusivity goals. As highlighted by Zaccaria [44], strategies to strengthen engagement include awareness-raising campaigns, educational initiatives, and participatory governance mechanisms that foster institutional credibility and trust, a key resource that simplifies decision-making in periods of uncertainty [57,58]. Economic incentives, like subsidies for renewable energy installations, active participation in assemblies and forums, and strong institutional and political support, also play a critical role. These elements, as reported by Seyfang *et al.* [48], intertwine with individual goals (such as cost savings and job opportunities), communitarian objectives (such as energy independence, social cohesion, and public health improvements) and ecological goals (such as emissions reductions and environmental education) as main motivations behind community energy projects. Other studies agree with these findings emphasizing the interplay of personal interests, community values, and ecological concerns [59,60], or discussing the differences between *pull factors* (goals) and *push factors* (enablers) in driving community energy initiatives, such as a sense of community, trust, social norms, cultural variables [49] and aspirations and collective ownership [56].

In this light, RECs embody a model of collective sustainability by fostering shared ownership and participatory governance, challenging traditional paradigms of energy production and consumption, and creating pathways for equitable and inclusive transitions that address both environmental and social challenges.

3. Methods

The research adopts a qualitative approach, based on desk analysis and multi-source documentary investigation, including grey literature review and institutional document analysis. To illustrate the *en-communiting* process in action, a selection of RECs experiences is presented. These examples demonstrate how collective agency, trust and reciprocity, and territorial embeddedness operate in practice, highlighting the integration of environmental sustainability with social well-being. Given the heterogeneity of energy community experiences across different regions, the selected cases are not intended to represent broader national or regional contexts; they just offer localized insights, shedding light on how RECs can develop in specific urban environments shaped by contextual socio-economic conditions, governance structures, and community needs. To capture this diversity, four privileged – although not exhaustive – cases were purposively selected following the principles of maximum variation sampling, ensuring a range of urban settings and community-led energy transition strategies [61]. The case selection was guided by a theoretically informed sampling approach, designed to maximize insights into the *en-communiting* process across distinct geographical and socio-economic contexts. The Bassett-Avocado Heights Advanced Energy Community in Los Angeles was chosen for its innovative approach to energy independence in economically disadvantaged neighbourhoods. The Seongdaegol Energy-Independent Village in Seoul, South Korea, was selected for its emphasis on community empowerment and localized resilience. The Banister House Solar Project in London, United Kingdom, was selected for its status as the country's largest community energy initiative within social housing, demonstrating how renewable energy can promote social inclusion and economic empowerment. The San Giovanni a Teduccio Solidarity and Renewable Energy Community in Naples, Italy, was chosen for its solidarity-driven approach, addressing energy poverty and social marginalization in an economically disadvantaged urban context.

To operationalize the *en-communiting* process and assess the role of RECs as territorial assets, the study develops a 7-point analytical framework. This framework, conceptualized by the author based on an extensive literature review and insights from community energy projects, provides a multidimensional lens to explore how RECs foster collective agency, social cohesion, and eco-welfare.

I) *Collective Agency*: refers to the ability of community members to actively participate in decision-making processes related to energy production, distribution, and consumption, fostering democratic governance. It also encompasses shared ownership structures, reflecting the degree of community control over energy assets and benefits. High levels of collective agency are characterized by the presence of cooperative governance models, participatory decision-making platforms, and mechanisms that ensure inclusive representation within the RECs.

II) *Trust and Reciprocity*, highlights the strength of social bonds, mutual accountability, and collaborative engagement among community members. Trust-building is facilitated through transparent communication, inclusive governance practices, and community-driven initiatives. Educational programs further reinforce reciprocal relationships by equipping members with the skills needed to actively participate in energy governance while promoting collective identity and solidarity.

III) *Territorial Embeddedness*, captures the alignment of energy community initiatives with the specific social, cultural, and ecological characteristics of their local context, ensuring tailored

solutions. Strong territorial embeddedness emerges when energy initiatives address community-specific challenges (such as energy poverty or unemployment) while promoting resilience and social inclusion through tailored solutions and partnerships with local organizations.

IV) *Technological Innovation*: refers to the adoption of renewable energy technologies, smart systems, and digital platforms that enhance energy efficiency, resilience, and decentralized management. High levels of technological innovation go beyond implementation, prioritizing user-friendly solutions and equitable access to technological advancements within the community.

V) *Social Impact*: encompasses the broader societal benefits generated by the REC, including energy cost savings, job creation, capacity-building, and strengthened social networks. High-impact initiatives typically address multiple community needs, such as reducing energy poverty while promoting civic engagement, environmental awareness, and local economic empowerment.

VI) *Governance Model:* assesses the structure and processes of decision-making within the energy community, highlighting whether the approach is grassroots, top-down, or hybrid, and its implications for inclusivity. High levels of participatory governance are characterized by transparent decision-making, equitable representation, and mechanisms that allow all members to influence project development and benefit distribution.

