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EUROPEAN JOURNAL OF SPATIAL DEVELOPMENT

Editorial

Place-based just transitions: exploring the links between policies and practices in Southern Europe

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Keywords

place-based, just transitions, urban and territorial governance, Southern Europe

Abstract

This special issue explores the concept of "place-based just transitions" and its implications for both research and practice. Energy and environmental transitions are understood as complex and multi-dimensional processes, embedded in material, social, spatial, and political factors. It is crucial to consider how transition processes affect cities and regions differently, including distribution of costs and benefits, acknowledging the diversity of actors and interests at play, and the relations with environmental, spatial, and social justice. A place-based perspective is particularly relevant, as initial conditions vary greatly across territories and the mechanisms triggered by transition policies can differ significantly can lead to different outcomes. Given this context, several questions arise: what approaches enable just transitions in policies and practices? How can social and energy justice be operationalised? And how it can be spatialised and adapted to existing systems and infrastructures? And crucially, to what extent do local dynamics shape the social and political outcomes of transitions? This special issue of the European Journal of Spatial Development addresses these questions by shedding light on the spatial and socio-political dimensions of transitions in Southern Europe (including Greece, Italy, Portugal, Spain, among others), namely a region that remains underexplored in international research, despite its wealth of socially rooted practices, hybrid governance models, and complex institutional geographies.

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Why places matter in just transitions?

The urgent global challenge of climate change and the need to reduce carbon emissions in energy systems have prompted various policies, investments, measures, and experiments to support an "energy transition." Academic interest in "transition(s)" partly stems from broader discussions on sustainable development, which gained momentum in the late 1980s and 1990s (Waas et al., 2011). Initially, energy system change was thought to occur mainly through the diffusion of new renewable energy technologies. However, it became rapidly evident that energy transition necessitates an integrated approach, able to take into account technical, economic, spatial and social factors (Geels, 2002; Sovacool, 2016). In other words, this entails a rethinking of how energy is produce, distributed and used, with implications for energy systems, environmental outcomes (direct and indirect emissions), economic elements (such as energy costs and technology), spatial settings (e.g., the location of infrastructure and the complexity of authorization procedures) and also social impacts (such as behavioural changes, greater user involvement, and the inclusion of marginalized groups). Such changes aim at mitigating climate problems, ensuring energy security, and promoting inclusivity, while emphasizing the goals set out in the 2015 Paris Agreement (UNFCCC, 2015).

In response to these challenges, the concept of a "just transition" has gained importance in both academic and policy circles. Originating in the late 20th century from labor and environmental movements in North America (Eisenberg, 2019), it initially addressed workers' concerns about the advantages and disadvantages of the shift to a low-carbon economy. Over time, the concept has expanded encompassing issues of equity, process, and recognition (McCauley et al., 2013; Lee and Byrne, 2019), together with social innovation to meet unmet needs (Moulaert et al., 2010; Bragaglia, 2021) often from a place-based perspective. At the EU level, it has become an integral part of the regulations and policies guiding the European Commission's agenda (European Commission, 2020). These policies include social justice objectives in the energy transition through the introduction of measures such as retraining programs, social inclusion strategies, and redistributive approaches (Newell & Mulvaney, 2013). The implementation of these measures differs depending on national decarbonization plans. While EU and national policies show broad consensus on technical, economic, and environmental aspects, there is growing recognition that transition is not socially neutral. The distribution of the costs and benefits of decarbonization is uneven and may affect certain regions and communities particularly hard. Specific groups, such as those living in energy poverty or workers in carbon-intensive industries, are at risk of facing disproportionate costs. These communities could lose the benefits of the transition and find themselves in economic hardship, often due to increased energy costs for households that cannot afford the necessary adjustments (Smiech et al., 2025) or face job losses (Jenkins et al., 2016; Heffron & McCauley, 2018).

To make these inclusive and redistributive policies work, the local socio-spatial and political aspects of the transition need to be considered. This has led to growing interest among scholars in a "place-based perspective" of energy transition, which emphasizes understanding the economic, political, cultural, and social characteristics of specific areas (Bridge et al., 2013; Coenen, Benneworth & Truffer, 2012). This approach recognizes the diversity of regional contexts and aims to adapt regional policies and local practices to available resources, institutional contexts, and social dynamics (Valkenburg and Cotella, 2016). It also encourages the active participation of local stakeholders, as described in detail in a multilevel governance framework (Hansen & Coenen, 2015; Kivimaa et al., 2019; Tricarico, 2018). This conceptual shift pushes the focus back to critical issues such as the distribution of costs and benefits throughout transitions, the actors and forms involved in decision-making, and how governance arrangements take into account multiple needs and rights.

Building on this new research agenda, we argue that the energy transition should primarily be seen as a matter of socio-spatial justice. This requires careful examination of solidarity, equity, and inclusion in the transformative processes (Luque-Ayala et al., 2018; Sareen and Haarstad, 2018; Heffron, 2022). This special issue explores how a place-based just transition can be defined, implemented in practice, and situated within specific energy systems. By focusing on Southern Europe—a region rich in innovative practices and diverse governance models—this issue looks at how local factors shape the social and territorial effects of transitions, especially regarding environmental and social justice.

Between policies and practices in Southern Europe

Over the past decades, the *just transition* slowly become part of European policy agenda. This change has been supported by regulatory frameworks to deal with the social and economic impacts of climate neutrality goals (Bergamaschi, 2020). At the European level, the adoption of the Clean Energy for All Europeans package in 2019, followed by the European Green Deal, marked a coordinated path towards decarbonisation (Pianta & Lucchese, 2020).

In this framework, the Just Transition Mechanism (JTM), as part of the European Green Deal, aims to address risks of uneven development, social exclusion, and labour market disruption that might arise from decarbonisation within the EU's climate and territorial agendas (European Commission, 2019; European Parliament, 2021). The JTM comprises a tripartite structure—including the Just Transition Fund, InvestEU support, and a public loan facility—designed to mobilise both financial and technical support in regions "*most affected by the transition*", with a particular emphasis on territories with high carbon dependency or structural vulnerabilities. In parallel, the Social Climate Fund aims to counteract the effects of the EU Emission Trading System ETS2, which is expected to drive up energy prices and could unevenly affect the most vulnerable households. Yet, as stated by Sabato and Vanhille (2024), the just transition dimension in the European Green Deal implementation remains uneven

and insufficient, with a number of gaps and limitations, referring, for example, to its scope, funding and level of coherence and comprehensiveness.

While these instruments reveal a normative shift toward greater equity in transition strategies, their operationalisation often remains bound within a compensatory rationale focused on mitigating the costs of industrial conversion. This approach tends to equate territorial justice with redistribution, thereby privileging macro-regional indicators of disadvantage and offering technocratic responses to socially embedded challenges (Rodríguez-Pose & Bartalucci, 2023). A growing body of critical scholarship has pointed out that such an approach risks reinforcing existing power asymmetries by prioritising already-institutionalised actors and regions capable of absorbing and deploying policy instruments effectively (e.g. Bouzarovski & Simcock, 2017; Barca & McCann, 2020). The prevailing emphasis on compensatory funding may obscure the broader systemic tensions underlying the transition, limiting the scope for more transformative and anticipatory policies.

Against this backdrop, recent research and practice show that the value of just transition lies beyond mitigation, in creating different development models through local and socially innovative strategies (Boeri et al., 2024). This broader interpretation calls for a reorientation of the just transition agenda—from an ex-post mechanism of redistribution to an ex-ante framework for guiding inclusive and participatory transformation (Filipovic et al., 2022). Rather than limiting justice to distributive metrics or macroeconomic targets only, this perspective also foregrounds procedural and recognitional dimensions, highlighting the role of community agency, democratic governance, and context-sensitive forms of action (Escario-Chust et al., 2023).

Such an orientation is particularly relevant in the Southern European context, where spatial fragmentation, institutional asymmetries, and persistent socio-economic vulnerabilities intersect with dense urban fabrics, ageing infrastructures, and hybrid governance arrangements. Within these settings, the implementation of transition policies frequently collides with material and cultural legacies, which in turn generate specific modalities of adaptation, resistance, and experimentation.

For instance, the experience of regeneration programmes in existing urban contexts—such as the cases of Rome and Bologna—demonstrates how environmental goals, when reframed through inclusive governance, can catalyse broader social transformations (Calzado 2024, D'Angelo 2025, Massari et al. 2024, and Rotondo 2024a). Rather than seeing large-scale interventions solely as tools for reducing emissions, these cases suggest that a just transition may operate as a vector for redistributing voice and capacity, particularly in marginalised neighbourhoods. Similarly, design-led approaches attentive to bioclimatic conditions, embedded energy, and community resilience point to the possibility of an expanded understanding of transition—one that considers energy not merely as a commodity, but as a socio-spatial relation mediated through forms of care, sufficiency, and commoning.

Moreover, collective energy actions, such as energy communities in Greece or citizen-led cooperatives in Italy, Portugal and Spain, are fostering decentralised models of production and governance, while also challenging technocratic narratives of transition (Massari et al. 2024, Margosi and Koukoufikis 2024, Pioletti et al. 2025, and Rotondo 2024b). These practices are not always recognised or supported by mainstream policy instruments, yet they reveal the importance of embedding transition pathways within everyday life, institutional cultures, and socio-spatial configurations.

Taken together, these trajectories invite a rethinking of the place of just transition within the European policy architecture. If seen through a local lens, just transition becomes more than just compensation for disadvantaged regions. It implies the creation of diversified and context-sensitive strategies that recognize territorial differences and promote systemic change from below. In this regard, the contributions collected in this special issue offer both empirical insight and conceptual tools for advancing a more relational and grounded understanding of just transitions—one that is attentive to the interplay between local dynamics, spatial configurations and broader institutional frameworks, and capable of informing a next generation of policies that are socially embedded, spatially aware, and democratically negotiated.

Mapping thems, approaches and case studies

As previously mentioned, the papers included in this Special Issue foster further reflections on a context-sensitive and relational understanding of just transitions in Southern Europe. On one hand, there is a focus on the energy rethinking of existing urban contexts (including heat networks, energy renovation of buildings, etc) at the intersection of transition policies, inclusive governance and urban regeneration programs, highlighting the importance of political, social, and spatial dimensions. On the other hand, attention is drawn to collective energy initiatives (such as energy communities, energy cooperatives, etc.) situated at the crossroads of territorial cohesion policies, grass-roots and collective practices, and transition policies, which raise questions of governance, economics, and politics. Finally, as a cross-cutting issue, there is a growing concern with political discourses and public perceptions surrounding just transition-related concepts.

From a methodological point of view, the approaches adopted range from single case studies to comparative analyses of multiple cases in Southern European contexts. In more than one contribution, a direct engagement approach by researchers within the case studies investigated emerges. In other words, analysing energy transitions from a spatial perspective often involves a research-action approach, which allows the author or authors to be directly involved in on-site activities and exchanges with residents, organisations, and institutions. As will emerge from the contributions, the research-action approach can be applied in various ways. For example, the special issue will present experiences of university public engagement

and living labs. This highlights the need to bring together multiple actors and encourage the emergence of community needs, as well as the collection of multiple sources of knowledge to support the co-construction of local action and the implementation of social innovations (Bragaglia et al. 2023, 2024).

Massari et al. explore the relationship between just transition and citizen action toward energy transition, particularly within the context of three collective energy initiatives in three Southern European countries. It offers meaningful insights about barriers and enablers that emerge in the promotion and implementation of energy communities in Bilbao and Bologna, and an energy cooperative in Lisbon. The authors offer an original perspective by focusing on communities and their interactions with institutions regarding involvement in decision-making processes, access to information and resources, and the interpretation of energy-related data and evidence.

Both the contributions of D'Angelo and Calzado offer insights and reflections about the energy rethinking of consolidated urban context and large housing estate, and adopting a single-case study approach. More specifically, Calzado's contribution unravels the dynamic interplay between new environmental considerations and the lifespan of housing estates within urban regeneration programs in the Corviale neighbourhood, Rome. To achieve this, it proposes a sociotechnical approach to study the interplay between the physical features of the housing estate and socio-political factors at the crossroads between architecture and political science.

From another point of view, D'Angelo's contribution lies in exploring context-sensitive tools and approaches in the case of the Ostiense neighbourhood, Rome, which enable the spatial design of place-based energy transitions. To this aim, three main research actions are proposed: the care of the existing, focusing on the existing spatial conditions and infrastructure, the spatialisation of energy behaviours and practice; and bioclimatic design, including an on-site training program for the transformation of public spaces

The contributions by Margosi and Koukoufikis, and Pioletti et al. offer complementary perspectives on the development of energy communities and their potential to contribute to energy justice and just transitions in Southern European countries. Margosi and Koukoufikis focus on the Greek context and present the findings of a survey aimed at investigating households' perceptions of energy justice, their awareness of and attitudes towards energy communities, and their willingness to participate in and invest in them. The discussion of the results brings into focus the complex interplay between structural factors, institutional enablers, and the discursive practices that shape these interactions.

Pioletti et al. examine the activation processes of energy communities through a comparative policy analysis at the regional level in Italy, Spain, and Switzerland. Their contribution places particular emphasis on spatial governance and planning, and on the role of regional and local authorities in supporting local activation processes. The approach offers

insights into the multi-level relationships between national regulations and instruments, the efforts and challenges of regional implementation and coordination, and the specificities and dynamics at the local level.

The contribution by Shaker and Persico presents a multidisciplinary exploratory study investigating just green transitions on social media. It offers a social network–based analysis, highlighting of dominant discourses and narratives, and framing the virtual space as a political arena. In doing so, it constitutes a meta-reflection that helps contextualize the broader debate on energy transition.

Conclusive remarks and perspectives

This special issue attempts to highlight a common issue: just transitions cannot be limited to compensatory measures or forms of distributive justice, but must also be the result of processes shaped by local histories, institutional cultures, and socio-spatial conditions. It also seeks to shed light on the links between socially innovative energy transition policies and practices. Communities and governance systems interact in ways that create both challenges and opportunities. Grassroots initiatives, energy communities, and locally-based energy regeneration projects illustrate how just energy transitions should involve community empowerment and the co-construction of a collective vision, drawing on everyday practices and experiments already implemented in local governance. At the same time, the context of Southern Europe reveals clear vulnerabilities—such as economic uncertainty, weak public institutions, and regional inequalities—that should be addressed systemically. These issues test EU and national policy instruments, but they can also foster experimentation and new forms of governance with a strong socially innovative character.

The cases from Southern Europe presented here can offer a broad overview of experiences that can provide fertile ground for debate. Looking ahead, three directions for research and practice appear urgent. First, broadening comparative perspectives across Southern Europe and beyond can reveal how different institutional and cultural contexts influence justice in transitions. Second, new methods such as action research, living labs, and participatory approaches can help co-producing shared knowledge towards a just energy transition. Third, further reflections warrant how transitions unfold over time, following different trajectories and how they intersect with policies on closely related issues such as housing, transportation, and welfare.

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EUROPEAN JOURNAL OF SPATIAL DEVELOPMENT

Research Article

Collective energy actions to pursue a just transition. A Southern European observation.

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Abstract

The EU recent energy policies aim to rapidly transition to a sustainable and citizen-centered energy system. However, many regulations do not fully acknowledge the social dimension of the energy transition. The interplay between individual and collective energy action (energy citizenship) and the just transition framework requires further examination. This paper aims to explore the relationship between just transition and energy citizenship particularly within the context of collective energy initiatives in Southern Europe, showcasing their association and varied impacts based on agency dynamics, contextual factors, and governance models. Additionally, the paper proposes new tools and analytical lenses to assess and govern/guide place-based collective energy actions, thereby complementing existing policy-making efforts.

Keywords

Just transition, energy citizenship, collective energy actions, South Europe

Introduction

The European Union's (EU) most recent energy policy initiatives have been geared toward a rapid transition to a more sustainable and citizen-centric EU energy system. These policies underscore the adoption of renewable energy technologies and more efficient energy use (Trevisan et al., 2023). At the same time, there has been a surge in mobilizations led by more or less organized citizens and activists (Boulanger and Massari 2022), putting forward grassroots initiatives that intervene in the socio-political debate on climate and energy transition. In this framework the potential effects of collective energy actions could be very meaningful, proposing changes at the global level on the one hand and the adoption of practical measures within communities and their own homes on the other. Citizen involvement in transforming households into a proactive energy system (Jansma et al. 2023), by producing their renewable energy, contributes to adjusting their consumption to more sustainable patterns. Accelerating the transition to sustainable energy requires not just a shift to low-carbon solutions but also an essential reconfiguration of energy needs and consumption habits: it appears indeed crucial to adopt new approaches to energy conservation and sobriety (Laurent 2020) nurturing a culture of energy as a vital but finite resource.

Moreover, the inclusion of citizens in energy-related decision-making processes, especially when it reveals existing inequalities and steps to overcome them (Jenkins et al.

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2016, 2018) influences community response and adoption of decarbonization solutions. Involving users in key decisions and actions for energy savings (Ryghaug et al. 2018) is widely recognized as essential to intervene in the habits of a society accustomed to consuming massive amounts of energy. Collective energy production, management, and consumption must become central to the public debate and widely recognized as leverage for just transition (Szulecki and Overland 2020). This approach is supported by recent EU legislation that gives communities and individuals the right to generate, store, consume, and sell their energy (European Commission 2016; 2019a; 2019b; 2021; 2022). These regulations are worth a first step away from the conventional view of citizens as passive price takers or presumed recipients of technologies (Boeri et al. 2020; Boulanger et al. 2021). However, what appears overlooked by these regulations is the socio-behavioral facets of the energy transition, as solely technologically driven and market-centered policies are inadequate to evoke citizen action or endorse policy decarbonization solutions (Lonergan et al. 2022).

The current literature and policy landscape highlight a significant knowledge gap, particularly in the absence of operational guidance that effectively empowers both individual (Trevisan et al. 2023) and collective actions within the combined socio-technical domain of the energy sector (Olivadese et al. 2020; Jansma et al. 2023). Meanwhile, many engagement methodologies outlined in existing literature inadequately link to the dynamic framework of just transition, thereby diminishing their relevance to policymaking (Lonegarn et al. 2023). This lack of alignment reduces the support for both policymakers and citizens, impeding the successful implementation of energy transition policies.

Additionally, while there is a global interest in the growth of energy transition, the interpretation of a just energy transition varies depending on the context. Countries like Spain, Portugal, and Italy are experiencing significant growth in collective energy transition initiatives. Despite their heavy reliance on fossil fuels, there has been a growing interest in renewable energy sources (Soeiro and Dias 2020), making them valuable case studies for countries aiming to enhance citizens' participation in the energy transition. Therefore, it is essential to examine both the energy citizenship initiatives and the enabling (or hampering/inhibiting) context for their emergence, operationalization and management. The impacts of these collective phenomena which use energy to shape shared actions in the cities and territories are still not enough investigated in southern European regions, where the richness of natural resources does not match a fast policy action regarding their utilization (ibid. 2020).

To address this, the link between collective energy action, described here as energy citizenship (Walker and Devine-Wright, 2008; Schlindwein and Montalvo, 2023) and the three-tenet framework of just transition applied to energy (Lee and Byrne 2019) requires further elucidation and study. By harmonizing these perspectives, it is possible to offer a more robust and holistic analysis of energy transitions, effectively addressing respective challenges

and providing new methods for overcoming many of the barriers that citizens face in energy participation: in particular, exclusion and lack of ability to interact with important stakeholders - whether other citizens or institutional actors - lack of access to appropriate information to support decision making, and difficulties in understanding and interpreting data and other energy-related information. Bridging this gap would contribute significantly to understanding how societal engagement in energy initiatives aligns with the principles of justice, equity, and fairness, providing valuable contextual insights for both academia and policymakers.

In this scenario, this study aims to establish the empirical link between energy citizenship and just transition within the framework of collective energy initiatives in Southern Europe. The research will examine the varying impact of these initiatives by considering the interplay of agency dynamics, contextual factors (Šćepanović et al. 2017), and governing models employed (Avelino et al., 2021). Insights into how the enabling or hindering context influences outcomes can be gained through this exploration.

The second objective is to explore new avenues for nurturing energy citizenship within specific contexts. This involves developing novel tools and analytical frameworks for evaluating and governing place-based collective energy initiatives, complementing policy-making efforts (Manzo and Devine-Wright, 2020). This approach aims to promote a comprehensive understanding of the complexities involved in fostering a just transition through community-driven energy projects.

To achieve this, the paper comprises an in-depth analysis structured into four key sections, each serving a distinctive purpose. Section one initiates the exploration by clarifying essential concepts and objectives. It defines the notions of energy citizenship and just transition and delves into their synergic frameworks, acknowledging their limitations and proposing an integrative approach. Building upon the theoretical foundations, section 2 delves into the policy landscapes of three distinct Southern European countries, intricately connected to the H2020 GRETA[1] project's case studies. Through detailed case studies, section 3 examines the deployment of novel supporting tools within three collective energy initiatives. In the final section, the paper culminates in a comprehensive discussion that synthesizes the empirical findings with the theoretical framework established earlier.

Objectives and methods

This paper aims to explore the potential convergence of aspects of the literature on energy citizenship and just transition to arrive at a comprehensive analysis to be verified in empirical cases of collective energy actions located in Southern Europe. The goal is to facilitate a

[1] H2020 GRETA – Green Energy Transition Actions (GA 101022317) is a Research and Innovation project funded under the topic H2020-LC-SC3-2020-NZE-RES-CC. The consortium is composed of twelve partners coordinated by LUT University. www.projectgreta.eu

nuanced examination of the multifaceted dimensions of collective energy actions, particularly those closely tied to localized contexts.

This paper used different qualitative methodologies (Hunter & Brewer 2015) (Figure 1) such as qualitative literature review carried out using a snowballing approach, with keywords search on both Google Scholar and Scopus, to identify pertinent literature on energy citizenship and just transition; qualitative data gathering through participant observation of three selected context in Southern Europe while undergoing empirical iterative testing of collaborative trajectories (Energy Citizenship Contracts and Community Transition Pathways) aimed at guiding energy citizens from various levels of just and fair interplay within the energy system.

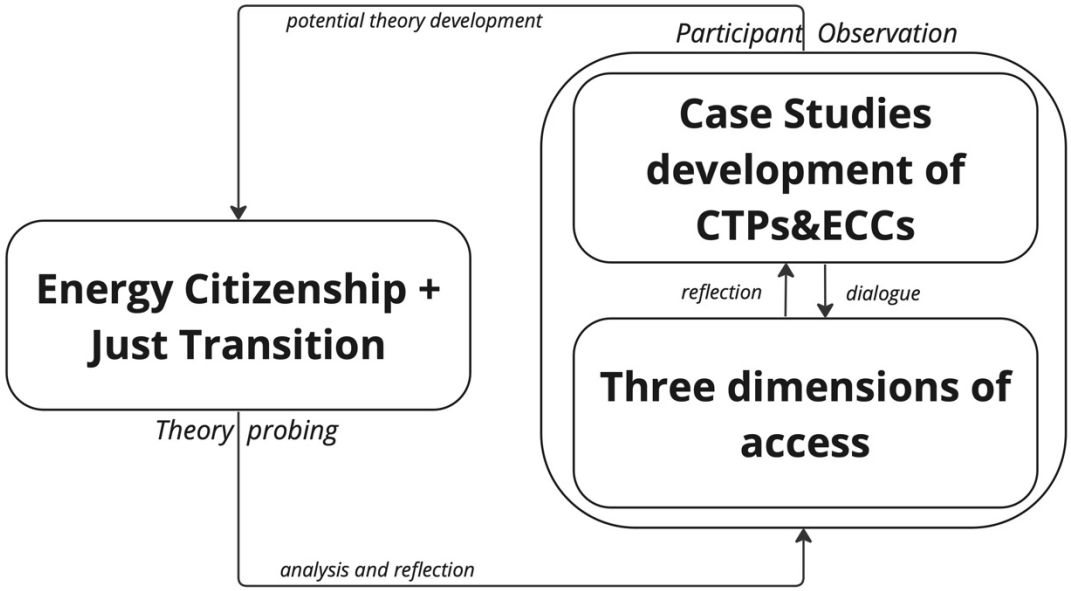

Figure 1 – Abductive research methodology adapted from Kovács & Spens (2005, p. 139)

Employing an abductive scheme (Timmermans & Tavory 2012) this research delves into selected experiences in Southern Europe, which constitute a subset of the cases examined under the GRETA project a research and innovation project focusing on investigating the factors that enable or hinder the development of energy citizenship. Abductive reasoning is applied to design a flexible research approach, adaptable to explore and incorporate diverse theoretical and empirical perspectives, facilitating a comprehensive understanding of the topic without stifling potential conflicts or dissenting views.

The selected representative case studies served as both an observation and test field to verify and adapt initial hypotheses (Groat & Wang 2013): the UrBeroa energy community in Bilbao (Spain), the Coopernico energy cooperative in Lisbon (Portugal), and the emerging Pilastro-Roveri energy community in Bologna (Italy).

Data gathering was facilitated through participant observation, made possible by the involvement of researchers in the GRETA project. This qualitative research approach establishes direct contact with the experiences under scrutiny (Kawulich 2005, Clark et al.

2009). Participant observation served as a cornerstone of the methodology, enabling the researchers to immerse themselves in the context of the case studies. Through active engagement with the communities and stakeholders involved in collective energy actions, researchers gained firsthand insights into the dynamics, challenges, and opportunities associated with these initiatives. This approach encompassed both data collection and descriptive information obtained from documents (websites, reports, articles) related to the case studies, thus highlighting critical aspects. By adopting this methodology, a profound understanding of the lived experiences and perspectives of the actors within the energy transition systems was achieved. Participant observation incorporated iterative testing of tailored initiatives, where energy citizenship can actively contribute to just transitions, ensuring that the benefits of sustainable energy are equitably distributed. This iterative process involved the refinement and adaptation of two interconnected collaborative tools co-developed based on the evolving needs and responses of the case study communities: Community Transition Pathways and Energy Citizenship Contract.

This abductive research process recognizes the dynamic nature of the experiences described, impacting various dimensions of the relationship between energy citizenship and justice. Thus, continuous navigation between empirical observations and theoretical concepts enhances comprehension of both theoretical frameworks and case studies as well as develops a context-sensitive approach to ensure that the research remains relevant, meaningful, and sensitive to the unique circumstances of each case study.

Energy Citizenship in a Just Transition Framework

Energy Citizenship and its Growing Significance

Citizens' participation and activation (Jansma et al. 2023) have been at the forefront of recent energy transition policies. As the recognition of the pivotal role of citizens in the energy transition grows and establishes itself in academia and policy, the concept of "energy citizenship" emerges as a valuable framework for examining the local conditions that either enable or hinder citizen action toward energy transition. It represents an "umbrella term" to describe the various ways in which citizens are actively involved in the energy transition, whether as consumers, users or through political engagement in protest movements to influence the institutional direction of change (Schlindwein & Montalvo 2023). Preliminary scholarly definitions suggested that within energy citizenship the public is conceived as active rather than passive in energy system evolution and framed by notions of equitable rights and responsibilities across society for dealing with the consequences of energy consumption, notably climate change (Devine-Wright, 2004). This and similar definitions point to the human and social dimensions of the energy system, focusing rather on a shared collaboration on a fair, equal and right-based set of actions to address decarbonization through mainly

collective behaviors and initiatives. The concept seems to move beyond individualistic approaches - centered on energy technologies and personal consumer investment - to include collective spaces of participation (Ryghaug et al. 2018), psychological (Devine-Wright 2012) and behavioral commitment (Schlindwein & Montalvo 2023).

Energy citizenship highlights a precise connection between the rights and duties of individuals or a group of individuals (Lennon et al. 2020) and the different domains of energy (Devine-Wright 2012; Wahlund & Palm 2022). It defines that energy should be accessible to all who enjoy a citizenry status and how these are responsible for better management, consumption, and production of it (Longo et al. 2023).

Nevertheless, a necessary clarification entails an understanding of the concept of citizenship. Throughout history, the dynamics of citizenship have undergone significant transformations (Hildebrandt et al., 2019). Citizenship is seen here as a performative concept (Ryghaug et al. 2018), shaped by ongoing political and social struggles to define who can or cannot be considered a subject. This perspective extends beyond traditional citizens to encompass non-citizens as well, recognizing them as relational actors within diverse social groups asserting their rights. That means to approach citizenship not merely through juridical rights, but as embodied, practiced and performed acts, a process of becoming (Hildebrandt et al. 2019). According to this perspective, individual and collective energy actions can be identified as performative expressions of citizenship and explored as one of the many possible ways to navigate energy transitions by making both citizens and non-citizens claim energy rights.

This claim can also take more problematic and contradictory forms, as in cases of opposition and contestation of renewable energy installations and projects. Critical or oppositional stances toward prevailing energy policies, practices, or systems are still involved in the discourse, albeit in an agonistic way (Silvast and Valkenburg 2023), raising concerns, proposing alternatives, and advocating for change within the energy sector. These cases often conceal broader concerns that affect the history and development of an area and its people, and which cannot be reduced to the use of the NIMBY (Not in My Backyard) label. Furthermore, not all energy initiatives are fair and inclusive, as they tend to engage specific categories of users and members of the community who have the knowledge, power, connection, and possibility to participate without compromising their daily life necessities or without depriving themselves of time to devote to work, family, study.

Finally, not all energy citizenship initiatives take place in fertile contexts (politically, geographically, etc.). The contexts in which transition is territorialized are often characterized by power differences, given the hybridity of actors and their networked interactions (Sareen and Haarstad 2018). This involves considering the often-neglected individuals, communities, and territories in energy policies, emphasizing the heterogeneous nature of the citizenry, prompting a critical examination of how involvement influences the ways citizens engage and

are categorized acknowledging both intended and unintended forms of citizenship as meaningful and legitimate.

Just Transition Perspective

Just transition has garnered substantial attention within the realm of energy studies, drawing interest from various academic disciplines over the past decade (Jenkins et al., 2016). While there has been a growing focus on the justice aspects of the energy system (Walker and Day, 2012), a gap remains in understanding the intricate relationship between justice and the emergence of energy citizenship (Lee and Byrne 2019; Olivadese et al. 2020). Furthermore, exploring how the concept of just transition translates into practice is essential, as it not only serves as an analytical framework, but it also influences policy development and provides an ethical basis for decision-making in the energy sector (McCauley et al. 2013).

The just transition perspective accentuates the importance of integrating principles of justice into energy transitions. Over the decades, just transition literature has extensively explored the influence of social power relations on shaping energy systems (Sovacool 2021). From this viewpoint, it is important to recognize that collective energy actions may not necessarily benefit all social groups equally, highlighting disparities in access and participation. Not every citizen may have access to community decision-making processes or the opportunity to shape the advantages, roles, and benefits associated with individual or collective energy actions.

Scholarly discourse has extensively reflected to integrate energy-related considerations with principles of justice, aimed at addressing the emergent and crucial concerns - social, economic, political, environmental, and more - that the process of decarbonization has brought to the fore (Sareen and Haarstad 2018). These principles are centered around achieving equitable distribution of costs, fostering inclusivity in decision-making processes, and acknowledging diverse vulnerabilities (Heffron and McCauley 2017; Lee and Byrne 2019).

This perspective naturally leads to the recognition of disparities and imbalances in various dimensions. These inequities manifest in the unequal apportionment of costs and benefits resulting from energy development (distribution justice), in the access to energy decision-making (procedural justice), and in the political recognition of different types of vulnerabilities with specific needs related to energy services (recognition justice). These issues are particularly evident in underserved and vulnerable communities, where power imbalances often hinder effective challenges to the marginalization of social values in energy decisions (Bridge et al., 2018, Lee and Byrne 2019).

Expanding upon this line of thought, the insights of Jenkins et al. (2016) emphasize the procedural justice dimensions, particularly in relation to inclusion mechanisms. They argue that achieving a just transition requires three key elements: mobilization of local knowledge, dissemination of information, and institutional representation. Incorporating local knowledge into decision-making processes can have a significant impact on policies, but only if technical

resistance is taken down and eliminated. Additionally, active participation requires transparent disclosure of information and accessible mechanisms of involvement, allowing for real-time feedback loops to address distributive injustices. Moreover, ensuring better representation in public and private institutions offers a proactive approach to achieving representative justice, ensuring responsiveness to communities affected by injustice.

Overcoming Limitations Through Integration

Although the perspectives on energy citizenship and just transition enrich our understanding of the impacts of the transition on society, they are nevertheless limited. One of the primary challenges of energy citizenship is ensuring the inclusivity of citizen participation. Certain segments of society, such as marginalized or less empowered communities, might struggle to engage effectively due to resource constraints or lack of awareness. Moreover, energy citizenship frameworks sometimes struggle to bridge the gap between individual and collective actions. While emphasizing collective engagement, they need to accommodate individual behaviors and preferences that play a significant role in energy consumption patterns. On the other hand, the perspective on just transition often neglects the intricate complexities involved in the practical implementation of energy transitions. The focus on justice and equity may overshadow pragmatic challenges, including economic viability and technological feasibility. Indeed, this perspective alone risks to not consider the feasibility and the complex and contradictory work involved in implementing energy transitions - implementation, economic investment, technological development, and user behavior.

Therefore, it is imperative to explore how dimensions of justice intersect with those of energy citizenship, as well as the multiple connections between energy transition, active participation, and the potential reproduction of unjust and unequal socio-ecological relations. Rather than favoring one branch of literature over the other, the attempt is to leverage the strengths of both while identifying common ground for discussion. While energy citizenship is a newly developed concept compared to just transition, their relationship is intriguing as they both stem from local dynamics (Valkenburg and Cotella, 2016).

On the one hand, energy citizens bring situated knowledge that can inform practical energy transition deployment. This citizen-driven innovation can improve the feasibility of technological solutions by incorporating on-the-ground insights and providing a useful framework for economic viability.

On the other hand, just transition allows acknowledging the heterogeneous circumstances across countries, sectors, and economies, mandating a context-sensitive approach, heavily reliant on localized insights and solutions (Muttarak et al., 2021) but also aware of the necessary structural societal changes (Catney et al 2013).

This imperative underscore the necessity of evaluating and monitoring the conditions underpinning the emergence of collective energy actions in specific contexts (Avelino et al.,

2021) requiring exploration where geographical analysis assumes paramount importance. The geographical context intricately shapes the implementation and success of energy citizenship initiatives, thereby influencing the journey towards territorialized and just energy transitions.

The two integrated frameworks highlight the need to address exclusion and barriers faced in energy transition research and the importance of considering justice principles. On this basis, we argue that an inclusive approach is useful to consider the removal of barriers to relational, institutional, knowledge access.

Relational access refers to the ability of communities to interact with multi-level stakeholders and be represented in public and private institutions (Sovacool 2021). To foster relational access, appears crucial to formalize infrastructures that facilitate representation and relationship-building. In the realm of energy initiatives, forging strategic alliances appears essential, ensuring transparent citizens' roles and concerns complement institutional perspectives (Valkenburg and Cotella 2016). These alliances should embrace diversity, incorporating the participation of various actors, both established and emerging. A more expansive representation within the community enhances the ability to influence decision-making, ensuring a comprehensive consideration of diverse interests.

Despite concerted efforts to cultivate relationships among communities, institutions, and stakeholders, persistent power imbalances may endure, particularly in marginalized communities. These communities often lack the resources and influence needed for effective engagement, resulting in diminished visibility. Such disparities not only impede relational access but also escalate potential conflicts, misunderstandings, and biases.

Institutional access refers to communities' proximity to appropriate information and resources that support decision-making and enable action within institutions. It has been recognized that the inclusion of just energy dimensions in other policy sectors such as employment and social policy might lead to the breaking of established political divisions, policy siloed thinking, which is crucial for effective fair energy use and management (Heffron and McCauley 2017; Olivadese et al. 2020). Measures to support it entail capacity-building in navigation and accompaniment in policy, legislation, subsidy reading, and interpretation. Technical assistance and skills development should be incorporated as drivers for institutional access to avoid ambiguity or lack of transparency. Despite the openness of these measures, limitations may arise if institutional responsiveness is limited. Even with formal channels for community engagement, institutions may not always be receptive to community input or may only pay lip service to community concerns. Furthermore, when access is granted, it is important to imagine a medium-long-term commitment plan, encouraging the institutional level not to abandon demands and the commitment to make them come true, for example when a government changes, as it is often occurring in the South of Europe. In this regard, the success of collective energy action is expected to be measured by their ability to endure, grow and evolve.

Knowledge access refers to the understanding and interpretation of data and other evidence related to energy. Enhancing technical expertise within communities (encompassing residents, vulnerable people, workers, city users and policymakers) is essential for fostering access to necessary skills, critical concerning equality (Martins et al. 2020). A robust strategy for promoting energy literacy involves collaboration with educational institutions, workshops, and community-specific resources. For example, collaborating with educational institutions and hosting workshops can equip community members with foundational knowledge about energy systems, renewable technologies, and energy policies (Lane et al., 2014). This approach helps build a knowledge base that contributes to informed decision-making (Martins et al. 2020). Moreover, facilitating inner knowledge-sharing among participants fosters a collective learning process that strengthens their capacity to address energy-related challenges—a powerful mechanism of peer-to-peer sharing and circular knowledge creation. This approach nurtures a circular process of collective learning, enhancing communities' capacity to navigate complexities and fostering a sense of ownership and empowerment.

This inclusive perspective serves as a guiding framework for addressing barriers and inequalities within three case studies located in Southern Europe. By integrating this perspective into the analysis, the project aims to achieve a multifaceted exploration of energy citizenship dynamics while considering how the distribution of the transformation costs impacts inequalities and pre-existing vulnerabilities. It emphasizes the role of citizens and the necessity to remove barriers related to relational access, institutional access, and knowledge access in the energy transition.

A Southern European context on Collective Energy Transition

Diving deeper into the three selected case studies of Portugal, Italy and Spain, this section shows the presence of energy citizenship-related policies, with the aim of critically understanding which is the current starting point and the potential future developments. It offers a comprehensive overview of the policy context in these countries, elucidating the broader regulatory frameworks within which the collective energy actions unfold. It sheds light on the contextual nuances that shape the local energy transition pathways, thereby setting the stage for the subsequent case study data gathering via participatory observation and empirical testing of transition trajectories.

