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Bottom-up Energy Transition – Exploring Community Centred Development in Austria and Spain

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ABSTRACT

Energy communities continue to gain popularity across Europe as a promising approach to advancing energy transitions. Since 2021, Austrian legal reforms have promoted renewable energy communities to foster local energy production, equitable resource distribution, and community engagement. This paper examines two contrasting cases: the rural Schönbühel-Aggsbach energy community in Austria and the industrial Urtinsa energy community in Alcorcón, Spain. Each community has distinct ways of operating, demonstrating the diversity of energy community structures. Using frameworks of institutional logics, energy justice, and critiques of capitalist structures, the paper identifies four key paradoxes within energy commons and proposes pathways toward more inclusive, integrated, and sustainable energy systems. The findings emphasize the need for additional empirical research and context-specific solutions to address the complexities of energy transitions.

KEYWORDS

Energy community, Rural regional collaboration, Cocreating PEDs, Just transition, Energy commons, Community-centred energy transition, Added social values, Community capacity building.

INTRODUCTION

The world's dependence on fossil fuels continues to accelerate climate change at an alarming rate, threatening all forms of life. Despite declining renewable energy costs, fossil fuels still dominate global energy consumption (81%) while renewables account for only 9.7% [1]. Conventional energy systems are market-driven and characterized by privatization, competition, and profit-driven-growth-strategies. Although these systems have become powerful actors and key drivers in the energy sector over the past century, their self-regulation toward carbon neutrality progresses extremely slowly, if at all [2].

Citizen energy projects are playing an increasingly crucial role in the green energy transition, as empowered communities actively produce, manage, and benefit from renewable energy, positioning communities and citizen groups as primary actors driving the shift toward green energy production. These initiatives often focus on sustainability, social community, collective self-consumption [3] local ownership, social values, communal benefits, community engagement, peer-to-peer energy trading, as well as establishing or forming Positive Energy

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Districts (PEDs) and renewable energy cooperatives. Given that approximately 40% of global energy is consumed by and in buildings [4], citizen groups represent both the end-user and one of the largest potentials (even key actors) capable of impacting the energy transition. Despite their efforts, they remain the least informed, least funded, least supported, and least impactful actors in this transformation.

RESEARCH GAP AND OBJECTIVES

There is growing recognition of the potential of citizen energy projects, but understanding remains limited regarding how different organisational models achieve energy transition goals while addressing justice concerns. Existing research has examined the technical and economic aspects of community energy, but systematic frameworks for comparing initiatives across governance structures, participation mechanisms, and equity outcomes are lacking. This gap is critical because successful replication of citizen energy projects requires understanding not only their technical configurations but also the organisational and justice parameters that enable sustained community engagement and equitable benefit distribution. This is addressed in the following research question: ***What organizational characteristics and justice parameters distinguish different citizen energy project models, and how can these insights guide the replicable development of community-led energy transitions?***

This paper employs a comparative case study analysis of two distinct energy community models, examining them through a justice-focused lens. This lens considers critical parameters such as governance, decision-making, financial mechanisms, participation, inclusion, benefit distribution, knowledge, capacity building, risk, responsibility allocation, scalability, replicability, policy, and institutional support (**Figure 2**). Utilising the PED Matrix framework (a multi-criteria self-assessment tool), the paper systematically examines how organisational choices in citizen energy projects impact justice outcomes and transition effectiveness. The two case studies that represent contrasting organisational approaches to community energy are the Austrian Bürger*Innenkraftwerk (a citizen initiative), and the Spanish Urtinsa (an entrepreneurs' initiative). The analyses of these models help identify critical success factors and transferable principles that can inform future citizen-led energy initiatives.

This research contributes to the energy transition literature and practice in three ways. First, a justice-focused analytical framework specifically designed for evaluating citizen or community energy projects is developed and designed. This framework integrates dimensions often examined separately in existing research. Second, empirical evidence demonstrating how organisational structures – particularly governance models and financial mechanisms – influence equity, participation, and sustainability outcomes in community energy initiatives is provided. Third, actionable insights and conditions necessary for scaling and replicating successful community energy projects, addressing a critical gap between pilot projects and widespread implementation are identified.

This paper is structured into two main sections. Section 2 reviews literature on community energy production and organisational typologies, describing the methods used in the paper and the selection of the cases. Section 3 presents the results of the PED Matrix self-assessment and its application to the cases, as well as the findings regarding replication. The final chapters discuss the results and conclude with implications for policy, practice, and future research.

REVIEW AND OVERVIEW OF ENERGY PROJECTS

Looking back at the energy transition pathway of the last few decades, it would be logical to conclude that applications to date have proven to be inadequate (as a driving or pioneer force) in addressing the climate crisis. As early as 2001, Kolk [2] had analysed the oil industry and noticed a move towards emissions reduction alongside investments in renewable energy, observing considerable shifts in corporate climate strategies. Fast-forward a quarter century later to 2025, reaching the established climate goals is still a distant dream [5]. This is related to

the low-self-regulation [6] practices of the key-players in the energy sector. Energy monopolies have mediated strong collaboration conditions with national decisionmakers in almost all countries; self-regulatory or regulatory frameworks favouring climate mitigation strategies have yet to be established. An analysis on the market value of U.S. companies and the impact of climate risk disclosure reveals that not all climate risks, such as emissions, transition risks, pollution, and physical risks, are treated with equal importance or urgency, yet attention to the issue of climate has strong impact on firm value [7]. This disparity suggests that, within the private sector, the prioritization of climate issues is shaped by internal boundaries that may not align with the actual urgency of the climate crisis.

Market shares demonstrate that renewables are not yet profitable enough, otherwise, their impact on the energy sector would have been more significant. This may explain why major market players haven't shifted their focus entirely to renewables yet. Meanwhile, existing energy systems continue to exacerbate intersecting crises including biodiversity loss, inequalities, and democratic challenges, creating issues that extend beyond market demand. Fundamental institutional reforms are necessary to achieve a just and sustainable energy transition, making it necessary for green energy transitions to address crucial themes such as fairness and democracy, while challenging conventional and oppressive structures. A move beyond profit-driven models to prioritize equity and strong sustainability is needed. This positions communities and citizen groups as the primary actors and drivers of the shift toward green energy production.

Simultaneously, people and citizen-groups continue to emerge under different circumstances around the globe, with the purpose of securing and advancing their climate mitigation ambitions, both as individuals and as communities. Yet, they're the less-informed, less-funded, less-supported, less-included and less-impactful actors in the energy transition. They encounter a wide range of climate change risks that impacts their lives, whether it be from a combination of multiple shocks and catastrophic events [8] to deepened vulnerabilities and dependencies [9]; the real impact of climate change on local opportunities and wellbeing is extensive. Yet, although the European Parliament had mandated zero-energy standards for new buildings by 2019, full and complete implementation remains unaccomplished.