VII) *Eco-Welfare Potential*: reflects the capacity of RECs to integrate environmental sustainability with social equity, demonstrating their holistic contribution to societal resilience. High eco-welfare potential is demonstrated by projects that not only reduce carbon emissions but also foster community resilience, promote social inclusion, and address structural inequalities through sustainable energy solutions.

These categories provide a multidimensional lens through which to explore the role of RECs as territorial assets, the mechanisms driving "*en-communiting*," and their contributions to eco-welfare in the four different territorial contexts.

4. Renewable Energy Communities key example around the world

The four case studies are presented with brief reference to their specific territorial contexts. However, they should not be viewed as fully representative of their broader geographical contexts, as the diversity of socio-political, economic, and cultural conditions within each region prevents any single initiative from serving as a universal model. Rather, the case studies are analyzed as illustrative examples, offering valuable insights into how RECs can develop in diverse socio-political and economic settings, shaped by local opportunities, challenges, and governance ecosystems.

4.1. The Bassett-Avocado Heights project (Los Angeles, California, US)

The Bassett-Avocado Heights Advanced Energy Community (BAAEC) is located in Los Angeles, California, serving approximately 28,000 residents in an economically disadvantaged urban area. Funded by the California Energy Commission, this project represents a localized example of community solar innovation designed to foster energy independence while enhancing social cohesion and environmental sustainability [62]. Unlike other US-based renewable energy communities, it adopts a holistic energy ecosystem approach that redefines traditional relationships between infrastructure, technology, and community engagement.

This case is situated within the broader context of the American energy transition, which is characterized by a fragmented regulatory landscape and diverse community energy models across states. In the US, energy policy is primarily determined at the state level, leading to significant regional differences in renewable energy adoption and community energy initiatives. While states like California, New York, and Massachusetts have supportive policies that encourage community solar projects and decentralized energy systems, other states face regulatory and financial barriers that hinder community-based renewable energy initiatives [63,64]. California, in particular, is a pioneer in clean energy policies and community energy models, committed to achieving 100% clean electricity by 2045. It has implemented ambitious policies, such as the "California Community Solar Program", which promotes equitable access to renewable energy for low-income communities. These regulatory frameworks provide a conducive environment for initiatives like BAAEC, enabling innovative models of energy production and distribution that align with local social and environmental needs [65]. However, despite these favourable conditions, challenges remain, including high costs of solar installations, community resistance to new infrastructure, and disparities in energy access across socio-economic groups. BAAEC addresses these challenges by integrating community engagement strategies that prioritize social equity, building localized energy resilience in a region historically affected by environmental injustices and economic disparities. Nevertheless, it is important to emphasize that this case study is not intended to generalize about community energy practices across the entire US, given the diversity of regulatory frameworks, socio-economic contexts, and community dynamics across the country. Instead, it provides localized insights into how *en-communiting* operates within a specific urban setting, contributing to a more articulated understanding of community energy transitions.

One of its distinctive features is its robust community engagement strategy, which illustrates the *en-communiting* process through the fostering of collective agency. Community members are engaged as "prosumers", actively participating in both energy production and consumption while influencing decision-making processes through a Community Advisory Board. This governance structure embodies participatory governance, empowering local stakeholders to shape the project's design and implementation. This reflects the theoretical argument that *en-communiting* enhances collective agency by transforming energy users into active participants, fostering democratic governance and localized resilience [50,51]. Educational initiatives, such as the "Youth Advocacy Program" and the "Energy Leadership Academy", play a key role in building collective identity and social cohesion. By involving residents in energy education and leadership development, these programs cultivate a sense of ownership and shared purpose, reinforcing reciprocal relationships within the community [62]. This resonates with the *en-communiting* emphasis on trust and reciprocity as foundations for social cohesion and participatory governance.

From the technological side, BAAEC employs a multi-layered technological approach that integrates smart solar systems with advanced storage capabilities, creating a decentralized energy network supported by a virtual power plant managed through blockchain technology. This digital infrastructure not only enhances energy resilience by ensuring renewable energy availability during peak loads but also democratizes energy management by enabling real-time monitoring of decarbonization rates and facilitates the emergence of "prosumers" who actively participate in energy production and consumption, embodying the material participation theorized by Marres [4]. However, technological advancement alone does not explain the project's success. BAAEC strategically aligns its renewable

energy solutions with the socio-economic and environmental needs of its local context, demonstrating strong territorial embeddedness. The project specifically addresses challenges faced by a marginalized urban community, including high energy costs and pollution levels, thus tailoring solutions to the community's socio-economic realities. This reflects the theoretical framework of eco-welfare, where technological innovations are deeply rooted in local contexts to enhance both environmental sustainability and social well-being [19,20]. The integration of social and environmental goals within BAAEC illustrates the potential of purpose, reinforcing reciprocal relationships within the community [62]. This resonates with the *en-communiting* to generate eco-welfare outcomes. In addition, the project reduces transportation-related emissions thanks to an electric vehicle vanpool network and provides significant energy cost savings through its shared solar model, democratizing access to renewable energy for low-income residents. Finally, by empowering community members through education and leadership programs, it contributes to local capacity building and social mobility, addressing systemic socio-economic inequalities.