As reported by Sareen et al. (2018), Portugal, especially its southern part, has a huge potential in using solar-generated energy. At the same time, the authors report the presence of high energy poverty rates and the necessity for the country to import energy from abroad. In this context, the country shows a strong political inclination to implement local solar energy generation. This can be traced back to the first years of the century, with the starting of different policy initiatives and pilot projects. Among them, the most important ones to be recalled are synthesized as follows. The first one to be mentioned is the National Energy and

Climate Plan - Plano Nacional Energia e Clima (PNEC) for 2021-2030 which sets ambitious targets to reduce by 55% emissions (compared to 2005), increase energy efficiency by 35%, reinforcing the weight of renewable energies by 47% and increase the electricity interconnections by 15%. These targets align with Portugal's commitment to the European Union's Energy Union strategy. To facilitate citizen participation, Portugal has established a legal framework for energy communities through Decree-Law No. 162/2019. This framework enables citizens to form community-led initiatives for renewable energy production, consumption, and trading. It empowers citizens to collectively own and manage renewable energy projects, fostering local ownership and engagement. The framework provides a clear structure for the establishment, operation, and governance of energy communities, ensuring transparency and accountability in decision-making processes. As reported by Klein et al., in 2022, the Portuguese energy policy context experienced a significant development with the inclusion of Citizen Energy Communities (CECs). Decree-Law 15/2022, enacted on January 14, 2022, transposed EU Directives 2019/944 and 2018/2001, marking the first incorporation of CECs into Portugal's energy framework. CECs are defined as legal entities formed through voluntary participation and aim to provide environmental, economic, or social benefits rather than pursuing financial profits. They can engage in activities such as renewable energy production, distribution, sale, consumption, aggregation, energy storage, and energy services. CECs have similar regulations as Renewable Energy Communities (RECs) but with added capabilities such as owning closed distribution networks and engaging in energy activities irrespective of the energy source being renewable or non-renewable. This development demonstrates Portugal's commitment to citizen participation and empowering communities in the energy transition. Several projects and pilot experiences are also underway in the country to assist citizens on their journey toward an energy transition empowered by the community. The Portuguese Renewable Energy Association (APREN), for example, supports the creation of solar energy communities and the increase in renewable electricity generation through the creation of a supportive network of renewable energy producers.

In Italy, many policies in the energy sector are present to support the growth of collective energy actions. The country has implemented a range of policies and initiatives to advance its energy transition and promote energy citizenship in line with the European Commission requests. It is committed to reducing greenhouse gas emissions and increasing the share of renewable energy sources in its energy mix. The National Energy Strategy (SEN, 2017) provides a general orientation and planning strategy for national energy policy, setting the objectives of enhancing the competitiveness of the country to reduce the gap between the energy price and costs, of achieving the decarbonization goals identified by the European Commission. The SEN has been the political and planning platform for the following adoption of the National Integrated Plan for Energy and Climate (PNIEC) in 2020. This plan establishes the national goals by 2030 on energy efficiency, renewable energy and CO2 emissions

reduction as well as the goals on energy security, interconnections, single energy market and competitiveness, development and sustainable mobility and the necessary measures to take in order to ensure the achievement. First Decree Law 162/2019 and then Decree 8/2020 set the conditions for the activation of collective self-consumption from renewable sources and the creation of a renewable energy community, starting the experimentation of a framework of rules aimed at allowing final consumers and/or energy producers to join for "sharing" the electricity produced locally by small-sized plants powered by renewable sources. Even if the law and the following Directives and Decrees support the creation of energy communities, some limitations are still present. On the one hand, the electricity must be locally produced by new small plants (maximum power 200 kW) located near the users of the group of self-consumers (in the case of self-consumers who act collectively, the systems must be located within the confines of the condominium, while in the case of an energy community, the plants must be connected to the network served by the secondary transformer substation - from medium to low voltage - under which the users who are part of the energy community must also be located). Some of the constraints present in these decrees were solved with the implementation of the RED II European Directive through the Legislative Decree 199/202. However, as also recalled by Trevisan and colleagues (2023) the implementing decree which would have made more precisely operative the 2021 Legislative Decree 199 is not yet ready. This is one of the possible causes of the slow pace of the creation of new energy communities in Italy (Musolino et al. 2023).

In Spain, many policies directly manage and operationalize actions around energy at the community level, in line with the European request. The first one is the Long-Term strategy for a Modern, Competitive and Climate Neutral Spanish Economy in 2050, set in 2020. This strategy responds to the commitments of Spain as a Member State of the European Union and with the Paris Agreement and sets the path to achieve climate neutrality. It is a roadmap to move forward towards climate neutrality within the horizon 2050, with intermediate milestones in 2030 and 2040. Due to its time frame, the strategy is built on the basis of technology neutrality, and the different technologies have the same development opportunities to offer the best cost-efficient solutions for the decarbonization of different sectors of the economy, taking into account externalities and degree of maturity. Inside this strategy, self-consumption is present, even shortly, in the context of promoting social participation in achieving renewable energy targets and setting citizens in the centre of the transition. The second important policy is the Integrated National Energy and Climate Plan (2021-2030, NECP), set in 2021, which is the new national energy and climate plan developed by the Spanish Government to meet the objectives and goals of the European Union in the framework of energy and climate policy. Inside this plan, there is a specific measure about individual and collective energy actions, that include assessment of the existing barriers for development of energy communities to ensure that they can produce, consume, store and sell

renewable energy, in particular through renewable electricity purchase contracts, as well as have access to all appropriate energy markets, both directly and through aggregation. The energy communities should be allowed to own, establish, acquire, or lease distribution networks and manage them autonomously, as well as to access all organized markets. The country also has specific Decrees on energy communities. The Royal Decree 244/2019, issued on April 5th, establishes the administrative, technical and economic framework for the self-consumption of electrical energy in Spain. This decree represents a pivotal step in energy policy, as it eliminates the taxation previously imposed on self-consumed energy and outlines the essential regulations governing energy self-consumption. The royal decree introduces a new definition for energy self-consumption, defines rules for access and permits, introduced two modalities of self-consumption including: "self-consumption without surpluses", which does not permit discharges of energy to the grid and "self-consumption with surpluses", in which discharges can be made to the distribution and transmission networks.

Given the described policies, it is evident that there is a significant presence of regulations and laws related to energy, including energy communities, in all three cases. Many of these laws align with European Commission resolutions rather than being standalone initiatives, although empirical experiences in the three countries have been identified, as demonstrated by Trevisan and colleagues (2023). The access, transformation, and distribution of renewable resources in Southern Europe face significant challenges, primarily due to the dominance of large private energy companies in the market, which limits access to energy grids by cooperatives or communities. Capellán-Pérez et al. (2018) observe that Southern European countries like Spain, Portugal, and Italy possess strong potential for renewable resources but still lack space for local and democratic energy projects. This constraint can be attributed to various factors. For instance, Portugal boasts a high percentage of wind energy and geothermal resources, but has only recently begun to focus on electrification and hydrogen (Fernandez & Ferreira 2014). In Spain, the decentralized government system requires effective coordination between regional and central authorities to enact successful energy strategies, leading to bureaucratic bottlenecks (Heras-Saizarbitoria et al. 2018). Additionally, Italy has raised its climate ambitions by aiming for carbon neutrality and has made efforts to reduce reliance on Russian natural gas imports through diversification (Esposito & Romagnoli 2023). However, despite these efforts, a flexible legislative framework and supportive policy environment are still hindering the emergence of collective energy actions in the country, where such enabling conditions are currently lacking.

It is also worth mentioning that the policies mentioned do not show a distinct emphasis on energy citizenship and strategies to support its development. This could be attributed to the novelty of the concept. However, it is interesting to note the absence of a direct link between the potentialities of the Mediterranean climate and the challenge of energy poverty, as highlighted by Bardazzi et al. (2023).

The GRETA Project and Preliminary Results

Following the policy framework of the three countries and to demonstrate the analytical value of the synthetic approach between just transition and energy citizenship, three case studies have been selected as examples, showcasing the empirical application of this combined perspective. As already mentioned in the methodology section, the cases have been intentionally chosen from experiences in Southern Europe, which are among those analyzed under the H2020 GRETA project. GRETA, a research and innovation project initiated in 2021 and concluded at the end of 2023, focuses on investigating the factors that enable or hinder the development of energy citizenship across local, regional, national, and transnational dimensions. This research establishes five distinct objectives:

- describing the identity and characteristics of energy citizens by delineating who these energy citizens are, their demographics, motivations, and affiliations within the energy system;
- detecting how energy citizens engage and interact within the energy domain, through the exploration of their behaviors, collaborations, and participation in energy-related initiatives and decision-making processes;
- devising effective strategies, approaches, and models that facilitate and promote energy citizenship;
- scaling the project's outcomes from local to regional, national, and even supranational levels;
- enhancing the policymaking process by creating roadmaps for decarbonization that prioritize and integrate energy citizenship, the project aims to provide policymakers with actionable insights to encourage robust citizen participation in the energy transition.

The project involves a comparative analysis of diverse case studies, wherein it contributes to modifying certain soft conditions, primarily through participatory pathways, to transition from a state of minimal awareness to heightened activation towards energy-related matters.

For this paper, two main outputs are considered interesting to add insights into the research questions: the Community Transition Pathways (CTPs) and the Energy Citizenship Contracts (ECCs). CTPs are operative and intervention-led transition routes designed with and for communities at different geographical levels (ranging from local to supra-national) to expedite their energy transition, encompassing both mitigation and adaptation actions. Implementation of CTPs aims to enhance energy citizenship across these geographical levels, empowering and engaging communities in addressing decarbonization and promoting a clean and equitable energy transition.

CTPs served multiple purposes: 1) facilitating multi-level communities in establishing a clear trajectory towards deeper engagement within the energy system; 2) assisting policy and

decision-makers in supporting the transition of cities and territories by integrating well-defined pathways into the existing European policy framework; and 3) enabling local associations and committees to forge stronger partnerships with citizens, fostering an inclusive transition. In the three case studies, Community Transition Pathways were developed through participatory processes aimed at first describing the level of preparedness of the community towards decarbonization (declaring knowledge, commitment, potential for resource allocation of both policymakers, businesses and community members); second at defining a series of collaborative actions that the communities could take to build transitions towards the consolidation of energy citizenship (dividing them into short and medium term achievable goals, potential resources to unlock and alliances to establish). CTPs incorporated diverse ideas and practices of transitions, by outlining specific actions and steps that the community is willing to take to move towards the established decarbonization goals. This may include investing in renewable energy sources, improving energy efficiency in apartments and blocks, promoting active mobility, and fostering community education on sustainable practices. This approach emphasized the need to diversify knowledge and engage a range of actors in decision-making processes, acknowledging that models are more valuable as "learning machines" rather than as definitive sources of truth (Turnheim and Nykvist, 2019; Berkhout et al., 2002). By considering different perspectives and narratives regarding the direction and nature of change, diverse pathways of transformation can emerge that deviate from conventional approaches, aligning more closely with emerging alternatives. Following this, CTPs accounted for changing technological, geopolitical, policy circumstances, being designed to be adaptable and flexible to accommodate evolving needs and opportunities.

Energy Citizenship Contracts (ECCs) represent a subset within the upcoming Climate City Contracts (CCCs) framework, which forms the basis for the ambitious "100 climate-neutral cities by 2030" initiative put forth by the Mission Board for Climate Neutral and Smart Cities to the European Commission (EC). The ECCs provide a framework for fostering collaboration between stakeholders, facilitating energy interventions such as the establishment of self-producing energy groups, associations of self-consumers, energy communities, and other services and activities related to energy and resource conservation. The contracts are tailored to the unique circumstances of each case study through a multi-level and co-creative process. They will encompass three key elements: 1) establishing goals and targets for the community to accelerate its energy transition, 2) defining the transition strategy and action plan, and 3) identifying stakeholders and their corresponding responsibilities. Each case study's community is responsible for outlining its own ECC, which will strengthen and regulate the relationships among the parties involved in the energy system, within each specific context. As operational facilitators, the ECCs have clear objectives and engage various stakeholders on a voluntary basis. The primary aim is to establish a mutually beneficial context that enables activities related to energy sustainability and community well-being, proposed and

implemented by citizens, associations, businesses, and other interested parties within the specific context.

The construction of both the CTPs and the ECCs and the identification of their constituent elements have been open to participation from all interested individuals and groups from the case studies. Explaining the territorial context in which the three selected case studies are situated not only clarifies the spatial drivers and barriers influencing the emergence of energy citizenship, but also enables informed case selection and enhances result comparability.

Pilastro-Roveri Renewable Energy District

The Pilastro-Roveri Renewable Energy District, situated in the northeastern part of Bologna (Italy), is a mixed-use area built in the 1960s. The district comprises two zones: Pilastro with residents predominantly living in public housing or in cooperative-managed buildings, including owners and renters, and Roveri, predominantly industrial. Originally designed as a self-sufficient "village" with local services and artisanal activities, Pilastro unfortunately lacks these amenities, resulting in a single-purpose residential neighborhood that has become a source of social and economic challenges. This area also accommodates numerous associations, reflecting a longstanding tradition of collaboration on different policy matters. The municipality acknowledges that the area is affected by energy poverty crises. However, energy considerations were not previously prioritized by these associations, potentially excluding segments of the already engaged population from community activities. In Pilastro area, a group of property owners recently established the Promoting Committee for a REC to facilitate the creation of the first REC in Bologna.

Roveri area is characterized by a high concentration of small and medium-sized enterprises, particularly in precision mechanics. The area's warehouses make it attractive for companies interested in joining and establishing a REC due to available space and roofs.



Figure 2 - View from the district heating plant in Pilastro and a part of the social housing dwelling

From a policy perspective, the Municipality of Bologna is actively promoting the establishment of energy communities within the city, using Pilastro-Roveri as a pilot area. This commitment is remarked by the most recent development of planning tools and regulations, such as the new urban plan extensively dedicated to resilience, the city participation in the Mission for 100 climate-neutral cities, and the climate adaptation strategy (Boeri et al. 2018). While these initiatives might serve as crucial steps towards fostering energy citizenship in the city, their regulatory and normative nature, strongly subject to the energy market, does not easily accommodate the specific requirements of the community in terms of energy engagement.

The participant observation activities in the area provided partial insights into the social and power dynamics of energy-related actions. The area has been involved in a series of participatory activities aimed at first defining the CTPs vision, actions and main resources. To support the vision, a co-developed ECC was created to serve as the primary tool for raising awareness and sensitizing both institutions and marginalized segments of the population. The ECC established clear roles, commitments, and benefits for the energy citizens of the Pilastro and Roveri areas. The precondition of ECC was for all stakeholders to share a common energy justice vision for all future interventions they plan and implement. While participation in the ECC is voluntary, it was designed to monitor the progress of energy transition collective action officially and transparently.

The activities allowed to observe how these tools could mediate the emergence of energy citizenship by tackling in particular the non-existent interactions among the actors, and asymmetries across the knowledge access of the community members. Residents of Pilastro and workers in Roveri demonstrated different levels of commitment towards energy. The inhabitants of Pilastro generally lacked awareness regarding opportunities to enhance energy efficiency in their homes, workplaces, and recreational spaces. Nevertheless, they expressed willingness and commitment to participate and seek information. In contrast, Roveri's workforce exhibited awareness and interest. Businesses are regarded as "prosumagers" (producer-consumers), however, it is challenging to classify them as a geographical community, let alone fully leverage the potential of the entire Pilastro-Roveri district.

In terms of relational access, the power imbalance elicits the struggle to represent the diversity of voices within a community (in terms of age, gender, culture, etc.), especially in Pilastro, where the average age of residents is high. This limitation has always resulted in the exclusion of important perspectives and in compromising the effectiveness of relational access. The establishment of formal channels for community engagement and representation through the ECCs was effectively oriented towards advocating for their interests and ensuring that the concerns of diverse groups are considered during the energy transition.

Pilastro-Roveri members experienced a blockage in institutional access. Moving from ideation to materialization of collective energy actions is critical due to a lack of experience on the topic both in communities and in institutions. For example, although the promotion committee for a REC is highly active, citizens still require a top-down change facilitated by a leadership role from local institutions. Simultaneously, given the absence of prior experiences with REC projects in institutions, it remains unclear who should take the initiative first, resulting in a general impasse. This lack of functional collaboration can undermine the institutional access provided by any transition-supporting tool. Overall, the co-design of operative enabling tools has allowed for the generation of interactions, through which biases and knowledge gaps among participants were deconstructed, creating comparability between their realities. Through bridging events, promoters of a technology/initiative related to energy (often coming from Roveri) and the actors who could benefit from it (residents of Pilastro) were able to explore each other's worlds and articulate socio-technological and future cooperation scenarios.

The participant observation of the development of both CTPs and ECCs in the community of Pilastro-Roveri allowed to register how participants have been increasingly motivated to act, both individually and collectively, to improve energy-related behaviors. However, they recognize the need for a group of gatekeepers who are generated by local and contextual associations, who can lead and organize stable processes linked to energy and appropriate to the community living context. Partnering formally with local grassroots organizations that are already embedded in marginalized or vulnerable communities could guarantee the genuine

integration. In this domain, ECCs were co-created as platforms for community representation, conversational objects and direct communication channels to share concerns and collectively influence decision-making processes in a structured process.

These gatekeepers would be also responsible for knowledge access, providing technical expertise on energy matters, ensuring the commitment of all stakeholders involved, and guiding the overall energy actions.

Coopérnico renewable energy company

Coopérnico, a renewable energy cooperative, is a non-profit institution that crowdfunds photovoltaic power plants and collaborates with a supplier to provide virtual solar electricity to its members at competitive rates. Founded in 2013 by 16 citizens who aimed to support sustainable development, Coopérnico allows its members to simultaneously be customers and owners of the energy cooperative. Since its inception, the cooperative has attracted many new participants, reaching a current count of 2,295 members.



Figure 3 - Coopérnico crowdfund model realized on their headquarters in Lisbon. Source: Coopernico

The renewable energy cooperative focuses on economic and environmental benefits for society, by adopting home energy management systems that enable better monitoring and understanding of energy usage. It envisions a complete transformation of the energy sector, gradually increasing the number of citizens committed to a decarbonized and socially equitable society. It relies on spillover and network effects stemming from its expanding customer base, as well as national lobbying and community engagement activities.

Environmental consciousness is deeply ingrained among Coopérnico members, and they are unwilling to invest in production that carries significant environmental consequences, such as large-scale solar projects.

Currently, Coopérnico is actively pursuing investments in decentralized collective self-consumption and Renewable Energy Community initiatives, aiming to distribute the benefits among local consumers of this renewable electricity. Currently, its trajectory relies on voluntary engagement, coordination of local groups, and other voluntary contributions. In doing so, the cooperative supports governments, citizens, municipalities, and councils in their efforts to establish Renewable Energy Communities in Portugal.

For the GRETA project, Coopérnico conducted internal deliberations regarding methods to enhance the active participation of its members in cooperative activities. The consensus has been reached that further expansion is essential, necessitating the allocation of a dedicated budget to engage a professional capable of fostering cooperation among the volunteer members. This endeavor calls for increased investments in both human resources and skills advancements, considering the availability of platforms that facilitate the voluntary involvement of community members.

The CTPs developed in Coopérnico allowed to establish a hierarchy of objectives and actions leading to highlight three main objectives to accomplish: the need to broaden its array of renewable energy generation sources; Coopérnico endeavors to strike a balance between renewable production and the technical challenges it presents; the aim to facilitate processes that guide already energy-active citizens towards more extensive community action, akin to activism, in driving a clean energy transition.

This final objective aligns with the potential of the ECC here co-created as a container platform, which is expected to take the form of a digital environment, thereby fostering greater citizen participation and engagement within the cooperative. Successfully attaining this objective would result in half of the councils in Portugal having energy cooperatives for renewable self-production by 2030, with Coopérnico itself transitioning into an energy retailer. This accomplishment would ensure that the cooperative possesses adequate policy influence to shape legal framework developments that are better suited to the cooperative's reality, ultimately placing them on an equal footing in the energy market.

As Coopérnico experience shows, by building collective knowledge, ECCs can facilitate institutional access serving as knowledge hubs, providing communities with information about energy systems, technologies, and policies. Actors involved in the delivery or concretization of individual or collective energy actions in Portugal often find limitations and barriers to access to clear and long-term institutional support. Bureaucratic-administrative barriers were frequently mentioned as bottlenecks by the Coopérnico members who feel only supported by its members (i.e., citizens and companies) as opposed to all other stakeholders with decision-making power (e.g., the government, the regulatory entity, other companies in

the sector, the energy network operators) – who are seen with mistrust given the long-lasting, pending power imbalance between energy cooperatives and traditional market players. While the legislator states that it tries to accommodate a citizen-centered view on the development and implementation of enabling legal frameworks (while still considering the needs of other stakeholders), energy citizens see that as resistant to the democratization of the energy sector. This is due to the slow pace of policy development, perceived governmental inertia, feeling that the government backs up the energy monopoly (against citizens and cooperatives), and lack of incentive mechanisms to support them in the clean energy transition.

To solve this, the experience of ECC development in Coopérnico included reflections about how to empower community members to make informed decisions, understand advantages and benefits, and not only actively participate in energy-related discussions but also advocate for it. Knowledge and information on technical, financial, legal, and market operation matters are considered fundamental to engaging in the clean energy transition – along with continued learning of good practices stemming from academia and the market, as well as knowledge on the code of conduct of cooperatives in the case of Coopérnico's members.

For this purpose, the creation of a dedicated desk aims to offer technical expertise and resources to support community-led projects, enhancing communities' capacity to improve their engagement with institutions.

Ur Beroa energy cooperative

Ur Beroa, an energy cooperative established by residents of a high-income neighborhood in San Sebastian, Spain, has provided domestic hot water and community heating services to its members since 1985 when community members assumed control of the private company responsible for these services. Currently, the cooperative has 570 members and supplies its services through district heating based on cogeneration systems.

The cooperative is located in a neighborhood with a low social mix and low unemployment rates. These factors suggest a community that likely possesses a high level of education and technological engagement. This favorable environment and the abundance of renewable technologies in the neighborhood have so far facilitated the acceptance and embrace of climate-related issues as shared challenges. This aspect benefits from active collaboration due to the prevalence of longstanding associations and participation in social and energy-related fields, including consumer groups and neighborhood associations.



Figure 4 - Aerial view of the Bera-Bera Neighbourhood where UrBeroa is based

The active presence of a neighborhood association (Ragrupamiento de Comunidades del Polígono de Bera Bera) aimed to secure favorable economic conditions, ensuring that partner remuneration aligns with the cost of services, supplies, and general cooperative expenses. However, while the cooperative current membership represents a generational continuity, the absence of generational and socio-cultural renewal within the cooperative may pose challenges in addressing the evolving needs and perspectives of the community. As time progresses, there is a risk of losing diverse viewpoints and innovative ideas that a younger generation could bring to the table. Moreover, without a formal representation mechanism, important voices and concerns may go unheard, potentially hindering the cooperative's ability to adapt to changing circumstances and emerging challenges.

In this scenario, the work conducted with the Ur Beroa community has set forth several primary objectives for their CTPs, including a significant expansion of the member base, augmentation of energy services, and implementation of collective renewable energy-based self-consumption. The initial steps towards achieving this envisioned future are anticipated to be completed within a five-year timeframe. These steps entail the exploration of collective self-consumption and the establishment of additional energy services and socio-technical infrastructure, tailored for the community. Realizing these ambitious goals necessitates an improved understanding among Ur Beroa members and the management office of energy technology development trajectories, particularly in their adaptation to the community scale. For these purposes, they also need to navigate public policies, legislative frameworks, and potential subsidies available for investments related to expanding activities. Moreover, the

cooperative must address the challenge of generational renewal. It falls upon the new generations and residents to sustain the cooperative and enhance energy awareness and engagement among members. Lastly, the implementation of planned actions requires substantial financial resources and collaboration among various stakeholders, including cooperative members, residents in surrounding neighborhoods, public administrations, project promoters, technology providers.

Ur Beroa's aim to expand its members base, resonated with a stronger support to relational access. In particular, the diversification of the community members would have granted a larger part of the younger generation to commit to a longer-term effort in the area's energy transition. In response to that CTP offered a less technical tool and a community-led process, to set the basis to empower communities from different age groups to actively participate in shaping energy policies and projects. ECC further supported that, by proposing the establishment of advisory boards comprising representatives from various demographic segments to offer input on project decisions and informal communication channels and pathways to make sure different voices and perspectives are heard.

The co-creation of the ECC for Ur Beroa allowed to formalize these efforts and facilitated the organization and coordination of multiple actors at different levels, uniting them around a comprehensive set of actions aimed at the overarching objective of expanding and diversifying the cooperative's membership, particularly in terms of age demographics. The ECC and its co-design were considered as a forum for strategic discussion – something that is not taking place during the ordinary meetings of the cooperative – allowing less-active members of the cooperative, external actors and potential stakeholders, to participate and start building a common and shared vision and priorities for the future of the cooperative and beyond.

Regarding knowledge access in the case of Ur Beroa, ECCs and CTPs may face limitations in providing comprehensive training and support, particularly in complex areas such as energy systems analysis or policy interpretation. This can hinder (current or future) community members' ability to fully understand and utilize energy-related knowledge. For these reasons, the ECC is proposed as "Declaration" to play a pivot role in improving accessibility and clarity of information by promoting energy literacy within communities through interaction with existing educational programs and infrastructures, workshops, and awareness campaigns. This integration can also constitute a recruiting tactic to get closer to different additional potential members of the communities, also at an earlier age.

Discussion on Lesson Learned and Bottlenecks

In the context of this paper's inquiry, the implementation of new tools and analytical framework to accompany, foster and guide the energy transition at the local level allows to dialogue and build further reflections on emerging literature.

The empirical observation of the CTPs and ECCs deployment in the case studies has yielded valuable insights and lessons that contribute to the advancement of relational, institutional, and knowledge access as an integrated framework for just transition and energy citizenship. While the findings remain limited to specific case studies and contexts, they offer essential reflections on the interplay between these concepts.

The critical role that energy citizens play in guiding just transition efforts emerges as a framework encompassing both a lens for analyzing transition policies and projects and a contingent process subject to dynamic interactions among actors, technologies, and institutions.

Following the lesson learned from the three case studies, we can discuss the potential for ECCs and CTPs in addressing the three lenses of intersection between energy citizenship and just transition: relational access, institutional access, and knowledge access.

	Barriers	**Case studies**	**Enablers**	**Case studies**
Relational access	Power imbalance	Pilastro-Roveri community members are not homogeneous in their interests for participation in collective energy actions	New and different actors' representation -- Integration of vulnerable communities -- Formalization of infrastructures for representation and relationship-building	Pilastro-Roveri ECC became a formal channel for communication and engagement. -- Pilastro Roveri ECC included partnership with grassroots organisations. -- Ur Beroa CTP paved the way for an informal process to engage younger generations. -- Ur Beroa included an advisory board with various demographics in the ECC
Institutional access	Unclarity, impasse --	Pilastro-Roveri members face impasse in implementing	Knowledge hub on policies, regulations,	Coopérnico ECCs offers technical expertise and resources to

	Institutional unreceptiveness and resistance -- Mistrust and skepticism	ECCs' actions for lack of experience on the topic both in communities and in the institutions	subsidies navigation -- Long term institutional commitment	support community-led in their engagement with institutions.
Knowledge access	Lack of comprehensive support for a complex subject	Pilastro-Roveri members exhibit resistance to addressing energy issues, which stems from their experience of social fragilities, which, in their perception, appear more pressing and immediate than the concerns related to the energy transition.	Enhancement of technical expertise (training) -- Interaction with existing education programme -- Peer-sharing	Ur Beroa and Pilastro-Roveri included in their ECC the possibility to interact with existing educational programmes incorporating energy engagement as subject. -- CTPs and ECCs development in the three cases incorporated internal peer-exchange sessions with members of the communities -- Coopérnico ECC will function as an accelerator platform for technical skills for collective energy actions

Table 1 - Energy Citizenship and Just Transition dimensions

Examining the case studies of Pilastro-Roveri, Ur Beroa, and Coopérnico sheds light on how these dimensions are either granted or hindered in these specific contexts.

Examining the collective energy actions efforts in Pilastro-Roveri, Ur Beroa, and Coopérnico reveals notable lessons for the three dimensions of access hypothesized. Pilastro-Roveri highlights the need to address power imbalances by formalizing communication

channels and partnering with grassroots organizations to foster inclusivity. In facing institutional access barriers, the case underscores the importance of establishing knowledge hubs and ensuring long-term commitment for effective navigation of complex regulatory landscapes. Ur Beroa introduces a nuanced approach by combining formal and informal strategies, engaging younger generations and diverse demographics in advisory boards. The interplay of knowledge and relational access is evident in Ur Beroa, where participation in educational programs and internal peer exchange sessions breaks down knowledge barriers and cultivates collaborative learning. Coopérnico strategically positions itself as a knowledge enabler, offering technical expertise and resources to empower communities for active participation in collective energy actions. Collectively, these insights emphasize the significance of inclusive representation, proactive engagement with institutions, and a balanced blend of formal and informal strategies for fostering strategic collaboration and knowledge empowerment as pivotal factors in overcoming barriers and guiding future endeavors in community-led energy initiatives.

It is important to recognize and address both risks and limitations and opportunities to ensure that ECCs and CTPs can effectively promote relational, institutional, and knowledge access while minimizing potential drawbacks. By actively working to mitigate the challenges, strategies can be adopted to bolster the longevity and impact of collective energy initiatives. Strategies for diverse representation, institutional engagement, energy literacy, and peer-to-peer learning should be thoughtfully employed to mitigate challenges and amplify positive outcomes. These findings offer a just transition roadmap for fostering equitable participation, informed decision-making, and the sustainable advancement of energy citizenship within communities. However, rigorous and additional empirical testing remains essential to ascertain their actual impact and determine their role as drivers of the energy transition, ensuring that policy decisions are grounded in tangible evidence and community needs.

A final observation involves the engagement of academia as participant observer in these processes. The selected research methodology holds the potential to address the challenge of recognizing the researcher's experience in a manner that not only avoids undermining but rather enhances the research. An abductive approach aims to foster a spirit of inquiry, especially when the researcher is in close proximity to the phenomenon under study and the source of the data.

Given their independent and informed position, researchers can advocate for the equitable representation of marginalized voices, by implementing a reflexive approach aimed at de-structure participants' biases. This ensures the commensurability of research results, that every voice is heard and considered and that decision-making processes encompass a multiplicity of perspectives (Matschoss and Heiskanen 2017), extending beyond token inclusivity that might hinder meaningful involvement.

Conclusions

This paper highlights the necessity of integrating perspectives on both energy citizenship and the justice dimensions of energy transition. Within the context of collective energy initiatives in Southern Europe, three lenses—relational, institutional, and knowledge access—have been proposed as key points of convergence and integration between these frameworks, pending verification in specific contexts. The integrated framework has been illustrated in the empirical material derived from the H2020 project GRETA, maintaining an analytical focus on these aspects while developing supporting tools for collective energy action experiences.

In the context of environmental and energy policies at both EU and national levels, planning and decision-making processes increasingly incorporate citizenship involvement. However, it is vital to consider how empowerment activities truly impact citizens' opportunities for engagement and influence over process outcomes. Similarly, the extent to which citizens can influence decision-making processes concerning urban, economic, social, and environmental choices must be examined. User empowerment is considered crucial for the energy transition, facilitating the rebalance in the relationship between actors in energy systems and directing their trajectories of development and transformation. Yet, the usual debate on the duties of citizens in the energy transition often ends up proposing an idea of citizen(s) as a universal subject with an abstract interest, erasing differences and productive conflict. According to this approach, the field of action that the citizen-consumer can traverse is limited to purchasing choices in the private sphere, eluding any political discussion of how collective organizing and the sharing of mutual interests and responsibilities can help address both the environmental crisis and the technical, social and cultural changes required by the energy transition. Consequently, engagement on energy topics cannot be separated from citizens' rights to information, awareness, guidance, and training to exercise their rights collectively.

CTPs in their long-term dimension and the enabling tool of ECCs hold the potential to raise awareness, establish roles and commitments, and monitor progress in energy transition goals. The assumption posits that ECCs and CTPs are perceived as promising mechanisms by communities and policymakers for driving active community engagement within the energy transition. GRETA's communities have requested their adoption and policy makers have acknowledged their importance in policy implementation. This demand signifies a grassroots desire for greater involvement in shaping energy policies, indicating that these tools are perceived as empowering mechanisms to facilitate community engagement. Despite this recognition, the call for further empirical testing highlights the need for concrete evidence supporting the assumption of ECCs and CTPs as fundamental elements of the energy transition.

In the case of the Pilastro-Roveri district, UR BEROA and Coopérnico, ECCs and CTPs serve as leverages to enhance citizen participation, engagement, and collective action.

However, challenges in overcoming financial, technological, and generational barriers underscore the need for increased investments and community engagement oriented toward policy adjustments.

The examination of the case studies reveals interconnected insights that might operationalize the intersection of energy citizenship and justice. Central to these conclusions is the shared commitment among stakeholders towards advancing socio-environmental objectives; entities such as cooperative members, individuals grappling with energy poverty, and business actors exhibit intrinsic motivation towards participating in the transition towards clean energy, often leveraging their own social, cultural, technical and financial resources to facilitate this transition. However, significant operational and political challenges impede their progress.

Operationally, they often encounter complexities inherent in the clean energy transition, necessitating expertise across technical, financial, market, social, and legal domains. Conversely, political constraints arise from the perceived unresponsiveness or disinterest of decision-making entities, including governmental bodies and energy distribution networks, in fostering a genuinely citizen-driven transition.

However, they benefit from support provided by academia and local associations, as well as decentralized public administration bodies such as neighborhood councils and energy agencies. These entities furnish essential technical, financial, and legal expertise, thereby fostering socially just decarbonization efforts. Nonetheless, this support engenders a non-structured co-dependency between these entities and energy citizens. In this regard, the establishment of centralized institutional support mechanisms, such as dedicated information agencies for facilitating the implementation of RECs, monitoring energy poverty emergence, or expedited transposition of EU Directives, emerges as a salient recommendation. Such measures would lend structure and equilibrium to the clean energy transition, mitigating prevailing energy justice disparities and power imbalances.

In this context, academia emerges as a crucial facilitator, ensuring institutional access and providing a focused approach to addressing pertinent issues. Scholars serve as interpreters and translators, bridging scholarly insights with practical applications to empower community members for informed decision-making and contribute to the long-term sustainability of such endeavors.

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Conflict of interest

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Research Article

Fostering Energy Justice through Decentralised Transition: The Case of Energy Communities in Greece

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Abstract

This paper explores the potential of Energy Communities (ECs) as a conduit for achieving energy justice and a just transition in Greece's energy sector and promote socio-economic development. It provides an overview of the relevant framework of climate governance strategies, positioning the role of ECs in these. The paper presents a comprehensive country-level survey (n > 1000) investigating Greek households' perceptions of energy justice, their awareness of and attitudes towards ECs, and their willingness to participate in or invest in ECs. The findings highlight the challenges and opportunities of ECs in Greece's energy transition and suggest the need for increased public awareness, equitable energy policies, and inclusive decision-making processes. In the context of the ongoing energy transition in Greece, the article argues that energy communities although possessing a valuable agency and mobilise a widely accepted discourse that can contribute to a just transition promoting social and environmental justice, require further institutional enablers in order to challenge the structure of the current socio-economic status quo.

Keywords

Energy communities, Just transition, Energy justice, Greece, Citizens' engagement

Introduction

Given the urgency of the climate crisis, there is an increasing demand for transformative change and innovation within the energy system. Governments are facing the pressing task of swiftly reducing greenhouse gases emissions in a system that is growing in complexity, which inherently poses risks (Hampton et al., 2021). In Europe, since the early 2000s, the European Union (EU) has consistently followed a relatively progressive path in climate governance, with a notable increase in ambition and a broader range of policies. Significant progress has also been made in integrating climate policies into other areas. This upward growth trajectory was marked by the introduction of the European Green Deal (EGD) (Fetting, 2019) in late 2019, a package of policy initiatives, that aims to set the EU on the path to climate neutrality by 2050 (Von Homeyer et al., 2021). The energy sector is one of the major sources of greenhouse gas emissions globally, through the burning of fossil fuels for electricity generation, transportation, heating, and major industrial processes. As a result, the decarbonisation of the

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sector and its transition to a renewable energy- based system is essential to address climate change effectively. Consequently, a lot of policy attention is directed to the sector while the implications of the Russia-Ukraine war in the energy security of Europe further strengthened EU's commitment to the phase-out of fossil fuels and accelerated the clean energy transition, as new, targets that are more ambitious and strategies set via the REPowerEU plan[1].

One of the main non-technological challenges of the clean energy transition is to achieve it in a socially equitable manner. The debate surrounding "just transition" involves addressing social and economic inequalities, promoting fairness and inclusivity, and ensuring that vulnerable communities, workers, and regions aren't disproportionately impacted by the transition. The concept originates from the labour movement and concerns the fair treatment of workers and communities as economies shift towards more sustainable practices, including the energy sector. This concept has evolved to include broader considerations of social justice, particularly in relation to climate change mitigation efforts (Newell and Mulvaney, 2013; Heffron and McCauley, 2018).

Just-transition goals to address the challenges of energy insecurity, energy poverty, and climate change necessitates the mobilisation of new financial resources, the development of innovative technologies, and significant reforms to institutions and policy-making processes, are rather important for economic development, social equity and environmental protection (UN, 2015). Institutional top-down target-setting work on this domain had been framed as access to sustainable and affordable energy became part of the United Nations Sustainable Development Goals and the EU's European Pillar of Social Rights. Along the emergence of initiatives, policies and new regulatory frameworks aiming to the energy transition were standing out, like the c*lean energy for all Europeans* package, which was approved in 2019, aiming to the decarbonization of the European Union's energy system, aligning with the objectives of the EGD.

In parallel, the EU's long-standing cohesion policy via its strong territorial dimension promotes integrated territorial and local development strategies, in order to address the diverse development needs across Europe's cities and regions while helping the less developed European countries and regions to catch up (Pertoldi et al., 2022). The goal of a balanced and inclusive participation of countries, regions, businesses and individuals is also shared in the energy policy domain and largely expressed via the just transition narrative. In the framework of a just energy transition to a sustainable and low-carbon future, balanced territorial development is essential. It incorporates the notion of comprehensive and integrated energy and development strategies that take into account the special qualities, assets, and requirements of a particular region or territory. This underscores the crucial role of localised

[1] European Commission, Communication REPowerEU Plan: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A230%3AFIN 2022.

initiatives in fostering fairness and inclusivity in the transition towards sustainable energy practices.

Integrating Energy Communities (ECs) into the energy transition and territorial development strategies may be a key tool of effective policy making in both areas. Indeed, since the 2000s, many countries, as the Netherlands, Germany and the UK, had put together ambitious visions about how to become 'energy neutral', 'zero-emission' or 'low carbon' (Van der Schoor, 2016), and aimed to stimulate local energy production capacity on an individual as well as a cooperative basis.