Citizen projects in the green energy transition can take various forms and initiate a wide range of projects, including but not limited to: energy communities, crowdfunding for the shift to renewable energy, citizens science projects, energy sharing or trading (P2P), energy retrofitting, urban gardening and green space groups, advocacy and campaigning, local energy plans and initiatives such as Positive Energy Districts (PEDs), renewable projects, educational energy projects, mobility and transportation projects, renewable energy events, citizen-led policy activities, off-grid or micro-grid energy projects, art and culture projects, and many more. The diversity of the groups, their interests and variety are significant, (see **Figure 1**). All these factors make understanding how citizens can collaborate and unify to become a central player in the just energy transition, crucial.

This paper is organised as follows: first, community energy production and the different types of organising are presented, followed by and introduction of the case studies. Next, the criteria used in the PED Matrix is presented and applied to the case studies. Then, key parameters with justice perspectives are proposed in eight critical areas (**Figure 2**) for the two presented energy communities, followed by a comparative analysis. Finally, the replicability of such energy projects are addressed, followed by conclusions and suggestions for future research.

BACKGROUND: ORGANISING COMMUNITY ENERGY PRODUCTION

Citizen's attempt discovering new ways of producing local energy to cover their energy demands–these efforts are often related to global energy uncertainties (**Figure 1**). These initiatives take multiple organisational forms, each with distinct legal structures, ownership models, and operational scopes (see **Table 1**).

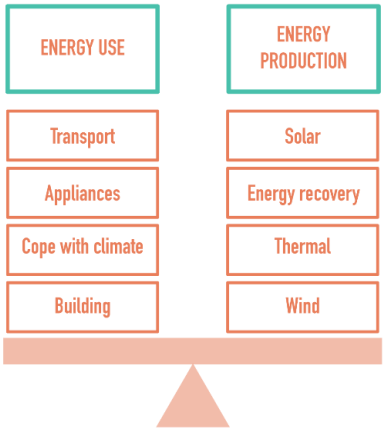

Figure 1. Covering the local energy consumption with local production [10]

An energy community creates an informal or formal governing body to facilitate energy exchange among its members. In contrast, a Positive Energy District (PED) aims to optimize energy balance toward carbon neutrality but does not require a governing body to oversee or manage this process. This task can be fulfilled, if at all, by a cooperative, an authority, a company, a service provider, or an energy community (Table 1).

Table 1. Differences between Prosumers, RECs, CECs and PEDs [11]

	Ownership	**Production**	**Technology**	**Legal**
Prosumer	Individuals, households or same building neighbours	On their own property	Mostly: PV, solar hot water, heat pumps, local energy storage	Covering own energy needs. Potentially selling excess energy to the grid or peer to peer trading
Energy Cooperative (co-ops)	Member owned – multiple households	Anywhere	Bottom-up network, can be large energy producers or marketers	Production, marketing
Energy Community (REC)	Households, individuals, authorities, enterprises.	Local	Only renewable energy	No commercial activity. Accessible for low-income households. Boundary regulations. Prosumer, Consumer, Producer, membership roles.
Citizen Energy Community (CEC)	Individuals, authorities, enterprises.	Anywhere	Any form of energy	Can engage in generation, distribution, supply, consumption, aggregation, storage and services.
Positive Energy District (PED)	Households, individuals, authorities, enterprises	Local (autonomous & dynamic PED)	Only renewable energy, balance or exceed demand	Inclusive, no legal determination. Can include Prosumer, REC and CEC

Energy Communities have had a legal foundation in EU legislation since 2019, thanks to the "*Clean energy for all Europeans"* legislative package [12]. The implementation of these regulations however, vary across member states. Communities can operate as an independent energy project or aim to achieve PED status (covering their own energy demands) through a combination of energy production and energy saving measures. Despite the legislation intending to provide the European public with ease of access to affordable energy, major barriers persist. The energy system governance remains to be top-down, fragmented, and dominated by market and state mechanisms, side-lining citizen communities [13]. Large energy corporations control production, transmission, and distribution, leaving the European public with limited influence over system evolution. For community initiatives – particularly in low-income areas, accessibility to knowledge-sharing, technology, and financing remains challenging, as Dall-Orsoletta *et al.* [14] highlight.

Two critical knowledge gaps emerge from this context. First, while energy communities continue to gain attention and popularity, they remain underutilised in the European energy transition [15]; there seems to be a lack of understanding regarding the barriers particular organisational models can effectively overcome. Second, social dimensions in energy projects [16] along with microclimate-related issues, remain among the least researched topics in the field [17]. Specifically, understanding the contribution of energy projects across justice parameters such as inclusivity, benefit distribution, and decision-making power is under-researched.

The use of renewable energy is the pre-condition for an energy community and PED system. The governance system and the purpose of collaboration essentially defines what kind of community collaboration is established. In this regard, cooperative-like communities may be more restricted to energy sharing and exchange, and communities that place community benefits as an initial goal might be closer to (energy) commons. The cooperative kind of communities very often define their activity through material aspects, such as the produced energy, financial schemes, ownership, and access to equity. Whereas commoning communities pay greater attention to the culture of doing things collaboratively, creating common social values and sharing benefits, which are beyond material benchmarks. These dimensions relate strongly to the scientifically acclaimed institutional analysis and development (IAD) [18], often utilised in systemic method to analyse policies.

Table 2. Case overview [19], [20]

	Bürger*innenkraftwerk	**Urtinsa**
Location	**Austrian case**	**Spanish case**
Type	**REC**	**REC**
Spatial context	rural, low-density area multiple municipalities	Urban/peri-urban One municipality
Reach	The REC boundaries are defined by the electric substation network. The REC can serve the villages Schönbühel-Aggsbach, the town Loosdorf and the district capital Melk, given that the substation reaches all three municipalities. This is a wide reach – but difficult to manage as the 3 municipalities aren't well connected with citizen activities.	The REC boundaries are required to be within the 2 km radius distance. Consequently, the REC can only serve within the municipal boundaries of Alcorcon, with the ability to reach out of the industrial zone to the housing areas of the city.

	Bürger*innenkraftwerk	**Urtinsa**
Geographic aspects	Elevation 230 m a.s.l. Continental climate (Köppen class: Cfb) Average annual temperatures 9-10 °C **Moderate** solar irradiation 1.200-1.300 kWh/m^2/year	Elevation 690 m a.s.l. Semi-arid Mediterranean climate (Köppen class: BSk) Average annual temperatures 4-15 °C **High** solar irradiation 1.700-1.900 kWh/m^2/year
Ownership	Individual households and homeowners (currently) NGO structure for the trading of energy.	Enterprises. (currently) NGO structure for the trading of energy.
Maturity	Established with operational governance in 2021	Recently established (2023), six founding entities
Production	On the own property of the members Currently 42 members (12 prosumers, 30 consumers) and further household on the interest list. The production reached 100,000kWh in 2025. The prosumers could cover 1/5th of their energy needs and share with the members 2/5th. The rest went to storage and to the net.	in industrial area of the city on the plant buildings of the members currently 7 prosumer members (industrial partners) and further companies on the interest list. The production capacity 300,000 kWh in and 89.5kWh installed in 2025 but not able to produce, store and share yet.
Technology	Mostly: PV; few: local energy storage possibilities of prosumers.	Mostly: PV
Characteristics	Diverse membership (prosumers and consumers), regular public events, social projects, one-person-per-household model (not one-per-energy-contract), multiple energy sources (hydro, solar).	Differentiated member roles (producers, consumers, space-providers), one-vote-per-entity model, primarily solar energy
Legal	Energy trading through the public electricity grid. An established association, electric energy trading is in the sub-station network through the public network	Energy trading through the public electricity grid. An Association, electric energy trading within a defined area using energy network.
Facilitator	National law and funding. No direct administrative support	Collaboration and support by the municipality
Analysis	Formalized governance, inclusive membership.	Formalized but evolving governance, multiple organizational roles.