4.2. The Seoul Energy-Independent Villages (Seoul, South Korea)

South Korea represents a unique model within East Asia, as its approach to renewable energy transitions is characterized by strong governmental support, a focus on technological advancements, and an emphasis on citizen participation. The country aims to generate 20% of its electricity from renewables by 2030 and has implemented progressive energy policies that promote local energy autonomy through financial incentives, public-private partnerships, and grassroots engagement initiatives [66]. In particular, the city of Seoul has emerged as a leader in integrating social equity with climate action; a key example is the Energy Welfare Public-Private Partnership (PPP) program which won the C40 Cities Climate Leadership Award in 2016 for its efforts in reducing greenhouse gas emissions while tackling energy poverty. As part of this initiative, the city installed 1,600 micro-photovoltaic systems in low-income neighborhoods, demonstrating how social equity and sustainability can be interwoven in energy governance [67]. One of the most successful extensions of Seoul's energy strategy is the development of Energy-Independent Villages (EIVs), self-organized neighborhoods that strive for energy self-sufficiency through a combination of solar power, energy efficiency programs, and collective governance mechanisms. These villages exemplify the *en-communiting* process, as they foster collective agency, trust-based social cohesion, and participatory governance, transforming residents from passive consumers into active energy managers. Among the most recognized EIVs is the Seongdaegol Energy Village, located in the Dongjak district [66,68]. Established in 2016, it emerged from a grassroots effort to increase local energy autonomy while reducing overall consumption. Residents implemented a variety of bottom-up initiatives, including: installing solar panels on homes and public buildings; adopting pellet stoves and solar-powered air heaters to enhance heating efficiency; engaging in urban farming as a carbon-offsetting strategy; conducting community-led energy audits to support low-income and elderly residents in reducing energy waste; reinvesting revenues from energy-efficient product sales into local community services, creating a self-sustaining energy ecosystem [69].

This experience underscores the role of social interaction in energy transitions, as energy production and savings are publicly monitored through a public collective energy graph, where households can compare their energy performance. This transparency fosters a culture of accountability and mutual encouragement, reinforcing a sense of community belonging through social norms and peer pressure.

Additionally, the EIVs host socialization workshops, clean energy events, and public education programs [66], further strengthening the civic engagement and participatory governance dimensions of the *en-communiting* process. By combining technological solutions with strong local governance mechanisms, Seoul's EIVs exemplify how decentralized energy transitions can be socially embedded and community-driven, aligning with the principles of eco-welfare and localized resilience.

This case in Seoul provides a valuable example of community-driven energy governance, and its success is shaped by the South Korea's specific policy framework, strong institutional support, and high levels of civic engagement; this model cannot be generalized to the broader Asian context which is diverse and with significant territorial differences. For instance, while East Asian countries like China, Japan, and South Korea lead in technological innovation and large-scale renewable energy integration [70,71], Southeast Asia faces regulatory and infrastructural challenges, and South Asia prioritizes rural electrification and energy access as part of broader social development strategies. The region as a whole is experiencing a shift towards decentralized energy models, driven by national policies, international investments, and local initiatives that combine technological solutions with community-based governance [72].

4.3. The Banister Solar House project (London, UK)

The Banister House Solar Project (BHSP), located in Hackney, London, stands as the UK's largest community energy initiative on social housing and exemplifies how collective agency, trust-building, and participatory governance can emerge through community-led renewable energy initiatives. The project, launched in 2014, was initiated through the collaboration of three key organizations:

- *Repowering London*, a social enterprise dedicated to advancing community energy projects, provided technical expertise and project management.
- *Hackney Energy*, a local advocacy group, mobilized residents and facilitated community engagement.
- *Hackney Council*, the local government authority, provided financial support and access to housing infrastructure.

Community involvement was embedded in every stage of the project's development. A crowdfunding campaign launched by Repowering London enabled residents to invest in the project, fostering a sense of collective ownership and financial participation. At the same time, a partnership with Hackney Council ensured the project was aligned with local social needs, particularly regarding affordable energy access for low-income households. A critical aspect of the project was its community capacity-building strategy, which included [73]:

- 91 community meetings at Banister House Community Hall, where residents co-designed the energy initiative.
- Leadership roles for five local residents, with seven additional community members directly involved in development.
- Investment from 22 estate residents, reinforcing trust, accountability, and a shared commitment to energy self-sufficiency.
- Educational programs, including two workshops on photovoltaic panel construction, 106 energy surveys, 15 home energy audits, and three energy efficiency sessions [23].