The mentioned "Clean Energy for All Europeans" EU policy package formally acknowledges ECs as a new participant within the European energy system. Furthermore, it recognizes the crucial role that ECs can potentially fulfil, as they embody principles of equity and inclusivity in line with just-transition goals. Indeed, ECs may assume a transformative role in territorial development and the pursuit of a just transition. These communities can empower local actors by actively involving them in the generation, distribution, and consumption of renewable energy through decentralised and community-driven projects. By championing localised energy production and democratic decision-making, ECs generate economic diversification, job opportunities, and the retention of economic benefits within the region. Moreover, their emphasis on community ownership and participation fosters social cohesion and inclusivity.

By stimulating the growth of community energy projects, a multitude of benefits for energy consumers that align with the principles of energy justice is anticipated. The concept of ECs revolves around facilitating collaborative energy initiatives that emphasise open, democratic participation, and governance. The overarching goal is to deliver benefits and enhance resilience for the members of local communities (Caramizaru & Uihlein, 2020). EC initiatives adopt diverse legal structures. While some initiatives may not necessitate a specific legal form, community ownership often requires the creation of a legal entity capable of entering agreements, assuming responsibilities, and conducting activities on behalf of its members. Throughout Europe, a wide range of legal forms has been utilised, including cooperatives, partnerships, community interest companies, foundations, non-profit organisations, various types of social enterprises, and associations (Roberts, 2020).

Given the above framework, this paper aims to fill a knowledge gap regarding just transition trajectories in Southern Europe. We present and analyse public perception survey data to provide a comprehensive picture of the current state of energy justice and energy communities in Greece, contributing to the broader conversation on how to achieve a more equitable and sustainable energy future. A significant novelty in comparison to most studies examining the links of just transition and ECs regards the fact that in those usually the object of analysis is existing ECs themselves and their stakeholders (Bommel & Höffken, 2021; Lupi et al., 2021; Hanke & Guyet, 2023). Our analysis focuses on broader public opinions of non-

energy community stakeholders, and includes awareness and knowledge of ECs, attitudes towards ECs, demographic and socio-economic data, perceptions of energy justice, and barriers to participation. The paper's insights serve as valuable inputs in aligning development strategies with the principles of energy justice, fostering a holistic approach to sustainable and inclusive energy practices at the local level.

Energy Justice and Energy Communities

Energy justice plays a significant role in a just transition by addressing fairness and equity issues within the existing energy system that is often extractive in nature. The concept has emerged as a framework that integrates concerns about the social and ethical aspects of energy production, distribution, and consumption. It is closely linked to the principles of deep democracy, cooperation, and regeneration, which are all key components of the just transition framework, while can serve as an analytical conceptual, analytical, and decision-making tool (Sovacool and Dworkin, 2015). Indeed today, energy justice has become a pressing issue, with experts advocating for actions to avoid perpetuating or creating new inequalities during the energy transition (Heffron 2022; Jenkins et al., 2020). Rather than solely focusing on implementing new technologies, developing a new energy system should prioritise creating a fair and equitable distribution of both the benefits and burdens of energy services and encourage inclusive decision-making (Sovacool et al., 2017).

The literature on energy justice often centres around three key principles: distributional, procedural, and recognitional, which have been discussed in various studies (Jenkins et al., 2016; Sovacool and Dworkin, 2015). This represents an expansion of the broader environmental justice debates, describing recognition, participation and capability as key justice components, in the energy field (Schlosberg, 2007). According to Goldthau and Sovacool (2012), distributive justice is concerned with ensuring that the entire population has access to and shares in the advantages of the energy industry. In order for each stakeholder to participate fairly in the decision-making of energy infrastructures, procedural justice focuses on the legal side of energy justice (Thomas et al., 2020). The importance of both formal and substantive equality is emphasised by recognitional justice (Pellegrini-Masini et al., 2020). By emphasising on the diversity of all people and the need to engage them in the energy transition, recognition is a strategy to address distributional and procedural fairness (Heffron and McCauley, 2017; Walker and Day, 2012).

The current discourse in energy community literature revolves around the inquiry into whether ECs facilitate a fair, democratic, and just transition in the energy landscape. ECs. has been perceived as a potentially perfect embodiment of energy citizenship and energy democracy (Strachan et al., 2015), and already address pressing social issues like energy poverty (Koukoufikis et a., 2023) though their actual social and environmental effects can vary (Berka and Creamer, 2018).

The energy justice framework is progressively utilised to examine diverse community energy processes and outcomes, exploring their capacity to promote energy justice (Mudaca et al., 2018; van Bommel & Höffken, 2021; Dudka et al., 2023). This comes as no surprise since ECs could be seen as a solution to the need for a balanced approach that integrates security, poverty, and climate change within energy policy frameworks ensuring that energy transitions do not exacerbate existing social inequalities (McCauley et al., 2019). How ECs can promote energy justice is especially evident when discussing democratic participation and the potential to enable citizens to actively participate in the energy transition, echoing Schlosberg's (2007) emphasis on participation and capability (Becker & Naumann, 2017).

Current policy initiatives in Europe encourage the development of community energy projects, with the explicit goal of facilitating a fair transition to a low-carbon energy system (Mengolini & Masera, 2021). This is since legislative and non-legislative policies can diffuse local community initiatives in the energy sector as they are mutually influenced and propelled by advancements in the field (Matschoss et al., 2022).

Nevertheless, while ECs tackle energy matters locally, the attainment of energy justice must extend to a systemic level. To achieve this, bold political measures are necessary to address issues at their roots (Meynen & Marin, 2022). It is crucial to emphasise that the responsibility for addressing energy-related vulnerabilities remains with the welfare state, and there should be no transfer of this responsibility from social policy to local communities (Hanke & Guyet, 2023).

In our paper, we will assess the ECs potential to promote energy justice in Greece focusing mainly on the procedural and distributive pillars of the concept of energy justice, and in particular on issues of accessibility, equity, participation and governance.

Accessibility ensures that everyone, regardless of socioeconomic status or geographic location, has access to affordable, reliable, and sustainable energy (IEA, 2020). This includes issues such as energy poverty, energy access in rural or remote areas, ensuring for example that vulnerable communities have access to the benefits of renewable energy technologies.

Equity addresses the unequal distribution of energy resources and ensures that everyone benefits from the energy transition (Sovacool and Dworkin, 2015). It includes issues such as fair allocation of costs and benefits, energy affordability for low-income households, and access to clean energy for marginalised communities.

Participation requires that communities and stakeholders have a say in energy decision-making and policy development (Jenkins, 2019). It includes issues such as community engagement, democratic decision-making processes, and access to information or resources to participate effectively.

Finally, governance refers to the promotion of a just and democratic energy system through effective governance structures and policies (Sovacool et al, 2016b). It includes issues

such as transparent and fair regulation, accountability of energy producers, and policies that prioritise the social, economic, and environmental dimensions of energy.

Energy communities with their democratic decision making processes, the equity on benefits sharing, the structures that support inclusivity and capacity building can address energy justice issues. However, it is important to note that achieving energy justice requires a broader and more comprehensive approach than just creating ECs. Other factors such as government policies, socioeconomic disparities, and energy infrastructure also play a significant role in achieving energy justice. Additionally, there may be potential barriers to the implementation of ECs in Greece, such as legal frameworks, funding, and technical challenges, which should be closely examined and addressed in order to ensure that ECs can contribute to achieving energy justice in the country.

Methodology

In the pursuit of a sustainable and equitable energy future, energy justice principles have become a guiding framework, addressing fairness, inclusivity, and environmental integrity in the transition to cleaner energy sources. For an adequate account of territorial socio-economic development, one must refer to the *actions* that steer or interfere with the development processes, the *structures* that both constrain and enable action, the *institutions* that guide or hamper action and mediate the relation between structures and action, and the *discourses* and discursive practices that are part of these interactions (Moulaert, et al., 2016).

Thus in order to combine the socio-spatial and justice elements and conduct our study on ECs and their potential role in facilitating a just energy transition in Greece we adopted a comprehensive approach to data collection. In ensuring the validity of our data in terms of spatial distribution, it's essential to note that our survey respondents were strategically sampled across various regions in Greece. A professional agency specialising in public opinion surveys was engaged to distribute the questionnaire and collect the data. This sampling approach is designed to reflect the population distribution of each region, thereby ensuring representation from diverse geographic areas. By including participants from all over the country, our data provide an encompassing perspective on energy-related viewpoints and experiences, taking into consideration regional differences and dynamics. This regional stratification in the sampling improves the relevance of our results and offers a strong basis for examining energy justice and community involvement across the divergent regions of Greece. Through this study, we are trying to capture and assess the current state of the different elements of energy justice in Greece and explore the potential of ECs within the Greek context.

We initiated our research by conducting a systematic review and analysis of pertinent legislative documents. This encompassed an examination of energy laws such as N4414/2016, N4513/2018, and N5037/2023, in addition to related regulations, policy documents, and

reports. These documents provided us with the foundational legal and policy context essential for our study.

Then, through a thoughtfully designed survey, our primary objective is to identify how these various principles of energy justice resonate with the Greek households. By analysing survey responses, we aim to uncover not only how awareness, attitudes, demographics, perceptions, and barriers intersect with these justice principles but also the extent to which these principles are pertinent in Greece today. This investigation will provide valuable insights into the Greek perspective on energy justice and its relevance in shaping the country's sustainable and just energy landscape. Our research aims to present the Greek reality of energy justice principles and the possible role of ECs, while acknowledging that they are mutually reinforcing and interrelated. To obtain the essential data, the survey was meticulously designed to gather opinions on the various organisational, operational, and economic matters related to energy transition, energy justice and ECs. To ensure widespread participation, we distributed the survey online, collaborating with a non-governmental organisation for its execution.

The survey's questionnaire had the following structure:

1. *Perceptions:*

- Environment: Explore participants' perspectives on the current environmental conditions and concerns.
- Climate Crisis: Assess the level of awareness and concerns regarding the ongoing climate crisis.
- Energy Transition Policies: Gauge opinions on existing energy transition policies and their effectiveness.

2. *Household's Energy Aspects:*

- Energy Cost: Examine participants' experiences and opinions on the cost of energy for their households.
- Energy Prices: Evaluate perceptions of energy prices and their impact on daily life.
- Views on Energy Policies: Understand participants' views on broader energy policies affecting households.

3. *Energy Communities:*

- Knowledge Level: Measure the understanding of participants about the concept and functioning of energy communities.
- Willingness to Participate: Explore participants' openness and interest in actively engaging with energy communities.

4. *Demographics:*

- Gather demographic information to understand the diverse backgrounds and contexts of the participants.

By employing this survey, we aimed to build a coherent understanding of the potential of ECs in Greece within the context of energy justice and the pursuit of just energy transition objectives while using a methodological framework that considers the intricacies of the Greek social and energy landscape, recognizing its unique challenges and opportunities. In our analysis, we will be presenting descriptive statistics to provide a clear and comprehensive overview of the data we have collected. The use of descriptive statistics allows us to summarise and present key features of the dataset, providing insights into central tendencies, variability, and distribution. By presenting these, we strive to extract complex information into manageable, interpretable summaries that enhance the accessibility and clarity of our findings. Finally, we performed a parametric analysis to explore the monetary willingness to invest in these initiatives by greek households.

The ongoing framework of Energy Communities in Greece

In the realm of energy justice, legislation plays a pivotal role in translating principles of fairness, equity, and inclusivity into tangible, legal frameworks that guide the energy sector (ILO, 2015). The European Commission has introduced a comprehensive supportive policy for community energy initiatives across its member states, providing an enabling framework. Nonetheless, as suggested by Hanke and Lowitzsch (2020), the effective realisation of inclusion objectives depend on the adaptation of this framework to the unique life circumstances and behavioural traits of vulnerable consumers when it is transposed into national law. Failing this adaptation, the goal of inclusion is likely to remain unattainable. Consequently, the challenge lies in the national and local implementation and operationalization of this enabling framework (Hanke & Lowitzsch, 2020). In this context, it seems rather important to explore the ongoing framework of energy related legislation in Greece.

In 2016, Greece implemented legislation concerning virtual net metering (law N4414/2016), targeting farmers and municipalities. This move marked the initial advancement towards collective energy sharing. Under this law, charges for public service obligations on net-metering and virtual net-metering installations are determined based on the total energy consumption, which includes the sum of energy withdrawn from the network and consumption from behind the metre. However, network charges, renewable energy tariffs, and other regulated fees are applied solely to the energy physically withdrawn from the public network, excluding consumption behind the metre and energy netting.

In 2018, a significant step was taken in the energy sector with the introduction of law N4513/2018, which focused on ECs and further expanded the scope of virtual net metering to include community energy initiatives. The law defines ECs as urban partnerships driven by the goals of social and solidarity economy, as well as fostering innovation in the energy sector.

According to the first legislation, the primary objectives of ECs are to combat energy poverty, promote energy sustainability, and encourage various aspects such as energy production, energy storage, collective self-consumption, distribution, and supply. Additionally, it is aimed to enhance self-sufficiency and energy security, particularly in island municipalities. ECs are also tasked with supporting efficiency measures at the local and regional levels, promoting cogeneration, rational energy use, energy efficiency, sustainable transportation, and demand-side management. Under the provisions of the law, members of the EC, whether they are natural persons or legal entities, are entitled to participate in virtual net metering. Moreover, vulnerable consumers or citizens living below the poverty line can also be included in the virtual net metering arrangements, provided that the EC consents to their involvement. It is important to note that these individuals don't necessarily need to be members of the Energy Community itself, but they must reside within the same district where the EC is established. By ensuring that energy projects cater to local needs and harness locally available renewable resources, it sought to empower communities and promote collective self-sufficiency, thereby aligning with the distributive and procedural justice principles of energy justice.

The Greek energy community law was setting itself apart from other concepts by tackling distinct concerns like ensuring independent energy supply for islands and combating energy poverty. Moreover, it was deviating from the traditional classification of Renewable Energy Communities (RECs) and Citizen Energy Communities (CECs) based on proximity. Instead, the law was differentiating them based on whether they operate for profit or non-profit purposes (Frieden et al., 2020).

Thus, in March 2023, Greece tried to incorporate all the European Directives as well as the differentiation of RECs and CECs in the law N5037/2023. In both cases, citizens, businesses, and local communities have the opportunity to take part, with the distinction being that farmers' associations are exclusively eligible for participation in RECs.

However, the introduction of the new law raised great concerns among Greek ECs and other relevant national and European support institutions, which addressed an extensive letter[2] listing every problematic provision of the new law to the minister of Energy. The greatest concern refers to the transitional period introduced by the new law, which is expected to cause further uncertainty in the existing ecosystem of ECs in Greece operating under the legal framework of the previous law (N4513/2018).

A pivotal aspect of law 4513/2018 revolves around the concept of locality, emphasising the creation of collaborations within energy projects that cater to local requirements and leverage locally available renewable energy resources, ultimately ensuring that the community's members reap the rewards. It imposes a requirement that more than half (50%

[2] Available in Greek: https://www.greenpeace.org/static/planet4-greece-stateless/2023/03/bf11a6df-greenpeace-greece-sxoliasmos-desmis-energeiakon-koinotiton-pros-ypen-20230308.pdf

+1) of an energy community's members have a connection to the geographical area where the project is officially registered. This requirement is no longer valid according to the new law.

In addition, it expressed the concern regarding the article that allows the establishment of ECs exclusively by enterprises. This provision of the new law contradicts the Article 2(11) of Directive 2019/944[3], which distinctively refers to the open and voluntary participation of citizens in ECs, as well as to citizen control over them.

Another significant alteration is that a minimum of 30 members is now necessary to establish a community, a notable increase from the previous requirement of five. This change aims to prevent the misuse of the framework by individuals who have no genuine intention of setting up a power plant but rather seek to exploit the system by selling their producer licence. However, several concerns have been expressed related to the ability of 30 individuals to get together and establish an EC from scratch.

Finally, it is worth noting that the new legislation currently lacks provisions addressing several critical aspects of transitioning an EC established under the 2018 law to one of the new legal structures. There is no provision regarding the Final Connection Offers, the Connection Contracts and the general procedures for the licensing and construction of the ongoing community energy projects. Specifically, while the 2018 law permits the involvement of small and medium-sized enterprises (SMEs) in virtual net-metering projects, the 2023 law excludes them. However, it does not specify how existing Connection Contracts would be impacted in the event of a change in the EC's legal structure. The absence of guidance in the new legislation can leave ECs grappling with how to adapt their existing operations to comply with the new legal requirements, potentially disrupting their ongoing activities. At the same time, this uncertain environment may discourage prospective investors and collaborators from participating in ECs, impeding the expansion of sustainable energy initiatives.

In conclusion, the lack of provisions addressing the transition of ECs from the 2018 law to the 2023 law introduces a high degree of uncertainty across multiple dimensions, including legal, operational, financial, and investor confidence. Addressing these uncertainties and providing clear guidance for the transition is essential for ensuring the smooth evolution of ECs and the continued growth of renewable energy projects in Greece.

Energy Communities status and challenges

Data over the number, status and maturity of ECs in Greece are scarce and not centrally available since the digital register of "*Renewable Energy Communities and Citizen Energy Communities*" is not yet operational. A first mapping effort of ECs in Greece in 2020 took place 2.5 years into the new legislative framework where 409 energy communities had been identified according to the country's General Commercial Registry (GEMI) (Electra, 2020). By November 2022, their number rose to 1,406 according to another mapping study using the

[3] Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0944

same data source accounting for 14% of the total installed capacity of RES projects in the country (The GreenTank, 2023). This can be considered a general success over the acceptance of the ECs as a new institution however further analysis indicates that the operationalisation of those projects is yet not adequate. The number of cancelled projects ranges between 10% and 30% approximately (depending on the type of electrification requests and region) while limited grid availability leads to rejections for the project's interconnection (The GreenTank, 2023). Indeed, the lack of grid availability for energy community virtual net-metering projects is a major issue as almost half of the requests (49%) for projects in the low-medium voltage were rejected by the Hellenic Electricity Distribution Network Operator (HEDNO) over the period November 2021 - November 2022 (The GreenTank, 2023). As a result, less than 17% of the requested capacity had been electrified (ibid).

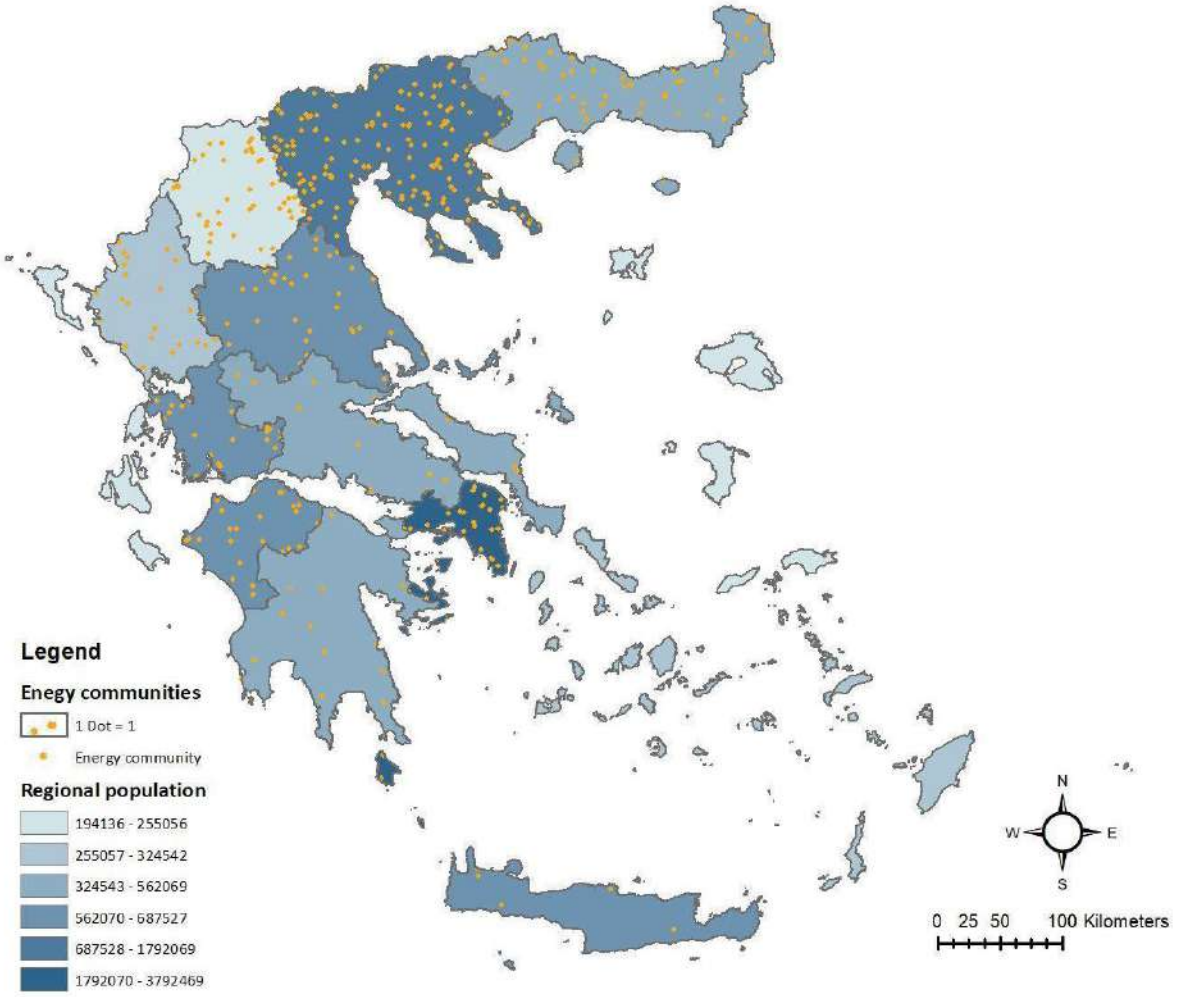

Figure 1 - Energy communities in Greece (August 2020) and regional population Source: Authors, based on Electra, 2020 data and eurostat

The installed capacity of virtual net-metering RES projects by ECs is much lower than that of RES projects by the for-profit ECs, indicating that ECs are mainly used by individuals and SMSs as instruments in order to profit from the sale of electricity rather than to meet their own energy needs (The GreenTank, 2023). Indeed, there is a wide speculation that

entrepreneurs had used the legal entity of ECs as a vehicle to advance private for profit RES projects utilising legal gaps. The vast majority of projects are reporting a low initial invested cooperative capital less than 10,000 euro (Electra, 2020) which can be attributed to multiple factors from financial constraints and risk aversion to a private investment masquerading as an energy community.

Finally, when it comes to territorial analysis a spatial segregation across the country is observed in regards to the density of the initiatives. The vast majority of them are established in the north part of the country (regions of central, western and east Macedonia) while in the south mainland and islands regions there are a limited number of initiatives (Electra, 2020; The GreenTank, 2023).

Public perceptions on energy justice

Up to our knowledge this survey is the first of its kind in Greece, and delves into public attitudes, beliefs, and behaviours regarding the energy transition, uncovering knowledge gaps and misconceptions about ECs and the overall energy scheme. Conducted from February 3rd to February 15th, 2022, it engaged 1,241 households representing 3,167 citizens, offering a window into the populace's diverse demographics.

Demographics

Gender representation among survey participants included 41.9% women, 57.4% men, and 0.4% non-binary individuals. Age distribution was broad, with 20% aged 18-35, 43% between 35-50, and 37% over 50. Educationally, the sample was varied: 0.2% had only primary education, 2.19% finished lower secondary, 22% upper secondary, nearly 40% had a university degree, and 22.2% held postgraduate qualifications, including Master's or Ph.D. degrees.

A notable 48% of the sampled population spends over 10% of their household income on energy, indicating potential energy poverty—a condition where a significant portion of income goes toward energy, impacting the ability to afford other essentials (Halkos, G., & Kostakis, 2023). This data is crucial for informing policy that resonates with public experience and values, shaping interventions that directly address the realities of energy expenditure and its implications on household welfare.

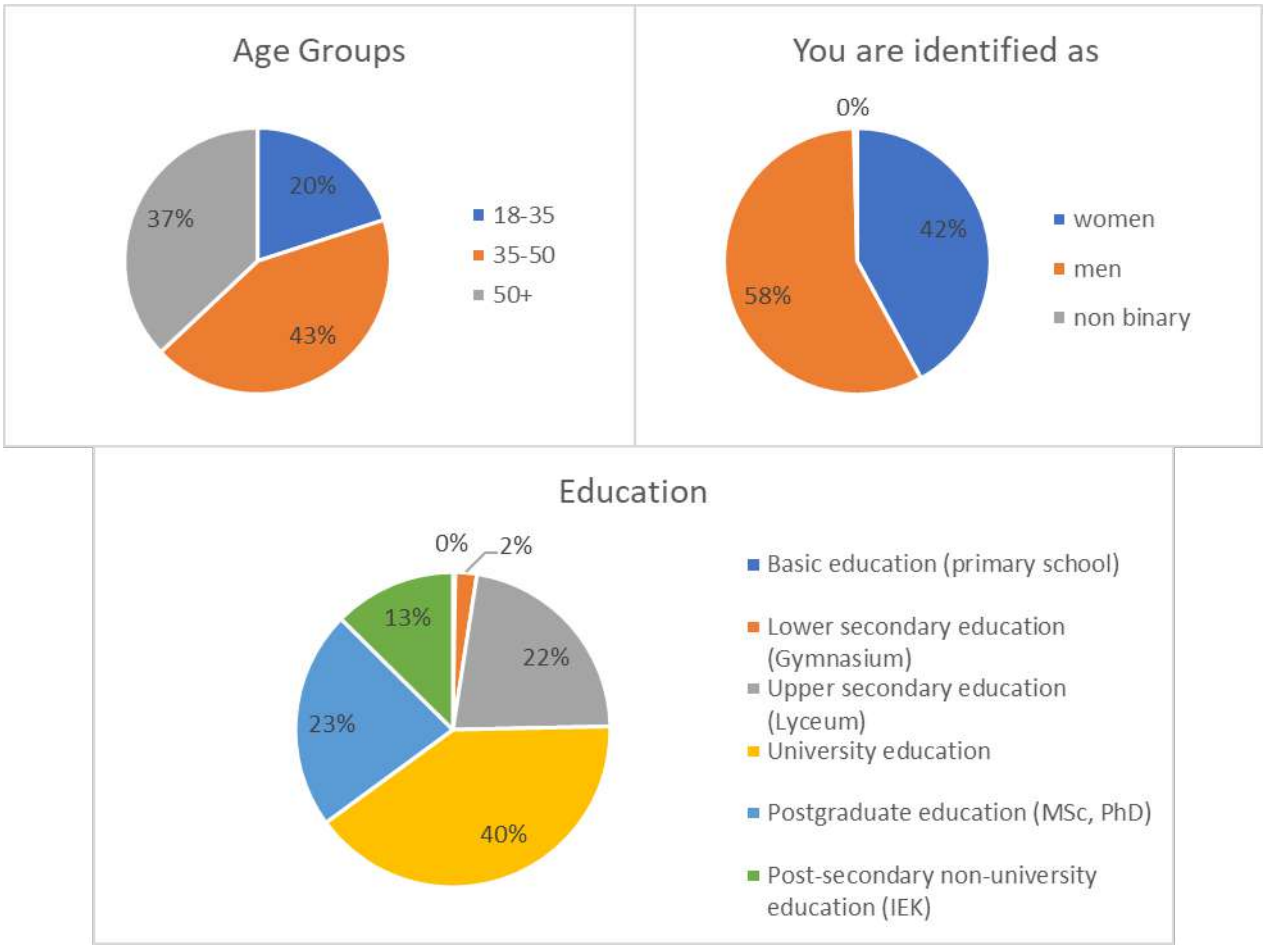

Figure 2 - Survey's sample demographics

Perceptions on energy transition

In the societal context of energy justice, our survey uncovers compelling insights into public opinion on the political significance of addressing various environmental issues. Public acceptance, as Roddis et al. (2018) emphasise, is essential for energy justice and the successful energy transition. This is particularly pertinent for renewable energy projects, which face challenges in public engagement and participatory decision-making, mirroring the wider issues in the industrial sector. These challenges, often linked to distributive and procedural injustices (Levenda et al., 2021), highlight the need for inclusive and fair processes in energy developments.

Respondents prioritise these concerns differently, with 59.8% advocating for high political priority on the energy transition and renewable energy sources (RES). Addressing the climate crisis is a high priority for 63% of participants, while a striking 78.8% view environmental pollution and its health impacts as urgent political issues. Additionally, 68.4% believe that extreme weather events should be a key political focus. These figures collectively signal an overwhelming demand for greater political commitment to environmental challenges, particularly in the realms of renewable energy, climate change, pollution, and weather-related disasters. In terms of attitudes toward RES, the data reveals that a vast majority, 73%, hold positive or very positive views. Only a small fraction, 8.6%, view RES negatively, and about

one-fourth of respondents are neutral. This sentiment reflects a general optimism about renewable energy among the population surveyed.

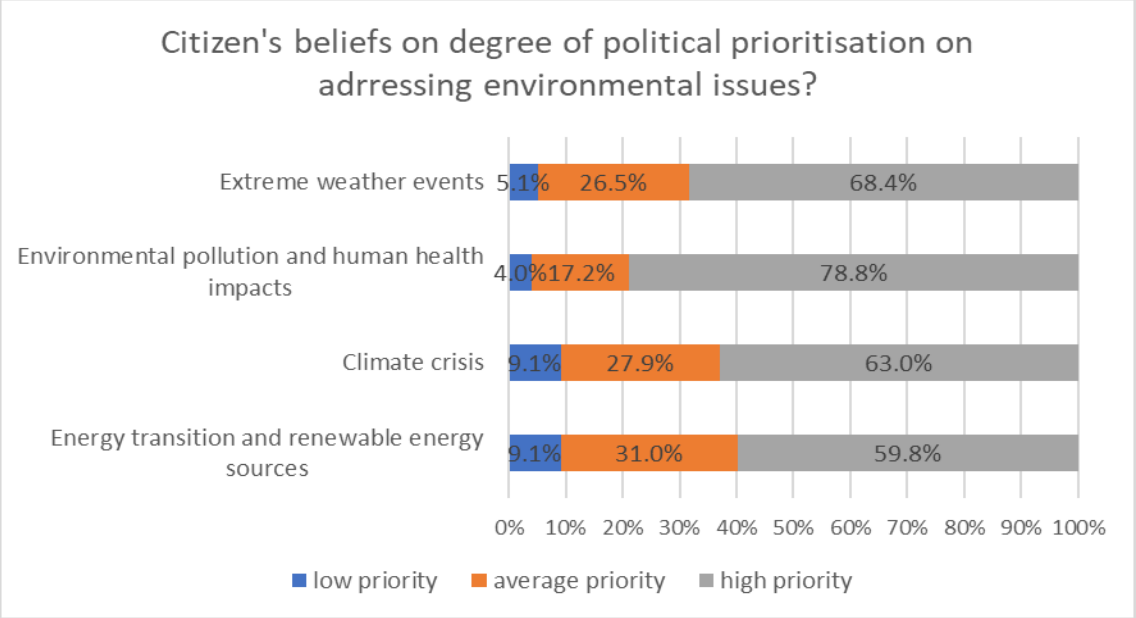

Figure 3 - Citizen's viewpoints on political importance over environmental affairs

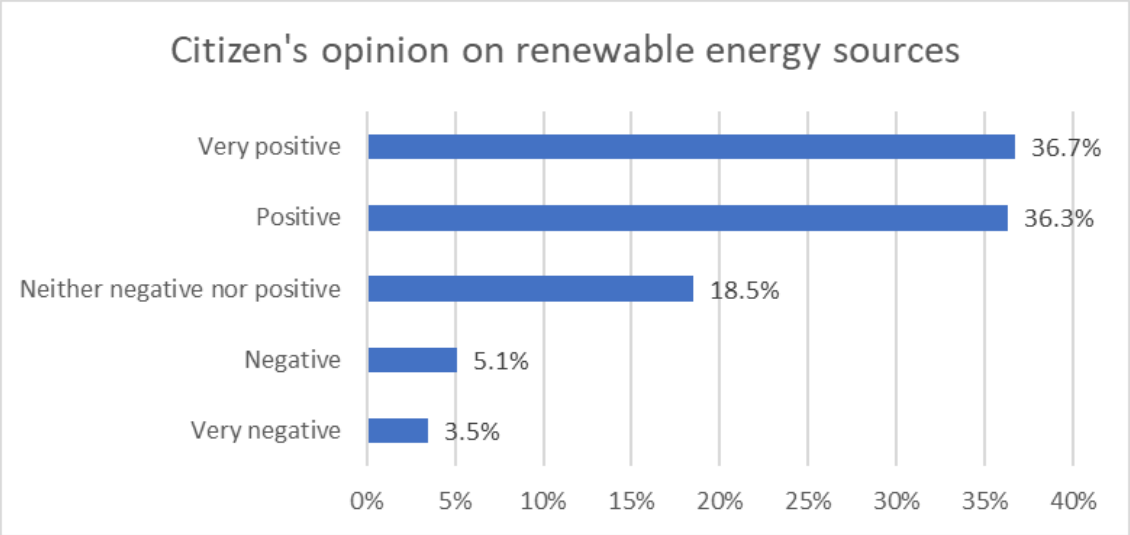

Figure 4 - Citizen's viewpoints on renewable energy sources

When it comes to the role of transitioning from fossil fuels to renewables in combating the climate crisis, 35.2% of respondents predict a highly positive impact, and 28.2% expect a moderately positive one. A smaller group, 17%, remains cautious about the potential benefits, and only 8.1% see no impact. Overall, these views underscore a prevalent optimism regarding the role of renewable energy in mitigating climate change.

Perceptions on accessibility and equity

The findings from this survey shed light on a pressing issue related to energy justice in Greece – energy poverty; also an issue of accessibility. A significant 78.3% of participants acknowledged energy poverty as a notable concern, with 42.3% identified it as a significant

issue. Given that Greece records one of the highest energy poverty rates in the EU (Koukoufikis & Uihlein, 2022), these findings indicate the widespread challenges households face in affording energy bills and achieving comfortable living standards, highlighting the urgency for targeted social and economic interventions. A considerable segment of the population is financially burdened by energy costs, with implications for their well-being and life quality. Ensuring equitable access to affordable and sustainable energy is paramount for both individual welfare and societal benefit.

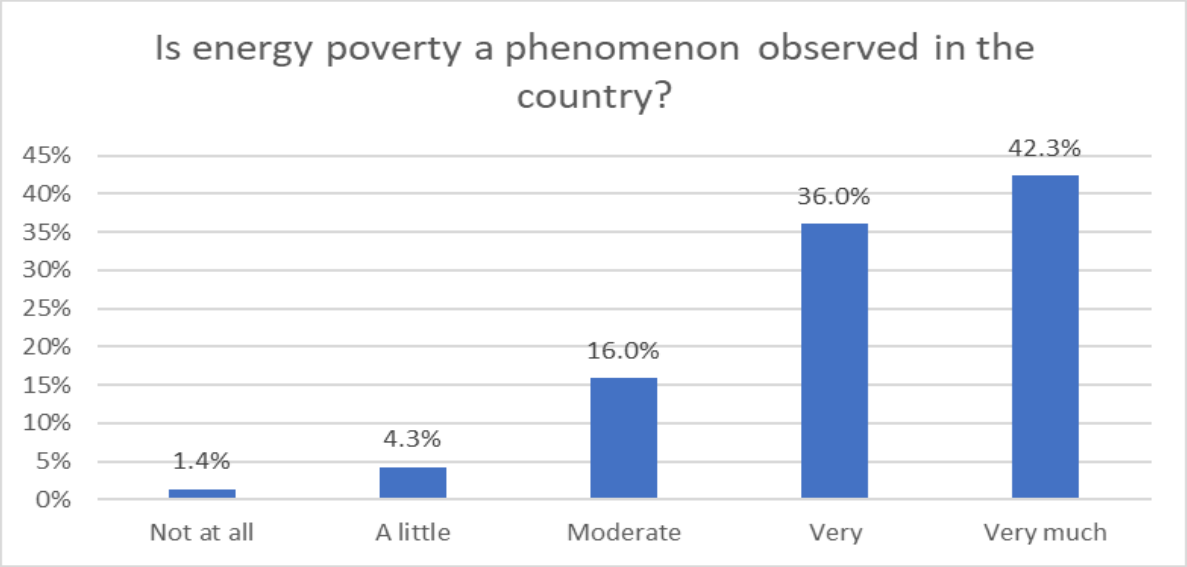

Figure 5 - Citizen's perception over the intensity of energy poverty

In the literature, the proportion of income allocated to energy bills, is a commonly used objective measure of energy poverty (Churchill et al, 2020). Thus, taking a closer look at how the percentage of income spent for energy bills in combination with the income clusters of responders, can provide useful insights regarding the distribution of energy-related economic burdens.

Our analysis reveals disparities in energy expenses relative to income, with lower-income households shouldering a disproportionate energy burden. Specifically, 14.16% of households earning under €7,000 and 24.5% of those in the €10,000 - €15,000 bracket spend more than 10% of their income on energy. In contrast, higher-income households (earning €20,000 - €30,000 and above) generally allocate up to 5% of their income to energy, indicating more financial flexibility. This uneven financial commitment across income levels suggests distributive injustice in the energy sector.

The discussion also underscores the multifaceted nature of energy poverty, energy services like heating, lighting, and space cooling, becoming elusive for energy-poor households, leading to a disproportionately high share of energy expenditure in their total income—defined as the 'energy burden.' Notably, the lowest-income households may prioritise other expenses over energy, resulting in lower energy burdens than slightly wealthier yet fuel-poor households. The hypothetical nature of affordability considerations emerges,

emphasising the need to assess whether a high energy burden is requisite for adequate home comfort (Bouzarovski, 2014; Bouzarovski & Simcock, 2017).