Both cases (**Table 2**) operate under the EU Clean Energy Package frameworks, but within distinct national implementations. For instance, Austria's Renewable Energy Expansion Act (2021) **[17]** and Spain's Royal Decree 244/2019 **[21]** are examples of these national implementations. This policy context offers an opportunity to assess how the context

influences organisational outcomes. To achieve this, a qualitative comparative analysis was combined with descriptive quantitative analysis.

METHODS FOR RESEARCH AND ANALYSES

This study employs a comparative case study methodology to test the hypothesis on how organisational structure affects outcomes in energy projects. Two contrasting energy communities, one in Austria and one in Spain (Table 2), were selected. These communities have distinct legislation, cultures, organisational maturity levels, governance models, and national regulatory contexts. This research design allows for a systematic analysis of whether formalised structures, legal frameworks, and spatial contexts influence participation equity, benefit distribution, and governance inclusivity, as hypothesised. To operationalise the analysis, the PED Matrix [22], developed in the PED-ACT project as a multi-dimensional assessment tool for energy projects, was applied. This matrix addresses aspects that collectively shape energy community performance but are rarely analysed comprehensively in existing research, such as the technical, financial, environmental, legal, management, governance, and social factors. To further enhance the analysis, the PED Matrix was extended by integrating justice-oriented parameters derived from energy commons theory [23] and institutional analysis frameworks [24]. Each case was then evaluated across justice parameters. These parameters operationalise the distinction between "cooperative-like" communities, which prioritise material aspects such as energy production, financial schemes, and ownership, and "commoning" communities, which emphasise collaborative culture, social values, and non-material benefits. This framework allows us to test the hypothesis by providing measurable dimensions across which organisational models can be compared.

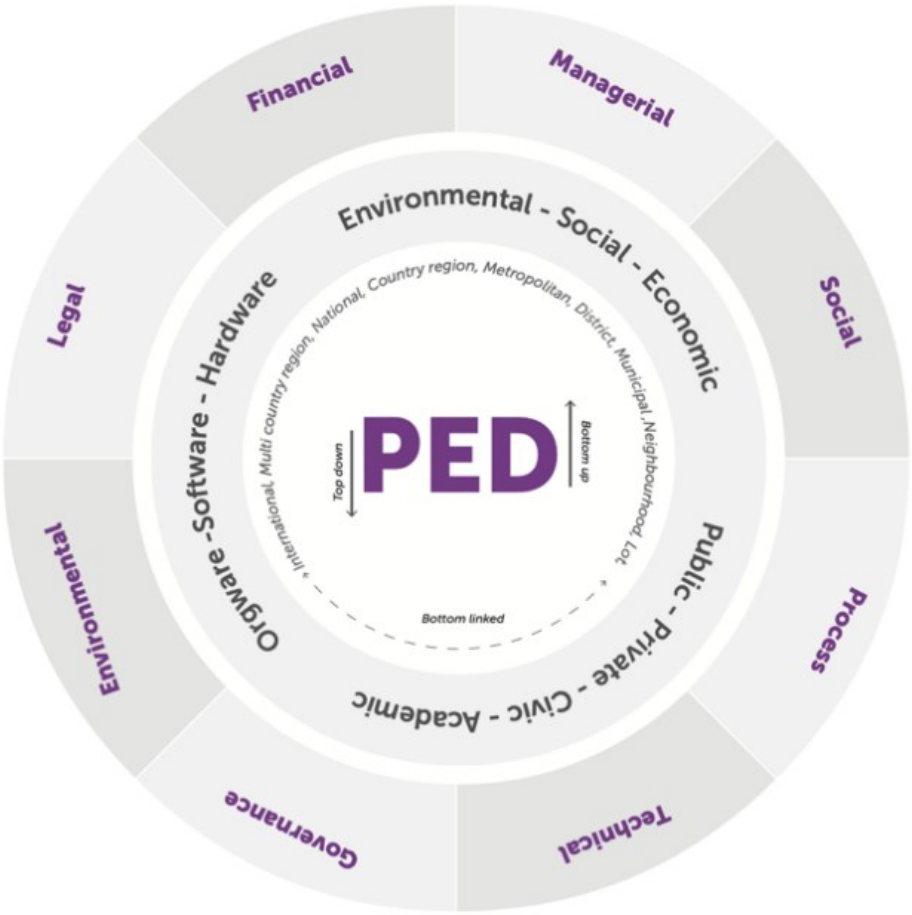

Figure 2. PED Matrix [26]

To understand the energy communities' "commoning capacity", a reflection on the paradoxes in energy commons as described by Bauwens [23], becomes necessary. These paradoxes position energy projects in relation to inclusion, power schemes, geographic assets, and economic structures within which they operate. Energy project developers recognise that social aspects can be both a key driver for successful project implementation and a significant challenge [25]. To facilitate this role shift, projects need to create collective and inclusive spaces for citizen participation and engagement [18], [25]. Social dynamics vary significantly across contexts and require being tailored to local conditions, needs, and stakeholder capacities. This work spans across two distinct national contexts, each with unique conditions and legal frameworks, highlighting the importance of adapting approaches to local realities.

For each case (Table 2), a systematically coded dataset against the eight parameters was used with The PED Matrix framework to analyse interview transcripts and documents using thematic coding. This allowed both the identification of strengths and the assessment of the framework's capacity to handle the topic. Quantitative descriptors were applied where available, including socioeconomic diversity indicators, energy production and consumption data, financial and benefit distribution. Systematic cross-case comparison was conducted across each parameter to identify patterns, capacities, strengths, organisational features, context-specific barriers and facilitators, and transferable mechanisms versus context-dependent factors.

LIMITATIONS

This study acknowledges several limitations. While the small sample size of two cases restricts the generalizability of findings, it facilitates detailed comparative analysis. Self-reported data from interviews may reflect social desirability bias, and the availability of quantitative membership data varied between cases [19], [20]. Additionally, the short operational history of the Spanish case (established in 2023) limits longitudinal assessment. Cross-national comparison involves confounding variables beyond organisational factors. Despite these limitations, the contrasting case selection and multi-method approach provide a robust empirical basis for testing the hypothesis and generating transferable insights for community energy development.

MATERIAL: CASE STUDIES

Bürger*Innen Kraftwerk Schönbühel-Aggsbach, Austria

In the Austrian context, energy communities have gained significant traction as a key component of the country's energy transition and climate goals. Austria's Renewable Energy Expansion Act [17] enacted in 2021, provides a robust legal framework to support the establishment of renewable energy communities (RECs) and citizen energy initiatives. It empowers citizens, municipalities, and small businesses to collectively produce, share, and consume renewable energy, fostering local energy autonomy and reducing reliance on fossil fuels.