This extensive engagement process illustrates the *en-communiting* process in action, as it fostered a community-led governance structure that was not only focused on energy generation but also on social cohesion, reciprocal relationships, and long-term resilience [7,23].

From a technological point of view, the BHSP introduced 102 kWp solar array, able of generating up to 82,000 kWh of clean energy annually. Over its projected lifetime, it is estimated to prevent 679 tons of CO_2 emissions, making a significant contribution to London's decarbonization strategy. Beyond its environmental benefits, the project also showcased innovative financial mechanisms that reinforced community resilience: through a community share offer, the initiative raised £142,500, providing an average annual return of 4% to investors. The partnership with Hackney Council also ensured that energy cost savings were reinvested into community initiatives, creating a circular model of local sustainability. Unlike traditional top-down renewable energy projects, the BHSP model illustrates how decentralized energy governance can be rooted in community-driven processes, strengthening both ecological and social resilience in urban settings [73].

In general, UK has been at the forefront of community-led energy transitions. Unlike Denmark's cooperative-led model or Germany's municipally supported RECs, UK community energy projects often emerge as bottom-up initiatives supported by social enterprises, intermediary organizations and municipal collaborations [74]. Cities like London, Bristol, and Manchester have actively promoted decentralized energy projects, particularly in low-income communities, where energy justice and public participation are central concerns [75]. Today UK community energy initiatives face growing challenges due to policy shifts, reduced subsidies, and financing barriers. The withdrawal of Feed-in Tariffs (FiTs) in 2019 and the uncertainty surrounding future government support have made it difficult for new projects to scale. Nonetheless, organizations like Repowering London and Community Energy England continue to drive the sector forward by promoting collaborative governance models and citizen-led investment schemes [76]

4.4. The San Giovanni a Teduccio iniziative (Naples, Italy)

The San Giovanni a Teduccio Solidarity and Renewable Energy Community is an Italian experience launched in March 2021 in one of Naples most economically challenged districts. In general, the Italian context is experiencing a slow but growing transition toward decentralized renewable energy systems with RECs emerging as a key policy tool for local energy production and consumption. Unlike in Germany or Denmark, where community energy projects have benefited from long-standing cooperative models and strong state support [75], Italy's REC sector has developed more gradually, constrained by regulatory delays and complex bureaucratic processes. Historically, Italy's energy landscape has been dominated by centralized production and large-scale utilities, leaving limited space for local participatory models. However, recent policy changes, such as the 2024 decree on shared energy incentives [77], have developed more favourable conditions for community-driven initiatives. The Italian REC movement has gained momentum through grassroots initiatives, often spearheaded by civil society organizations and environmental advocacy groups rather than municipalities or large cooperatives [78].

The case in Naples became notorious for explicitly integrating social empowerment into its mission, unlike traditional energy cooperatives that focus primarily on economic returns. It has been built by a strategic collaboration between the Famiglia di Maria Foundation (FMF), a community-focused

organization deeply rooted in the neighbourhood; Legambiente Campania (LC), a prominent regional environmental association; and Fondazione con il Sud (FcS), which provided critical financial support.

In technological terms, central to the project is a photovoltaic (PV) system with a capacity of 55 kWp and 10 kWh battery storage. Installed on the roof of the Famiglia di Maria Foundation building by the local PV company 3E, this system provides "shared energy", benefiting from official incentivization. The Solidarity REC is designed to significantly reduce electricity bills, with annual savings projected at 40%–50%, amounting to approximately 300,000 euros over the system's 25-year warranty period. Currently, it comprises 18 households, with plans to expand to 40 members, focusing on families, predominantly women and mothers, who face complex social and economic challenges.

Nevertheless, the distinctive feature is the social oriented nature. By addressing issues such as energy poverty, unemployment, and social marginalization, it promotes civic engagement, energy legality, and community resilience, stressing – also in its narration – the "solidarity" dimension. Its emphasis on trust-building and strong relational networks has been instrumental in its success, supported by strategic partnerships and a comprehensive approach to social innovation. The Famiglia di Maria Foundation has also introduced targeted educational programs to complement the Solidarity REC's technological advancements. These include environmental awareness training, workshops on energy-saving behaviors, and initiatives that engage families and children in sustainable practices, fostering a culture of environmental responsibility. Despite encountering bureaucratic and technical challenges, the project has gained significant visibility and recognition as a model for sustainable energy interventions and has inspired similar initiatives in other urban areas, demonstrating its adaptability and scalability. By integrating technological solutions with social objectives, the initiative highlights innovative approaches to urban energy transitions and community-driven sustainable development. It transcends its immediate context, offering valuable insights into grassroots sustainability strategies and urban regeneration and it exemplifies how targeted, community-centered interventions can simultaneously address environmental sustainability, economic inequality, and social empowerment, serving as a replicable blueprint for other urban communities facing similar challenges.