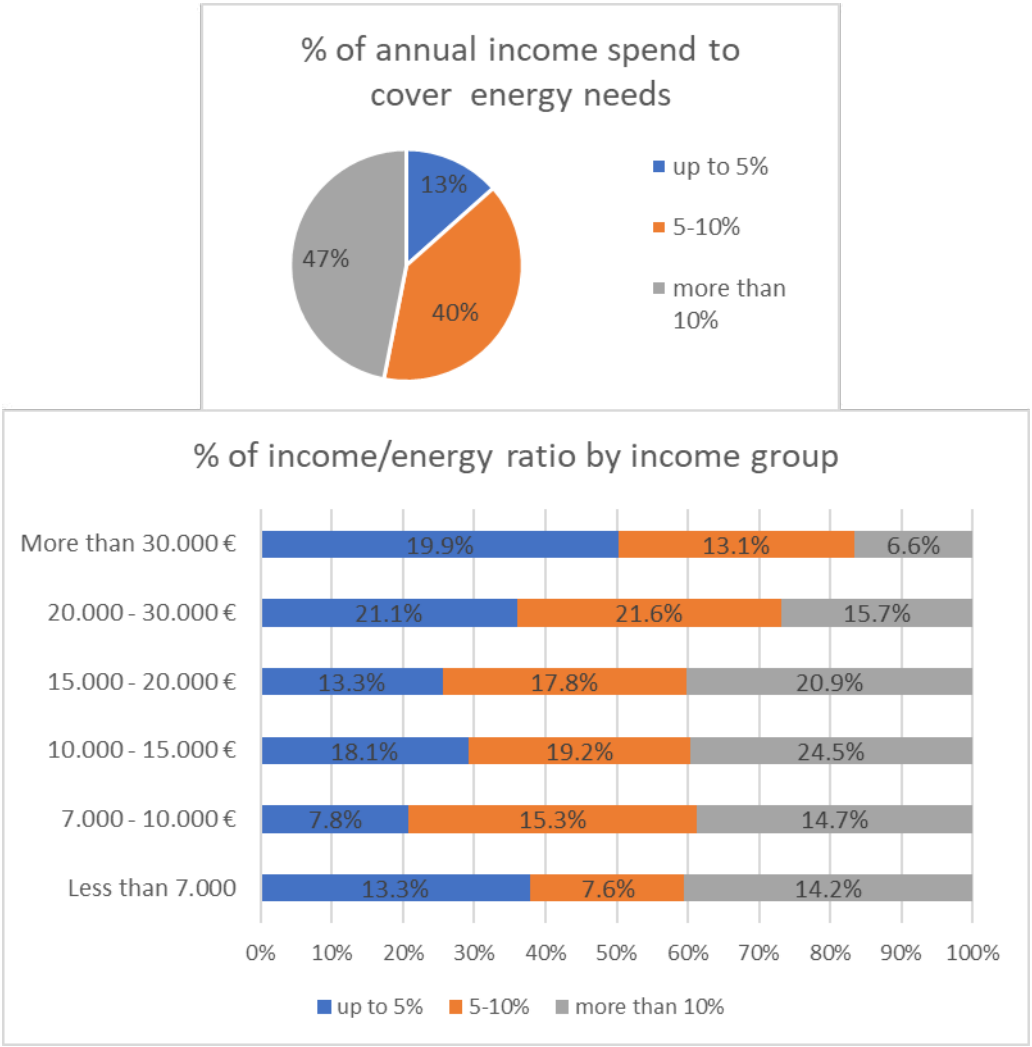

Figure 6 - Energy burden on households' budget

The survey also reveals a significant distrust in the fairness of Greece's energy transition, with 35.9% expressing complete mistrust. This distrust highlights procedural justice concerns and underscores the importance of transparent processes and equitable decision-making to ensure the energy transition is perceived as fair and its benefits are universally felt.

Perceptions on Governance

The survey explored respondents' consensus on different energy transition approaches, employing a Likert scale for responses. The governance framework is critical in a just transition context. Investing in Renewable Energy (RE) installations allows consumers to become prosumers, actively producing some of their energy, thus reducing costs and potentially earning from surplus energy sales (Lowitzsch et al., 2020).

We aimed to understand attitudes towards various energy transition strategies and the roles of key stakeholders (figure 7). The survey evaluated how these strategies influenced local and regional development and provided insights for policymaking by measuring public

opinion. Over 60% supported Greek companies spearheading large-scale RE projects, whilst almost 20% strongly disagreed. Foreign companies' involvement saw greater resistance, with over half the respondents disapproving and only 15% in support. Public-private partnerships were viewed more favourably, with state-level partnerships backed by nearly 66% and municipal partnerships receiving slightly higher approval.

Cooperatives involving local entities and citizens in small-scale projects were particularly well-received, with over 65% support and 17.4% expressing complete agreement. While finally, partnerships between citizens and the public sector also received positive feedback from over two-thirds of participants.

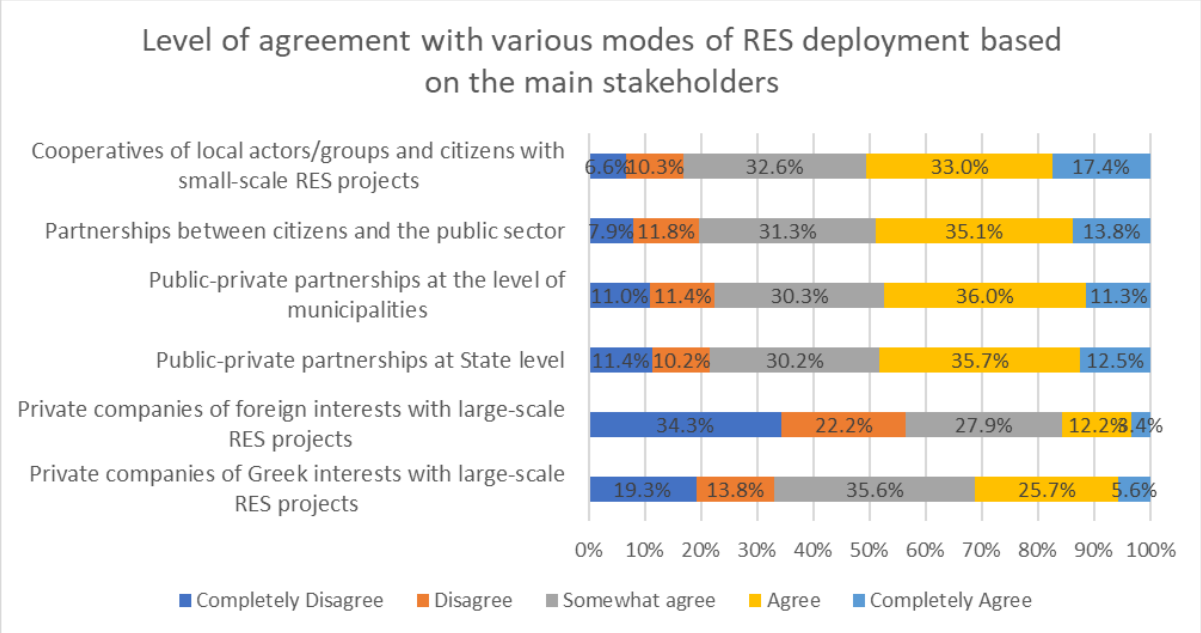

Figure 7 - Level of agreement with types of RES investment partnerships

The survey unveiled varied views on energy transition methods. Public-private partnerships at state and local levels enjoyed more popularity than initiatives led solely by private companies. Local cooperatives were met with relatively high approval, contrasting with the scepticism towards foreign company involvement. The diversity in opinions emphasises the need for multiple transition strategies to reflect societal views.

Another finding highlighted a preference for the public sector to play a pivotal role in Greece's shift to renewables, with about 66.5% in support (figure 8). Moreover, nearly 31% advocated for a central role for local communities via partnerships. Enthusiasm for local cooperatives demonstrates support for distributive justice, signalling the value of empowering communities to achieve an equitable energy transition.

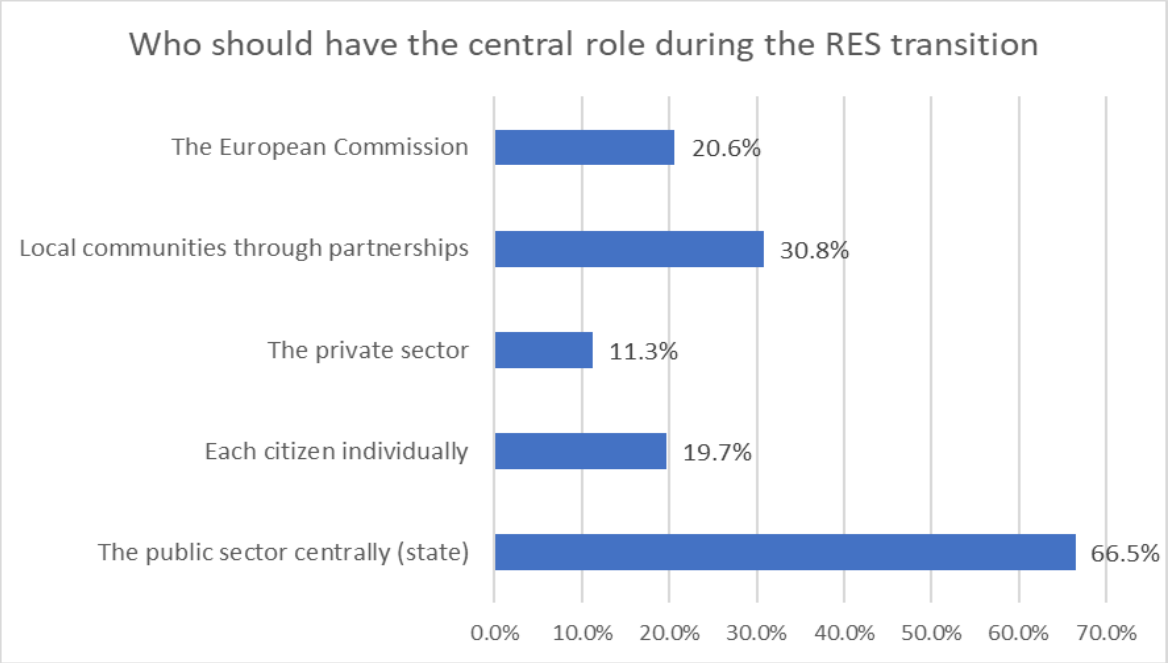

Figure 8 - Preferences on the primary governing stakeholder for RES deployment

Perceptions on participation

Participation is crucial for community-based initiatives, yet our findings indicate that a considerable number of respondents (39%) are unaware of local or state government sustainable energy projects. This points to the need for better communication and outreach to raise public awareness since only one-eighth of the respondents are both aware and knowledgeable about such government-led initiatives.

Views on the extent of citizen inclusion in energy transition decision-making vary (figure 9). A significant group (35.5%) feels completely excluded, while 19.4% perceive only minimal inclusion. Conversely, a quarter of respondents sense a moderate level of involvement, and 15.1% see substantial engagement. Notably, only a small fraction (5.1%) believes there is a high degree of citizen participation in energy transition decisions.

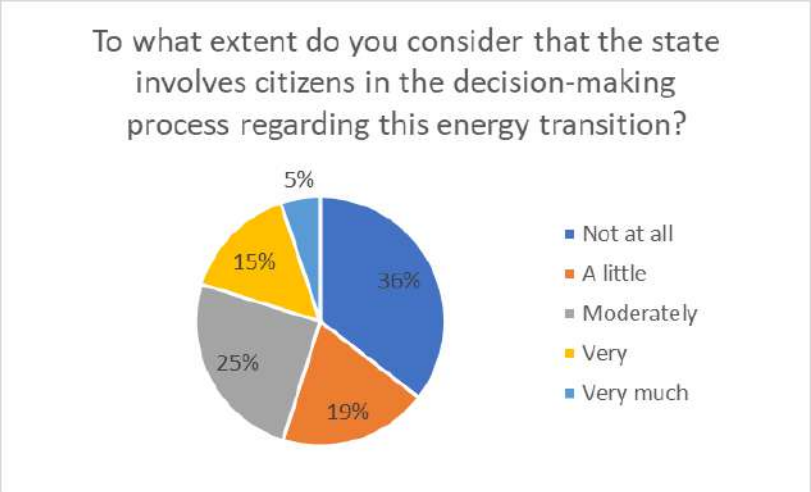

Figure 9 - Citizen's perceptions over citizens' engagement in RES decision making

Attitudes towards Energy Communities

The survey underscores a significant lack of awareness, familiarity and comprehension concerning ECs. Nearly 45% reported no knowledge of ECs, highlighting an urgent need to further information dissemination in Greece. About one-third had heard of ECs but lacked in-depth knowledge, while only 4.9% were well-informed, and 17.7% had moderate familiarity.

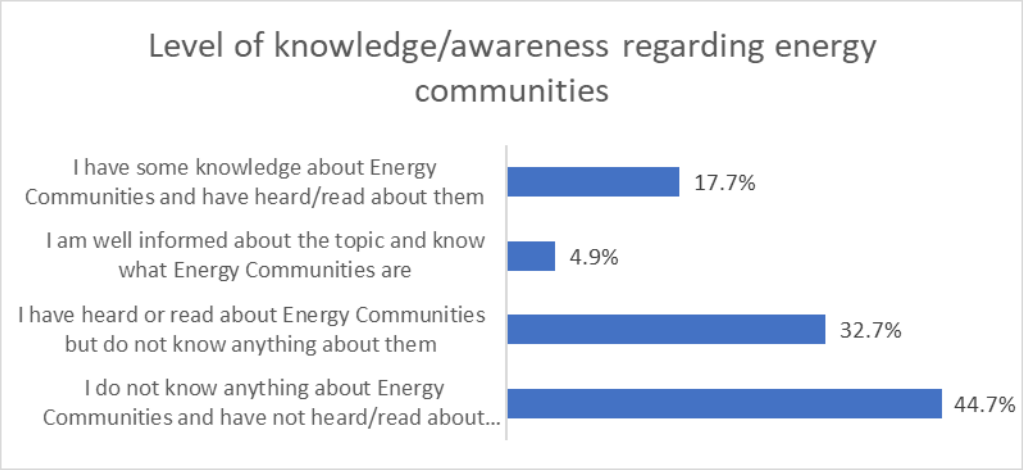

Figure 10 - Citizens level of awareness regarding energy communities

Despite this lack of knowledge, after a short presentation over the ECs definition and role tailored for the survey, a significant level of interest in participating in EC projects arises. Over half the respondents (54%) showed concrete interest in EC involvement after learning about their role, and a further 30% might consider participating with more information or motivation. Only 16% were uninterested.A statistical analysis over key variables influencing the willingness to participate in ECs revealed by no surprise that more affluent households have greater resources and access to information, which can also make their decision to participate in ECs initiatives easier. Thus, households' income levels are a key influencer on driving the interest of households to participate in an energy community. Specifically, those in the top income bracket (> 30,000 €) are 1.32 times more likely to be interested in joining an energy community. While consistently the higher the income group, the more likely is for a household to be interested in joining an energy community initiative (figure 11).

Educational attainment and energy literacy is also an important factor driving attitudes towards energy communities' participation. Prior knowledge over the institution and role of ECs significantly improves the willingness to participate in a project. Individuals with very good or adequate knowledge of ECs are 1.66 and 1.25 times more likely, respectively, to participate. Those with postgraduate degrees are 2.05 times more likely to possess such knowledge (Figure 12).

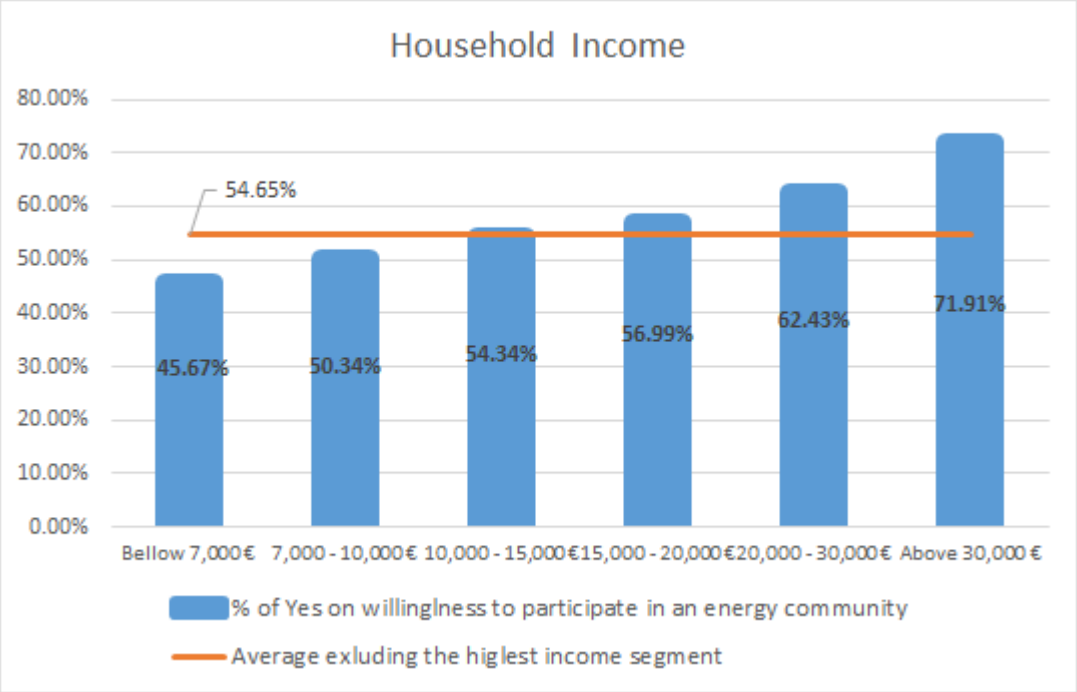

Figure 11 - Household's income influencing the willingness to participate in an EC

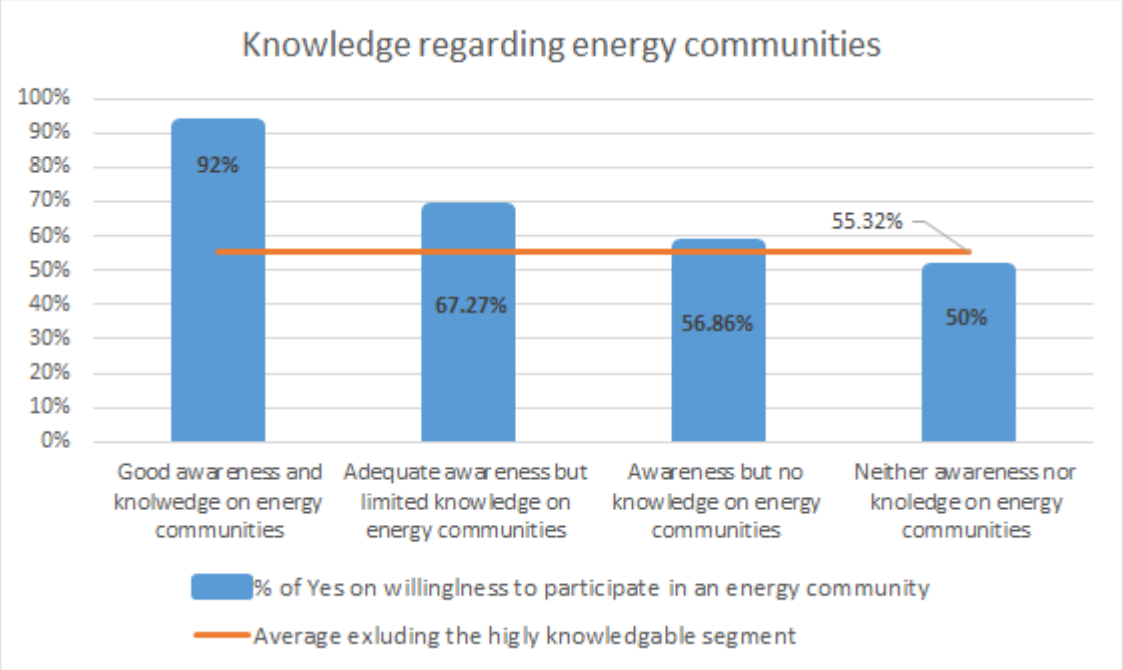

Figure 12 - Prior knowledge over EC influencing the willingness to participate in an EC

Observing the survey results so far, on the one hand there is an acknowledgement of the climate crisis emergency, accompanied with a public acceptance of RES while knowledge on ECs – as a way of actively involving communities to energy projects – is limited. The observed "social gap", where there is widespread support for renewable energy but a slower adoption of the renewable energy projects, is a matter that researchers have aimed to unravel (Eltham et al., 2008; Bell et al., 2013). The speculation is that this gap may be attributed to perceived

deficiencies in the fairness and quality of decision-making processes at the local level, influencing project outcomes (Huijts et al., 2012), just like what our findings indicate.

Acknowledging the importance of both extensive renewable energy projects implementation and social acceptance, scholars advocate for enhanced public engagement in planning processes. This is considered vital for fostering renewable development and ensuring a socially just transition in the energy landscape (Sovacool et al., 2016). Huijts et al. (2012) also emphasise the pivotal role of trust in shaping the acceptance of renewable energy projects. Marlin-Tackie et al. (2020) argued that public participation for promoting justice and fostering various positive socio-environmental outcomes, such as bolstering trust in government and industry. In this context, trust is identified as a key factor influencing perceptions of energy justice, as well as emotional responses that contribute to shaping attitudes toward both the energy projects itself as well as the involved actors (Dwyer & Bidwell, 2019). Promoting participation, transparency, and trust is vital for a socially just and environmentally sustainable energy transition.

Willingness-to-invest in Energy Communities

Taking a closer look to understand how ECs could contribute significantly to a fair energy transition in Greece, we've calculated responders' willingness to invest in these initiatives. To explore potential connections and determine whether a parametric analysis is appropriate, we employed Eta correlation, Spearman's rho correlation, and Kendall's Tau-b. After examining these correlations, it becomes evident that the willingness to invest shows very weak connections with the other variables. None of these correlations is significant enough to support a meaningful parametric analysis. Nevertheless, upon reviewing all the correlations, it can be suggested that education level, the income level and the percentage of income spent on energy bills may have a notable influence on the willingness to invest.

To gain insights into the appropriate amount to invest in an EC project, as indicated by the responses, we utilised a non-parametric analysis method. The analysis concluded that the willingness to invest is 1,723.88 euros per responder, which is a promising indicator of the potential for ECs to serve as a driving mechanism for a just energy transition in Greece. The fact that citizens are willing to financially commit to ECs suggests a high level of community engagement and interest in sustainable energy initiatives and reflects a commitment to collective action and community-driven solutions, aligning with the principles of participation and inclusivity within the energy justice framework. This is also evident in the rest of their responses since they recognize the potential positive effects of ECs on their communities, such as job creation, reduced energy costs, and enhanced energy security.

High willingness to invest could also send a strong signal to policymakers, as it indicates public support for renewable energy citizen initiatives. Policymakers should recognize these initiatives as a powerful tool for advancing the country's energy transition goals; fostering and

facilitating citizen participation in ECs should be a central policy objective, given that the public endorsement of such initiatives underscores the potential of the ECs framework to serve as a key proponent of advancing energy justice in Greece. In this context, given that a significant portion of respondents felt uninformed about local authorities and RES capabilities, there is a need for policy initiatives focused on education and awareness. Providing clear, accessible information about ECs, renewable energy benefits, and available investment opportunities can bridge this information gap.

Discussion

The survey results reveal a nuanced landscape of public perception and engagement with RES and ECs in Greece. While an evident public support for renewable energy emerges, with 73% of respondents expressing positive views, there is a stark contrast in the awareness and understanding of ECs. A significant majority, 44.7%, reported no knowledge of ECs, and 32.7% had limited knowledge despite encountering the term. This disparity highlights a critical gap between the endorsement of RES and the practical involvement in energy initiatives at the community level.

The lack of awareness about ECs could be attributed to insufficient dissemination of information, which suggests that educational and outreach efforts need to be strengthened. The finding that households with higher income levels and greater educational attainment show more interest in participating in ECs underscores the need for inclusive strategies that ensure all community members have equal opportunities to engage. This is particularly important since ECs are instrumental in localising the energy transition, fostering community resilience, and enabling democratic participation in energy decisions.

The data indicates that nearly half of the surveyed households allocate a significant portion of their income to energy expenses, with 12% spending more than 10% of their annual income. This highlights the pressing issue of energy poverty and the need for ECs to provide affordable energy solutions. The willingness of households in the highest income quintile to participate in ECs, being 1.32 times more likely than others, reflects the existing socioeconomic divide that may hinder the broader adoption of ECs. A just transition must consider these disparities, ensuring that the benefits of the energy transition are equitably shared and not limited to the more affluent citizens.

Educational attainment and energy literacy were found to be important drivers of attitudes towards EC participation. Those with very good knowledge of ECs were 1.66 times more likely to participate, and those with adequate knowledge were 1.25 times more likely. This suggests that increasing public knowledge and understanding of ECs could significantly increase participation rates. Policies and initiatives must, therefore, prioritise energy literacy and education to increase the public's willingness to engage in the energy transition.

The data also reveals a social gap, where a significant portion of respondents (39%) are unaware of sustainable energy initiatives by local or state governments, indicating a disconnect between policy actions and public awareness. This suggests a need for enhanced communication and transparency in government-led sustainable energy programs. Moreover, the perception of citizen involvement in energy decision-making varies, with 35.5% perceiving no involvement and only 5.1% feeling very much involved. This points to a perceived deficit in public engagement, which could be addressed by fostering a participatory culture in energy governance.

Considering these results, and the willingness of the surveyed households to potentially participate (with 54% of respondents showing a concrete interest and 30% being potentially receptive) and invest significant resources in ECs, their role in the just energy transition becomes even more pivotal. ECs have the potential to bridge the gap between public support for RES and actual involvement in sustainable energy practices. They can act as platforms for education, engagement, and empowerment, democratising the energy transition and fostering a sense of ownership among community members.

However, the success of ECs in facilitating a just transition is contingent on addressing the barriers identified in the survey. Overcoming the knowledge gap, mitigating the effects of socioeconomic disparities, and enhancing public participation in energy decisions are critical steps. Policymakers and stakeholders must collaborate to design strategies that are inclusive, educational, and transparent, ensuring that the transition to a sustainable energy future is equitable and just for all members of society.

In conclusion, the survey provides valuable insights into the public's perception and readiness to engage in ECs as a means to achieve energy justice and a just transition in Greece. The findings underscore the importance of addressing information asymmetries, socioeconomic factors, and participatory mechanisms to facilitate a truly inclusive and democratic energy transition. As Greece moves towards a sustainable low-emission future, ECs stand out as a catalyst for change, provided they are accessible and approachable for citizens from all walks of life.

Conclusion

This paper provided a comprehensive understanding of the role of ECs and their contribution to achieving energy justice and facilitating a just energy transition in Greece. Through a comprehensive survey of Greek households, we have gathered insights into public perceptions of the energy transition, awareness and attitudes towards ECs, and the willingness to participate in and invest in ECs. The survey has revealed several critical findings:

— There is a significant lack of awareness and understanding of ECs among the general population, despite a strong public support for renewable energy sources. This indicates a need for targeted information and education campaigns to bridge this

knowledge gap and encourage community participation in ECs. Nevertheless, we reveal a promising inclination among respondents to actually invest in ECs.

- Energy poverty remains a major concern in Greece, with a large portion of households dedicating a significant share of their income to energy costs. This underscores the urgency of integrating energy justice considerations into policy measures to ensure affordable and equitable access to energy for all.
- Socioeconomic disparities influence interest and participation in ECs, with higher-income households being more likely to engage. This highlights the need for policies that promote inclusivity and ensure that the benefits of ECs and the broader energy transition are accessible to diverse socioeconomic groups.
- Public trust in the equity and inclusiveness of the energy transition process is low, emphasising the need for improved communication, transparency, and participatory mechanisms in energy governance.

Based on these findings, we can provide several policy recommendations to strengthen the role of ECs in achieving a just energy transition in Greece. Firstly, the implementation of comprehensive information campaigns and educational programs aiming to raise public awareness about the benefits and functioning of ECs. This should involve accessible, community-driven initiatives that demystify ECs and showcase successful case studies. Then the development of targeted support mechanisms is needed for low-income households to participate in ECs, such as subsidies, low-interest loans, or grants. These measures should aim to alleviate energy poverty and ensure that the transition to renewable energy does not exacerbate existing inequalities. This should also be followed by the encouragement of the establishment of ECs with diverse membership, including representation from various income levels and social groups. To do so incentives can be created for ECs that demonstrate high levels of inclusivity and equity in their membership and governance structures. When it comes to public participation in energy transition, EC should be involved in decision-making in planning and development processes. This could include participatory budgeting for local energy projects, community consultation forums, and transparent reporting on energy policy outcomes. Finally, monitoring and evaluating the impact of ECs on local development and social cohesion is essential. Data collection and analysis should be ongoing to assess the effectiveness of ECs in promoting energy justice and informing the refinement of policies and programs.

In conclusion, ECs present a unique opportunity to democratise the energy system in Greece, foster social and environmental justice, and contribute to the fight against climate change. However, realising the full potential of ECs requires concerted effort from policymakers, industry stakeholders, and communities themselves to ensure that the transition is not only technologically and economically viable but also socially equitable and inclusive. At the moment this is not scaled enough though with recognition and adequate support, citizens' led

energy initiatives such as ECs can be a powerful tool for advancing the country's just energy transition goals.

Acknowledgments

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Conflict of interest

All authors declare that they have no conflicts of interest and did not receive financial compensation for this project. The views expressed in this paper are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

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Research Article

Mapping the Just Green Transitions in the Socio-political Virtual Space

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Abstract

Since the European Green Deal was launched (European Commission, 2019), social media and especially Twitter (now X) has become the one main socio-political virtual space where the European Commission is promoting the European Union's twinned (Just, Green, and Digital) Transitions. This multidisciplinary exploratory research crosscuts Spatial Planning & Territorial Governance (Nadine et al., 2018; Berisha, et al, 2021), and Social Media Studies and Digital Methods (Rogers, 2018; 2019), investigating the existence of the term "Just Green Transitions" on Twitter, highlighting the potential benefits that social media analysis could add to the disciplines of Governance and Policymaking. Utilizing Social Network Analysis, both Mention Analysis and Co-hashtag- Analysis were applied to capture and analyse three million original tweets over the first twenty months since the Just Transition Mechanism entered into force (European Parliament, 2021). The results highlighted the fragmentation of the terminologies and Twitter user communities, discussing the expected transitions of Europe which are expected to be Just and Green (European Commission, 2021).

Keywords

Just Green Transitions, EU Governance, Social Media Analysis, Spatial Planning and Territorial Governance, European Green Deal.

Introduction

Within the framework of the European Green Deal (EGD) (European Commission, 2019), conceptualising and operationalising transitions (Fischer-Kowalski & Rotmans, 2009) pivots on how their policies are communicated (Aagaard, 2023) between decision-makers and the public, ensuring no one is left behind (Sanderson et al., 2024). The EGD communications on social media (Balcarova et al., 2024) not only influence the public's opinions on the so-called Just Green Transitions (JGT) and the paths to achieving them but also influence the nature of their governance and public legitimisation (Aagaard, 2023).

With not much time left to deliver the 2030 goals of the EU transitions and not much room offered to conceptualise still their just dimension (Bouzarovski, 2022), the conceptualisation and operationalisation of the JGT is, to some extent, influenced by the

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terminologies policymakers use to communicate their policies and ideas which consequently, influence the public perceptions and interpretations (Hall, 1993). As governmental communications are considered a policy tool (Howlett, 2009), this contribution is thus building upon the potential of utilising social media analysis as a tool for governance and policymaking, following its role in European studies and policy communications (Barberio et al., 2020; Müller, 2022) as an instrument of governance (OECD, 2021). This contribution aims to explore one benefit of integrating social media analysis into governance and policymaking toolkits (Deane, 2015) by investigating the existence of the so-called Just Green Transitions on Twitter for its role as a dominant channel for politicians (Castanho Silva & Proksch, 2022) and policymaking (Severo et al., 2015; Şahin et al., 2021).

Since the introduction of the Just Transition Mechanism (JTM) (European Commission, 2021), the novel developments on the "Green Transition" and its "Just Transition" dimension have been growing both in literature and policy documents, while their conceptual combination is not yet agreed upon. Following the discussion of the exigency towards a theoretical framework for the JGT (Shaker & Berisha, 2024), the presence of the term "Just Green Transitions" is rare in academic literature and policy documents, is still not commonly agreed upon neither in the singular or plural forms[1] and is associated with various terms which are often employed interchangeably[2] to indicate the expected transitions. On the one hand, JGT is not yet defined neither at a conceptual nor operational level, on the other hand, it is still not sure whether it constitutes a distinct concept, a new umbrella term, or merely serves as a contemporary fashionable synonym for pre-existing terms (Shaker & Berisha, 2024).

Investigating the presence and the use of terminologies in the public debate on social media is becoming more crucial. Not only for its influence on societal changes (Rogers, 2019) but also for a better understanding of the trends in public debate and how public policies are shaping over time (González-Bailón & Lelkes, 2023). It is worth highlighting that the terminologies used in official policy documents and research papers might contrast the colloquial language used by the public to discuss the expected transitions of Europe. One possible reason could be that ordinary citizens (Mastropaolo, 2009) are more probably inclined to use straightforward and simple language that is easily understood by the citizens[3]

[1] **Terminological Inexactitudes**: "Just and Green Transition" (Huq & Khan, 2023), "Green and Just Transition" (OECD et al., 2022), "Green Just Transition" (EIB, 2021), "Green and Just Transitions" (Langthaler et al., 2021), "Just Green Transition" (Tavares, 2022), "Just Green Transitions" (Shaker & Berisha, 2024).

[2] **Conceptual Fragmentations**: "low-carbon future" (European Commission, 2021), "clean energy transition" (European Commission, 2019), "Carbon-neutral Transformations, and "Sustainability Transition" (EEA, 2020).

[3] **Plain Language in Policy Making**: see the European Commission Accessibility in Publishing https://op.europa.eu/en/web/accessibility/transcript-plain-language

as "energy prices," "renewable energy," "climate change," than using complex technocratic terms as JGT and its variations when expressing their opinion on the transitioning to a climate-neutral future.

Considering that, the justice dimension was not a core issue of the green policies (Kyriazi & Miró, 2023). The introduction of this new terminological combination–green, just, transition(s)–may have fostered a political convergence for a more just, fair, and inclusive transition at the EU level. Yet, it might have simultaneously engendered a level of ambiguity, evident when looking closely at the various public perceptions and interpretations[4] and, more crucially, when it comes to the conceptualisation and operationalisation of the JGT from a Pan-European perspective. We could say that one factor of ambiguity is the lack of clear and precise terminologies which are commonly agreed upon in advance (Moroni et al., 2020). This ambiguity affects the conduct of evidence-based policies (Colquhoun et al., 2014) and amplifies the research noise[5].

Conceptualising and operationalising transitions while ensuring that no one is left behind (European Commission, 2019) necessitates adaptive and social innovation engagement methods and simplified language in policy communication (Moroni et al., 2020). One social innovation engagement tool is social media (Geissinger et al., 2023), it plays a critical role in influencing both the public's trust in public policies (Gil de Zúñiga et al., 2022) and in adopting new societal participation models (Querol et al., 2011; Hadžialić, 2018). In this contribution, the focus is directed towards gauging how the public discussion on the JGT is articulated in the social virtual space over the 20 months since the introduction of the JTM.

Grasping public perceptions remains predominantly relative (Lenk, 2003), especially when the theoretical conceptions and the various societal perspectives[6] are not always aligned when discussing the JGT, neither at terminological nor conceptual levels (Terzi, 2020; Revez et al., 2022; Bouzarovski, 2022). Yet, with the digital transition, policymakers ought to leverage the social media analysis's potential (Driss et al., 2019) in grasping how the public debates are evolving within the framework of government social media (Yuan et al., 2023) shifting from the limits of using social media mainly for dissemination and monitoring (Barberio et al., 2020; Müller, 2022) and more in governance and policymaking (Rathore et al., 2021).

[4] On **public perceptions**: see the fairness perceptions on the Green Transition. (European Commission, 2022) and the perceptions on the European Green Deal through Twitter Analysis (Balcarova et al., 2024).

[5] **Research Noise**: Denotes the retrieving of any superfluous, irrelevant, or out-of-context data that can obscure or distort the analysis. Minimising the noise is fundamental for the reliability of the findings (Andrad, 2023).

[6] On **societal interpretations**: Indigenous perspective of the Sámi people on the EDG (Saami Council, 2024).

Social media and especially Twitter (now X), is one politicised sociopolitical arena (Luhtakallio & Meriluoto, 2022) where public policies are discussed between citizens and decision-makers in what could be called a public debate even if it does not necessarily represent the full spectrum of the opinions of the public who do not engage on social media (Gaisbauer et al., 2021). Beyond its spatiality and territoriality (Aliberti, 2019; Bernal, 2020), social media is thus the space where governments disseminate information and provide real-time interaction on their proposed policies and political decisions (Kamp, 2016), shaping individual and societal ideas on social and political issues (Kelm et al., 2019) regarding the expected future of Europe (Goldberg & Hoffmann, 2023).

The interactions between citizens in such socio-spatial and political–virtual–spaces (Patterson et al., 2017) could present one issue of governance (Hovik & Giannoumis, 2022). Arguably, the EU has been investing in effective and timely communication channels (Silva et al., 2019; Driss et al., 2019), supporting its Member States in becoming more fit for the future of Europe (European Commission, 2017). Social media and its analysis offer an unprecedented real-time interactive governance tool bridging the gap between the physicality and sociality of space, thus invigorating the space between citizens and public administrations (European Commission, 2017).

Social media analysis is becoming a valuable yet underutilised tool for decision-makers and policymakers (Nurmandi et al., 2023) that could help to better understand how public matters are discussed over social media. It, thus, offers a critical lens, magnifying how the public express their opinions on socio-political matters and providing a better understanding of public concerns and priorities (Chen et al., 2020; Al-Omoush, 2023). In 2020, the Nordic Council applied social media analysis to better understand the impact of the green transition in the Nordic regions. One outcome is the doubts among the Nordic populations regarding the implementation of the green transition (Nordic Council of Ministries, 2020).

This contribution presents a multidisciplinary exploration of crosscutting Spatial Planning and Territorial Governance and Social Media studies. It investigates whether the JGT exists on social media and whether this meta-concept or any of its variations have been impactable since the JTM was enacted on July 1st, 2021 (European Parliament, 2021) to open new horizons for further exploration of what social media analysis can offer to the research fields of governance and decision-making.

Research Methodology

The research design, summarised in Figure 1, is based on mixed methods of crosscutting:

(a) Theoretical and conceptual framework of the JGT (Shaker & Berisha, 2024) with a background in Spatial Planning and Territorial Governance (Nadine et al., 2018; Berisha et al., 2021).

(b) Social Network Analysis (Froehlich, 2023) with a background in Social Media Studies and Digital Methods[7].