The REC Bürger*innenKraftwerk Schönbühel-Aggsbach is in the municipality of Schönbühel-Aggsbach, in the district of Melk, Lower Austria (approximately 80 km west of Vienna), situated along the Danube Valley at an elevation of roughly 230 m. The region is characterised by a temperature continental climate (Köppen classification Cfb), with average annual temperatures of approximately 9 – 10 °C. It boasts cold winters and moderate solar irradiation averaging around 1,200 –1,300 kWh/m^2/year, which influences both heating energy demands and photovoltaic general potential.

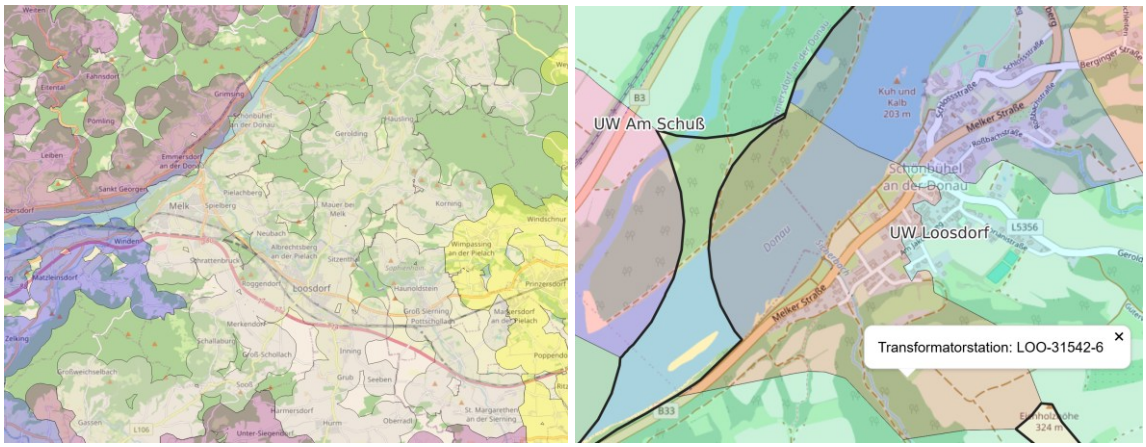

Figure 3. The buildings are located in UW Loosdorf transformer station (the white colored area in the first image) and LOO-31542-6 substation area (highlighted in the second image)

The initiative can legally and technically serve users from the bordering municipalities of Schönbühel-Aggsbach (932 inhabitants), Loosdorf (3,902 inhabitants), and Melk (district capital, 5,594 inhabitants). The community comprised 42 members in Spring of 2025, consisting of 12 prosumer and 30 consumer households, mainly based in Schönbühel-Aggsbach village. The community's installed renewable capacity includes rooftop photovoltaic systems, owned by prosumers (homeowners). In the peak summer period, the homeowners produce a surplus of energy and could serve more households [100,000 kWh/year]. Due to peak summers, the prosumer can use only 1/5th of the produced energy. In 2025, they were already able to deliver to 3/5^{ths} of the members. They still have surplus capacities, especially in the summer months. There are no storage facilities installed, the current concept is immediate energy-trading. The spatial distribution of the producing 12 buildings is in the village, but due to technical constellation the users in all other municipalities can consume with the REC defined prices. The potential geographical widespread of consumers and prosumers is illustrated in **Figure 3**. This means, the REC is still in the development and building-up phase and has little outreach in the big municipalities.

The adoption of the legal framework has further facilitated the growth of energy communities, particularly in rural areas where biomass, hydropower, and solar energy are more accessible due to low population density and simpler ownership structures. By promoting decentralized energy systems and participatory decision-making, energy communities in Austria not only contribute to achieving national and EU climate targets, but also enhance social acceptance and equity in the energy transition. For instance, the energy pricing (energy trading) is the collective decision of all members of the REC (producers, prosumers and consumer). This aligns with the broader European vision of democratizing energy systems and ensuring a just transition toward sustainability.

However, several barriers have hindered the success of these communities. Less densely populated areas face significant administrative, financial, and capacity challenges **[18]**, making organizational obstacles particularly difficult for citizen groups to manage. Structuring governance models and fostering membership growth require significant effort and dedicated expertise, as well as a different set of qualities and skills to accompany the dynamics of citizen groups initiating projects. Despite these challenges, hundreds of energy communities have emerged, particularly in remote areas. The community of Schönbühel-Aggsbach **[19]** is structured as an NGO comprising of prosumers and consumers, aiming to develop a PED through a bottom-up approach. The association has well defined roles and decision-making mechanisms, organizes regular public events, includes social projects in their activities and creates extra value for its members as well as for the larger community. It also offers membership to citizens of all backgrounds and capacities, in contrast to most ECs that only

offer membership to individuals with an energy contract, resulting in a membership rate of one person per household. The energy community is driven by strong social ambitions, aiming to create a diverse and inclusive environment where well-being, environment and heritage is as important as energy efficiency. By integrating diverse energy sources (such as water and solar) and collaborating with regional stakeholders, the community seeks to balance energy production with environmental and cultural preservation [19]. However, its impact remains limited, underscoring the need for supportive policies and resources.

Urtinsa Community Alcorcón, Spain

In Spain, energy communities continue to emerge, accelerating the transition to renewable energy, helping meet EU climate targets, and supporting the increasing number of citizens affected by energy poverty. The favourable conditions for solar and wind energy, coupled with supportive national legislation such as the Royal Decree 244/2019 [21] and the transposition of the EU's Clean Energy Package [26] have created a context that enables the establishment of RECs. These energy communities empower citizens, local governments, and small businesses to collectively generate, manage, and consume renewable energy, reducing energy costs and fostering local economic development. In regions such as Catalonia and the Basque Country, energy communities continue to gain momentum, often supported by municipal initiatives and cooperative models that prioritize social inclusion and environmental sustainability. Despite challenges such as regulatory complexity and initial investment barriers, energy communities in Spain continue to receive increased recognition as a vital tool for democratizing energy systems, enhancing energy resilience, and ensuring a just transition toward a low-carbon future.