While the San Giovanni a Teduccio REC has gained recognition as a replicable model for urban energy communities, it also highlights key challenges that community-driven projects face in Italy. Bureaucratic obstacles, regulatory delays, and complex administrative processes continue to slow the expansion of similar initiatives nationwide. In fact, in Italy, as well as in Spain, even though RECs have started to emerge, their number is still small.

4.5. Analysis

By applying the 7-point framework to the selected case, as detailed in the methodological section, we gain a multidimensional perspective that allows to explore the role of RECs as territorial assets, understand the mechanisms driving *en-communiting* process, and evaluate their contributions to eco-welfare. The following Tables 1–4 provide a detailed breakdown of each case study, analyzing how each RECs performs across the seven dimensions.

Table 1. Bassett-Avocado Heights Advanced Energy Community (Los Angeles, USA).

7 dimensions	Description
Collective agency	Community members are engaged as "prosumers," producing and consuming energy while actively participating in decision-making processes through a community advisory board.
Trust and reciprocity	Trust was built through comprehensive education campaigns, such as the Youth Advocacy Program and Energy Leadership Academy, initiatives that created a shared understanding of the project's goals, fostering reciprocal relationships among participants.
Territorial embeddedness	The project was designed to address the specific challenges of a disadvantaged urban area, integrating renewable energy solutions that aligned with the local community's socio-economic and environmental needs.
Technological innovation	Advanced technologies, including a blockchain-managed virtual power plant, solar energy systems, and IoT-enabled environmental monitoring, enabled decentralized energy management and enhanced community resilience.
Social impact	The initiative reduced transportation-related emissions through electric vehicle infrastructure, lowered energy costs, and provided educational opportunities, creating a multi-faceted social impact.
Governance model	A hybrid governance model combines institutional funding and expertise with grassroots participation, ensuring that technological innovations meet community needs.
Eco-welfare potential	Reduction of inequalities, fostering of environmental resilience, and creation of pathways for social inclusion through renewable energy solutions.

Table 2. Seongdaegol Energy Village (Seoul, South Korea).

7 dimensions	Description
Collective agency	Residents initiated and led the transition to energy independence, demonstrating strong collective agency through grassroots-driven actions, including the adoption of solar energy and urban farming practices.
Trust and reciprocity	Social cohesion was reinforced through transparent sharing of energy consumption data, creating a sense of mutual accountability and motivating collective efforts to save energy.
Territorial embeddedness	The initiative was deeply embedded in the local cultural and ecological context, addressing both environmental and social needs through community-specific solutions like carbon reduction measures and localized farming.
Technological innovation	Solar panels and energy-efficient technologies were central to the project. While less advanced than in other cases, the technological choices were accessible and well-suited to the community's resources.
Social impact	The project reduced energy waste, generated economic savings reinvested in social services, and provided educational programs, fostering a sense of community empowerment.
Governance model	Governance was entirely grassroots, relying on bottom-up decision-making processes and strong community involvement to drive the initiative. But the Public Administration act as enabler, creating the right ecosystem that made the project possible.
Eco-welfare potential	The initiative integrated environmental sustainability with social equity, reducing energy costs and fostering social cohesion, aligning with eco-welfare principles.

Table 3. Banister House Solar Project (London, UK).

7 dimensions	Description
Collective agency	The project empowered residents in a social housing estate to actively participate in the creation of a cooperative energy initiative; through regular community meetings they created a sense of ownership and collective decision-making, allowing residents to take an active role in managing renewable energy systems.
Trust and reciprocity	Pre-existing social bonds within the community were strengthened through the project's collaborative governance model, the transparent management of resources, and the sharing of benefits (such as reduced energy costs and investment returns) all of which enhanced reciprocal relationships among participants.
Territorial embeddedness	As an initiative rooted in an urban social housing context, the project addressed local socio-economic challenges, such as energy poverty, and tailored renewable energy solutions to the specific needs of low-income residents.
Technological innovation	The project incorporated photovoltaic (PV) systems with a capacity of 102 kWp, a modest but impactful technological solution for reducing greenhouse gas emissions and enabling local energy generation.
Social impact	Significant reductions in energy costs and the reinvestment of savings into the community were key outcomes. The project also provided training and employment opportunities for youth, enhancing social mobility and local empowerment.
Governance model	A cooperative governance model ensured inclusive decision-making processes, with support from local authorities and environmental organizations. The model reinforced the democratic management of energy resources.
Eco-welfare potential	By addressing energy poverty and promoting social equity, the project aligned with eco-welfare principles, demonstrating how renewable energy initiatives can simultaneously foster environmental sustainability and social well-being.

Table 4. San Giovanni a Teduccio Renewable Energy Community (Naples, Italy).