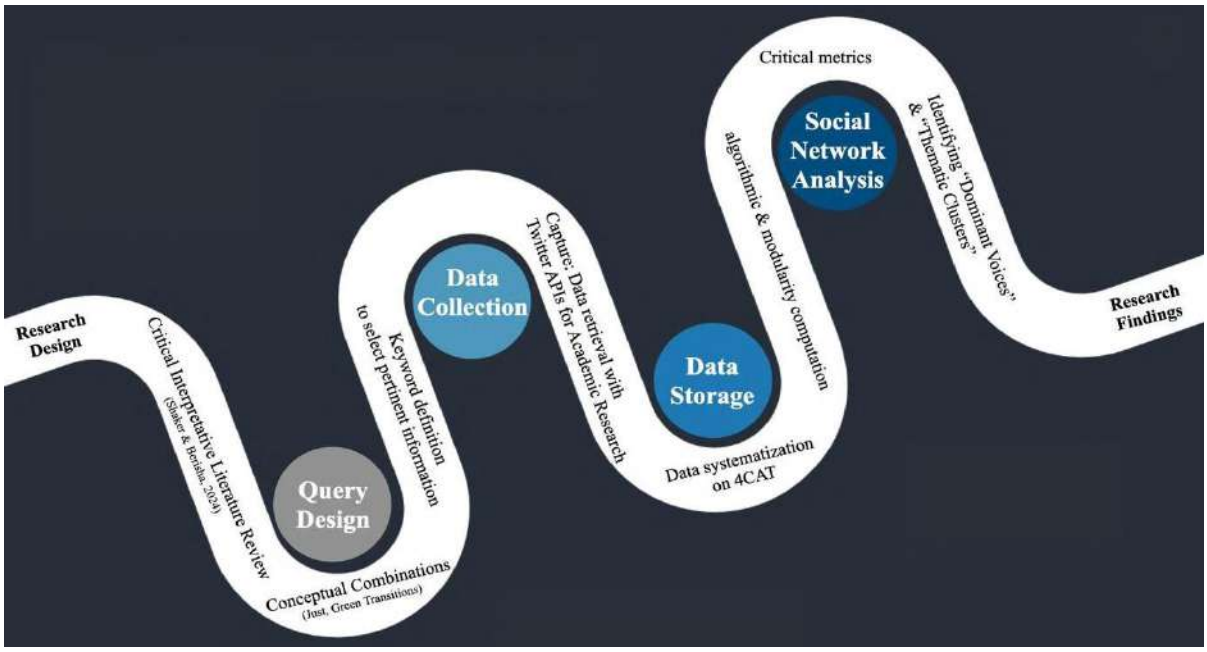

Figure 1 – Research Pipeline and Methods. Source: Authors' own elaboration.

The **query design** is based on the English language to maximise the exposure to a wide range of policy actors, including various EU public authorities, influencers, activists, and followers, since the discussion on the JGT cannot be detached from the global debate on climate justice (Tavares, 2022).

It is based on deconstructing the term Just Green Transitions into the collection of the parts of the definition that could be used in broader contexts (such as Green Transition and Just Transition) while excluding individual terms (Just, Green, and Transition) in the research string to avoid ambiguity and aiming to limit the research noise.

[7] **Digital Methods**: are methods to analyse natively digital data from social media aimed to stand for collective phenomena, social changes, and cultural expressions. The theoretical framework in the field of social media analysis has been shifting towards critical metrics, which not only measure attributes but illustrate relationships between digital objects based on platform affordances (Rogers, 2018a, 2019).

The keywords in the research string are all without spacing to eventually collect content labelled with hashtags, where every tweet has included at least one of the following:

{*Just Green Transitions* OR *Just Green Transition* OR *Just Green* OR *Green Transition* OR *justgreentransition* OR *greentransition* OR *justtransition* OR *justgreen*}

The **Data Collection** was performed on three million original tweets over 20 months between the 1st of July 2021 and mid-March 2023 using 4CAT (Peeters & Hagen, 2022). The keywords were forwarded as parameters of http-request using Twitter API v.2 with academic research access, and the correspondent http-response, containing a JSON (JavaScript Object Notation) file, and is automatically stored on 4CAT as an SQL database.

The **Data Analysis** based on Social Network Analysis (SNA) was found suitable to identify the dominant voices [8]and thematic clusters[9], which formed a Hashtag Graph-based - Topic Model (HGTM) (Wang et al., 2016; Steinskog et al., 2017). Therefore, SNA focused on two specific entities, users, and hashtags, thus performing mention analysis and co-hashtag analysis graphs to map narratives and communities that help capture more nuanced aspects of the topic. The two graphs have been processed using Gephi (Bastian et al., 2009). On the one hand, a Social Graph by Mentions (mention analysis) describes connections among users by looking at the network of mentions between them. This analysis shows Dominant Voices and their connections, which potentially highlight flows of information inside and between communities. To shape the social graph by mentions (Lutu, 2019), labels were dimensioned by the number of mentions received and filtered by degree, keeping only the profiles with more than twenty-five interactions to highlight the strongest ties. An OpenOrder algorithm has been applied using standard parameters to create the final layout. Thanks to the modularity calculation, it highlighted the twenty largest communities (Darmon et al., 2015) with assorted colours. On the other hand, a Co-hashtag Graph [10]describes the connections among hashtags by correlating them when used in the same tweet. The hashtags are a peculiarity of the platform that can be used to perform an exploration of the main narratives since algorithms help to create thematic clusters and perform HGTM. In this case, an OpenOrder algorithm has also been applied with standard parameters. It also dimensioned labels according to frequency to underline the most prominent hashtags and applied modularity calculation, which allowed it to detect and distinguish different thematic clusters.

[8] **Dominant Voices**: are the profiles considered most impactful within their communities and who stand for a point of reference for their community calculated by looking at the mentions' dynamics (a specific Twitter affordance). They function as a point of reference for the community, channelling most of the attention and influencing the public debate (Rogers, 2018b).

[9] **Thematic clusters**: identified by looking at the hashtags network based on co-occurrences in the same tweet.

[10] **Co-hashtag Graph**: analysis of the network of hashtags' co-citation in the same tweet (Severo et al., 2015).

Research Results

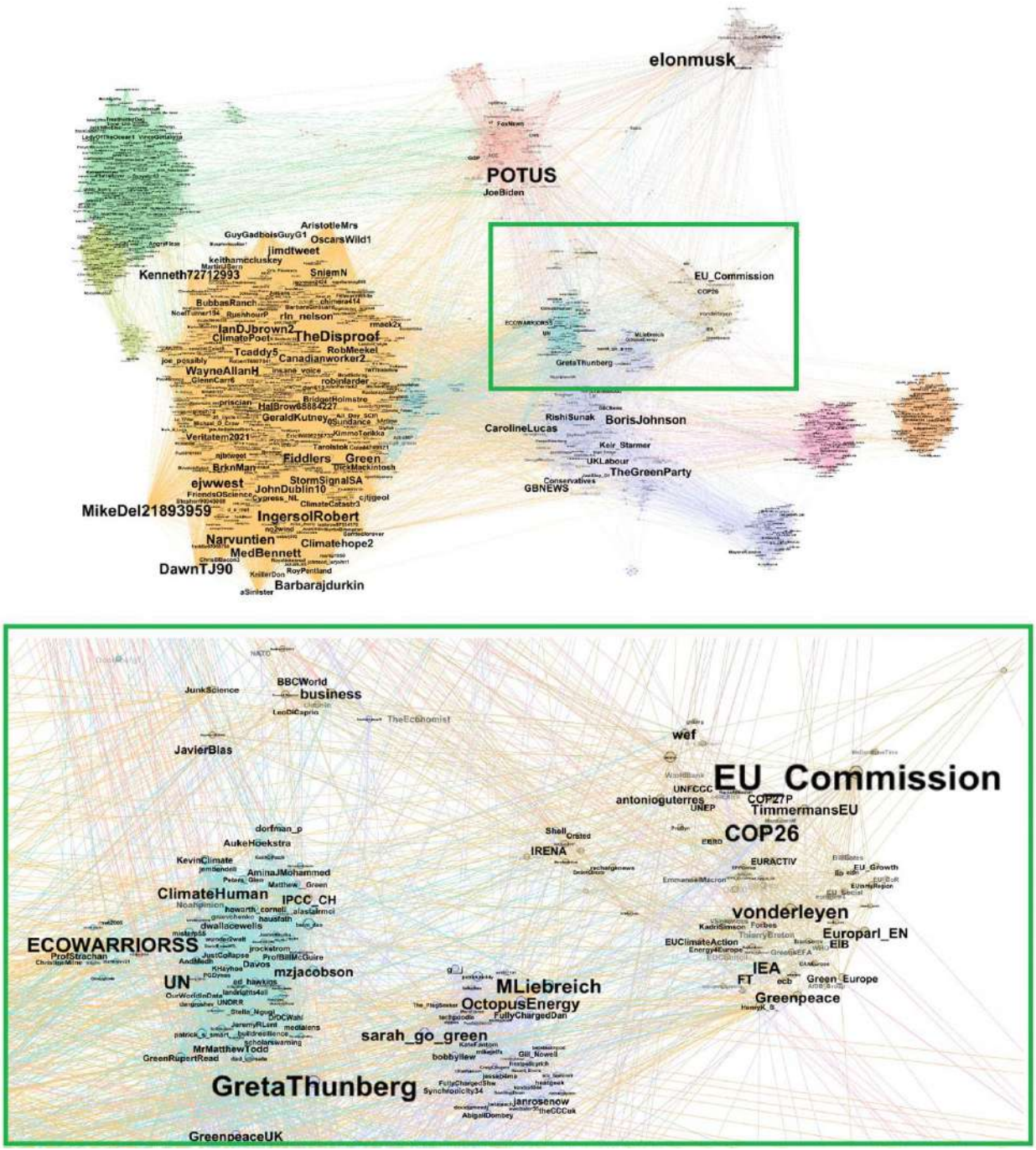

Figure 2 –Mention Analysis of the main communities. Source: Authors' own elaboration.

The Mention Analysis performed for the entire dataset underlines the presence of many fragmented communities. The major interactions are within the common users' communities.

A high presence of dominant voices has been noted (visible in the zoomed section), mainly official institutional and global players (EU Commission, UN, EIB, COP26, Von der Leyen, EU Council, World Bank, UNFCCC, UNDRR, IPCC, WHO), global activists and influencers (Greta Thunberg, Climate Human, Greenpeace, Ecowarriorss).

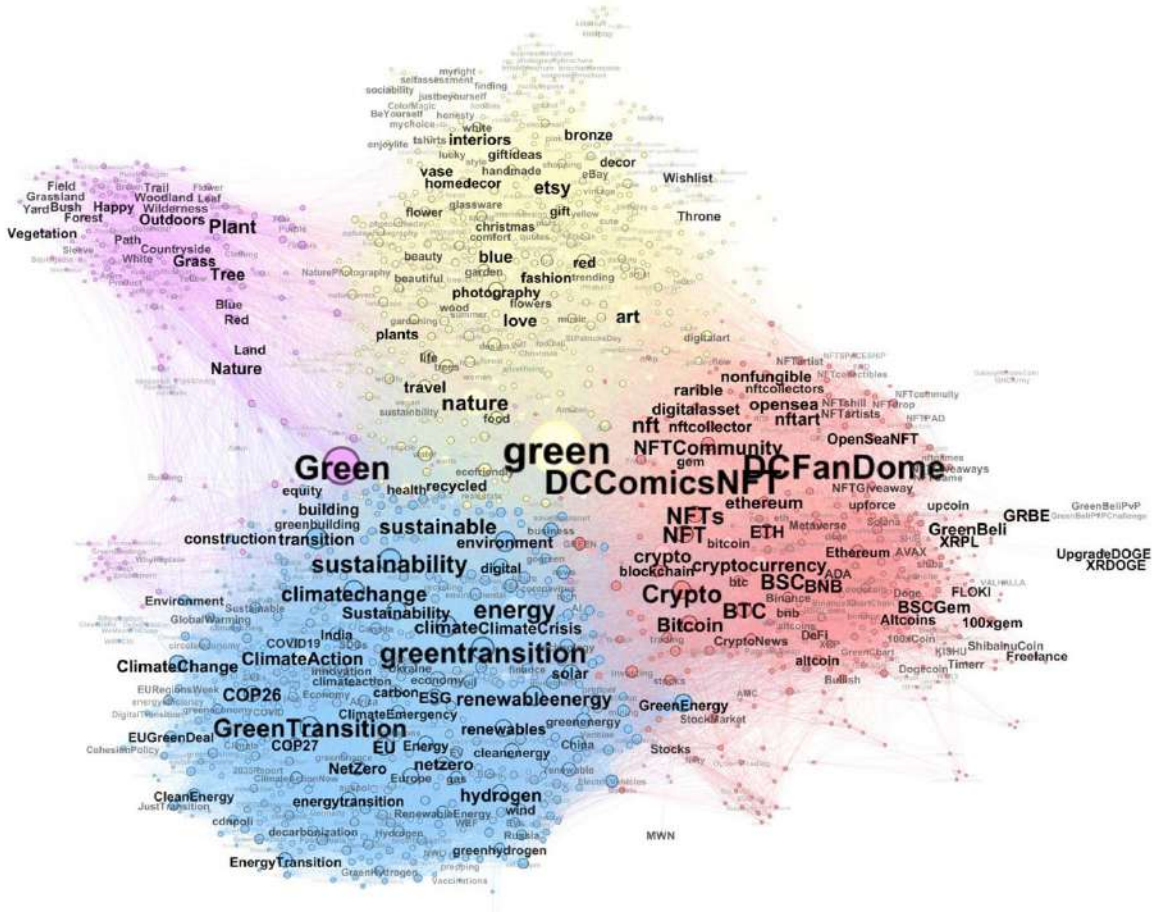

Figure 3 –Co-hashtag Analysis to highlight the main topics. Source: Authors' own elaboration.

The co-hashtag analysis performed on the entire dataset shaped four thematic clouds. The first noted aspect is the presence of thematic clouds not strictly related to the JGT: the violet cloud encompassed some discussions related to (nature, land, plants, and vegetation), and the yellow cloud encompassed topics related to (art, design, and fashion), and the red cloud included topics related to (marketing, bitcoin, crypto and NTFs) were limited from the analysis process.

A predicted level of research noise was expected in the query design phase because of the polysemic nature of the terms (Just, Green, and Transition), which could be used in multifaceted contexts. Therefore, it was found suitable to focus the analysis only on the blue cloud, which held clear references to the "Green Transition" and the topics related to its notions. The blue cloud has been analysed and categorised into different thematic clusters and sub-clusters, as in Figure (4). The graph above is the result of reiterating the hashtag analysis of the blue cloud from Figure (3) using the circular layout plugin algorithm of Gephi to represent the Twitter data in the form of a sphere. This allowed to set the graph shape with ranking and degree distribution to avoid nodes' overlapping and enhancing the readability of the Graph, highlighting four main thematic clusters:

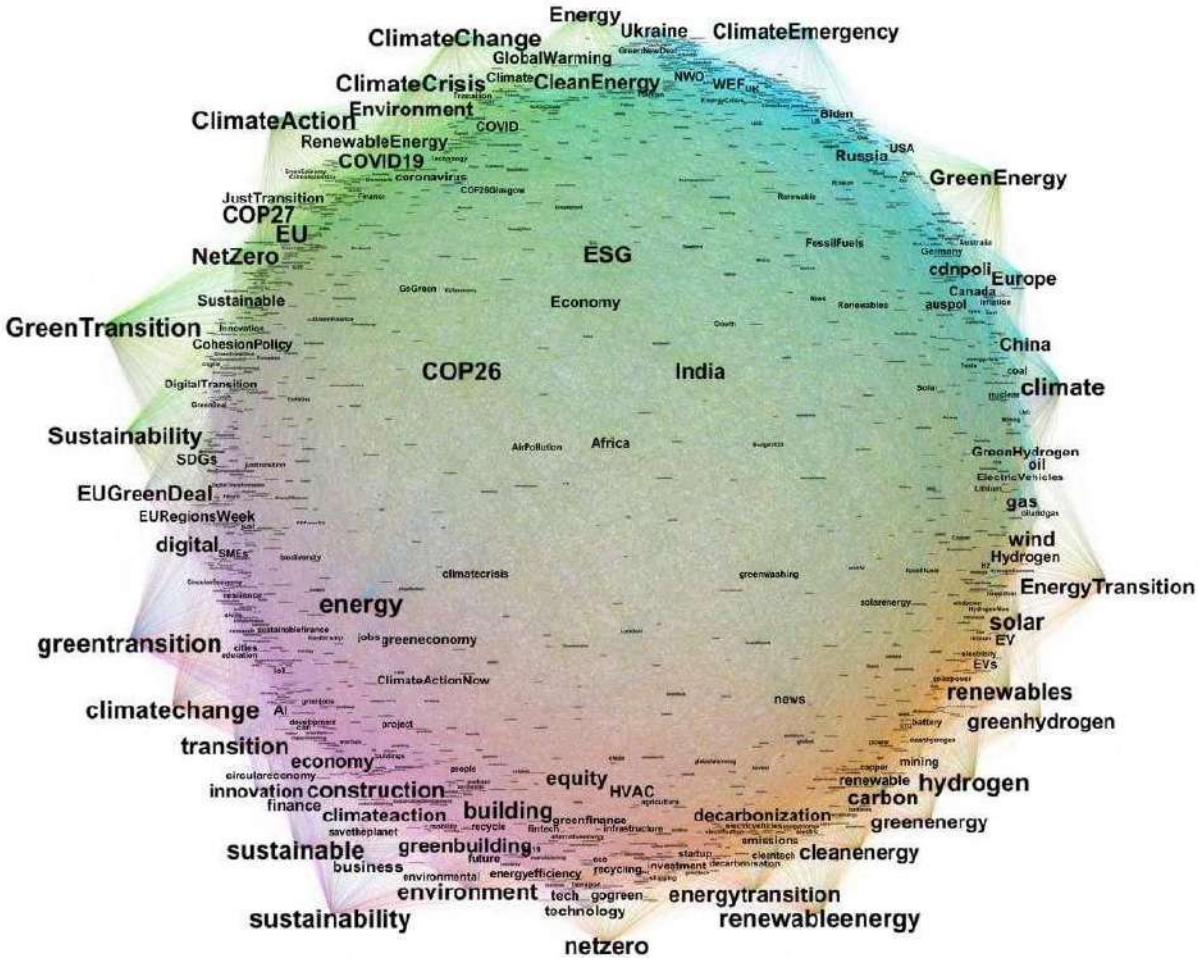

Figure 4 –Reiteration of the analysis on the blue cluster to highlight subtopics. Source: Authors' own elaboration.

- **Light blue**: Geopolitical dimension of the JGT

Sub clusters: Global Governance, Global Players, and Global Emergencies.

- **Orange**: Energy dimension of the JGT

Sub clusters: Energy Transition, Decarbonisation, Renewable Energy Resources, and Energy Storage.

- **Violet**: Policy dimensions of the JGT

Sub clusters: Socio-economic, Just, Technological, EU Governance dimensions.

- **Green**: Green dimension of the JGT

Sub clusters: Climate Change, Sustainability, and Climate Governance.

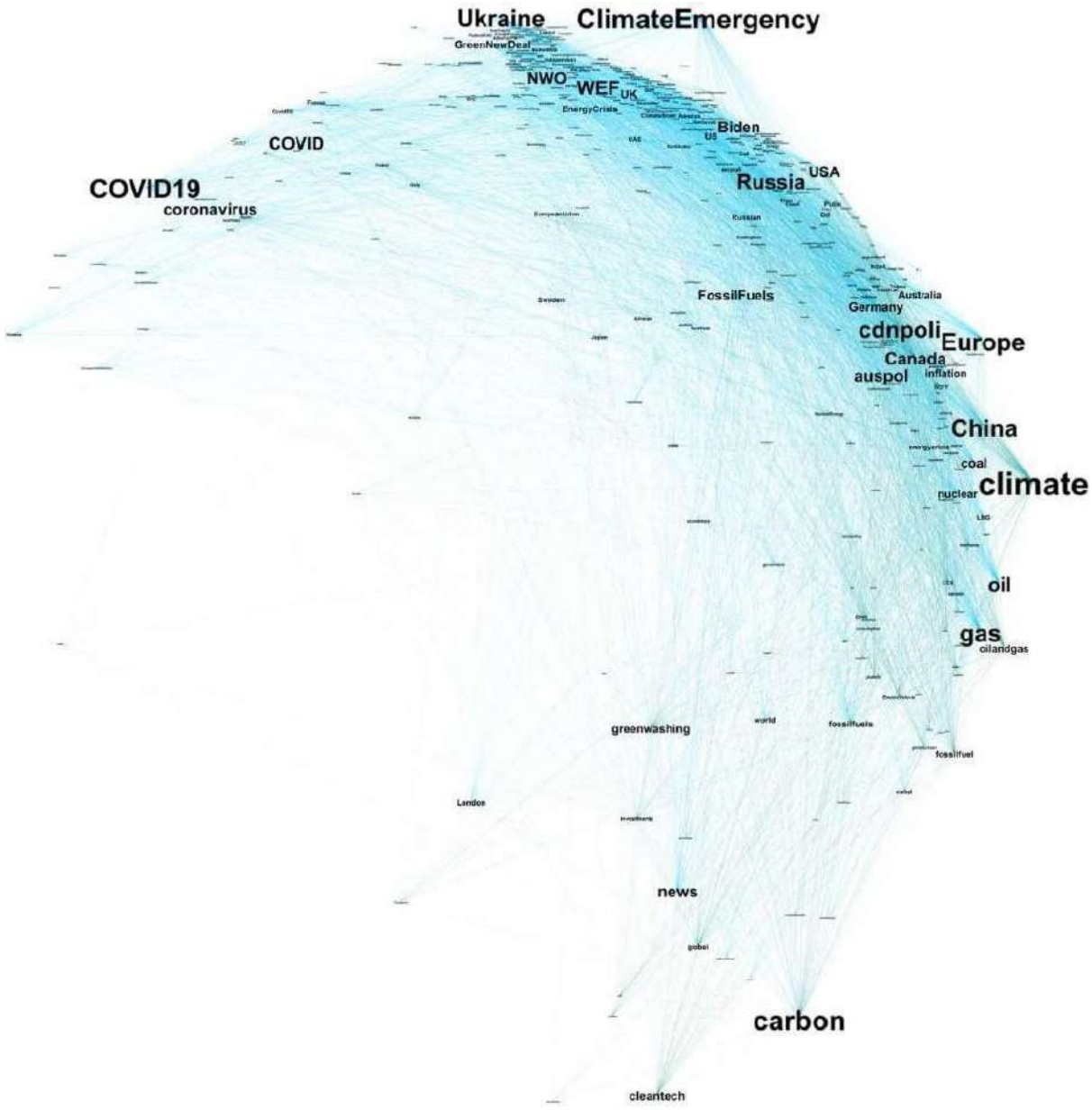

Figure 5 –Light-blue thematic cluster: JGT related to Geopolitics. Source: Authors' own elaboration.

The light-blue thematic cluster includes references related to international geopolitical actors that contribute to the discourse of the following:

- **Global Governance** (#fossilfuels, #greenwashing, #greennewdeal, #gas, #oil, #nucelar).
- **Global Players** (#Europe, #Ukraine, #Russia, #USA, #China, #WEF-#WorldEconomicForum).
- **Global Emergencies** (#covid19, #COVID, #coronavirus, #pandemic, #inflation, #energycrisis).

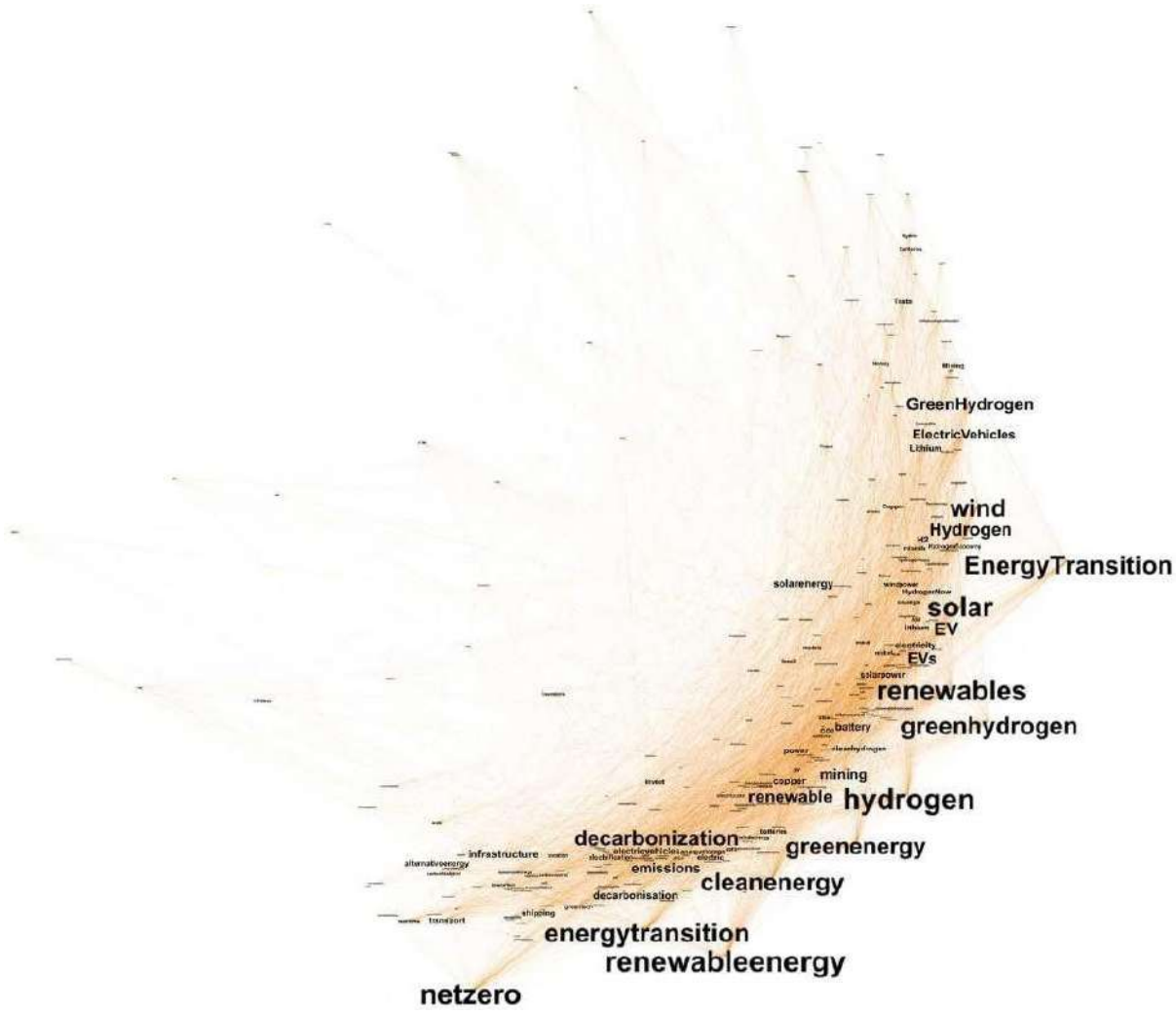

Figure 6 –Orange thematic cluster: JGT related to Energy Transitions, Renewable Energy, and Energy Security. Source: Authors' own elaboration.

The orange thematic cluster includes references to issues of:

- **Energy Transitions** (#cleanerenergy, #alternativeenergy, #energytransition, #renewableenergy, #greenenergy).

- **Decarbonisation** (#co2, #emissions, #mining, #netzero, #transport, #infrastructure, #shipping).

- **Renewable Energy Resources** (#wind, #hydrogen, #H2, #greenhydrogen, #solar, #greentech).

- **Energy Storage** (#electricvehicles, #EVs, #lithium).

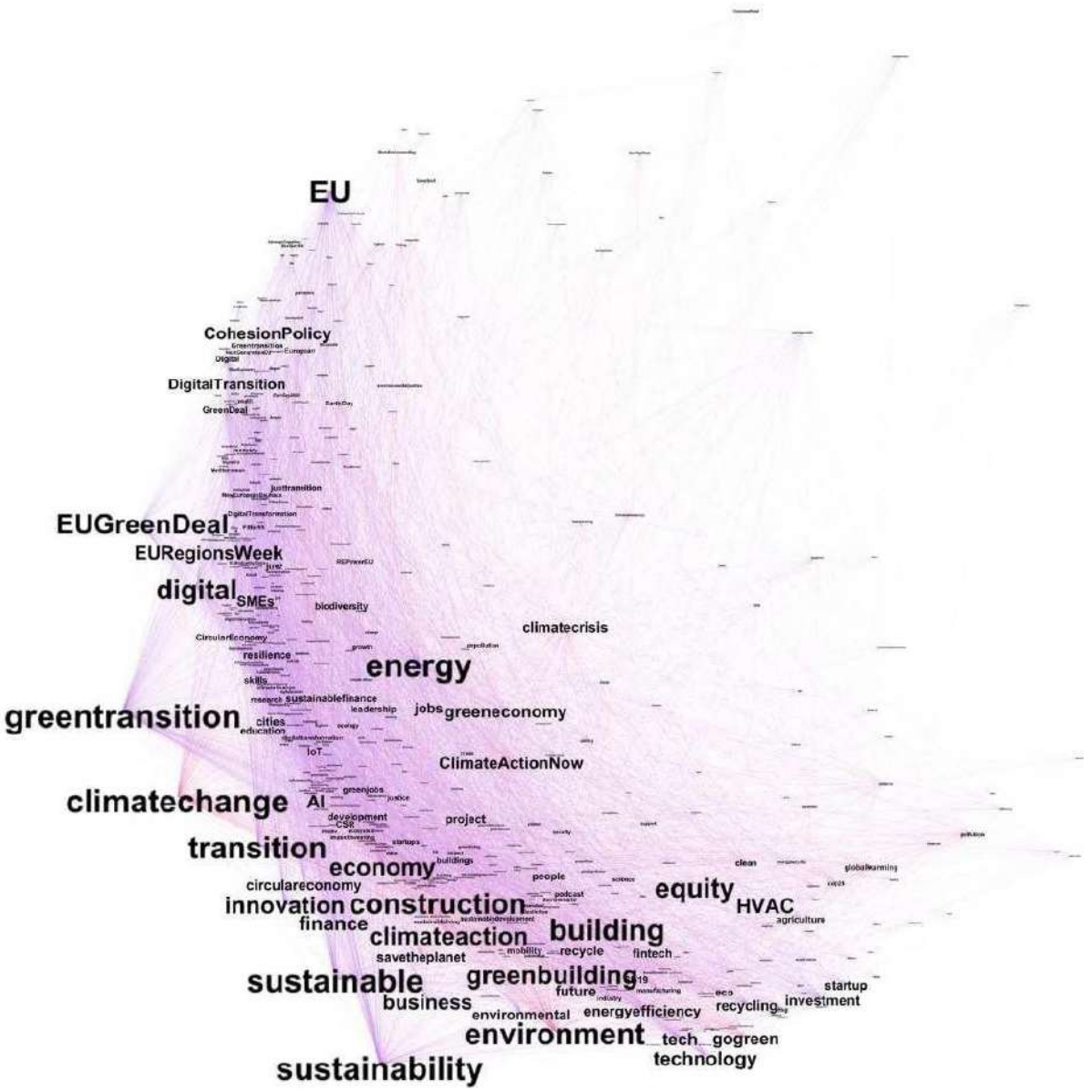

Figure 7 – Violet thematic cluster: Policy dimension related to the JGT. Source: Authors' own elaboration.

The violet subcluster includes references related to various subtopics of the Green Transition:

- **Socio-economic Transition** (#sustainablefinance #greenjobs, #circulareconomy, #digitaltransition, #greeneconomy, #finance, #SMEs).

- **Just Transition** (#justice, #climateaction, #climnatecationnow, #savetheplanet, #Earthday, #globalwarming, #sustainability, #environment, #innovation, #equity).

- **Technological Transition** (#digitaltransition, #digitaltransformation #techgogreen, #IoT, #AI, #greenbuilding, #innovation, #tech, #technology, #greentech, #HVAC, #startup).

- **EU Governance dimension** (#EU, #EUGreendeal, #GreenDeal, #cohesion policy, #EURegionsWeek, #REPowerEU, #recovery, #NewEuropeanBauhaus).

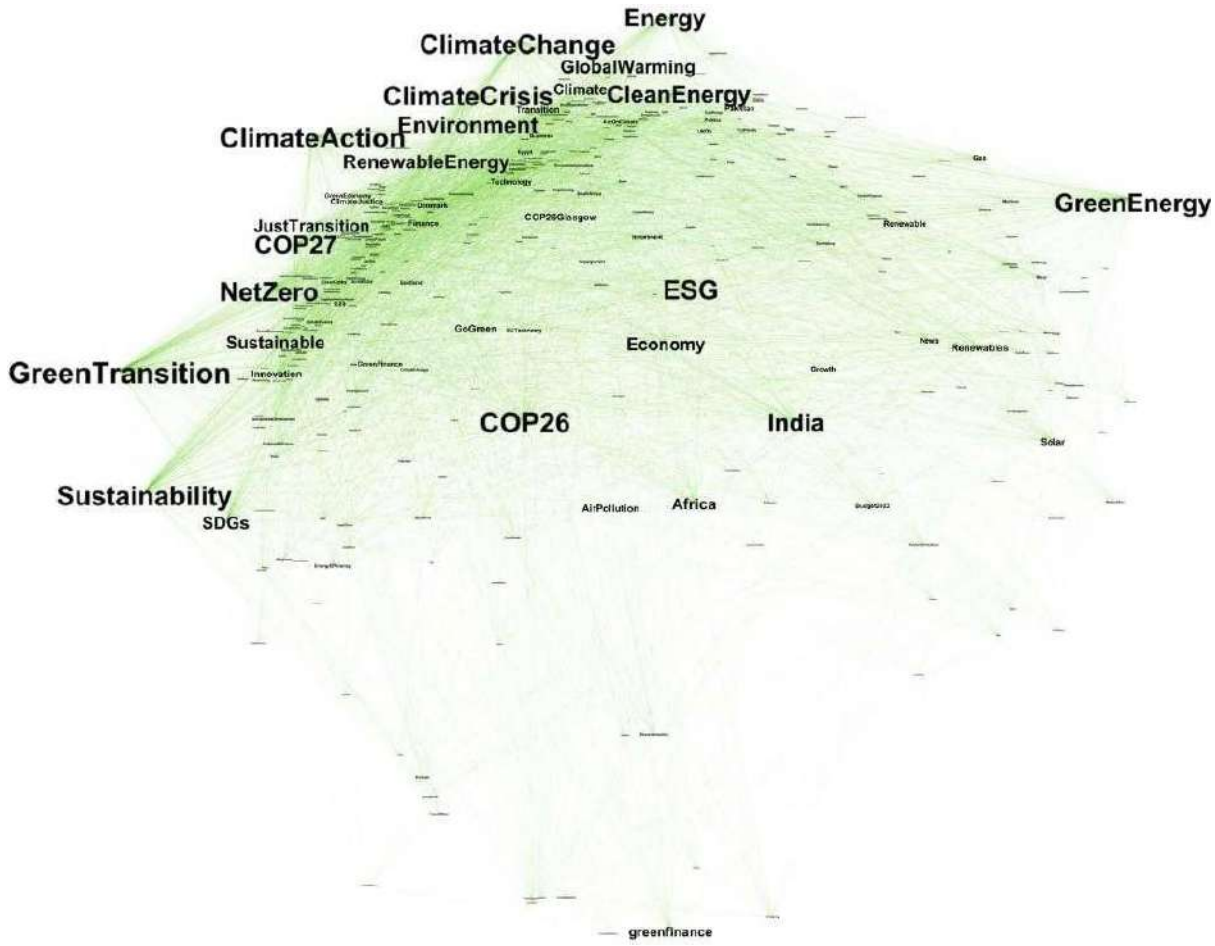

Figure 8 –Green thematic cluster: Green dimension related to JGT. Source: Authors' own elaboration.

The green thematic cluster holds references related to:

- **Climate Change** (#ClimateChange, #climatecrisis, #GlobalWarming, #GoGreen, #CleanEnergy, #ClimateAction).

- **Sustainability** (#GreenTransition, #JustTransition, #Sustainability, #Sustainable, #Environment, #NetZero, #Renweable, #Renewables, #GreenEnergy)

- **Climate Governance** (#COP26, #COP27, #ESG, #SDGs).

Discussion

The public debate on Twitter on the JGT has been multifaceted and fragmented. The clusterisation showed various narratives, dimensions, and terminologies that were used in the public debate to discuss the expected transitions. The Mention Analysis highlights different communities of assorted sizes, returning the discussion to the fragmentation of the debate. The presence of distinct dominant voices presenting global institutional, social, and political actors, using various terminologies related directly or indirectly to the discussion on the JGT, has been multifaceted and articulated at various degrees, represented in the size of the terms used in the hashtags.

The results have also demonstrated that the public debate has suffered a level of research noise resulting from (a) the abundance of near-synonyms gaining ground on the expected transitions, (b) the various meanings that each term (concept) of the JGT (Just, Green, Transitions) holds, (b) their conceptual combinations of the JGT are rarely used either by the official institutional accounts (dominant voices) or by the general public (Twitter users), (d) the terminological inexactitudes has contributed to their lack of presence.