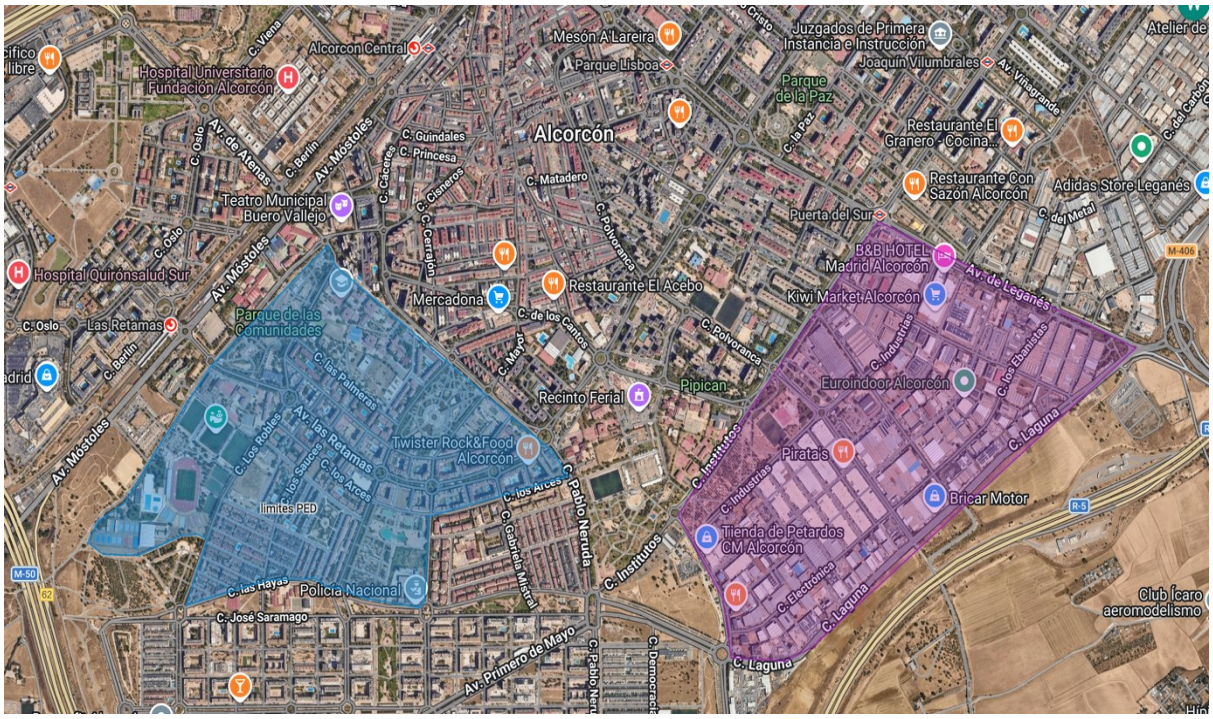

Figure 4. The Las Retamas area mainly housing is selected PED area for Alcorcon to form virtual PED with Urtinsa

The REC of Urtinsa is located in the municipality of Alcorcón, approximately 12 km southwest of Madrid city centre (see **Figure 4**). The area sits at an elevation of approximately 690 m and is characterised by a semi-arid Mediterranean climate (Köppen classification BSk), with hot and dry summers and cold winters. Average annual temperatures range between 14 –15 °C. The region benefits from high solar irradiation

averaging approximately 1,700 – 1,900 kWh/m^2/year, making photovoltaic generation particularly advantageous and central to the community's energy strategy. Urtinsa is an NGO established in 2023, comprising six foundational entities drawn from the local industrial zone, with a current membership of 7 prosumer members and an additional 5 business entities in acquisition. The members are organised into three functional roles: producers, who generate renewable energy and sell their surplus to the community, consumers, who purchase energy without participating in the production, and space providers, who contribute rooftop or land area for the installation of photovoltaic modules. The community installed PV capacity currently amounts to 89 kWh, but the production and sharing is not yet enabled. The REC has the long-term ambition of delivering as virtual PED a Positive Energy District (PED). The spatial extent of the community is defined by Spanish REC law and includes a zone of 2km around the REC. Governance follows a one-entity-one-vote model, ensuring balanced decision-making power among all six partners regardless of energy contribution or consumption volume. The community has not yet established a specific model for meetings and social gatherings but plans to do so as it grows [20]. Despite the challenges related to regulatory complexity and initial investment barriers, Urtinsa represents a growing recognition of energy communities as a vital tool for democratising energy systems, enhancing energy resilience, and ensuring a just transition toward a low-carbon future in Spain.

RESULTS

This section presents the findings from the comparative case study analysis, organised by the research hypothesis and the eight parameters operationalised through the PED Matrix framework. **Figure 3** and **Figure 4** show the PED Matrix scores for Bürger*innenKRAFTwerk (Austria) and Urtinsa (Spain) across eight dimensions: legal, managerial, technical, financial, environmental, governance, social, and process aspects. These scores reveal distinct organisational profiles, allowing to test the hypothesis about how organisational structure affects justice outcomes. The scoring allows to list and prioritise the key quantitative findings.

BürgerinnenKRAFTwerk scored highest in social aspects, followed by financial, governance, and environmental dimensions, with the same scores. The lowest scoring aspects were technical, and process related. Urtinsa REC scored highest in the legal aspect. The managerial dimensions are becoming clearer, indicating substantial progress in establishing a functioning energy community, reflecting strong municipal support. However, this progress is significantly lower in social and environmental aspects compared to BürgerinnenKRAFTwerk. The absolute lowest score was achieved for the process aspects, which is a result of the rapidly evolving energy community. These divergent profiles provide the empirical basis for testing the hypothesis.

ANALYSING KEY PARAMETERS WITH JUSTICE PERSPECTIVES

The scoring system connected to the PED Matrix allows energy communities to self-evaluate their preparedness in the listed eight aspects. The scoring of Bürger*innenKRAFTwerk clearly exhibits how well this citizens' initiative performs in social aspects (**Figure 3**). In the case of Urtinsa – the community of enterprises – the energy community is supported and facilitated by the municipality, which sets the Renewable energy community (REC) operations on very strong legal foundations [20], which is where the community excels the highest scores (**Figure 4**). The scoring system also exhibits (and helps assess) how organisations might need support in other areas to fulfil their capacities, as is highlighted by Dall-Orsoletta *et al.* [13]. A simple comparison of the citizen and business driven energy communities underline the main features determined by the partnership model in which they operate, for instance in the legal and managerial aspects. While the missing social interactions with citizens in the Spanish case yield a lower score social related topics, the citizens driven REC reaches the highest scores [19]. This means that there is an opportunity to learn from each other and strengthen the social practice.

Figure 5. Bürger*innenKRAFTwerk scoring. © wonderland/Batuhan Akkaya

It's quite natural for various members of each group to have different levels of knowledge and capabilities, especially when it comes to the topic of energy. Individuals in such groups are often involved in an energy project out of personal interests or motivations. A group may have various individuals with vast knowledge on issues such as technology, social dynamics, financial or legal expertise. The diversity among members might be the community's biggest capital and depending on the context, the geographical location, attributes of the societal group, gender representation, vulnerabilities, or ownership structures as well as professional occupation, members and conditions will eventually determine the core values of the energy project as well as the fields they might need assistance and expert guidance in.

Figure 6. Urtinsa scoring © wonderland/Batuhan Akkaya

The two case studies outlined above – a community driven by entrepreneurship and a citizen driven community with social values at the core – exemplify the different ways of organising community energy projects and the kinds of challenges they face. Energy projects may have the capacity to alleviate energy vulnerability [27] yet most collaborative energy projects are new, and their societal contribution (aside from sustainable local energy production) needs facilitation and orientation, as well as direct support – both financially as well as in terms of expertise. As it stands, many stakeholders perceive energy concepts such as PEDs as a technological challenge to achieve net-positive-energy, neglecting their wider contribution to societal benefit and just transition pathways.