7 dimensions	Description
Collective agency	Led by local women and mothers, the community demonstrated moderate levels of collective agency by participating in energy production and decision-making, with plans for expansion to include more households.
Trust and reciprocity	Trust was a foundational element, built on pre-existing relational networks within the marginalized community; educational initiatives further reinforced trust and encouraged participation.
Territorial embeddedness	The project directly addressed the challenges of an economically disadvantaged urban area in Naples, tailoring renewable energy solutions to meet the community's specific needs and promoting social inclusion.
Technological innovation	The installation of a 55 kWp PV system with 10 kWh battery storage represented a practical and effective technological solution for reducing energy costs and emissions.
Social impact	The initiative contributed to the local energy poverty reduction and fostered community resilience by addressing unemployment and promoting energy legality; educational programs further enhanced the community's capacity to engage with renewable energy.
Governance model	Based on a partnership-driven approach, fostering collaboration between local organizations and the community, while integrating top-down support with grassroots initiatives.
Eco-welfare potential	The project is a model for addressing energy poverty while fostering social cohesion, contributing to eco-welfare by integrating sustainability and equity.

5. Discussion

Through a cross-case comparative discussion, analysing how each REC performs across the seven framework dimensions it is possible to highlight recurring patterns, contextual differences, and critical enablers of the *en-communiting* process. Each dimension is rated as Moderate, High, or Very High, where I) Moderate indicates that the dimension is present but limited, with partial community engagement, external facilitation, and localized benefits; II) High indicates that the dimension is well-established, with significant community involvement, shared decision-making, and clear social or environmental impact; III) Very High indicates that the dimension is fully integrated, community-led, with strong grassroots leadership, widespread participation, and transformative social and environmental benefits.

Considering the four cases, *Collective Agency* emerges as a defining factor even with differences across the contexts, depending on the degree of community involvement in decision-making and energy governance. It emerged that higher collective agency correlates with stronger social resilience and long-term project sustainability, particularly when community-driven governance replaces top-down facilitation.

- Very High: Banister House and Seongdaegol stand out for their bottom-up approaches, where community members initiated, managed, and governed the projects.
- High: Bassett-Avocado Heights despite showing a quite strong collective agency through its Community Advisory Board, is an initiative institutionally driven.
- Moderate: San Giovanni a Teduccio engaged local women and families in decision-making but remained partially institutionally facilitated.

Trust and Reciprocity was crucial across all cases, enabled by transparent governance, educational programs and community-driven initiatives.

- Very High: Banister House and Seongdaegol fostered trust through participatory processes, clear benefit-sharing and transparent resource management.
- Moderate to High: Bassett-Avocado Heights built trust through youth programs and leadership training facilitated by institutions, while San Giovanni a Teduccio relied on pre-existing networks within the marginalized community and targeted educational efforts.

Territorial Embeddedness varied across the cases showing that projects with stronger territorial embeddedness not only address energy needs but are also better able to promote social inclusion and economic resilience, demonstrating the importance of aligning energy transitions with local socio-cultural dynamics

- Very High: Seongdaegol demonstrates deep territorial embeddedness, integrating solar energy, urban farming, and carbon reduction strategies tailored to local socio-environmental conditions.
- High: Bassett-Avocado Heights and San Giovanni a Teduccio show strong contextual alignment, addressing urban socio-economic challenges such as energy poverty, unemployment, and social exclusion.
- Moderate: Banister House tailored its approach to social housing but did not fully integrate broader community development goals.

Technological Innovation varied significantly across the cases, reflecting different priorities and resources, ranging from advanced smart systems to more accessible, community-oriented technologies. It emerged that technological sophistication was less important than community accessibility and usability.

- Very High: Bassett-Avocado Heights leveraged advanced technological approach, integrating a blockchain-managed virtual power plant, smart solar systems, electric vehicles and IoT-enabled monitoring.
- Moderate: both Banister House, Seongdaegol and San Giovanni a Teduccio employed accessible solar technologies suited to community needs but without advanced digital systems.

Social Impact emerged as a core benefit across all cases, ranging from High to Very High, with all the initiatives contributing to energy cost savings, educational opportunities and community resilience. Thus means that initiatives that paired energy projects with social programs have the highest levels of impact.

- Very High: Banister House and Bassett-Avocado Heights achieved significant social impact by reducing energy costs, offering youth internships, and reinvesting savings into community services.
- High: Seongdaegol and San Giovanni a Teduccio promoted energy equity, resilience, and social inclusion.

Governance Model differed across contexts, ranging from grassroots approaches to hybrid and partnership-driven structures. From the analysis it emerged that community-led governance is most effective in fostering long-term sustainability and collective ownership.

- Grassroots (Very High): Seongdaegol and Banister House adopted fully community-led governance structures, ensuring inclusive decision-making.
- Hybrid (High): Bassett-Avocado Heights employed a hybrid model, combining institutional leadership with community participation.
- Partnership-Driven (Moderate to High): San Giovanni a Teduccio relied on partnerships among local organizations, fostering community involvement but retaining institutional oversight.

Eco-Welfare Potential was evident in all the initiatives at a High level, as each case promoted environmental sustainability while addressing social equity, though further expansion and institutional support could enhance long-term sustainability.