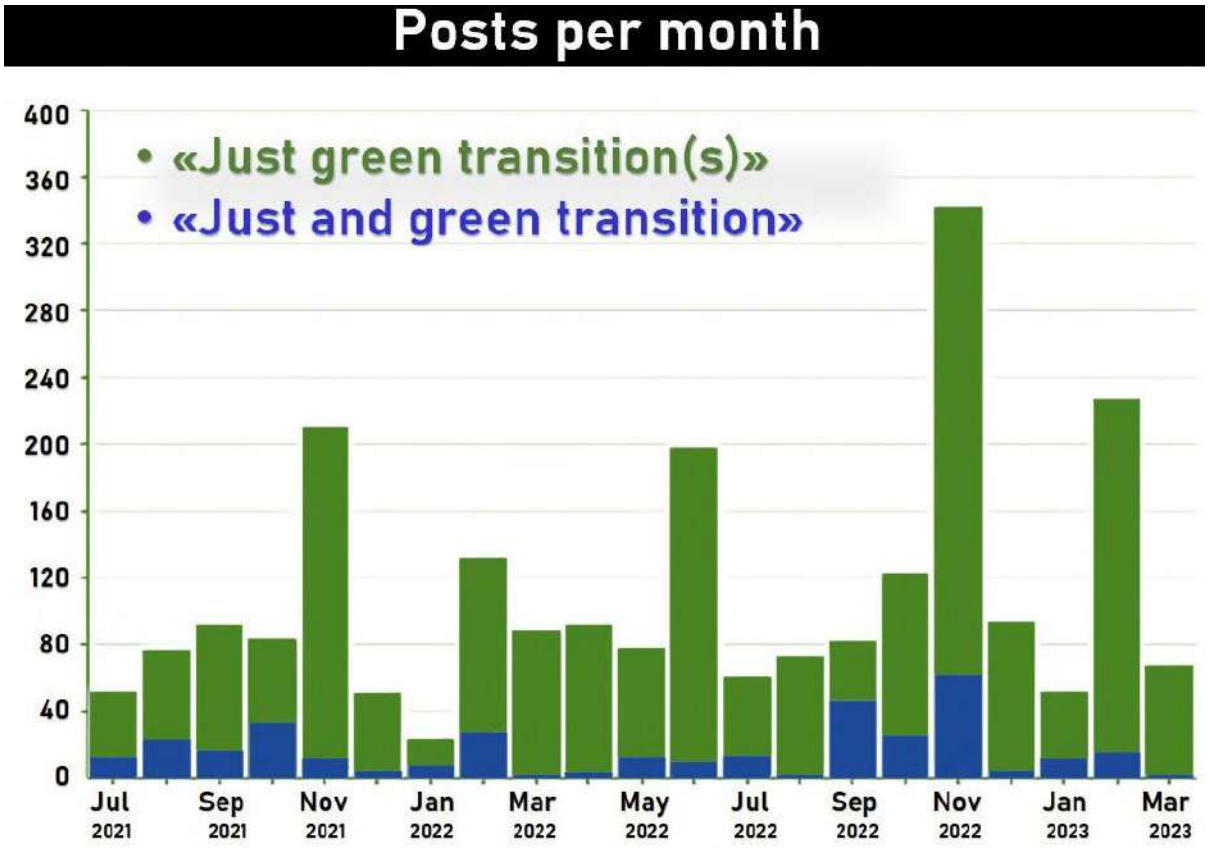

Figure 9 –Histograms showing the frequency of use of "Just Green Transition(s)" and "Just and Green Transition". Source: Authors' own elaboration.

Among the hashtags described in the results, the absence of the terms "Just Green Transition" and "Just and Green Transition" has been noticed, terminologies that are not primarily evident in the hashtags, as demonstrated by the histograms below that show the usage of the above- mentioned definitions.

To calculate the frequency of the JGT both in the form of a hashtag and as a word string, 4CAT were used to analyse text fields of original tweets and found that the term "Green Transition" was used 45.000 times (1.5%), while the term "Just Transition" was used 4.500 times (0.155%). The term "Just Green Transitions" is 2.300 times (0.076%), and "Just and Green Transition" is 357 times (0.0119%).

Terms such as "Green," "Energy", and "Sustainability" are actively used in public debates on social media, while "Just Green Transition" and Just Green Transitions" are not as impactable.

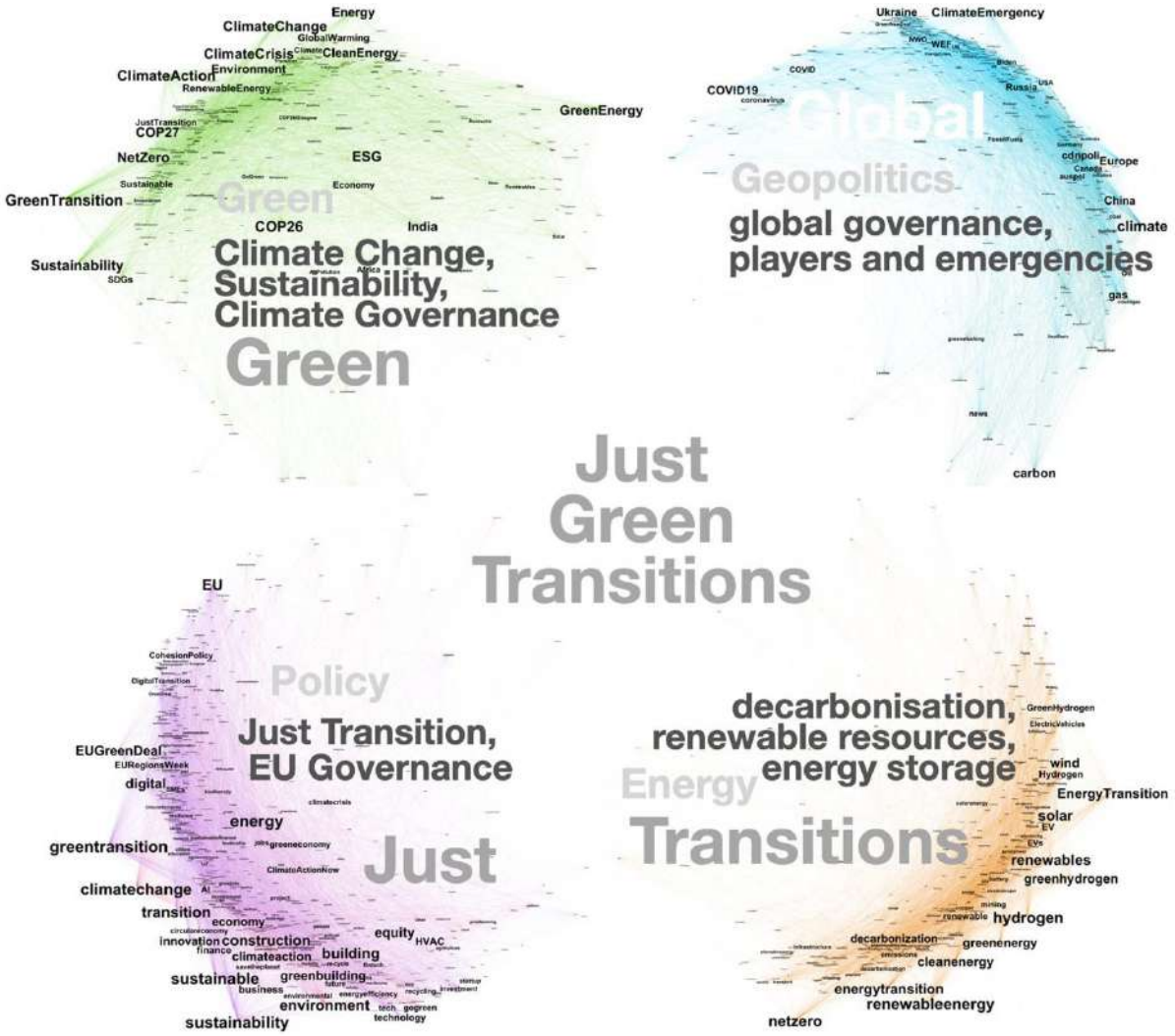

Figure 10 –Clusterisation of the JGT narratives on Twitter. Source: Authors' own elaboration.

When looking closely at the four thematic clusters, sub-clusters, including various terms, were shown in the hashtags. In the light-blue thematic cluster, the discussions seem more oriented toward the role of geopolitics (Kamruzzaman, 2022) as a tool for shaping and mobilising the global actors and events leading to the necessity for decarbonisation (Strambo, 2022), as confirmed in the literature. Moreover, fossil fuels and climate emergency crises are directly connected to global governance, players, and crises. The orange thematic cluster drew attention to the energy transitions, which is one pillar of the EDG. More specifically, this cluster focused more on the "Transition" dimension. The violet cluster highlighted the main policy dimensions of the debate, especially the ones related to the EU and the Cohesion Policy. While in the Green cluster, the discussion has given more attention to global climate governance (COP26, COP27, ESG), reconnecting to the international dimension in the light-blue section. Despite its minimal relevance of a direct narrative inherent to JGT, the graph has shown that, in addition to the three core dimensions of the JGT (Just, Green, Transition), there is a fourth one: their geopolitical dimension.

Conclusions

This contribution aimed at shedding light on the importance of using social media not only for dissemination purposes but in governance and decision-making. The results highlighted the role of social media as a socio-political virtual space where policy communications are becoming crucial, especially when it comes to social and political topics (López-Ornelas et al., 2017). In conclusion, this contribution has arrived at the following conclusions:

- Social media analysis could offer some room for better grasping the public debate on prompt political issues. It offers a critical analytical tool for policymakers and could help the disciplines of governance and decision-making.

- The introduction of new terminology, which is not commonly agreed upon, might take more time to grow, evolve, and saturate in literature and public debates.

- The use of plain, direct, and simple terminologies could narrow the gap between the official language used in policymaking and the colloquial language used by the public to discuss the same phenomena; the term “Just Green Transitions” is barely used in the public debate on social media; nevertheless, the debate related to its notions is yet active.

Avenues for future research

It is worth highlighting the various research limitations, for it is important to make sure that the results of this contribution do not present the full public debate on the JGT as the topic is prompt and ongoing.

First, the **methodological limitations**: the main limitation lies within using social media as the main field of inquiry as its reach is socially and spatially relative. Thus, the data analysed is limited to a relatively small group of participants, considering the continental scale of the JGT and the EDG agenda. Another limitation is using a single platform for the analysis (Twitter) and not all the social media platforms. The choice for limiting the inquiry to Twitter has been based upon its reputation in literature for being the main social media political arena, an aspect which fits the requirements for our research aim. Nevertheless, Twitter (now X) does not cover all the voices on social media, not to mention the role of fake news, misinformation, disinformation (Gil de Zúñiga et al., 2022), and the radical influence of the below-the-radar platforms on the political debates on Twitter (Monaci & Persico, 2023). Another issue is that social media reach is socially and spatially relative. Thus, the data analysed is, to some extent, limited to a small group of participants, considering the continental scale of the expected transitions.

Second, **confirmational biases**: It is crucial to highlight that this research has been undertaken in an independent, neutral manner, meaning that each author has been undertaking the data collection and analysis independently and within their field research

field. This was found adequate to prevent any potential influences that might have affected the research design, data collection, data analysis, and findings. Nevertheless, the individual results have been almost undistinguishable both from theoretical (Governance Studies) and empirical (Social Media Studies).

Third, **language limitations**: the research is entirely based on the English language, which has allowed us to capture the most out of the public debate on Twitter, considering the EGD and its JGT play a vital role in global geopolitics (Leonard et al., 2021). With more accessibility to data in different languages, it would have been possible to run a content-based-geo-localisation of the Tweets (Cheng et al., 2010). If combined with EU datasets, the EIB climate survey, and the Eurobarometer on the perception of citizens on Decarbonizing Europe and the Renewable Energy Transition of the EGD (Panarello & Gatto, 2023), Climate Change (EIB, 2024), and the Fairness of the Green Transition (European Commission, 2022), a possibility for a more profound reading on the perception. Of the EU citizens on the JGT, it could be possible to use sentiment analysis (Balahur & Turchi 2013).

Fourth, **time limitation**: the time limit for this study is cross-sectional (20 months), which cannot give a full image of the real-time debate on the JGT until reaching their climate targets by 2030 and the assumed 100% climate neutrality by 2050. It is an ongoing discussion, and any matters of perceptions and terminological uses are subject to change over time. Nevertheless, there are various avenues yet to be explored: (a) How do the terminologies used in the official language of the public administration affect the public perceptions and interpretations of contemporary global policies? (b) How could the EU Governance benefit from social media analysis to better conceptualise and operationalise JGT considering public opinion?

This contribution's primary focus has been to critically examine the presence of the JGT in the socio-political virtual space and grasp the inaccuracies surrounding their terminological use. This research suggests that the JGT are better perceived as socio-political constructed realities that are exposed to an elevated level of relativity and uncertainty and are subject to ideological, political, philosophical, societal, and environmental interpretations. Addressing the conceptualisation of the JGT as one issue of the commons and forging commonly agreed-upon terminologies in EU policymaking could guide our societies towards achieving the once-in-a-lifetime opportunity of becoming climate-neutral but without leaving no one behind (European Commission, 2019).

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Conflict of interest

The authors declare that there is no conflict of interest in their knowledge nor financial or personal interests that might have influenced the ideas presented in this paper.

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EUROPEAN JOURNAL OF SPATIAL DEVELOPMENT

Research Article

Funding the social transformation of housing estates. Environmental ambitions as catalysers of the regeneration of Corviale

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Abstract

This study aims to unravel the dynamic interplay between new environmental considerations and the lifespan of housing estates within urban regeneration programs. Through a case study, the following contribution paper examines how the funding of urban regeneration projects has evolved and is today mobilised under the umbrella of just transition initiatives in the European context. This holds particular significance in the context of Southern European nations, which are key beneficiaries of the comprehensive recovery funding provided by the EU through initiatives such as the Next Generation EU funds. The study adopts sociotechnical methods to analyse the case of Corviale, a housing estate built for 8,500 residents in the outskirts of Rome, along with two main regeneration programs: the Contratto de Quartiere II and the Piano Urbano Integrato (PUI - PNRR).

Keywords

Urban regeneration, housing estates, demolition, climate change, social innovation

Housing estates regeneration in a climate crisis context

Although the challenge of governing large housing estates has been a concerning issue for some decades (Dekker et al., 2005), the new climatic regime raises (Latour, 2018) new challenges in their governance. Acknowledging that the environmental impact of transforming housing buildings is considerably lower than that of demolition (Power, 2008), different scholars (e.g. Lees, 2008) claim a transition to a model of sobriety that defends the practice of transformation over building new mass housing developments. Large housing estate regeneration initiatives are emerging, with a notable portion of these initiatives often receiving funding through programs with strong environmental ambitions (e.g. REHA program by the Ministry of Ecology of France, or the PUI-PNRR in Italy). This article delves into alternative modes of governing the transformation of housing estates by studying the opportunities that climate change politics can bring to the regeneration of such estates. The objective of this research is to analyse the nexus between the lifespan of housing estates and new environmental policies in the context of housing estate regeneration initiatives. The study explores this nexus through one case of housing estate regeneration in Southern Europe:

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Corviale housing estate in the suburbs of Rome. Corviale had been thread with demolition in different moments of its history but is today engaged in a profound regeneration process.

The demolition of large housing estates spread in Europe during the 80s and 90s. The UK, France, and The Netherlands accumulate the largest rate of demolitions of housing estates in Europe (Thomsen & Van der Flier, 2006). In these countries, demolition is still an established practice (ibid.). As described by A. Berland-Berthon (2012) through the study of different demolition examples in France, housing demolition has been reshaped as a legitimate line of public action regarding the management of public housing stock, as it was integrated as a tool within the French Urban Renewal National Program in 2003. The demolition of housing estates has proved to be harmful to the mental health of the displaced community (Lees, 2008), and also to have environmental consequences. The recurrent critics against demolition, the scarcity of affordable housing in many European cities and the current climate crisis are factors that in the last two decades have started changing the approach to the maintenance of housing estates. Despite demolition is still a reality on many Western European countries, today large housing estate regeneration initiatives are on the policy agendas of Western European countries (Dekker et al., 2005). In South European countries such as Italy or Spain, demolishing public housing stock is less common. Situations of mismanagement and social unrest within Italian or Spanish public housing estates tend to be approached by either selling or abandoning the public housing estates (Belmessous et al., 2005, Bricocoli et al., 2021; Puccini, 2016).

While a large amount of literature studies the decay and regeneration process of housing estates from Western European countries (mostly the UK and the Netherlands), there is a lack of studies tracing similar processes in Southern Europe cases (Monclús & Díez Medina, 2016). This paper addresses this gap in the literature by examining the renewal process of a housing estate located in Italy. Additionally, building on the research of Simon Guy and Andrew Karvonen (2011), this paper enhances existing literature by employing sociotechnical approaches and methods to study the interplay between the physical features of the housing estate and the planning tools implemented along the renewal process.

Corviale is a housing estate in the outskirts of Rome, designed in 1975 and finally built in 1984 by the IACP (*Istituto Autonomo Case Popolari*)[1]. Corviale is selected as a case study to investigate the nexus between the lifespan of the housing estate and new environmental policies in the context of housing estate regeneration due to the presence of a well-documented long-term transformation process. The study approaches Corviale as a context of contingency and political contestation, where the uncommon features of the place have left space for the rise of different forces on the site, leading to the expansion of its lifespan, and later to the

[1] The IACP was a public Italian company for the development and management of public housing. The company's roman section is currently known as ATER (Azienda Territoriale per l'Edilizia Residenziale).

development of top-down social innovations initiatives, financed with the support of two regeneration programs with environmental budget.

This article is divided into seven sections. After this first section presenting the main issues and objectives of the research, the paper reports on the methodology followed through the study. In the third and four sections, the study analyses the features of Corviale: its outstanding proportions, its long corridors, its standardised constructive system. Then the study explores the local context through the relation between these physical characteristics and social context[2]: the extensive networks of actors engaged in its governance, the active participation of local associations, the work of community groups and the notoriety of the housing estate, that goes beyond the scope of the neighbourhood. In the fifth and sixth section, the study focuses on the evolution of the housing estate through the live cycle method, delving into what contributed to potentially increasing or reducing the lifespan of the housing estate. Finally, the seventh section examines how specific social conflicts are addressed through regeneration programs with environmental budgets, which modify particular physical features of Corviale and promote government-led social innovation initiatives.

The study is attentive to the endogenous and exogenous factors of the housing estate that have conditioned the governance of Corviale by tracing, with a socio-technical approach[3], the influence of the physical conditions of the housing estate in the evolution of its governance process, leading to the extension of its lifespan. Additionally, this study posits that the local characteristics of Corviale and the regeneration programs with environmental budget have provided an alternative scenario favourable to the development of government-driven social innovation initiatives at Corviale, that have contributed to ensuring the regeneration of the neighbourhood.

Methodology, from the micro-scale to the grid

This study uses qualitative methods to collect and analyse data on the operationalisation of the regeneration project in Corviale. This article relies on some of the data and findings from a one-year research, which involved a 4-month field mission in Rome. The access and contact to the group of researchers of the Lab. Città Corviale helped define Corviale as a main case study, and has provided great access to primary data.

[2] For social context this article intends the extensive networks of actors engaged in its governance, the active participation of the local community and the notoriety of the housing estate, that goes beyond the scope of the neighbourhood. However, it must be noted that this article has only approached a section of the full complexity of the social groups that, through the 40 years of Corviale, have been involved in the governance process of the housing complex.

[3] This sociotechnical approach is based in the work of Guy & Karvonen (2011), who describe for such an approach a way of studying technical objects as technologies that are inseparable from developments in the social sphere. The sociotechnical approach requires the analysis of the interaction of such technologies with a broad range of social actors, including scientists, engineers, policymakers, politicians, activists, artists, and users.

The process of data collection followed a three-part methodology. First, it involved a literature search, combining both general academic literature on housing estate governance and sociological studies of Corviale (e.g. del Monaco 2006, Di Giovanni 2022, Clough Marinaro 2021), with all the official documents related to the regeneration of the building and the review of academic work on the regeneration of Corviale (e.g, Calzado, 2023; Caudo, 2022; Di Giovanni, 2020). Specifically, the study of the regeneration programs of Corviale involved the analysis of the original briefs of the program, the study of funding structures and governance of the program, and the review of the environmental dimensions of each program.

Secondly, the study relied on primary data, based on observations on the use of the public space of Corviale, in neighbourhood meetings and official group meetings with social workers, and 25 interviews conducted with the different actors of Corviale such as interviews at a municipal level (policymakers and politicians, senior city officials), at the housing authority level (board members, operations managers, security personnel), and at the inhabitant's level (association leaders, long-term inhabitants, local social workers or informal occupants).

Finally, secondary data, such as former surveys and data provided from the Lab. Città Corviale was used again a posteriori to complement and triangulate information gathered through the interviews and the observations. For that, a coding process was developed using the text analysis software Quirkos. This process helped to combine the secondary and the primary data, by organizing the data efficiently using a coding grid. This method was used to study the relationship between the local characteristics of Corviale (its local governance dynamics and physical features) and the development of two regeneration programs, the Contratto de Quartiere II, approved in 2003 and the Piano Urbano Integrato (PUI - PNRR) approved in 2022.

The study aligns with sociotechnical research methods (Guy & Karvonen, 2011; Wassenberg, 2013) that specify how such relations cannot be traced according to traditional methods of analysing the decision-making and the way power is distributed in housing estates governance and requires a new sociotechnical approach. This approach integrates the physical characteristics of a place within a classic governance analysis, that studies the actors, the objectives of these actors and their instruments (Lascoumes & Le Gales, 2007). This analysis draws on the comparison of the lifespan of buildings to that of living beings (Lönberg-Holm & Carl Theodore, 1953, Straub, 2001). This method allows to study the decision-making process within the governance of housing estate and distinguish with precision the factors that have contributed to potentially enlarging or reducing the lifespan of the building. The life cycle method provides a sociotechnical framework that allows mixing the social components of the governance of the building with the physical characteristics of the housing estate.

The main limitation of considering the Corviale neighbourhood as a single study case does not pertain to data scarcity; on the contrary, an excess of data exists, necessitating the arduous task of editing and elucidating the origins and authenticity of these data. The high amount of the myths surrounding the history of Corviale, and the large number of initiatives that were

eventually stopped without much administrative tracking in their operations complexified the search of veracious data. A second limitation of this study concerns time: the four-month fieldwork mission only allows for partial coverage of the numerous local initiatives organized by community groups over Corviale's forty years of inhabitation. Consequently, this article focuses solely on government-driven social innovation initiatives. The support of the researchers of the Lab. Città Corviale has been particularly important in this task, for identifying pertinent pieces of information that contribute to the construction of a compelling case.

Corviale case study

Corviale is a housing estate conceived by the IACP for 8500 inhabitants, built between 1975 and 1984, as a result of the PEEP I (Piano di Edilizia Economica e Popolare) of Rome, which aimed to resolve the post-war housing emergency that existed in Italy during the 1960s and 1970s (Di Giovanni 2019). Corviale is sometimes exclusively associated with its most recognisable element, an almost 1 km long high-rise housing slab. However, Corviale refers to a larger housing estate that includes three public housing buildings, the almost 1 km long building with apartments and a commercial floor that runs along the hill's ridge, a parallel lower building connected to the first one through several bridges, and a 250 metres long housing building, called the 'VI lot' located at a 45° angle (figure 1). Additionally, the housing estate is equipped with a circular one-way street that surrounds a large area with green spaces, civic, commercial, and cultural amenities, as well as a large Thermal Power Plant that provides heated water to the complex (Caudo, 2022).

1km of housing estate. Corviale's physical characteristics

Corviale's most recognisable volume is a housing building of 958 meters long block that rises to 30 meters. The dimensions of this building gain an even more monumental character as it is located on top of a ridge (Vidotto, 2017). The building comprises 11 levels, two underground and primarily designated for parking and storage. The remaining nine levels are above ground and intended for residential use, except for commercial space along the 4th and the 5th floor of the building, called the "Free floor" by the lead architect of Corviale, Mario Fiorentino, which separates the building horizontally into two blocks with two different types of apartments. The upper floors featured houses arranged along galleries and accessed by five primary staircases, while the lower floors contained in-line houses connected by secondary staircases.



Figure 1 - Bird eye view of the whole complex of Corviale. The image shows the 1Km long housing building, the VI lot situated at a 45-degree angle from the main structure, and portions of the public services. Furthermore, the image also depicts the adjacent countryside that begins just beyond Corviale. Source: Ater Roma

The building is divided transversely by five vertical elements where the stairwells and elevators are concentrated. Its structure runs uninterruptedly for almost a kilometre, except for a single disruption between the 2nd and 3rd stairwells to accommodate topographical changes. The layout of the building was designed to reproduce the mobility patterns of an urban system, separating different types of fluxes, such as the pedestrian or the vehicular flux, and including specific access points to the whole development. These access points are identifiable from the building's facade and coincide with the five primary stairwells. Fiorentino, Corviale's head architect, referred to these entry points and the open space in front as "true public squares" (Vidotto, 2017), giving again an urban character to the design of the building. In the words of the architect, the main building of Corviale was "not just a longer house: it is a 1 km system, highly integrated between services and residences, with distinct vehicular and pedestrian paths" (Mario Fiorentino, as cited in Del Monaco, 2006, p. 156). However, some consulted experts, members of the IACP, and neighbours during this research linked the distributive layout of Corviale to one of the biggest problems of the neighbourhood. The few entries to the building forced all the neighbourhoods to go through long corridors that were generally perceived as unpleasant, dark, and unsafe spaces[4].

The decay process of Corviale. Occupation and stigma.

The example described in the previous section illustrates the contrast between the planners' initial intentions and what has taken place at Corviale. This continuous deviation

[4] This feeling of insecurity in the corridors of Corviale was visible through the results of a survey conducted in the Elementary School of Corviale, where the pupils were asked to participate in drafting affectivity maps that linked their feeling in different parts of Corviale. These maps showed the concentration of dark dots along the ground floor corridor of Corviale, marking it as the most dangerous and ugliest part of the housing estate (Del Monaco, 2006).

from the planners' intentions is not unique to Corviale. Housing estate developed in the second half of the 20th century frequently experienced a mismatch between the architectural team's conceptual intentions and the actual results of their designs (Coleman, 1990). In the case of Corviale, Fiorentino and the rest of the architecture team were often blamed for having created an "Uncontrollable monster", a "prison-like building" that inevitably generated social difficulties (Vidotto, 2017). Taking some distance from the spatial deterministic approach of Coleman (1990), some academic studies on Corviale have linked the decay process of the housing estate to the IACP's management problems that emerged in the first years after the apartment assignations (e.g., Del Monaco, 2006; Giovanni, 2019; Puccini, 2016). Others have linked this decay to misfortune design decisions (Bartocci, 2016). An in-depth analysis of the different elements of the building (e.g. the long corridors, the heating system or the elevators) has shed light on the relation between the design of the building and the management decisions (Calzado, 2023), aligning with the theories of Wassenberg (2013) that established direct relations between larger governance dynamics of housing estates and their physical characteristics.

The following section explores the role of the physical features of Corviale influencing processes of physical decay and the development of social conflicts within the complex. Due to the pressing housing crisis in Rome that was still present during the early 1980s, the assignation process of the housing units of Corviale was initiated in 1982, two years before the end of the construction phase. The rough aesthetics of the complex together with its unfinished status quickly created an overall feeling of delusion and rejection among the assignee inhabitants (Campanella, 1995). In addition, the commercial and community services that were planned for being placed on the commercial floor of Corviale named the "Free floor" had not arrived, and the space left vacant was eventually informally occupied by different families. This occupation phenomenon also took place in other PEEP neighbourhoods in Rome, such as at Laurentino 38, where the buildings originally designed as bridge structures meant to have shops and offices for the neighbourhood were transformed into improvised shelters and eventually occupied on a permanent basis by families in search of housing (Caudo, 2022). Studies on the occupation of PEEP neighbourhoods have revealed that many families among the first occupiers had been affected by Law 392, also known as the Equo Canone Law, introduced in 1978 (Clough Marinaro, 2021). Despite the aim of this law to ensure fairer private rental prices, the Equo Canone led to numerous evictions and created a housing affordability crisis in Rome in the early 1980s (Ibid.). As was the case for many other PEEP housing estates, criminal networks often mediated in the occupation of the free floor, charging illegal renting fees to the occupants of these spaces. The occupation of the Free floor spanned over 30 years, drastically modifying the layout of the original project, as collective spaces were privatised, and the long walkable floor was turned into an inaccessible route. This occupation integrated new actors in the governance process of Corviale, such as the presence of illegal managers of the occupied apartments and the occupant residents of these apartments.

The coexistence of assignee residents and occupants created a conflict situation from the beginning. As explored by the sociologist Nicoleta Campanella (1995), the assignee residents would recurrently report these struggles to the IACP, who generally did not act upon it, inducing a degeneration of trust between the inhabitants and the housing authority (Ibid.). Numerous interviewees, comprising residents and housing authority members engaged in this research, correlated the housing authority's incapacity to address social concerns with its absence of an officially designated social support department. The IACP exclusively provides technical and administrative support to Corviale.

The lack of response from the housing authority prompted the inhabitants of Corviale to organise themselves and fight for their rights (Campanella 1995), resulting in a prolonged period of successful local bottom-up initiatives and collective reclamations of rights. The establishment of essential public services such as bus routes, schools, and healthcare centres has been attributed to the collective actions of these bottom-up initiatives, which were organised through spontaneous neighbourhood associations. The community of Corviale has long been engaged in a battle against sensationalized articles published by journalists, which contribute to the ongoing stigmatization of the building and its residents. In the early 2000s, this stigmatised image was instrumentalised by far-right-wing politicians and integrated into a political campaign that aimed at attracting votes from popular areas of Rome (Bonomo, 2021). These politicians asserted their support for the demolition of Corviale, initiating a debate that extends to the present day (Valeri, 2023).

Along this study, the interviews, the review of academic literature and of official documents have provided information that suggest a relationship between the physical characteristics of Corviale and the evolution of the social dynamics and local governance within the housing estate. Such is the case of the study of Clough Marinaro (2021) on the informal occupation of Corviale, and the result of the interviews to informal occupants and social workers at the housing estate developed for this study. The results of the analysis of both the literature and the interviews suggested that the existence of a large number of vacant commercial spaces within Corviale enabled the occupation of the 'Free floor' when the housing crisis in Rome hit even stronger after the passing of the *Equo Canone Law*. The 'Free floor' could be therefore considered as a physical element that interacted with a wide range of contextual factors, including social, cultural, and economic dynamics, promoting the decay process.

The monumental aesthetics associated with a socialist symbolic dimension of the building have also been analysed as an element that promoted the physical decay process of Corviale. Initially conceived during the rule of the *giunte rosse* (Left wing administrations) in Rome's municipal government, Corviale was eventually reframed by right wing parties who launched a campaign calling for its demolition, arguing that the building was the symbol of a flawed concept of the city rooted in left-wing utopian dreams. The relation between the monumental aesthetics of Corviale and the process of urban decay is traced through the analysis of media

reviews spanning from the 1980s to the present and delving into specific literature, such as Bruno Bonomo (2021) on the political life of Corviale or Vittorio Vidotto (2017) on the semiotics of Corviale allows to stablish a relation between the monumental aesthetics of Corviale and the process of physical decay.

The regeneration projects of Corviale. Enlarging the lifespan of a housing estate

Almost parallel to the processes of physical decay and social conflicts that have endangered Corviale with the possibility of demolition, a regeneration process has taken place, pathing the way for a more optimistic future for the housing estate and the community. The results of the study of Corviale's physical elements trace the active role of some of these elements not only in the decay process but also in the decision-making process that influenced the regeneration of the housing estate (Calzado 2023). An example of this influence is the relation between the unordinary morphology of Corviale, which turned the building into subject of cultural interest, resulting in its submission under protection by the Roman urban regulation *Carta Per la Qualità* (Charter for Quality)[5], which ensured its preservation. Another example of the relation between the physical elements of Corviale and the preservation of the building is the high density of apartments that exist in the main 1km building. As pointed out in an interview carried out for this research by the former director of the housing authority: "*The evaluation of demolition (…) was made only based on the political consequences of this choice. It means that if you decide to demolish Corviale, you get 4500 people in the middle of the street*". The relocation of such a large number of inhabitants represented a complexity that influences the deviation of the political decision to demolish the structure.

This study oversees the two parallel processes that have contributed to expanding and reducing the life span of Corviale (figure 2). The lifecycle method (Thomsen & Van der Flier, 2006) consists of listing the main policies and events that have taken place at Corviale and organising them regarding whether they have contributed to potentially enlarging or reducing the lifespan of the building. The timeline presents the main physical transformation events, together with functional and (micro) economic performances (Van der Flier and Thomsen 2006) within the governance process of Corviale that have had an impact on the lifecycle of the building. The timeline is divided into two parts, the lower part studies the demolition-inducing events within the governance process of Corviale, and the upper part studies the transformation-inducing events.

[5] Carta Per la Qualità is a document that protects the architectural heritage of Rome. This document does not explicitly forbid the demolition of Corviale but complexifies a potential demolition process of the housing estate, as any large intervention in Corviale, once enlisted in this chart, would require the revision and approval from the Sovrintendenza Capitolina (Rossi, 2003).

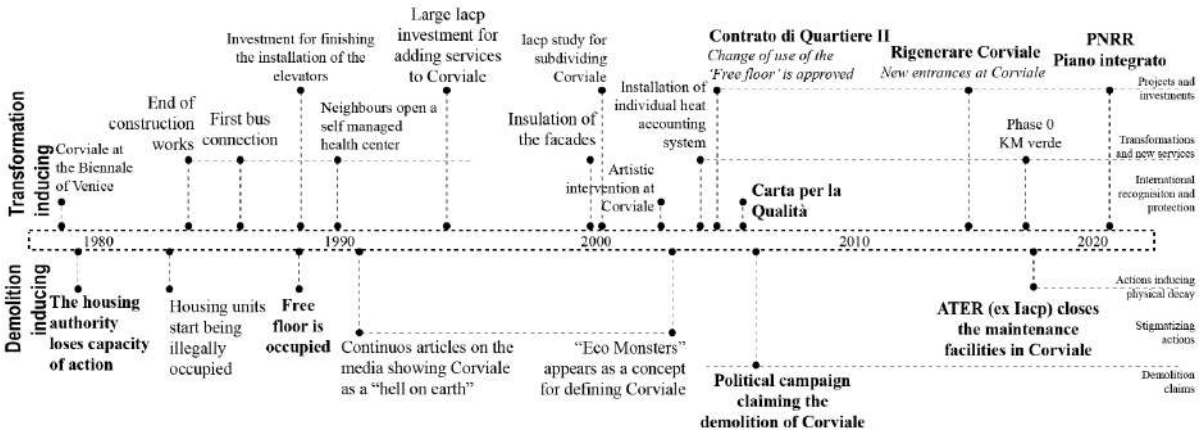

Figure 2. The life cycle of Corviale. Scheme of the main events and programs that have induced transformation or demolition. Source: Author's elaboration

Among the demolition-inducing events, this study gathers the main events that have accelerated the process of decay of the building, the main events that have contributed to the stigmatisation of the housing estate, and the direct propositions of demolition. As transformation-inducing events, this study gathers the direct transformation events and the main regeneration programs that have guided this transformation. Additionally, the study gathers the supra-national policies and measures, and heritage protection labels that complexify the demolition of Corviale by either making it more bureaucratic, or internationally well-known and part of a global debate.

Through this analysis we identify the two main regeneration plans that have contributed to enlarging the lifespan of Corviale. The two main plans are the Contratto di Quartiere II and the Piano Urbano Integrato Corviale. Under a top-down approach, these two urban renewal plans combine the integration of social innovation measures with environmental goals. Contratto di Quartiere II is a public initiative to regenerate Corviale approved by the Lazio Region through deliberations 574 and 922 in 2003 (Giovanni, 2019). The main objective of this initiative was to solve the informal occupation of the commercial spaces of the free floor, which had been transformed into private dwellings and occupied for more than 20 years. The program of the intervention was developed in a collaboration between public institutions (Lazio Region, Rome municipality), and the housing authority (ATER Roma, former Iacp). The designed intervention envisioned the punctual deconstruction of the self-built houses within the commercial spaces and the building of new public houses on the free floor to avoid forced evictions (Ibid.). This intervention would require the official change of use of the free floor, from a commercial area, into a residential area, which was approved in 2006. The project that emerged as the winner of implementing the intervention is known as Green Kilometre and is led by architect G. Salimei. At that time, the Municipality of Rome in collaboration with local grassroots initiatives of Corviale, created the Corviale Territorial Laboratory (Comune di Roma, 2005). This initiative had the aim of promoting forms of citizen participation and encouraging action for the enhancement of the environment and local development.

After years of stagnation, where the project seemed to have been abandoned, the Lazio Region allocated €10.5 million in 2019 for the implementation of the project. This project included demolishing and rebuilding the 120 self-built homes on the Free floor; retrofitting different areas of the building and including solar panels in one of the sections. In addition, the operation required the social support for the families being relocated. This support was appointed to a group of researchers from Roma Tre University, funding the Laboratorio di Città Corviale, with a similar role as the former Corviale Territorial Laboratory, by then dismantled. The Laboratory established a facility room onsite where they organised regular meetings with both the neighbourhoods, and the housing authority, mediating in the relation between both actors. The Lab. Città Corviale coordinated the reallocation of the families during the construction works in the free floor. The project in 2023 is ongoing, but some of the results of Phase 0 and Phase 1 are already visible.

The Piano Urbano Integrato (PUI) Corviale is a project funded by the Next Generation EU funds (NGEU). The NGEU is a European Union economic recovery package, approved in 2020 to support the EU member states in recovering from the COVID-19 pandemic (European Commission, 2021), from which Italy was the largest recipient. Italy's national government allocated these funds to the PNRR (National Recovery and Resilience Plan). Among the various missions of the PNRR, mission 2 Green revolution and ecological transition received the highest percentage of funding (31.05%) (Ibid.). The Piano Urbano Integrato Corviale and two other Rome regenerations programs (Tor Bella Monaca and Santa Maria della Pietà) are framed under this mission (Osservatorio PNRR, 2023). The estimated amount to be allocated at Corviale is 50M euros. In Corviale, this funding is meant to be used for repeating a similar operation done on the *Free floor* at a smaller scale in the VI lot of Corviale (the building at a 45° degree), and for the development of some green areas around the housing buildings.

The Contratto di Quartiere II and the PUI of Corviale combined have mobilized over 60 million euros to regenerate various areas within Corviale. This sum is larger (proportionally) than any accumulation of investments in any other public housing estate in Rome. Consequently, the average investment per apartment in Corviale stands at 50,000 euros as a result of this funding. Considering that the cost of public housing construction in Italy is estimated to be around 1000 / 1200 euros per m², this investment could potentially fund the creation of a new housing development with a similar number of apartments (though smaller in size) as Corviale. This calculation is not mentioned in this article to argue that Corviale should not be renewed but to demonstrate the elevated investment committed to its renovation, to which different consulted experts have referred to as a disproportionate sum.

The following chart gathers the main details concerning both plans and allows for an easier comparison.