Table 3. Keywords and self-evaluation scores for the five cases on the eight PED aspects

PED aspects	Alcorcon: Urtinsa	Schönbühel-Aggsbach: Bürger*innenKraftwer
Social	**Limited** *(3 points out of a potential of 15)* There is further need for social and cultural inclusion	**Comprehensive** *(12 points out of a potential of 15)* Has good social and cultural identity integration; a need for social inclusion
Process	**limited** *(1 point out of a potential of 15)* A strong need for capacity building	**Moderate** *(6 points out of a potential of 15)* A need for clarity and availability on the PED process; a need for knowledgeable partnership
Technical	**Moderate** *(6 points out of a potential of 15)* Needs technical expertise	**Limited** *(5 points out of a potential of 15)* Has need for technical expertise
Governance	**Moderate** *(8 points out of a potential of 15)* Alignment with strategies, everything else needs to be elaborated.	**Moderate** *(9 points out of a potential of 15)* Structures set up; a need for further elaboration
Environmental	**Limited** *(3 points out of a potential of 15)* Very limited integration and alignment of environmental goals.	**Moderate** *(9 points out of a potential of 15)* Prioritised aspects; a need for support in circular economy (CE) and biodiversity; untapped sustainable mobility potential.
Legal	**Comprehensive** *(14 points out of a potential of 15)* Support and good set-up through collaboration with the municipality.	**Moderate** *(7 points out of a potential of 15)* Has established rules; possible but infeasible compliance; a need for support and training.
Financial	**Moderate** *(8 points out of a potential of 15)* Possesses available funds; has an impactful business model; needs to focus on barriers and implementing the business model.	**Moderate** *(9 points out of a potential of 15)* Has available funds; an impactful business model; needs to focus on barriers and implementing business model
Managerial	**Moderate** *(8 points out of a potential of 15)* Local establishment; has a need for support, elaboration, and development.	**Moderate** *(7 points out of a potential of 15)* Local establishment; needssupport, elaboration, and development.

If energy projects are reduced to merely extending profit-driven monopoly structures within the energy sector, they risk creating exclusive societies, deepening class divisions, and exacerbating social injustice. In the absence of a strong regulatory framework, the long payback periods of energy investments tend to favour for-profit business models. Only through targeted regulation can this market dominance be balanced in favour of citizens and ensure benefits are shared across diverse social groups. A bottom-up, community-driven energy

transition is more likely to reflect the needs of its members, where group diversity plays a crucial role. Projects situated in contexts such as social housing, shrinking communities, or industrial zones will each follow distinct trajectories, requiring tailored support and facilitation to overcome structural barriers and local constraints. In their critical analysis of PEDs in Europe, Carlborg *et al.* [28] argue that these initiatives often fail to contribute meaningfully to restorative justice, as social concerns are typically addressed only after project development, rather than being embedded in the project from the beginning.

The concept of energy communities intersects with institutional logics, particularly in relation to the tension between community-oriented and market-driven approaches. Bauwens et al. [23] highlight the connection between community logic and energy justice, emphasizing principles such as equitable access, fair distribution, and participatory governance. However, many energy communities operate within market-based frameworks, engaging in activities like selling electricity to utilities or peer-to-peer trading, as demonstrated in the case of Urtinsa [20]. This blending of logics reveals the complex and often ambivalent relationship between energy commons and capitalist structures. While some scholars advocate for reforms within existing systems, others – such as Giotitsas *et al.* [29] – argue that energy commons can actively challenge capitalist exploitation and foster greater social equity. These differing perspectives highlight the ideological foundations of energy collectives and their transformative potential within the energy system. Such considerations are essential for shaping the governance and management schemes of energy communities, influencing how core values and operational principles are defined and communicated to members. In particular, the paradox of inclusivity versus exclusivity [30] will play a critical role in informing both the internal social dynamics of the community and its relationships with external stakeholders and wider society.

While energy communities aim to be inclusive, they often encounter participation barriers, particularly for marginalized groups [15]. In the Spanish case, overall citizen inclusion is limited, whereas in the Austrian example, the involvement of younger citizens remains underdeveloped. Decentralisation in the energy sector is difficult to manage, as large market players offer limited flexibility for energy communities to exercise self-determination. Decentralised systems require coordination to maintain both efficiency and equity. As a result, the governance structure of an energy community often evolves in response to the existing market and infrastructure conditions. In the case of Bürger*innenKRAFTwerk, the community depends on a partially publicly owned energy supplier for its operations [19], whereas the Spanish case benefits from direct municipal support [20], providing a stronger communication channel and partnership with the regional energy provider.

Research links community logic to energy justice, emphasizing equitable access, fair distribution of benefits, and participatory governance [31]. Despite challenges, inclusive community energy initiatives can foster stronger social bonds and enhance environmental responsibility. Although these projects reflect the ideals of the commons, they frequently intersect with market logic by engaging in electricity sales or peer-to-peer trading, sometimes out of necessity. Even energy communities striving for self-sufficiency may integrate market mechanisms, combining both institutional logics. Governance plays a key role in this context, which is notable given that it complements many other activities through its organizational focus and relatively low capital demands.

REPLICATION OF ENERGY PROJECTS

This section analyses the replicability potential of the two case studies by examining how their organisational characteristics and justice outcomes translate to transferable principles for other contexts. Working with energy communities to replicate energy projects for PEDs involves the creation of sustainable urban areas that produce their own energy while actively

engaging local communities in energy production, management, and consumption. The replicability of such models depends on several factors, including regulatory frameworks, technological infrastructure, community engagement, and financial mechanisms. Key considerations for ensuring the replicability of PEDs with energy communities deal with regulations and policies, technological infrastructures, community engagement, financial mechanisms, scalability, and adaptability. We analyse the various factors when it comes to scalability, with examples from our two cases, below.

Regulatory and Policy Frameworks

Both energy communities operate under EU Renewable Energy Directive (RED II) [32] transpositions, but national implementations create significantly different operating conditions. Governments need to establish clear policies and incentives that promote renewable energy generation, energy efficiency, and community energy projects. This includes feed-in tariffs, tax incentives, and grants. Both energy communities would not be possible without the policies that promote energy communities. Energy communities require legal frameworks that allow collective ownership, shared energy production, and distribution. For example, the European Union's Renewable Energy Directive (RED II) [32] provides a legal basis for citizen energy communities, yet the national take on the directive can differ depending on local conditions. In Austria, energy communities evolve around the capacities of the energy network, mostly around the transformer reach and sometimes on the substation reach. In Spain, the legislation defines a radius of 2 kilometres distance to the energy community centre. Simplified grid connection processes and fair pricing mechanisms for energy fed back into the grid are essential for PEDs, while an energy community can define (in most cases) the price for energy sharing within the group, and this aspect may reduce the PED area's dependence for market development. The PED evaluation of the Austrian case has high scoring in the aspects of financial, environmental and governance, and this high scoring (9) is due to the national policies, the funding scheme and consultation services for energy communities. The legal aspect remains as having unresolved issues in regard to feeding into the energy system, given that the energy monopolies can decide about their rules and regulations, leaving energy communities with legal uncertainty regarding energy storage and exchange. In contrast, the legal stability in the Spanish case is outstanding with 14 points, since the collaboration between the REC and the municipality has a legal task force behind it. Furthermore, they (municipality and the REC) are rather equivalent collaboration partners for energy suppliers (power symmetry). The financial and governance aspects in the case of Urtinsa are influenced by the available national funds and the support system for energy communities, resulting in a slightly lower score in this area. The main difference is the environmental motivation and pressure (3 points). While the members of the Austrian energy community feel a strong connection and adherence to environmental goals, the activities of the industrial partners and the municipality are rather seen as silo-solutions not very integrated and connected. In summary we can conclude the relatively high scoring in the four aspects signal that the frameworks for both energy communities are rather well developed and that successful replications of such energy communities are quite likely.