The following Table 5 summarizes the results.

Table 5. Comparative assessment of RECs based on the 7-point analytical framework.

Dimension	Bassett-Avocado Heights (USA)	Seongdaegol (South Korea)	Banister House (UK)	San Giovanni a Teduccio (Italy)
Collective agency	High	Very High	Very High	Moderate
Trust & reciprocity	Moderate to High	Very High	Very High	Moderate to High
Territorial embeddedness	High	Very High	Moderate	High
Technological innovation	Very High	Moderate	Moderate	Moderate
Social impact	Very High	High	Very High	High
Governance model	High (Hybrid)	Very High (Grassroots)	Very High (Grassroots)	Moderate to High (Partnership-Driven)
Eco-welfare potential	High	High	High	High

From the analysis emerges the pivotal role of RECs as transformative catalysts that transcend traditional energy paradigm; they provide variegated solutions to complex socio-environmental

challenges by strategically driving energy transitions and cultivating participatory governance frameworks that prioritize collective well-being. Summarizing we can describe:

- Bassett-Avocado Heights as a model of technological advancement and community engagement that demonstrates very high potential as a territorial asset, addressing socio-environmental challenges comprehensively.
- Seoul Seongdaegol Energy Village as an example of grassroots participation and territorial embeddedness, which showcases strong integration of cultural and environmental dimensions despite moderate technological advancements.
- Banister House Solar as a RECs with moderate technological innovation but excellent in fostering collective agency and addressing energy inequality through cooperative governance.
- San Giovanni a Teduccio as a quite strong model of social innovation in economically marginalized areas, which integrates practical technological solutions with community engagement and resilience-building efforts.

At the core of their effectiveness lies the *en-communiting* process, understood as a dynamic mechanism of building community around the energy issue, mobilizing collective agency, strengthening social cohesion, and advancing the principles of energy democracy. By fostering active citizen participation, building interpersonal trust, and promoting collaborative problem-solving, these RECs strategically embed eco-social policies that fundamentally reimagine societal well-being. Despite their diverse cultural and geographical contexts, all four cases exhibit a common capacity to build trust through transparent governance, educational initiatives, and collaborative decision-making. Whether it's the youth-led programs in Bassett-Avocado Heights, the transparent energy data sharing in Seongdaegol, or the cooperative governance at Banister House, each case demonstrates how RECs can transform energy infrastructure into a platform for social empowerment, fostering what can be termed an emerging "energy culture." From these case studies emerge that RECs are not merely energy production mechanisms but rather comprehensive social laboratories for eco-welfare. By addressing localized challenges, such as energy poverty, social inequality, and environmental degradation, these communities create multifaceted impact models, ranging from reducing greenhouse gas emissions to generating economic savings, from providing educational opportunities to fostering technological innovation. The holistic approach reflects a broader vision of sustainable development, where social and environmental goals are both pursued.

Critically, these initiatives are distinguished by their deep territorial embeddedness; indeed, each case study reveals how renewable energy solutions are tailored to specific local contexts, be it a disadvantaged urban area in Los Angeles, a community-driven village in Seoul, a social housing estate in London, or a marginalized neighborhood in Naples. This contextual sensitivity ensures that technological interventions are not generic imports but organic responses to the local socio-environmental needs.

Furthermore, the governance models of these communities reinforce their transformative potential: ranging from hybrid institutional-grassroots approaches to purely bottom-up initiatives, they demonstrate flexible, adaptive strategies that prioritize inclusive participation. The involvement of diverse stakeholders (from local women and youth to public administrators and environmental organizations) highlights the democratic and collaborative nature of these energy transitions.

6. Conclusion

The trajectory of RECs represents a promising socio-technical innovation that has the potential to transcend traditional energy infrastructure, offering a pathway towards more just and participatory energy transitions, though this potential remains contingent on specific contextual factors and community dynamics. The case studies highlight how RECs can generate social value (from fostering collective agency to addressing localized environmental challenges) and reframe energy not merely as a commodity, but as a collective resource embedded in social relations and local contexts. However, the extent to which these benefits can be generalized remains uncertain without further empirical validation.

To reply to the research questions, we can affirm that RECs serve as territorial assets by embedding energy solutions within the unique social, cultural, and ecological contexts of specific regions; they address socio-environmental challenges through local tailored strategies: reducing energy poverty (e.g., San Giovanni a Teduccio and Banister House), promoting environmental awareness (Seoul Energy Villages), and integrating advanced technological solutions (Bassett-Avocado Heights); their territorial embeddedness allows them to align energy initiatives with local priorities, creating synergies between energy transition goals and broader social objectives. In addition, the *en-communiting* process enhances participation and governance by fostering trust, collective agency, and participatory governance. Mechanisms such as community advisory boards (Bassett-Avocado Heights), transparent energy data sharing (Seoul Energy Village), and cooperative governance (Banister House) illustrate how RECs build inclusive decision-making frameworks that rely on trust-building, education, and shared ownership, empowering citizens to play active roles in energy transitions while reinforcing social cohesion and accountability.