	Contratto di Quartiere II at Corviale	PUI 24 Polo della Solidarietà Corviale
Date of approval	2003	2022
General scope of the program	Contratto di Quartiere come from Italian Law 21/2001, art. 4 paragraph 1. They are regeneration programs no longer exclusively addressing physical degradation but also social degradation.	The PUI come from the Article 21, Decree-Law No. 152 of 6 November 2021. The primary objective of PUI plans are the ecological regeneration of existing building structures and public areas.
Environmental dimension of the program applied to Corviale plan	The official description of the program holds very light references regarding an environmental dimension. The only reference of the text mentions how “Contratti di Quartiere II” aimed at the redevelopment of buildings, the improvement of environmental conditions, the adaptation and development of urbanisation works and the provision of public and private services.	The environmental dimension is present along the whole document of Corviale. This environmental dimension is in line with the sustainability objectives of the PNRR, and with the DNSH of the EU taxonomy.
The other roman housing estates involved in this plan	Corviale, Primavalle-Torrevecchia, Tor Marancia, Quarticciolo,	Corviale, Tor Bella Monaca and Santa Maria della Pietà
Planned actions within the plan	The redevelopment of the 4th and 5th floors of the main building of Corviale, with a change of use from commercial to residential (to end the informal occupation of the free floor). The inclusion of educational, cultural, artistic and museum functions, and the completion and redevelopment of the public services of the 'Area Plan' (green areas, sports facilities, a play centre, and the Multipurpose Centre).	Renovation and energy efficiency of different buildings. Completion of a sports hall. Biodiversity recovery of the East and West Park. To that the project develops a series of intangible interventions for the promotion of social, cultural and economic activities and accompanying activities such as participatory processes and communication.
Budget of the plan	Total budget of the project at Corviale 10.580.729,40 euro. Most of these initiatives have a social regeneration scope. Of that budget, approximately a 9% was spent on initiatives with an environmental focus.	Total budget of the project at Corviale 50.043.779,00 euro. Most of these initiatives have an ecological scope. Of that budget, approximately a 4% is meant to be spent on initiatives with a social regeneration focus.

Actors engaged within the design and implementation of the plan	National government, Municipality of Rome, XV Municipality, ATER di Roma (housing authority), Regione Lazio. Additional actors such as local associations and universities are engaged in the development and implementation of different parts of the program. The programme is funded 65% by the State and 35% by the Region.	EU commission, National government, Municipality of Rome, ATER di Roma (housing authority), Regione Lazio. Additional actors such as local associations and universities are engaged in the development and implementation of different parts of the program. The program is funded 100% by the State.
Environmental actions developed for Corviale within this program	The retrofit of the new apartments of the free floor, the retrofit of the additional public service areas. Installation of photovoltaic panels.	Large scale retrofitting operations. Restauration of public green.
Added social dimension	The "Corviale Territorial Laboratory, West Rome" was created by the Municipality of Rome, with the aim of promoting forms of citizen participation and encouraging action for the enhancement of the environment and local development. The participatory experience was active in the following years of the plan. However, the activity was abandoned in 2009, and only recovered in 2017, with the creation of the "Lab. Città Corviale", this time managed by University Roma Tre. The aim of such lab was to ensure the best possible involvement of the neighbourhood's inhabitants on the process of reallocation of the inhabitants of the free floor.	The plan designs the initiatives of urban regeneration parallelly to the community building experiences. The experience of community building is based in the accumulated knowledge from the work of researchers from the Lab. Città Corviale over the years of the Contratti di Quartiere II. In the case of the PUI, there is a specific budget within the plan dedicated for the activity of the Lab.

Table 1 - Details of the Contratto di Quartiere II at Corviale and the PUI 24 Polo della Solidarietà Corviale

Environmental ambitions as innovation catalysers

Over the two decades separating the two plans, there has been a significant increase in global awareness regarding the pressing climate crisis. This heightened awareness has led to a greater political emphasis on incorporating ecological objectives into new urban transformation plans. The analysis of data from both plans further substantiates this idea, as it reveals a larger allocation of funding towards environmental initiatives in the case of the Piano Urbano Integrato (PUI) when compared to the Contratto di Quartiere II. In the case of "Contratti di Quartiere," the environmental dimension is closely integrated with other dimensions. In the case of " Piano Urbano Integrato", there seems to be almost exclusive attention to the ecological and environmental dimensions.

The growing significance of the environmental approach in Corviale's regeneration plans aligns with a worldwide trend of increasing awareness regarding environmental issues, which

has recently mobilized funding initiatives like the EU NextGeneration plan. In the case of Corviale, this approach also aligns with the intention to redefine the symbolic meaning associated with the building. In recent years, the semiotics of Corviale have been instrumentalised again by a political force, the left-wing Regional president Nicola Zingaretti, who has focused part of his political rhetoric in the recovery of the suburbs of Rome and has launched a campaign to enhance the sustainable dimension of Corviale. In public interventions Zingaretti described the recent transformation actions at Corviale as "the biggest green construction work of Europe". This strategy repeats the formula of reframing the symbolic meaning of Corviale that had been explored by the right-wing party between the 90s and the early 2000s, during the launch of the demolition campaign of Corviale (Bonomo 2021). As explored in the section 'The decay process of Corviale' (p.10), the symbolic meaning of Corviale is related to the physical and spatial characteristics of the building[6] (Bonomo, 2021; Vidotto, 2017). The relation between the symbolic meaning of Corviale, framed now in sustainability terms, and the allocation of larger funds to finance the regeneration strategies of Corviale showcases the existing relationship between the local characteristics of Corviale and the regeneration programs with a robust environmental focus.

When comparing the environmental approach of both plans, we can observe how in the case of "Contratti di Quartiere," the environmental dimension is closely integrated with other dimensions, while in the case of "PUI," there is almost exclusive attention to the environmental dimensions. The Contratto Quartiere II predominantly adopts a social approach, with minimal emphasis on environmental activities, which receive only a small portion (9%) of the total budget for funding. On the other hand, the PUI places the environmental approach as its central pillar, allocating a mere 4% of activities for the social approach. Instead, the program prioritizes retrofitting and greening activities throughout the complex. However, the data indicates that the 4% allocated to social matters in the PUI plan is greater than the 91% dedicated to social matters in Contratto di Quartiere II. The data presented supports the hypothesis that environmental programs have the potential to foster social innovation by attracting substantial investments.

Examining the data from both plans also unveils the involvement of distinct actors engaged in the governance process. In particularly the presence of EU-level administration, which on one hand possesses the capacity to finance significant projects, while on the other hand, imposes specific guidelines regarding the allocation of funds, as evidenced in the Allegato Piano Integrato Corviale (Regione Lazio, 2022). Additionally, the plans have promoted the existence of new intermediary groups such as the "Corviale Territory Laboratory" and the "Lab. Città Corviale".

[6] For example, the monumental aesthetics of Corviale were associated with a socialist symbolic dimension (see page.10).

In the context of Corviale, intermediary groups played a crucial role in compensating for the historical lack of social support provided by the housing authority IACP to this neighbourhood, as highlighted by experts consulted for this study. These groups are either bottom-up initiatives, such as local associations, which have a long history of community work at Corviale, or government-driven groups, such as "Corviale Territory Laboratory" and the "Lab. Città Corviale". The role of intermediary actors within transition processes is approached in the study of Kivimaa et al. (2019) '*Passing the baton: How intermediaries advance sustainability transitions in different phases*'. Their research overviewed the different functions of intermediary actors within transitions and concluded that their work was crucial throughout the entire transition process. Aligning with the study of Kivimaa et al. (2019), the Lab. Città Corviale as an intermediary engages in activities such as facilitating experimentation and identifying requirements during the predevelopment phase, then progressing to gathering knowledge, pooling resources, establishing networks, and enhancing institutional support and capacity during the following phases (Kilelu et al., 2011). The group was constituted by a group of researchers from Roma Tre University and oversees the social support for the families being relocated in the free floor and constitutes an innovative experience that merges both technical and academic knowledge with long-term experience on the site (Caudo 2022). The Lab. Città Corviale has also developed part of the initiatives of the PUI, repeating the strategies of the Contratto Quartiere II on different parts of the complex, such as the change of use from commercial to residential, now applied to the 'VI lot', and the social support tasks developed by the Lab. Over the years, the Lab has acted as a bridge between the social approach of the Contratto de Quartiere II and the integrated approach of the PUI. The establishment of the Lab. Città Corviale was originally linked to the change of use of the free floor, however, since its inception, the Lab has accumulated a wealth of knowledge on the territory, which proved highly significant and valuable when responding to the call of the PUI in 2021.

Concluding remarks of this article

This article takes the case of Corviale to study the nexus between the lifespan of housing estates and new environmental policies in the context of housing estate regeneration initiatives. The study proposes an alternative approach to analysing housing estate's governance by tracing both physical factors and socio-political decisions and paying attention to how these two factors relate to each other. Additionally, this study explores how climate change politics can catalyse government-driven social innovation initiatives within housing estates.

To achieve this, the study first describes the physical characteristics of the housing estate, pointing out the mismatching physical results of Corviale with the planners' initials intentions. This physical analysis nourishes the development of the lifecycle reconstruction of Corviale,

that traces the main policies and initiatives that have contributed to either enlarging or reducing the lifespan of the housing estate. The lifecycle method involves mapping out the main physical transformation events at Corviale, the achievements of the work of local community groups that have taken place on site, and the top-down actions from housing, local, and regional authorities developed on site. The results of the lifecycle analysis present how the physical characteristic of Corviale have influenced the evolution of the housing estate towards both the reduction and the enlargement of its lifespan. However, as developed through the article, some sociotechnical relations, such as the relation between the morphology regulation instrument *Carta Per la Qualita,* have paved the way towards the long-term regeneration of the housing estate.

The long-term regeneration process of Corviale is studied through the analysis of its two main regeneration programs, the Contratto de Quartiere II and the PUI plan. The analysis of the programs shows how both combine social innovation measures with environmental goals. Comparing the environmental approaches of the two plans highlights a significant increase in attention to ecological aspects from the Contratto de Quartiere II, approved in 2003, to the PUI, approved in 2022. These results also highlight how the Contratto di Quartiere II experimented with some social innovation initiatives developed by intermediary groups, that were later consolidated through the larger investment provided by the PUI plan; through the PNRR and the NGEU funds. Initially developed by the Corviale Territorial Laboratory led by the Comune di Roma, social innovation initiatives were later continued by the Lab. Città Corviale, appointed by the Lazio Region and dependent from Roma Tre university. The analysis of the two regeneration programs of Corviale indicates how the intermediary groups, initially appointed by local or regional authorities, have developed social support tasks within the housing estate and have connected the social approaches of Contratto de Quartiere II with those of the PUI plan. The work of this initiatives has entered into the larger constellation of social innovation initiatives that have historically taken place at Corviale, with the difference than in this case, such initiatives are government-driven instead of bottom up.

Social innovation initiatives in Corviale encompass the community support activities, social mobilisation, data gathering and documentation that has been carried out by multiple local associations, community groups and research institutions since the opening of the building. These initiatives have been developed by both grassroots organisations and by government-driven arrangements. Although Corviale has a rich history of grassroots initiatives, this study has focused on the social innovation actions that have been fostered by institutional arrangements, fitted within the framework of the two urban regeneration programs Contratto de Quartiere II and the Piano Urbano Integrato (PUI - PNRR). By studying how government driven social innovation can be fuelled through the funding of housing estate regeneration programs with environmental budget, the study intends to contribute to the literature that approaches the government's role in social innovation processes (Bragagilia, 2020) and align with the ideas presented in the SI "Place based Just

Transition", which explores how place-based energy transition policies and practices can support processes of social innovation (Bragaglia, 2020). The main limitation of this research lies in the ongoing nature of government-driven social innovation initiatives. As these initiatives continue to unfold, further study will be necessary to revisit and evaluate their long-term effects. A future review will offer the necessary time distance to assess the impact of these initiatives within the framework of government-led arrangements.

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Conflicts of Interest

The author declares no conflict of interest.

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EUROPEAN JOURNAL OF SPATIAL DEVELOPMENT

Research Article

SPATIAL DESIGN FOR THE ENERGY TRANSITION

Exploring Tools and Approaches in Consolidated Urban Contexts

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Abstract
The space neutrality of eco-modernist energy policies contrasts the transition in many consolidated urban areas, in which "just technofix" transformations are not always feasible in historical, dense, fragmented and car-oriented urban patterns. What is lacking -and crucially needed- is understanding and developing design solutions that cross the scales from deepening the attention to existing configuration and living community. The ongoing research PEDFORALL is trying to interpret this challenge starting from a specific urban context -the neighborhood of Ostiense in Rome- exploring and testing possible design solutions for a place-based energy transition. Integrating diverse energy transition paradigms -as the energy sufficiency- the contribution builds a theoretical framework collecting and conceptualising design references in three main design strategies. The same strategies are tested then in the case study, raising first questions, limits and potentials of this application. The paper mainly suggests a spatial approach to energy transition, overcoming a mere idea of technological transformation to caring for the design of space (both domestic and urban) and for the bodies that inhabit it.

Keywords
energy sufficiency;
energy behaviours;
bioclimatic;
embedded energy;
Positive Energy District

Energy Transition for No People and No Space: The Case of Rome

Urban environments consume vast amounts of the world's primary energy, not only for large-scale processes, but also to support everyday activities mediated by artificial lighting, transportation, climate control, and household appliances (Smil, 2021; Rahm, 2023a). All these uses are known but little visible, escaping from an awareness of consumption and contributing to a growing and "impact-blind" demand for energy. This dynamic, coupled with the evidence of exhaustibility and geopolitical instability of fossil sources, has fuelled an unprecedented global energy crisis (IEA, 2022). What is worrying is no longer the economic turbulence of the energy market but also the socio-spatial repercussions. The massive use of fossil fuels has reached levels of global climate disruption with evident and dramatic effects in hotspots like the Mediterranean countries (IPCC, 2022). Here, rising temperatures and Urban Heat Islands (UHI) affect vulnerable people (not only physically but also economically) and force extensive use of electrical appliances -such as air conditioners- generating evident and uncontrollable short circuits (Roesler, 2022). Furthermore, the persistence of the energy crisis is leading to supply shortages and a surge in energy prices (IEA, 2022), making Southern

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Europe an "energy social hotspot" with a consistent number of people lacking adequate access to energy[1] and fuelling the phenomenon of energy poverty.

To address the energy crisis, the EU has shaped Community policies focused on an economy sensitive to technological development and environmental protection. The vision behind these policies follows the principles of the eco-modernist paradigm, thus the restructuring of the energy system for a sustainable metabolism starting from the economic and productive sectors (Asafu-Adjaye et al., 2015) and with appropriate "green" technologies promoted by incentives (Puttilli, 2014). The generous system of incentives has boosted the short-term implementation of new technologies, such as renewable energy plants (Frolova et al., 2019, Puttilli, 2014), and the technological efficiency of buildings and mobility systems that led to a wide urban retrofitting.[2] This acceleration represented a techno-economic success but, on the other hand, raised significant concerns on the socio-spatial dimension. First, the rapid and sprawled construction of new plants led to an accidental transformation of the landscape (Bridge, 2018; Frolova et al., 2019), where the space is considered just "a support" or a site "to be developed" for a maximum economic profit or technological functionalism (D'Angelo, 2023; Carrosio and Magnani, 2022). Second, the tax credit regulatory framework for efficiency does not contemplate specific spatial conditions (e.g. age, materials, heritage of buildings) or social conditions (e.g. ownership and economic status of dwellers) affecting the feasibility of interventions in existing buildings, specific climate conditions and different social groups. Third, the standardisation of some planning tools (e.g. Sustainable Energy and Climate Action Plan-SECAP), which are characterised by excessive expression of quantity, vague objectives, and lack of spatialised representation, completely affects the application in real contexts (De Pascali and Bagaini, 2018). More recently, models of Positive Energy District (PED)[3] seem to propose innovative contextual approaches.[4] A PED theoretically plans the energy transition at the neighbourhood scale to produce net-zero emissions and a local surplus of REN production (Gollner et al., 2020). The model, however, seems applicable today only in contexts governed by strong energy policies, with appropriate regulatory framework and with the availability of public-private investment capital (Bossi et al. 2020), all elements often weak

[1] For more details see the briefing of the European Parliamentary Research Service (EPRS) edited by Agnieszka Widuto in September 2023. Link available at www.europarl.europa.eu/RegData/etudes/BRIE/2022/733583/EPRS_BRI(2022)733583_EN.pdf (November 2023).

[2] A paradigmatic case is the Italian "Superbonus 110%" launched in 2020, a tax credit tool with a huge economic facilitation that led many buildings free intervention by deducting the expenses with the Tax Return, transferring credit to suppliers' banks or financial and insurance institutions, or with the discount on the invoice.

[3] PED are actions foreseen in the European Strategic Energy Technology Plan for establish one hundred sustainable energy districts by 2030. For more details, see the SET-Plan Action n. 3.2, Implementation Plan, 2018. Link available at https://jpi-urbaneurope.eu/wp-content/uploads/2021/10/setplan_smartcities_implementationplan-2.pdf (September 2024).

[4] For example, the local scale of PED facilitates the involvement of people and local stakeholders and provides the integration of different energy systems with the territorial one, generating an idea of multioperability. In addition, the integration between systems and forms of government ensures greater context-relatedness.

or not present in consolidated urban patterns (and communities), even less in historical cities and Southern European countries (Bossi et al. 2020).

The three dynamics described underline how spatially neutral interpretations of the energy policies do not favour any social, cultural or economic group and do not consider the specificities of a local context. This neutrality led to a wider "space blindness" intended as the inability to design and plan considering the real spatial dynamics, a condition that inevitably produces conflicts, new pressures on resources, layers of injustice and inertia to energy transition programs (D'Angelo, 2023). A paradigmatic example of the cause-and-effect of this space blindness is the city of Rome, case study of this contribution. In the city, large parts of the buildings were built before or out of any energy regulations, often as a result of speculative and unauthorised processes (Insolera, 2011). These starting conditions have obstructed the implementation or renovation of technical services -such as the electric distribution grid- while the widespread and numerous presences of low-energy performance buildings still requires difficult mediation processes between ownership, regulation and financial systems. The spatial neutrality of local planning tools, such as the *Piano Quadro per la Transizione di Roma* (Rifkin et al., 2010) or the local *SECAP* (2021, updated in 2023), proposed techno and isomorphic solutions without any contextualisation and rooting of the strategies within local actors and innovative social practices (Nessi, 2018; De Pascali and Reginaldi, 2016). The result is evident: the energy consumption in the building and mobility sectors still plays a relevant role in carbon emissions;[5] the construction of REN plants is weak,[6] the application of energy efficiency measures often fails,[7] and the house discomfort is growing with a high number of people suffering energy poverty condition.[8]

This critical framework underlines the urgency to overcome the spatial blindness of transition by rethinking tools that do not contemplate a standard or a mere technocratic approach but also integrate alternatives centred on local context and on space and its design. These tools do not constitute a clear picture yet and thus require innovative research paths. Building on the results of some research activities in the case study of Rome, the paper aims to explore spatial designs and urban planning strategies to figure out possible pathways for energy transitions by adopting a place-based perspective to integrate the current eco-modernist vision. The research question posed is thus: which tools and approaches enable the spatial design of place-based energy transition?

To address this question, the paper is structured as follows. The next section "Collecting theoretical references for a place-based energy design" establishes a theoretical framework

[5] In the 2019, the emission amount around 8.410.000.000 tCO2e; one third is in the mobility sector (around 2.930.000 tCO2e). Source: Piano Clima Roma Capitale, 2023.
[6] Within the city limits (1.285 km2), only 195 MW are available from 17.000 installations. Few of these are integrated into buildings, for example, only 1% of condominiums have photovoltaic systems. Source: Piano Clima Roma Capitale, 2023
[7] Today 65,5% of the total building stock is certified according to the EU Energy Performance Certificate in classes F ang G, the lowest. Source: Piano Clima Roma Capitale, 2023
[8] In 2023, the local population in conditions of energy poverty exceeds 100.000 units (Asdrubali et. al., 2023).

based on a heterogeneous corpus of literature to bring together little-known and more radical energy paradigms with research on space and experiments in architectural and urban design. The third section, “Ostiense a plac-based lab”, traced a research horizon and reported design strategies declined in the case study, following an introduction and problematisation of the context and the description of some actions from ongoing European JPI-funded research entitled PEDFORALL[9]. Each action tests one of the design strategies that emerged in the theoretical framework, tracing possible lines of research and design and discussing the idea of a place-based energy transition. The final section “Work in Progress: first Consideration and Future Developments” makes a recap of the consideration of the case study, merging theoretical reflections, design proposal and next research steps.

Collecting theoretical references for a place-based energy design

Overcoming the socio-spatial blindness of energy could mean a radical reinterpretation of the transition paradigms by questioning the premises instead of the assumptions. In this sense, it is useful to look at the transition paradigms defined as "radical" or "deep ecological" that advocate for a shift through a political-institutional revolution that challenges the assumptions of the energy system (Puttilli, 2014). These perspectives promote a co-evolution of the communities in the ecosystems while breaking away from contemporary development models in favour of reducing environmental pressures and fostering new social relations based on solidarity and sobriety. From this debate emerges the possibility of integrating the techno-economic concept of “efficiency” with the more socio-spatial of “sufficiency”. If theoretically applied to energy, sufficiency reduces "the problem" of consumption to its roots, eliminating or reducing some energy needs; in other words, i.e. reduces waste energy by consuming just “enough” (Burke, 2020). More precisely, energy sufficiency means that some behaviours and practices could reduce the need for some energy demands (Arrobbio, 2023) and call to the gesture of care where social engagement plays a fundamental and active role (Hertweck et. al, 2023).

The practices of energy sufficiency -per se- are quite explored and widely promoted: for example, the elimination of non-essential domestic appliances, the shading systems to reduce air conditioning use, and the car/ride-sharing systems to reduce individual consumption.[10] Most of these solutions are based on deliberate and voluntary actions of individuals and mostly depend on personal cultural position (Sorrel et al., 2020), which is why sufficiency is still

[9] The project involves an action-oriented network of PED and neighbourhood stakeholders in Belgium, Italy, and Turkey, who will apply a common co-design methodology to define a set of energy, policy, regulatory, governance, social, spatial, and design strategies for the implementation of Positive Energy District models. Three are the case study: Culturegheim in Bruxelles, Kartal in Istanbul. The Italian case study is in the neighbourhood of Ostiense and is led by the Architecture Department of Roma Tre University in collaboration with the Department of Law of the same university, the LUISS University, the Municipality of Municipio VIII.

[10] An interesting example of sufficiency practices is reported in the guidelines of NégaWatt (2022) to promote energy sufficiency (referred to as sobriété) in France. Link to: https://negawatt.org/The-negaWatt-2050-energy-scenario (February, 2024)

considered an abstract paradigm. The factors to consider for enabling sufficiency practices encompass the complexity of the socio-economic dimension (work, age, education, etc.) as well as aspects more linked to the physical space. This latter aspect seems particularly interesting for the question raised in this paper: in fact, a way to give concreteness may be to understand how to create physical conditions to facilitate and replicate sufficient actions in specific contexts. For example, it is not enough to say to people "use the bike instead of a car", but it is necessary to create spatial infrastructures that permit and encourage the use of a bike, such as cycle paths, widespread bike sharing, bike shelters, etc. In this sense, architectural and urban design expertise should converge to treat space as a continuum, shaped to accommodate configurations that enable social practices that reduce energy demand.

As a planning and design paradigm, reflections on sufficiency may tease the attention of architects and urban planners with the concepts of "taking care of the existing" producing design solutions and promoting narratives that do not waste or replace, but work with minimal gesture in the building heritage (Hertweck and Miessen, 2023). This paradigm goes beyond the just technofix of buildings, to rethink a radical mix of functions aiming to create a synergy between energy and other territorial systems and to optimise consumption through shared actions in spaces and with shared devices. Examples in this sense are the use of condominium laundries or bike/car sharing systems to reduce individual consumption or increase the quality of proximity daily-life open spaces to optimise uses and social practices as experimented in planning programmes such as "Superillas" in Barcelona; or the "Ville du quart d'heur" in Paris. Taking care of the existence means also saving the "embedded energy", preserving, counting, and recycling the accumulation of the energies used for the construction, maintenance and transformation of architectures and spatial configurations (Viganò et al., 2015). Work with the embedded energy led to reparation and maintenance gestures (Denis and Pontille, 2019), reversing the capitalist imperatives of innovation-growth-progress that produce consumption, overuse, and squander into an idea that not everything is replaceable (Hertweck et al., 2023), not even with the most advanced technology. That involves rethinking buildings and open spaces as neutral and never-finished structures ensuring characteristics of flexibility and longevity, contrasting approaches of "deep rewriting" -often translated as demolition and reconstruction- accepting the existing and the idea to care for it over time.

Another spatial declination of sufficiency prompts a reconsideration of "the way we use energy in our daily-life spaces", redefining and understanding our domestic energy landscape. This is not an easy task, the existing energy apparatuses (from a big power plant to the smallest appliance) are still "black boxes" where is not clear how they are made of and how they work (Denis and David, 2019). This is the result of a long process of detachment from the localised nexus of energy, which today is re-establishing connections with living communities (Pasqualetti and Stremke, 2017). Enhancing this nexus means deepening a context with place-based energy practices founded on public and shared interest within self and shared

responsibility, all aspect that calls for social innovation (Bragaglia, 2021). Inspiring examples in this sense are the experiences of self-build and self-maintenance of domestic spaces and devices that make inhabitants aware and conscious of their energy consumption system, independent from the supply of materials and services, and capable of producing intelligent solutions tailored to their own needs and mindful of the resources employed (Hertweck and Miessen, 2023).

Thinking about "intelligent" and self-tailored energy solutions induces an awareness of social practices and the spatial design we inhabit. As suggested by Elisabeth Shove (2007), the design of everyday life influences our performances in spaces and the constellations of products and practices co-evolving in cycles of production, consumption, and innovation. Our energy performances are particularly linked to daily comfort perception that to guarantee indoor and outdoor standards in terms of lighting, cooling, heating, and ventilation, a huge amount of energy is consumed. Interpreting comfort from a sufficiency perspective means rethinking the goals of achieving "standards" just by equipping spaces and architectures with homologated technological solutions such as artificially illuminating dark spaces, cooling warm environments with appliances, etc. As the work of Barber (2020) shows, the imposition of a universal technological standardisation of comfort has reduced and trivialised the relationship between the artefacts and the context in which they are located, entrusting mediation to mechanical means or relying on fossil fuels. Design explorations, as those of Victor and Aladar Olgyay, Glenn Murcutt, and Lacaton and Vassal, establish a close relationship with the external atmospheric and climatic conditions of the site to achieve a high level of climatic comfort with a minimum use of artificial air conditioning, ventilation, or heating devices. This line of research, better known as bioclimatic architecture, is once again attracting attention, and a set of solutions that make an economy of means is seen as one that can help to rearticulate the architectural project (Rahm, 2023a; Rahm, 2023b), also inspiring people to innovative solutions that reduce electrical and thermal dependency, even reducing the energy poverty status. At the urban scale, the sufficiency approach to comfort is informing many research and projects, particularly those dealing with the UHI effect. For example, the use of "cool material techniques" to reconfigure permeable paving with light-coloured asphalt or similar to reduce the albedo index (APUR, 2020); or the transformation of existing roofs to host PV panels or gardens to improve the self-consumption of energy and passively insulate buildings and reduce surface overheating (Guida, 2022; Toboso et al., 2023).

From these reference collections emerge at least three possible spatial strategies for a place-based design of energy transition. The first is described by the concept of "taking care of the existing" which forces working with and on the existing urban configuration and not on a "tabula rasa", acting on the quality of spaces and on the sharing of practices and devices to avoid the proliferation of individual consumption, and with gestures of repair to adapt the existing to new uses and configurations and planning its maintenance. The second strategy

focuses intensely on learning from social practices where the relationship between energy devices, energy metabolisms and energy behaviours is evident, and its design in domestic and urban spaces led to more intelligent and sensible consumption. The last strategy explores the management of comfort for less use of energy with the design of bioclimatic architecture and urban spaces. Each strategy, although not exhaustive and reinterpretable, has guided some test actions in the case study, which will be reported in the next paragraph.

Ostiense: A Place-Based Lab

Returning to the research question, namely, with what tools and approaches is it possible to spatially design the transition in defined contexts, and to test the design strategies for a place-based energy transition, it is necessary to draw the boundaries of a specific case study. Within the city of Rome, the choice fell on the Ostiense neighbourhood, a paradigmatic case due to its historical, urban and energy characteristics. The neighbourhood is recognised as Rome's historic energy district still characterised today by the presence of old energy infrastructures, including the former Italgas area (12 hectares with an iconic 90-meter-high gasometer) which today hosts a technological hub for new energies,[11] and the Montemartini thermoelectric power plant, which now houses an archaeological museum. From an urban planning perspective, the neighbourhood represents a consolidated and stratified urban pattern, in large part historical, characterised also by the presence of a university district and large former industrial areas undergoing regeneration, both characteristics of an interesting urban transformation area. The Ostiense energy system shows a great imbalance between consumption and production: an average of 150 MWh is consumed monthly, while the installed capacity, including the existing renewable energy installations, is only 0,4 MWp. Here, a significant weight of consumption is linked to the specific spatial-environmental phenomenon of UHIs. Ostiense is one of the hottest parts of Rome in summer, especially at nighttime when the temperature can rise to +3°C compared to the average in Rome (Pone, 2023). This condition leads to an impressive use of artificial air conditioning, with a +10% increase in electricity demand compared to the monthly average in Rome (ARETI, 2021). Many studies, such as the ones by Cattaneo (2023), show that the UHIs are strongly influenced by given topographic conditions such as the large presence of asphalted surfaces, the scarce availability of permeable soils, the lack of vegetation, and the massive use of cars.

[11] The ROAD -Rome Advanced District is a network of enterprises involved in innovative technological development. More detail available at the link: https://www.roadlab.tech/it (September 2024).



Figure 2: The "asphalt landscapes" of Rome. Oversized road sections, parking lots, asphalted courtyards and squares cover large areas of the city, absorbing a lot of heat and generating the Urban Heat Island phenomenon. (Via Ostiense-Rome. Credits: Fabrizio D'Angelo, 2023).

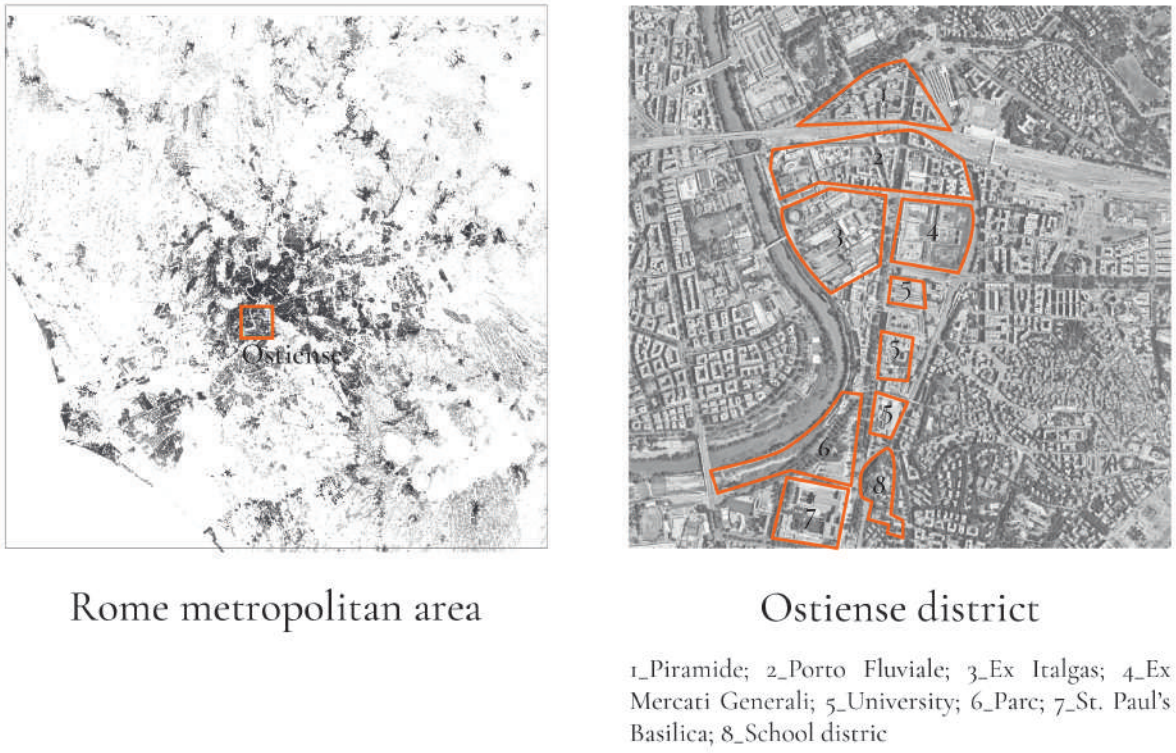

Figure 3: Ostiense location within the city of Rome (credits: Fabrizio D'Angelo, 2024).

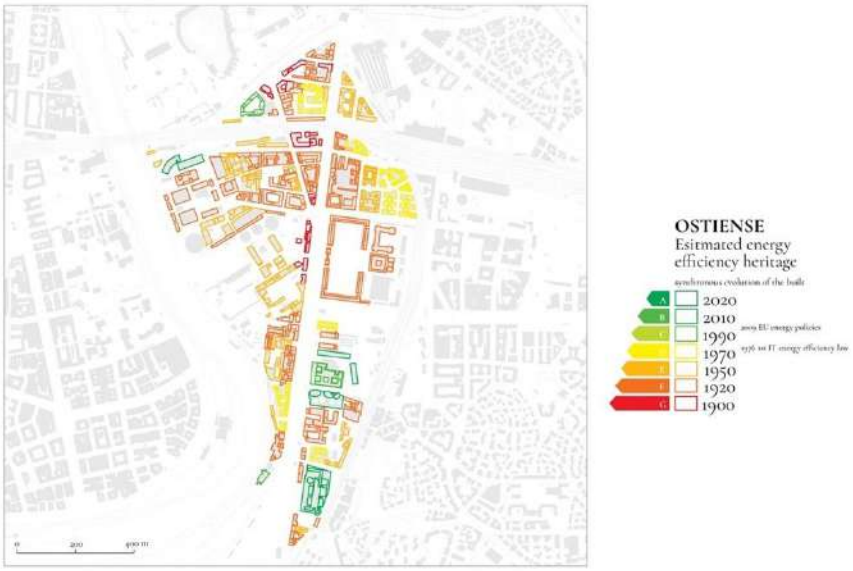

Figure 4: The historical and consolidated city. The estimated energy efficiency heritage of Ostiense, where just a dozen buildings (the greener ones) were built after the first Italian law on consumption control, so the larger part of the buildings is supposed to be in a deficit of energy efficiency. (credits: Fabrizio D'Angelo, 2023).

The local consumption system is also influenced by both the quality of the buildings and the social component of the tenants. The neighbourhood largely consists of buildings constructed between the early 20th century and the 1970s, predating the first energy efficiency law in 1976. Few are the retrofitting operations on a very old and highly fragmented property, often complicated by superimposed structures and unregulated interventions. Even rarer are the housing units with energy-efficient solutions, often resulting from demolition and reconstruction projects or simple new construction on the few empty lots. The same housing units are often rented out, sometimes for very short periods, especially for the large number of students living in the neighbourhood (Ostiense is consolidating as one of the university districts of Rome). This condition hinders the possibility for residents and tenants to directly intervene in their energy systems. Additionally, it should be noted that there are users in energy poverty conditions and squats with hundreds of users whose comfort conditions require urgent attention.[12]

The rich complexity of the context defines the ideal characteristics for experimenting and testing the strategies outlined for a place-based energy transition. These tests are currently carried out in three PEDFORALL research actions that, although following different work packages and deliverables,[13] contribute to the development of an integrated design strategy.

[12] In the neighbourhood there is a historical squatter building named "Porto Fluviale" which is under retrofit renovation by a public fund. The building, since 2003, is inhabited by 56 households from 13 different nations. The project includes insulation systems and the creation of a photovoltaic system for self-consumption. More information at (March 2024)

[13] The different actions described are part of ongoing work packages: the first is part of WP4 "Strategies for a Neighbourhood in Transition"; the second is part of WP5 "Living Lab", and the third one is linked to research-related training projects.

Each of these actions is tailored to one of the strategies identified in section 2, namely: the care of the existing, the energy behaviours and practices, and the bioclimatic design.



Figure 5: Energy devices exposure. Over the years, the buildings in the neighbourhood, lacking energy efficiency solutions, have been equipped with devices to mitigate living comfort, such as air conditioners, boilers, curtains, and ventilation systems (via Negri - Ostiense. Credits: Fabrizio D'Angelo, 2023).

As for the care of the existing, the first research action codesign strategies to apply the principles of a PED model to existing urban patterns. Here, a new analytical tool is needed to handle the complexity between lack of space, stratified build heritage, heterogeneous social components and fragmented regulatory frameworks. The new tool created and tested is entitled "Atlas of strategies" a matrix that crosses three different perspectives, each requiring different expertise. The three perspectives analyse the context, deepening the social, governance and spatial dimensions; the regulatory and policy system; and the energy and technological status.[14] Planning an ongoing transformation means considering also the time evolution and the development of different processes. For this reason, each perspective understands and orders the socio-spatial energy issues in three steps starting from the existing energy niches (e.g. the innovative actions of a local Renewable Energy Community[15]; or the local regulatory framework for the retrofitting of squatters building); the operating of the existing energy system (grid, presence of electrical cabins), and characteristics of the urban landscape. The elements collected from this cross-analysis are then analysed by success factors, challenges, and barriers, underlining the strong interconnection with the existing

[14] The PEDFORALL research group merge different expertise: the department of Architecture of Roma Tre University and the Vrije Universiteit Brussel for issues linked to spatial design and governance system; the Istanbul Technical University for technological issues; the Department of Law of Roma Tre University and the Luiss University for regulatory and policies framework.
[15] In Ostiense is being set up a Solidarity Energy Community that share public roofs to produce photovoltaic energy distributed then to energy-poverty users. For more details follow the link: https://www.cermunicipio8.it/chi-siamo/ (September 2024).

context. For example, it emerges a lack of large, unified spaces to install self-production energy systems but the presence of many public buildings (e.g. university buildings), which have large rooftops and are spread throughout the neighbourhood, can support the shared use of energy community serving the public interest. Or again, the presence of a museum in a former power plant could enhance spaces for energy-educational and awareness programs. These examples, along with others, have contributed to defining design strategies tailored for the Ostiense context, expressed by visuals and shared with local stakeholders.