Technological Infrastructure

Advanced grid infrastructure is necessary to manage the variable energy supply from renewable sources and multiple deliverers. This means infrastructure change on the supply network, and how energy suppliers handle customers so they can also become deliverers, or in the case of prosumers, both. The fluctuating delivery coming from the community needs to be balanced to ensure efficient distribution within the district or neighbourhood. This means that national and regional grids must be consistently updated and upgraded into smart grids across all areas. Solutions also need to cover local production gaps. Batteries or thermal storage are critical for balancing energy supply and demand, especially in districts with high renewable

energy penetration. Platforms for monitoring and managing energy consumption and production at the community level can enhance efficiency and engagement, but this is challenging for smaller energy communities. Therefore, citizens often make use of common tools, such as social media groups to stay in touch and exchange among members, as in the case of the Bürger*innenKRAFTwerk. Outstanding mobility actions may be combined with governance actions. Due to the significant impact of mobility within urban areas and the substantial potential for emission reduction associated with these two actions, the initial two mobility measures also attain a heightened level of importance. This aspect delivers the smallest gap between the cases across all dimensions. In the technological aspects both RECs have received positive reviews, (Austrian case with 6 points, Spanish case obtaining 5 points) with the difference being mainly connected to the years of experience – the Austrian energy community was established earlier, allowing it to obtain a bit more experience on the technical aspects of RECs. Also, the fact that energy communities are already supported means there are many existing energy communities to learn from and exchange experiences with. These cover everything from forming the legal entity to drafting contracts. This support allows the Austrian case to score higher in process aspects (6 points). Urtinsa on the other hand only scores 1 point in this area, given that they still need to develop their specific process (tailored to their context and collaboration model) from the beginning. In terms of replication, the technical aspect of the Spanish model currently requires more support, time, and experience. In conclusion, the technical requirements are highly transferable, but the implementation pathways differ based on the local organisational structure and legal background.

Community Engagement and Ownership

Successful energy projects require the active involvement of residents, businesses, and local stakeholders. Energy communities thrive when members feel a sense of ownership and responsibility. Energy communities developed by citizens have the benefit of personally knowing their target groups, their concerns, means and needs. They often organize collective events and gatherings, which serve as an occasion to talk about the energy community in detail. In a top-down project, the target group has to be identified, and the appropriate participation culture needs to be established, whereas bottom-up initiatives have the advantage of developing that culture organically. Raising awareness on the benefits of the energy transition and providing training on energy management can empower communities to take an active role, making such actions an integral part of the management tasks. Ensuring that energy communities are inclusive and accessible to all socioeconomic groups is crucial for scaling up and replicability, as well as the sustainability of the project. Community engagement demonstrates the largest performance differential between cases, validating the findings of the REC design importance hypothesis. Social engagement pathways are highly context-dependent, yet predictable and deeply ingrained in the organisational structure. A sense of ownership is necessary for sustainability of the engagement, especially for the individual motivation to engage, and this is mainly determined by the type of energy community. Despite the different revenue models in some cases, financial viability did exhibit convergence. The community and member aspects are captured with the social, governance, managerial aspects, and the biggest difference between the two REC examples are within the social aspects.

Due to its nature and the rural context, the Austrian case (scoring 12 points in the social aspect) evolved from the efforts of active citizens who were well connected to the local village community. They developed a governance and management scheme that allows the integration of personal and individual aims, skills and ambitions as social activities, on voluntary basis. In the rural context, where the social activity landscape is rather thin, the combination of social and environmental activism under the umbrella of an energy project can be highly motivational. In the case of the Spanish REC, the business-driven and municipality supported (Private-Public) partnership falls short on the topic of citizen engagement (scoring 3 points in

social aspects) and needs to create more capacities in this regard. In terms of management and governance, both RECs have scored between seven and nine, which makes them good candidates to learn from regarding how to establish successful management in different conditions. They both could, however, utilise some capacity building to strengthen their management and governance scheme.

The Urtinsa energy community has successfully developed a business model in which the energy-producing investor collaborates with building owners, allowing them to partially consume the generated energy instead of paying rent for rooftop or surface use. Various forms of financial support, such as public-private partnerships, crowdfunding, and national or EU funding programs (for example, Horizon Europe), can help overcome initial barriers. Transparent revenue-sharing models for energy communities, including collective savings on energy bills, self-determined energy prices, or profits from selling surplus energy, can further encourage participation. Expanding the use of renewable energy technologies and energy-efficient solutions can also lower costs over time, improving the economic viability of such projects. Multiple financial models are viable, the particular choice depends on community values. Innovative benefit structures can overcome participation barriers. Justice-oriented projects must design low-barrier financial entry points (payment plans, sliding scales, energy-for-contribution swaps).

Scalability and Adaptability

Different energy projects and concepts can be integrated into long-term strategies and should be designed with modularity in mind. For example, a prosumer can begin with their own household or building, and gradually form an energy community, eventually guiding that community towards becoming a PED. This modular approach is particularly important for bottom-up initiatives that receive little or no support from professionals. These initiatives are unlikely to implement complex systems from the start, so their development pathway should allow for scalability and flexibility across different contexts, scenarios, and sizes. Documenting and sharing successful case studies, tools, and methodologies can support other cities and communities in replicating effective models. However, when replicating a project, it is essential to consider the spatial context, meaning solutions must be adapted to local conditions such as climate, available energy resources, legal frameworks, and cultural preferences. Innovative technologies like bladeless turbines were explored by Bürger*innenKRAFTwerk, specifically when considering the visual character of the heritage-protected site [30](19). The evaluation in the technical and process aspects create a basis for the scalability and adaptability aspects of energy communities. In the case of these two communities, both have obtained a scoring of 5 – 6 points for these two aspects, with the Spanish case scoring low regarding the process aspect. In essence both energy communities potentially have capacities to scale-up or out their REC, but due to other restrictions the different options are not yet explored and developed.