The experience of RECs also contributes to eco-welfare by bridging environmental sustainability with social well-being: for instance, the Seoul Energy Villages integrate social equity with environmental goals, while San Giovanni a Teduccio addresses unemployment and social exclusion alongside energy poverty. But, while these success stories offer hope for the *en-communiting* process during a critical historical moment (where not only facilitating energy transition but also raising citizen awareness and promoting equitable energy consumption reduction are urgently needed), it is equally important to contextualize these results and approach them with caution. Despite the positive elements discussed, it is crucial to recognize that findings rely on secondary sources, making it difficult to assess the depth of community engagement, governance effectiveness, and long-term social impact without further primary data; in addition, there are critical limitations that demand careful reflection and strategic intervention. As Hanke and Guyet's research [79] on German energy communities reveals, significant structural constraints impede the full realization of RECs social potential. The authors conducted a survey on 113 German energy communities (out of ~900 in the country), primarily cooperatives (92%), participated mostly by citizens (70%+ men in 64% of cases). From their research emerged that only 28 communities out of 113 targeted specific groups (e.g., low-income, women, migration), the primary service was simply renewable energy at affordable rates, while additional services were related with energy efficiency advice and services (and limited to members). Only a few communities focused on social benefits and only 9% addressed energy poverty directly. This gap between potential and reality underscores a crucial challenge: while RECs hold promise as platforms for energy democracy and social inclusion, their impact remains uneven and context-dependent, often constrained by structural barriers,

homogeneous membership, and limited engagement with marginalized groups. These challenges, highlighted in the existing literature on RECs and energy justice were not the primary focus of this study's analytical framework, however, future research should further explore how governance models and participation structures influence inclusivity, ensuring that RECs fulfill their social and environmental objectives more equitably. Without robust, on-the-ground data specifically addressing these dimensions, it remains difficult to determine whether RECs can consistently deliver on their transformative potential.

A postcolonial critique further complicates the landscape by questioning the often Western-centric conceptualization of "community" in RECs literature. This perspective demands a more sophisticated understanding that acknowledges the complex social dynamics, pre-existing solidarities, and power structures that shape community interactions. Without careful consideration, there is a risk of imposing uniform community models that inadvertently reproduce existing inequalities [80].

Realizing the full emancipatory potential of RECs requires a multidimensional strategy that goes beyond energy generation to embrace social inclusion and participatory governance. This involves developing enabling policies that can distinguish between profit-driven and socially oriented energy communities, recognizing the diverse motivations of participants. As the research by Hanke and Guyet [79] demonstrates, there is a critical risk of overlooking the diverse realities within energy communities, making it essential to recognize their nuanced variations. Not all participants seek the same level of community engagement or aspire to imbue energy with deeper social meaning; some may simply desire access to affordable energy. As explored in the theoretical section, individual motivations for joining RECs are multifaceted, ranging from economic pragmatism to more transformative social objectives. This diversity underscores the importance of avoiding a monolithic understanding of community energy initiatives and acknowledging the varied expectations and aspirations of participants. In addition, dedicated funding and resource allocation strategies that support vulnerable and underrepresented groups are more and more necessary and require attention. Equally important, as seen, is the adoption of a place-based approach that deeply recognizes the unique social, historical, and cultural contexts of different communities, moving beyond one-size-fits-all-models. Finally, intersectional engagement is required, developing mechanisms that actively challenge existing power dynamics and create genuine opportunities for diverse community participation.

Concluding, while this research has the advantage of introducing the concept of *en-communiting* and providing a comparative analysis of different RECs, showcasing their potential, it has some limitations. First, the reliance on a small number of case studies constrains the generalizability of the findings, as the diversity of REC models and contexts is far broader than represented here. Second, the analysis is predominantly based on secondary data, including documentary sources and web communications, which limits insight into on-the-ground dynamics; primary data collection would strengthen the analysis and help avoid over-reliance on promotional narratives. Third, while the research offers a theoretical and comparative framework, it does not incorporate longitudinal data to evaluate the long-term impacts of RECs on social cohesion, energy equity, and environmental outcomes. Future research could expand the empirical scope, including a wider array of geographical and cultural contexts, and employ qualitative methodologies such as participant observation and in-depth interviews to capture the lived experiences of community members. Additionally, longitudinal studies could further clarify

how RECs evolve over time, identifying the conditions under which they achieve, or fail to achieve, their transformative potential.

Therefore, RECs offer a promising – yet complex – laboratory for experimenting with more democratic, inclusive, and just approaches to addressing our collective environmental challenges. The path forward demands ongoing dialogue, critical reflection, and a commitment to genuine social inclusion that goes far beyond mere technological solutions.

Conflicts of interests

The author has no conflicts of interest to disclose.

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