Monitoring and Evaluation

Establishing clear metrics for energy production, consumption, and community engagement helps track the success of an energy project and identify areas for improvement. Regular feedback and creating spaces for community members and stakeholders to come together and meet ensures that the energy project remains aligned with local needs and goals. Additionally, the results indicate that the inclusion of gender criteria [33] affects the prioritisation of actions. Without gender criteria, actions with a technical component are favoured. However, with gender criteria, actions involving social elements become more important. Additionally, gender criteria impact climate objectives, but not vice versa. The relationship between gender and climate criteria in policy actions is complex and context dependent but should be highlighted in the monitoring and evaluation of a community`s activities and development. While gender considerations can inform and enhance climate

policies, climate change itself can also have differential impacts on different genders and necessitate specific gender-sensitive responses. If no gender perspective is used in formulating urban decarbonisation policies, these can lead to the reproduction of the existing gender inequalities. In contrast, if policymakers formulate climate policies in cities with gender criteria, these can become a catalyser to overcome urban inequalities and contribute towards a more sustainable and equitable future. Social aspects play a significant role in evaluating vulnerabilities, inclusion, and social barriers. Regarding managerial aspects, equity considerations shape stakeholder engagement, managerial capacity development, and decision-making structures. For the community governance scheme of renewable energy communities (RECs), evaluating contributions to the common good and identifying governance failures can provide a balanced perspective on vulnerability issues. Neither case demonstrated fully developed monitoring and evaluation systems in our analysis, representing a gap in both models that limits learning for replication. Gender and equity criteria should be embedded in monitoring and evaluation frameworks.

Especially in regards of organisation and governance, both energy communities possess a good basis to assess the social contribution. The matrix allows cross-category assessment of the REC and determine where the strong and rather weak aspects of the energy community are. Using self-assessment to develop capacities and collaborations and re-assess conditions can deliver the justification (evaluation and monitoring results) to see the REC in all its aspects.

DISCUSSION

A comparative analysis of two contrasting energy communities provides empirical evidence addressing a critical gap in energy transition research. Corsini [34] examined 74,932 research publications and found that while technological advancements are extensively documented, the social dimensions of energy-related studies remain significantly underrepresented in academic literature. This gap is directly addressed by the hypothesis-driven case study methodology, which systematically evaluates how organisational structure affects justice outcomes across eight dimensions, particularly social, governance, financial, and participatory dimensions.

Two energy communities with ostensibly different starting points were examined in this article, with the purpose of exploring how social dimensions can be tackled when the main actors are the community itself. Keeping in mind that every community has its particular priorities, skill sets and trajectories, they all advocate for their own interests and therefore are an important player within sustainable energy transformations. Kalkbrenner and Roosen [35] examined how community identity, social norms, trust, and environmental concern influence participation in community energy schemes. They found broadly positive attitudes toward community energy, with greater willingness to volunteer than to invest financially. This served as a motivation to use the selected cases in which willingness is higher, given that members are already engaged and partially ready to invest. Rural residency and cultural heritage, like in the case of Bürger*innenKRAFTwerk, and renewable energy ownership further increase participation likelihood.The findings confirm Kalkbrenner and Roosen's [35] results, the centrality of social – not only environmental – motivations.

The key difference was the design of governance, not formalisation. The Austrian model lowered barriers by accepting citizens regardless of their energy contract status, while the Spanish model structured membership around energy production or property provision. Both were formally codified but had opposite implications regarding accessibility. This aligns with Kalkbrenner and Roosen's observation that community energy volunteering exceeds financial investment. The Austrian model offered participation pathways beyond capital investment, while the Spanish model required production capacity or property assets, excluding those with high willingness but low capital.

This finding contributes to energy commons theory, particularly Bauwens' [23] paradoxes of energy commons. Bauwens identified tensions between community logic, emphasising participation, equity, asocial values, and market logic, emphasising efficiency, return on investment, and professional management. The results empirically demonstrate that these tensions manifest as trade-offs in justice parameter profiles. Communities cannot simultaneously optimise all dimensions and must choose emphasis areas aligned with their core values. This also extends Giotitsas *et al.* [29] debate about whether energy commons can challenge capitalist structures or merely operate within them. The cases suggest a third possibility: value-driven selective optimisation. Communities intentionally de-emphasise certain dimensions (e.g., professionalised management in Austria, grassroots mobilisation in Spain) to preserve their core values. This is neither pure commons nor pure capitalism but strategic positioning within hybrid institutional logics.

This article promotes pro-environmental behaviours and highlights community energy's potential. It emphasises that community energy organisations can take various forms. The two-case design allows for deep comparative analysis but limits statistical generalisability. However, identified patterns, such as spatial trade-offs, complementary profiles, and value-driven emphasis, suggest underlying structural dynamics. The hypothesis-testing framework and PED Matrix methodology are replicable, so future research can expand case numbers to test these patterns across broader samples.

CONCLUSIONS

This study investigated how organisational structure affects justice outcomes in community energy projects. By comparing two contrasting cases, the citizen-driven Bürger*innenKRAFTwerk in rural Austria and the business-municipality partnership Urtinsa in urban Spain, the hypothesis was tested. The paper explored the relationships between governance formalisation, legal frameworks, organisational complexity, spatial context, and justice parameter performance.

The comparative analysis of the two case studies reveals notable differences across the evaluated dimensions. In terms of social inclusion, the citizen driven Austrian REC demonstrates a broad capacity to accommodate (comprehensive) the diverse interests of its members, predominantly private households, achieving a score of 12 out of 15. By contrast, the Spanish community of enterprises in its current configuration, exhibits a comparatively **limited** outreach to citizens, scoring 3 out of 15 currently. A similar divergence is observed in the integration of environmental objectives into community actions, where the Austrian case scores 9 out of 15 (moderate) against the Spanish case's 3 out of 15 (limited), reflecting the more embedded different sustainability aspects of the citizen-led model.

Regarding the legal framework, an inverse pattern emerges. Urtinsa benefits from its close collaboration with the municipal government, which provides access to a well-developed institutional and regulatory structure, resulting in a score of 14 out of 15 (comprehensive). The Austrian NGO, while able to draw on the knowledge and expertise of its members, operates within a more moderately developed legal framework, scoring 7 out of 15. In the domain of governance, both communities demonstrate comparable and moderate capacities, suggesting that this dimension represents a shared area of improvement regardless of the leading community, but signals that there is a good basis for governing the community already established.

Overall these findings indicate that targeted support in technical and process-related aspects would significantly enhance the impact and relevance of both RECs within their respective energy transition pathways.

The replication of energy projects with energy communities is feasible through tailored policy support, technological innovation, community engagement, and sustainable financing. A deeper

look on their benefit of empowering local actors and uniting them in a community is worth the effort, and the facilitating regulations and financial provisions throughout Europe could enable widespread replication. However, the energy transition's complexity demands a nuanced understanding of its drivers, as demonstrated by the analyses of two very different energy communities, in very different contexts, with different identities, revealing the risks of incremental approaches. Social dimensions need to be integrated into energy models to assess adoption barriers and societal acceptance, with governance and business model innovations playing a crucial role in decentralising energy systems.

Despite their potential, RECs face challenges, including limited awareness, path dependency on centralized infrastructure, and governance constraints, as seen in cases like Austria's underutilized capacity. A holistic approach, combining technological, social, and institutional reforms, is essential to foster resilient, community-driven energy systems. Future research should prioritize context-specific solutions that enhance participatory governance, local empowerment, and alignment with broader sustainability goals. Only through such integrated strategies can a just and inclusive energy transition be achieved, unlocking the full potential of renewable energy and energy communities.

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The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper. Any potential conflicts of interest have been fully disclosed to ensure the integrity and credibility of the research findings. This disclosure aligns with ethical standards in academic publishing.

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