As for the behaviour and practices perspective, the second research action is entitled "Paesaggio Elettro-Domestico", which in English sounds like an "Electro-Domestic" Landscape. In the context of PEDFORALL living labs, the relationship between energy devices, energy metabolisms and energy behaviours in domestic and urban dimensions has been explored. The action consists of interacting interviews with a selected group of inhabitants, chosen by different social, economic and professional statuses, paying attention also to the housing architectural conditions such as exposition, square meters, number of floors, year of construction, etc. With tenants are testing different kinds of representation and analysis. As a first step, using maquettes that reproduce the space of the interviewee's apartment, residents are asked to list and place all appliances and, in doing so, indicate their efficiency level (how old they are) and usage intensity. Based on a colour-coding system, each device is then classified according to its consumption intensity. This first step offers a form of spatialisation and qualification of domestic energy consumption. The second step focuses on the spatialisation of energy practices. Still using the maquettes, residents are asked to describe the practices they undertake to achieve or maintain indoor comfort and to indicate where and with which devices these practices occur. In this second step, forms are provided to spatialise energy practices and spatial conditions, particularly the building envelope and various technological systems. The result is a survey of how domestic spaces evolve regarding electrical appliances and, through the direct involvement of inhabitants, an awareness of everything that consumes energy and the spatial influence of energy behaviours. For example, it emerged that some energy consumptions are concentrated not only in specific rooms but also in spaces defined by comfort conditions (near a window, at a table, or in a well-ventilated spot); or that the availability of accessible outdoor spaces reduces the use of certain appliances (clotheslines instead of dryer machines) or decreases the need for artificial lighting. Even more interesting insights emerged from the analysis of energy practices to thermal comfort. In environments that are not fully or permanently artificially climate-controlled, people interact with space in search of thermal balance, often adopting creative and effective spatial solutions. For instance, it has been observed that in apartments with only one air-conditioned room, during the hot months, this space is repurposed to accommodate multiple activities, from sleeping to working and leisure. In these cases, the space is adapted to accommodate the rhythms of different functions coexisting within the same area. Other interesting aspects include the awareness

that has developed around the domestic experience, such as thermal conditions or convection. This is evident in DIY design solutions, for example, moving sofas and beds away from sun-exposed warm walls, using rugs to mitigate cold drafts in winter, and strategically opening doors and windows to create airflow.



Figure 6: "Electro-domestic" landscape. Moment of the workshops with inhabitants to understand and spatialise energy consumption and behaviours. (Credits: Fabrizio D'Angelo, 2024).

Finally, the bioclimatic perspective was implemented through *the "*Urban Frigidarium*",* a program of different on-site training projects which aims to test the transformation of public spaces with bioclimatic strategies. The first workshop is entitled "Marciapiede Fresco"[16], which in English could be translated as "fresh sidewalk". The workshop was a one-day open-air building site, focused on the transformation of a large asphalted surface in front of a school. The operation was promoted by PEDFORALL local consortium[17] and involved local actors and students at a university laboratory in urbanism. During a thermolaser survey to monitor the effects of UHI, it emerged that many urban soils with existing large asphalt surfaces (parking lots, streets, yards) absorb significant amounts of heat. As a result, it emerged that the UHI affects local energy consumption with intense use of comfort appliances (air conditioners, electrical fans, and dehumidifiers) that increase the 22% electricity consumption (Asdrubali et al. 2022). Among the spaces monitored, a big sidewalk in front of a school appeared as the hottest surface of the surroundings. Starting from design references of bioclimatic design,

[16] The workshop was part of the university lab of "Progettazione dello Spazio Urbano-LMPU" involving the researchers Fabrizio D'Angelo, Margherita Erbani, Ilaria Maurelli, Maria Pone, Marco Ranzato. The students involved from Roma Tre University- Department of Architecture are: Ait Baady Imane, Bevilacqua Marta, Comanducci Martina, Consiglio Tommaso, Cucciniello Matteo, D'Almeida Vitoria D'Ambrosio Anna, De Mari Laura, De Rosa Sarah, Del Gizzo Alisee, D'Emilio Chiara, Di Cesare Chiara, Di Dio Federico, Fabbri Edoardo, Fernandez Covadonga, Filoni Francesco, Fournier Emilie, Hesse Justine, Lemme Francesco, Marinangeli Riccardo, Marzo Alberto, Matehau Rehia, Mika Jiri, Brustolon Leonardo, Panico Anna, Ruiz Cobosm Elena Maria, Salzano Barbara Judith.

[17]The local consortium is made by Roma Tre University and the local municipality Municipio VIII. The initiative was supported by the "Dipartimento Politiche Sociali e Salute, Roma Capitale - Municipio VIII" and sponsored by "SportLab" association.

specifically the use of Cool Materials, almost 100 kg of white paint was used to recover approximately 250 square meters of the asphalted surface. Due to the proximity to a school, the painted areas also featured lettering about rising temperature and UHI effect. The action was particularly interesting for the social interaction it fostered. The white sidewalk attracted the attention of many residents and passers-by who crossed the transformed space getting in touch with the meaning of the workshop. The exchange between "workers" and citizens provided an opportunity to test the acceptability of the intervention and discuss and disseminate themes related to energy consumption mitigation.



Figure 6: "Marciapiede Fresco", the open construction site to test the Cool Materials technique. (Largo da Vinci-Rome, credits: Fabrizio D'Angelo, 2023).

Work in Progress: first Consideration and Future Developments

The case study experiences represent a new research approach that mixes different methodologies, outputs and tools. The neighbourhood was considered not just in terms of its techno-energetic potentialities (e.g. numbers of PV installable on roofs, amount of energy reduced in energy class upgrade), neither standardised scenario building approach was applied based on spatial-neutral common collection of good practices (e.g. a list of general objectives as those defined in SECAP plans). This territorial lens, instead, focused on closely observing the case study first, starting from its socio-spatial, technological, and legal conditions, and only in a second phase defining a possible vision of transition. This perspective guides the first action that, using a double lens, crosses socio-spatial and energy considerations in the context, providing a deep and critical analysis of the case study, highlighting the real needs and objectives of the transition and avoiding applying ready-made programs. At the same time, the threshold analysis by energy niches, energy context and urban landscape, built during the "Atlas of strategies", gives a more complex image of the possible

declination of the transition, emphasising possible success but also challenges. Start by planning an urban energy transition from the socio-spatial dimension, and not just by adapting an energy model, makes a difference in the quality and feasibility of the interventions. For example, this first action has brought to light that the application of energy efficiency models in existing buildings is difficult due to constraints related to historical heritage, as well as the fragmentation of property ownership and the different economic statuses of the inhabitants. At the same time, this type of analysis also highlights possible solutions. By valuing the preservation of existing structures, a careful study and description of the spaces and social dynamics of the neighbourhood reveals, for example, how the presence of numerous university buildings, with large and public roofs, can support the installation of energy production systems to be shared within an Energy Community.

This methodological tool is certainly applicable to any context; however, the results provide, each time, different and place-based urban design strategies. Observing the socio-spatial complexities of what already exists enhances the concept of "taking care of the existence," aiming to maximise the value of present spatial capital while preserving the embedded energy. These strategies, though seemingly obvious when intervening in a consolidated urban context, are still slow to be fully integrated into the political and planning visions for cities. Certainly, part of this resistance is driven by the many technological projects that attract capital and expertise in the urban transformation processes. On the other hand, however, there is still not enough design culture to rethink the energy transition of consolidated urban areas in an alternative way. The tested tool is merely a first attempt to offer concrete support and encouragement to restart from the existing, both spatial and social, to carefully and appropriately tailor a new urban energy system.

While a place-based analysis of the context can provide solid support for formulating design strategies, a large part of the energy system remains uncontrolled and unknown. The scale of consumption is still largely abstract, and, more importantly, actions to manage it are often limited to technological improvements. The construction of the “Electro-domestic landscapes” of the case study seeks to fill the knowledge gap related to energy behaviours and their relationship with space. “Electro-domestic landscape” serves as a test-lab to understand and then visualise the physical dimension of spatial design in social behaviours with relation to energy consumption. Working with residents in their domestic spaces creates the opportunity to build an interactive design process that moves through understanding, hypothesis formulation, and testing with the direct stakeholders. Using design tools, such as the maquettes, facilitates the spatialisation of energy behaviours and the interaction with the interviewer who is also a user and inhabitant. All the information collected -as the DIY solution and the use of artefacts or spaces to do things instead of using electrical appliances- are signs of a possible new culture of energy-sufficient design. The same ideas could be extended to the urban dimension, understanding how open and public spaces, infrastructures, workplaces,

and leisure landscapes shape our energy behaviours and how they could reduce energy consumption through a different configuration or function. This echoes some urban transformation paradigms, such as the “15-minute city”, which, however, are primarily focused on mobility. By starting from the energy dimension, these same paradigms can be enriched and deepened, providing a more comprehensive vision of socio-ecological transition. Exploring the bodily and social dimensions of energy habits also prompts a reflection on thermal comfort. "Marciapiede Fresco" and the other actions of “Frigidario Urbano”, are conceived as instant construction sites to test, simulate, and design potential transformations in existing urban patterns. Bioclimatic solutions such as the use of Cool Materials are quite well known in the urban design culture, although are lacking, again, experimentations in consolidated, stratified, and historic urban contexts. The operations carried out do not offer certain, ready-to-use, and lasting solutions, with the risk of generating scarce acceptability and difficult replications. However, they provide a space for temporary experimentation that simulates, measures and adjusts configurations and devices in search of the best-suited formula for a specific site. In “Marciapiede Fresco” a blank white surface was left without any design, and a film of Cool Material was available for monitoring temperature and paint wear.

Observations made in the following months showed its effectiveness in terms of climate mitigation, with an average asphalt temperature decrease of -10°C. However, some critical issues were noted, such as the paint's durability near vegetation and the blinding effect of the white colour reported by some residents. These construction sites are essentially attempting to disseminate a simulation that is useful both in design terms -only by testing on a real scale can the strengths and weaknesses of the action be identified- and as learning spaces. Getting back to the research questions, all the actions presented above, although separately implemented, contribute to the search and the definition of a range of tools and approaches for a place-based energy transition in consolidated urban contexts. The premise of working with existing configurations opens a field of study and experimentation that is far from being fully explored but is still urgent given the urban structure of many European cities and the planning paradigms no longer oriented toward expansion but toward rewriting. This represents a different way of observing cities, as well as a different foundation for making planning choices related to energy. The strategies themselves are based not only on careful contextual analysis but also on interaction with energy behaviours, breaking through the veil that has long covered the social dimension of energy. This highlights that not only can technological performance mitigate consumption, but also the space in which it occurs. Finally, some proposed strategies, much like in a scientific laboratory, have been tested in physical space. These simulations support the idea that innovation in the energy transition must not only arise from total-tech experimentation but should also occur within the dimension of spatial design.

The considerations, the concepts adopted, and the references used reaffirm the interest in advancing the paradigm of energy sufficiency. However, this does not imply a total rejection of other energy visions but rather a harmonious integration. Technological innovation and its application in architecture and urban planning -as proposed in the eco-modernist visions of EU policies- are certainly valid and necessary, and the energy sufficiency dimension still retains a certain critical and naive dimension. Nevertheless, it is enriching and sometimes essential to complement more established pathways with alternative experiences to contribute to a stronger idea of place-based energy transition.

The strategies proposed are not yet mature enough to represent a solution, but they serve as alternative points of observation to rethink the role of energy transition in urban areas. Therefore, this contribution aims to provide suggestions, entry points, and references to fuel the debate. PEDFORALL is, and will continue to be, engaged in developing further strategies: additional bioclimatic experiments on public space are underway (a new cooling device using water is being implemented in a public square), other workshops for the electro-domestic landscape are taking place (currently involving three new apartments), and the strategies outlined in the atlas will soon be shared in a publication. Hopefully, the reflections presented here will align with the new research results, stimulating a work that will find other opportunities for dissemination. Similarly, the thoughts and strategies produced will stimulate other works to enrich the debate on place-based energy transitions.

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Conflict of interest

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Research Article

Exploring the local and regional dimensions of the Renewable Energy Communities' activation in diverse European institutional contexts

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Abstract

Energy transition is a pivotal challenge for urban and regional development across European territories. Integrating this issue into local policy agendas and spatial planning tools is essential to foster effective engagement of public authorities and local communities in achieving climate neutrality by 2050. Renewable Energy Communities (RECs) are a key tool in climate policy, enabling citizens, civil society organizations, local authorities, and small and medium-sized enterprises to play an active role in the energy supply system. Within RECs, these actors move from being mere consumers to becoming prosumers, thus contributing to more decentralized and democratic energy systems. However, the successful implementation of RECs requires supportive multilevel governance structures and coherent legal and regulatory frameworks to facilitate their development in diverse national, regional, and local contexts.

This paper investigates the role of regional and local authorities, stakeholders, and planning tools in the activation process of RECs within European territories. It analyzes the activation process of different REC configurations by reconstructing the multilevel governance frameworks and exploring the interactions between local, regional and national levels. The work focuses on three case studies, Piedmont (Italy), Andalusia (Spain), Geneva (Switzerland), to illustrate the dynamics of REC creation. This study provides a basis for future research focusing on the interrelationship between energy transition processes and territorial governance frameworks. Empirical evidence suggests that integrated governance arrangements are more effective in aligning spatial planning with climate and energy strategies.

Keywords

Renewable Energy Communities, Spatial planning, Climate policies, Energy transition, European regions

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Introduction

The "just local energy transition" towards sustainable and renewable energy production and consumption patterns is a pivotal challenge for regional development policies in Europe (Otamendi-Irizar et al, 2022). This is because the social and economic benefits of the energy transition can be substantial, and their fair distribution is crucial for guaranteeing all actors equitable access to the opportunities offered by the transition itself. In order to reach energy and climate objectives by 2050 regional and local authorities are key actors (Santopietro & Scorza, 2023). They can drive a fair transition, since they have administrative and political power to develop and implement adequate policy instruments for enhancing energy efficiency and fostering the deployment of local renewable energy sources, as in the case of Renewable Energy Communities (RECs).

RECs as policy instruments

An energy community can be defined as "(...) a way to "organize" collective energy actions around open, democratic participation and governance, and the provision of benefits for the members or the local community" (Caramizaru & Uihlein, 2020, p. 4, referring to Roberts et al, 2019). Following Baratti, Barbanente & Marzocca (2020), RECs are not merely technical and administrative devices defined and implemented within the renewable energy sector, but social and political processes that develop simultaneously with local energy production in the local social, labour and economic systems, based on the valorisation of local energy potential as a common good and the reduction of energy dependence. From this perspective, energy communities are institutions that can be considered as policy instrument (Le Galès, 2010). Based on the principle of "agreement- and incentive-based instruments"[1], RECs can be approached as instruments of an overall social and environmental policy focusing on local energy transition. RECs' establishment is based on agreements and RECs' financial sustainability is often ensured by incentives. Not by chance, they have been in the limelight in Europe, owing to their potential to facilitate a more sustainable, horizontal and distributed energy supply (D'Alpaos & Andreolli, 2021).

According to OIPE (2023), public institutions play a fundamental role in both the establishment of RECs and the generation of economic and social benefits. Several studies highlight the decisive role of state, regional, provincial, and local governments in ensuring the viability and success of REC development and in promoting large investments in distributed renewable energy resources (Parreño-Rodriguez et al, 2023). Furthermore, Dudka et al (2023) suggest that an institutional approach is well-suited for studying RECs, due to the complex negotiations that involve a diverse array of participants and stakeholders.

[1] "Participatory instruments (...) able to provide adequate modes of regulation. A framework of agreements, with the incentive forms linked to it, presupposes a state in retreat from its traditional functions, renouncing its power of constraint and becoming involved in modes of ostensibly contractual exchange, mobilizing and enrolling resources and actors" (Le Galès, 2010, p.11).

The implementation of RECs represents a key opportunity for advancing a just and inclusive local energy transition. As shown in various case studies presented in literature, RECs foster social innovation by enabling citizens, civil society organisations, local authorities, and Small and Medium-sized Enterprises (SMEs) to become active participants in the energy system. This shift transforms them from passive consumers into prosumers who both produce and consume energy (Hanke et al, 2021).

Focusing on how actors involved in governance processes operate (Le Galès, 2010, p. 1), citizens and civil society organisations can influence the energy governance structures and contribute to bottom-up energy transition by becoming energy prosumers within a REC. Their involvement can occur in collaboration with municipalities and SMEs, regardless of which stakeholder leads the REC initiative.

However, the development of decentralised and more democratic energy supply models, predicated on RECs and energy efficiency cannot be left solely to private initiatives. This effort requires careful integration within existing energy and climate planning policies. This includes the incorporation of sustainable energy objectives into urban and regional plans and the adoption of broader integrated energy planning approaches (De Pascali & Bagaini, 2018; Asarpota & Nadin, 2020).

RECs thus serve as local transition initiatives that promote decentralised, participatory and democratic energy systems. These initiatives generate social, economic and technological returns within their territories (Bolognesi & Magnaghi, 2020).

Moreover, RECs can be assessed through their alignment with local energy potential and their ability to foster self-organised energy systems at the territorial level, which is increasingly central to political decision-making.

As the energy transition advances, the energy sector evolves from a centralised national industry into a key area of public policy with a pronounced territorial dimension. This transformation involves both urban and rural areas and reflects the shift towards diversified, multi-scale energy production and distribution systems (Araújo, 2014).

Research gaps, research questions, and objectives

To date, the analysis of Renewable Energy Sources (RES) supply, as well as RECs configurations, has been mostly focused on their social, economic, and environmental benefits (e.g. Kiamba et al, 2022; Algarni et al, 2023, among others) or organisational models (De Vidovich et al, 2023), being their spatial governance and planning dimension a trivial issue. In particular, at the local level, the mismatch between energy planning and spatial planning is critical, and the potential of shaping spatial and urban forms in the interests of energy efficiency is often overlooked (Roger-Lacan, 2019; Asarpota & Nadin, 2020). Nowak et al (2022) collected several European case studies to highlight how the interaction between

spatial governance and planning and renewables is noticeable, and how legal barriers limit the establishment of distributed energy configurations more than technological ones.

Therefore, the frequent lack of a spatial dimension and adequate articulation between different institutional levels in the definition and implementation of energy and climate strategies is the main research gap addressed by this paper. The potential of having an integrated energy, climate, and spatial planning approach is often underestimated, despite spatial planning being the crucial element for sustainable and resilient local development (IN-PLAN, 2023)[2]. Local development plans frequently exhibit an absence of integration with climate and energy strategies and may also limit the implementation of renewable energy investments. Arguably, this is attributable to the failure of local development plans to provide adequate technical regulations, financial incentives, fiscal conditions and the promotion of public-private partnerships to define, finance and implement projects (Solarek & Kubasińska, 2022).

All that being said, the main research question of the paper is "How do local and regional governance and planning frameworks influence the development and implementation of RECs as instruments of a just local energy transition in different European institutional contexts?" In order to answer this question, the paper aims to:

- Identify the main institutional, legal, and regulatory frameworks suitable for the establishment and functioning of RECs at the local and regional levels, and the regulatory barriers affecting the RECs.
- Examine the relationship between the local and regional levels and the relationships between these levels and the actors in the implementation of the RECs.
- Examine how spatial and energy planning frameworks interact and influence the development of RECs.
- Explore the role of public authorities in facilitating, promoting, or potentially constraining REC initiatives through policy instruments, governance practices, and support mechanisms.
- Analyse how different governance structures and institutional arrangements affect stakeholder engagement in RECs.

To this purpose, three distinct European regional contexts are examined: the Piedmont Region in Italy, the Autonomous Community of Andalusia in Spain, and the Canton of Geneva in Switzerland. These contexts empirically illustrate a range of institutional settings and experiences representing meaningful practices and show to what extent activation policy is defined at the national and regional levels, while it is implemented at the municipal level, where different practices and social impacts can be observed.

[2] https://fedarene.org/project/in-plan/

Methodology and conceptual framework

This paper investigates the activation processes of Renewable Energy Communities (RECs) through a comparative analysis of three regional case studies: Piedmont (Italy), Andalusia (Spain), and Geneva (Switzerland). These regions were selected to represent varying degrees of regional autonomy and to reflect different legal, regulatory, and institutional frameworks within the broader European context.

The EU introduced RECs in the Clean Energy for All Europeans Package in 2019. The Internal Energy Market Directive (IEMD) introduced the concept of Citizens' Energy Communities (CECs), and the recast of the Renewable Energy Directive (RED II) introduced the so-called RECs. Based on EU Directives, each member State is supposed to approve and implement its respective legal and regulatory framework.

Although Switzerland is not an EU Member State, its national energy legislation aligns with similar principles. The Federal Law on secure electricity provision based on renewable energy provisions, especially from PV, approved in 2024, creates favourable conditions to accelerate the national renewable energy development, also in terms of incentives, and in so doing, stabilising the solar energy sector. In Switzerland, Local Energy Communities (LECs) and Virtual Self-consumption Groups (VSCs) enable the local trade of solar energy using the connection line and the public electricity grid, thus favouring the optimisation of production, storage and consumption at a decentralised level.

Selection of case studies

The selected case studies highlight a variety of institutional settings and levels of articulation between national, regional, and local authorities. The regions fall under the NUTS2 (Nomenclature of Territorial Units for Statistics, level 2) classification provided by Eurostat[3].

The three case studies are presented in *Case studies* section, and show different nuances of regional autonomy. Italy has limited regional autonomy, Spain has a high regional autonomy, and the federal system of Switzerland offers to the Cantons a wide autonomy and strong implementation capacity in a number of policy sectors.

The selection of these case studies - whose data were mainly collected on the occasion of an INTERREG EUROPE project proposal by the authors of the present paper - offers an insight into the variable geometry of regional conditions for the development of place-based RECs' activation initiatives, which can leverage endogenous innovations, both in terms of needs and solutions. In particular, these cases represent a variety of institutional settings and forms of articulation between national, regional and local levels.

The Italian case represents the joint or individual municipal efforts towards leading the activation of RECs throughout the respective local communities and the articulation between

[3] https://ec.europa.eu/eurostat/web/nuts

top-down (municipalities and ESCOs) and bottom-up (citizens' initiatives) approaches. The Spanish case represents the social engagement deserving vulnerable contexts. The Swiss case represents the REC's establishment as a driver of redevelopment projects to implement energy transition by means of public-private partnerships.

Methodological approach

This study adopts a comparative policy analysis approach, conceptualising RECs as instruments of climate and energy policy. It employs qualitative methods to examine the interplay between policy frameworks and local activation processes. Firstly, the paper designs a comparative multilevel governance framework of the three cases referring to the REC establishment process (*The multilevel framework related to RECs in three European Regions*). Subsequently, the paper critically revises the three cases to understand which are the relationships between the local, regional and national levels with respect to the successful establishment of RECs (*The interplay of local, regional and national levels in the establishment of RECs in the three case studies*) and finally, it discusses *The multilevel framework*, and *The RECs' activation*. The paper devotes particular attention to the eventual integration of energy/climate policies and urban planning.

Data were collected from official sources, i.e. policy documents, planning tools, and institutional websites. Semi-structured interviews were carried out in 2023 and 2024 with RECs' relevant stakeholders, including civil servants and politicians from the regional, provincial and municipal levels of government, Non-Governmental Organizations (NGOs) committed to climate change mitigation and ecological transition, and academic experts.

For each case study involved at least five interviews were conducted, each lasting at least one hour, utilising a structured questionnaire. The content of these interviews encompassed the following areas: (1) the genesis and evolution of RECs, (2) obstacles or barriers encountered during the establishment process, (3) the adequacy of legal arrangements, (4) the role of local authorities and legal and regulatory provisions in facilitating the effective establishment of the REC, (5) the relationships between the local, regional and national levels, and in the particular the role played by the regional level, (6) social issues related to stakeholders' engagement.

For the Italian case, three municipal political representatives and two municipal public servants were interviewed. The Sustainable Energy Development Office of the Piedmont Region was interviewed on three occasions, along with the policy design process.

In the Spanish case, the Andalusian Energy Agency and the Granada Energy Agency were interviewed. Two different representatives from Torreblanca Illumina REC were interviewed as well as one from the *Rio Monachil REC*.

The Swiss case was presented in Task 63 - Solar Neighbourhood Planning (International Energy Agency) among other case studies[4]. Two representatives from the Foundation for Industrial Areas of Geneva (FTI) and from the Energy Entity of Geneva (SIG) were interviewed, respectively, in order to discuss with both a technician and an institutional representative for each entity. Finally, a representative from the cantonal energy department was also interviewed concerning the institutional and legal aspects of REC.

With reference to *The interplay of local, regional and national levels in the establishment of RECs in the three case studies,* the following figure summarises the common conceptual framework against which the case studies are analysed and compared. It is developed considering a multi-level framework articulating the national, regional and local levels. Each institutional level can facilitate and frame the initiation of RECs through regulations, subsidies, plans and other tools. The REC aggregation is made up of several stakeholders, distinguishing those who initiate (invest in), manage or simply participate to the REC.

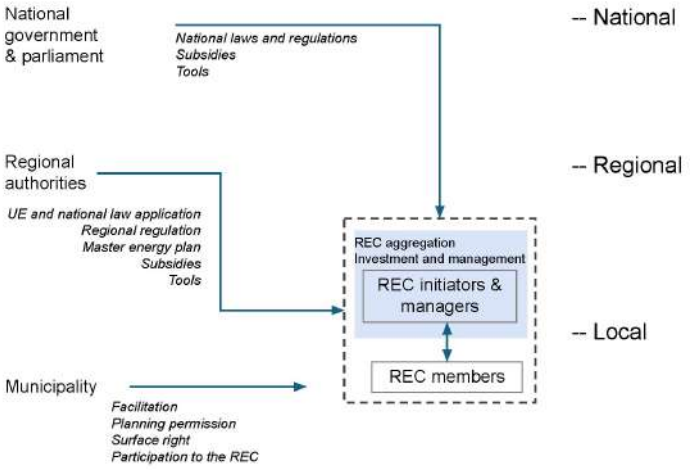

Figure 1 – Common conceptual framework for the analysis of the case studies.

Case studies

Piedmont Region, Italy

In compliance with the EU Directives 2018/2001 and 2019/944 regarding the promotion of RES and common rules for the internal electricity market, respectively, Italy has approved two Legislative Decrees, LD 199/2021 and LD 210/2021, to complete the national regulatory framework concerning energy self-consumption and energy communities. According to LD 199/2021, electricity can be shared between users within the same market area (of which Italy has six), while access to incentives for sharing electricity from renewable sources are exclusively reserved for users connected to the same primary substation and are limited to the share derived from new plants with a nominal power rating of less than 1 MW. To fully apply

[4] https://task63.iea-shc.org/case-studies
https://drive.google.com/file/d/1Ej91oe6mSKbh0n20KpL_Ev6dDzf4uK1j/view

the LD 199/2021, the Regulatory Authority for Energy, Networks and Environment (*Autorità di Regolazione per l'Energia e l'Ambiente*, *ARERA*) issued a series of resolutions and introduced a virtual regulatory model for widespread self-consumption. To implement this policy, the only recently approved Ministerial Decree MD 414/2024 introduces two main support measures: (i) non-repayable grants covering up to 40% of eligible costs, financed by the National Recovery and Resilience Plan (NRRP), specifically addressed to municipalities with populations under 5,000 residents, and intended to support the development of 2 GW of total renewable capacity; and (ii) an incentive tariff applied to renewable energy produced and shared across the national territory. These two measures can be combined, and the incentive tariffs will be available until either a national capacity of 5 GW is reached or until 31 December 2027, whichever is sooner. Regarding installation limits, the decree specifies that the maximum nominal capacity of an individual plant or an upgrade intervention cannot exceed 1 MW. The financial support offered by Ministerial Decree 414 should encourage small local governments to activate RECs located within their respective territories.

Regarding the features of RECs, LD 199/2021 (art 2 and art 31) explains that a REC is an autonomous, non-profit legal entity (e.g. an association, cooperative, or consortium) based on open, voluntary participation from companies, individuals, municipal authorities, and religious authorities, as well as organisations from the third sector and other local authorities. However, for companies, participation in a REC cannot constitute their primary economic activity. Both public and private members can be prosumers or consumers to reap economic benefits.

Turning to the regional legislative and regulatory framework, Piedmont was the first Region in Italy to approve a regional law on RECs, making Piedmont a pioneer in REC legislation. The Regional Law (LR 03/08/2018, n. 12) on the Promotion of the Establishment of Energy Communities attributes a territorial dimension to energy communities. Municipalities act as promoters, based on a memorandum of understanding and supervise the development of activities and the relationships among community members. After their constitution, RECs were supposed to set up an energy balance and a strategic document regarding energy saving and efficiency. Furthermore, RECs were expected to produce energy for self-consumption equalling at least 70 % of the total. The Piedmont Region also approved DGR n. 18-8520 8/03/2019, which specified the minimum requirements for a REC. However, the specific modalities proposed by the law have remained on the paper, and the REC establishment has been a bottom-up process led by municipalities or local stakeholders.

Beyond that law, the Piedmont Region currently prospects a regional role of territorial coordination, which consists of soft monitoring of REC initiatives, creating a REC regional network, raising awareness and building capacity, and facilitating relationships with

institutional entities, such as ARERA[5], GSE[6], RSE[7], MISE[8], and energy distributors, and providing support to RECs in their applications for EU funds.

Moving now from the regional to the municipal level, in Piedmont, two-thirds of the municipalities have fewer than 5,000 inhabitants and are therefore potential NRRP beneficiaries. Among them, Scalenghe is a small municipality belonging to the Metropolitan City of Turin. In 2019, Scalenghe, together with other municipalities in the Pinerolese area, signed a memorandum of understanding called the 'Oil Free Zone'. Based on this agreement, in 2021 the temporary association of municipalities known as the 'Pinerolese Renewable Energy Community' (ATS)[9] was established, including 41 municipalities, most of which have fewer than 5,000 inhabitants. However, the ATS has not progressed to become an operational REC and, according to the interviewees, this is due to the uncertain Italian REC regulation, only recently clarified by the aforementioned MD 414/2024.

Scalenghe is leading the ATS, with the municipality's vice mayor serving as ATS president. The municipalities involved are committed to the local energy transition. Supported by a private fund called 'Next Generation You', issued by Compagnia di San Paolo (an Italian bank foundation), in 2021-22, they developed the feasibility studies for setting a REC with the technical support of the Politecnico di Torino. Rather than using a subdivision by primary substation, these preliminary activities were developed by grouping the ATS municipalities in seven clusters, which, as observed by interviewees, makes the REC's activation even less viable.

It is worth mentioning that the aforementioned seven clusters developed the contents of the ATS Pinerolese's joint Sustainable Energy and Climate Action Plan (SECAP), which is aimed at addressing climate change mitigation and adaptation collectively. However, due to legal constraints, each municipality was required to approve its own SECAP separately. Among other actions, the joint SECAP includes the organisation of joint energy management, and the activation of RECs is one of the main pillars for increasing local renewable energy production. Nevertheless, the SECAP is not directly connected to the respective municipal master plan, as well as the land use assignments are inconsistent with the actions proposed by the SECAP. Consequently, the municipalities of the ATS Pinerolese have not yet integrated spatial planning and energy planning. Each municipality is implementing these plans in isolation.

Due to the impasse in activating the Pinerolese REC, the municipality of Cantalupa decided to create its own REC by including the neighbouring municipalities of Roletto and Frossasco, grouped under the same primary substation. Among the REC's founders are some local SMEs, the parish, and a hotel. The municipalities are not included for legal reasons. Specifically, the Cantalupa-led REC is a non-recognized association, a model acknowledged by

[5] Autorità di Regolazione per Energia Reti e Ambiente
[6] Gestore dei servizi energetici
[7] Ricerca sul Sistema Energetico
[8] Ministero dello Sviluppo Economico
[9] ATS, Associazione Temporanea di Scopo https://www.atspinerolese.it/

the Italian legislation that offers no guarantees to the municipalities. As the interviewees mentioned, municipalities tend to prefer legal forms such as cooperatives or consortia, as these offer greater managerial autonomy than associations and reduce the risk of direct oversight by the Court of Auditors. In these structures, the municipality can participate as a member and delegate operational management to third parties, thereby limiting municipal administrative and financial exposure. The decision to opt out of the legal structure of an association for RECs is frequently motivated by the objective of minimising administrative responsibility and the risk of rigorous oversight by the Court of Auditors. This tendency favours legal solutions that offer enhanced greater flexibility and reduced personal risks for municipal administrators.

Other municipalities located in the Pinerolese area are implementing different REC models, and they are about to establish their RECs under the legal configuration of a 'participatory foundation', for instance, the municipality of Villafranca. These local authorities opted for being supported by an Energy Service Company (ESCO) which directly invests in the photovoltaic (PV) installations on municipal roofs and pays the municipality for the surface rights (i.e. 10 euros per kW installed). The ESCO is responsible for the REC's long-term management (approximately 20 years) and will sell the energy to the citizens. This integrated model enables municipalities to alleviate the financial obligations associated with establishing a REC, while concurrently diminishing the benefits, particularly the social ones.

In the same area, out of the ATS Pinerolese, another interesting REC configuration was settled in the municipality of Sangano, in December 2023. The REC initiative was led by private users (mainly SMEs) and called Sangano Common Energy (*Sangano Energia Comune*), It operates within the regional legal framework of the community cooperative (Regional Law 28 May 2021, n. 13)[10]. This social innovation model is addressed to citizen participation mainly in small centres, in the mountain, marginal, and inner areas, with difficult access and connection to infrastructure and service networks. For these areas, where even essential services are at risk, citizens can play an effective role in providing answers to common needs, creating job opportunities for young people and exploiting local development potential. This model was selected because it is feasible and allows the participation of the municipality at a later stage.

The municipality of Sangano played a crucial role in the initial phase of the REC's activation by organizing several meetings with citizens, for example, a REC festival in June 2023. It consisted of three full days of debates and discussions (by covering technical, legal, and social issues), which involved experts from academia, industry, and consultancy experts in the field of energy. Furthermore, one of the interviewees recognised the key role of the Compagnia di San Paolo Foundation in supporting the municipality of Sangano through the

[10] https://www.regione.piemonte.it/web/temi/istruzione-formazione-lavoro/lavoro/sostegno-allimprenditorialita-cooperazione/cooperative-comunita

"Sinergie" fund, which was used for preliminary studies and mapping stakeholders, as well as providing institutional support.

Local private players in Sangano have taken a proactive attitude, competing with national and local ESCOs, which have recently demonstrated a keen interest in supporting the activation of RECs by proposing Energy Performance Contracts (EPCs), which enable users to avoid initial investment. In contrast, the municipality has decided to fulfil its role as aggregator by networking and planning to join the REC at a later stage, transferring existing municipal PV installations to the REC in the process. This private, bottom-up initiative has simplified the process of setting up a REC which is already operational. The current Italian REC framework enables public authorities to participate in a REC; however, until now, local public action has been confined to the promotion of the REC's principles and the support of participatory activities to facilitate their bottom-up initiatives. According to the Vice Major of Sangano, the municipality's participatory and networking approach, which prioritised REC activation in the political mandate, has enabled the activation of further municipal programmes and projects in collaboration with surrounding municipalities. For example, the municipality participated in drafting the Urban Area Strategy (*SUA, Strategia Urbana d'Area*), which includes energy-related topics.

Moreover, the cooperative community model of Sangano's REC is being evaluated by the ATS Pinerolese, alongside other models. The involved municipalities are torn between embracing the integrated ESCO-led initiative, which has fewer administrative burdens but fewer benefits, and choosing Sangano's bottom-up solution, which has more benefits but more administrative burdens.

Among the most common issues which limit the RECs' activation, the unclear national and regional legislation is mentioned by the municipal representatives interviewed, as well as the existence of many institutional actors, including the Ministry of Environmental and Energy Security (*Ministero dell'Ambiente e della Sicurezza Energetica*), GSE, ARERA, and the regional government, which overlap in the definition of clear rules and responsibilities. Furthermore, municipal policymakers are afraid of the control of the Court of Auditors, which can restrict the participation of public entities in RECs. Economic constraints are also among the current limitations. The administrative management of RECs is very expensive regardless of their legal status, and the national incentives do not directly cover these costs. The GSE, managing the national register of RECs, lasts three months to fulfil this task. In the meantime, future REC members need to apply for the NRRP funding, which covers 40% of costs in municipalities with fewer than 5,000 inhabitants. According to the interviewees, this mechanism is a vicious cycle, because the members of a REC cannot apply for national incentives without already having installed PV panels, but the aspiring prosumers cannot install PV panels without the GSE national registration.

Almost all of the interviewees acknowledged that a factor somehow influencing also the RECs' activation is the regional financial support from the European Regional Development Fund (ERDF) dedicated to the municipal energy transition. Although no specific regional funds on the RECs activation have been allocated, the ERDF fund has mostly been addressed to public buildings' energy retrofitting. These funds have enabled the most advanced municipalities for long-term planning of their energy transition, including RECs' activation. On the contrary, legal, technical, and institutional support has primarily been provided by such private funding institutions as the Compagnia di San Paolo Foundation.

Moreover, all of the analysed local case studies from the Piedmont Region reveal a discrepancy between climate and energy policies (primarily the SECAPs) and spatial planning. In fact, in the municipalities belonging to the ATS Pinerolese (including Scalenghe), municipal master plans are not connected to the approved SECAPs. In Sangano, no SECAP has yet been approved, and the path towards its definition has only recently been undertaken. According to all the interviewees, the regional government has not understood the need to foster spatial and energy planning jointly to tackle climate change challenges and to go towards a fair energy transition for all.

Autonomous Community of Andalusia, Spain

Spain is divided into Autonomous Communities (Regions), Provinces and Municipalities. At the national level, the Spanish Royal Decree-Law 23/2020 includes various measures for economic recovery, encompassing the energy sector, and amends several articles of Law 24/2013 on the Electricity Sector. This provision defines RECs as legal entities based on open and voluntary participation. They must be autonomous and effectively controlled by partners or members who are located in the surroundings of renewable energy installations owned and developed by such legal entities. Partners or members can be physical persons, SMEs or local authorities, including municipalities, whose primary purpose is to provide environmental, economic or social benefits to their partners or members, or to the local areas where they operate, rather than financial gain[11]. The Integrated National Energy and Climate Plan 2021-2030 (INECP) includes 'energy communities' among the measures envisaged to ensure the energy transition (Revuelta Pérez, 2022). The most common REC arrangement is composed of one or more collective self-consumption aggregations, which can currently be implemented within a limited radius from the installation site (Galera Rodrigo, 2023). In this solution, each REC can encompass several aggregations within the same legal entity. Regarding incentives, the Ministry for Ecological Transition and the Demographic Challenge has implemented the

[11] https://www.idae.es/ayudas-y-financiacion/comunidades-energeticas

Incentive Programme for Individual Pilot Projects of Energy Communities (*CE IMPLEMENTA*)[12], under the framework of the NRRP, funded by the NextGenerationEU[13].

The latter identifies RECs as key players in the energy transition, providing these entities with the financial capacity necessary to develop the construction and commissioning activities for facilities promoting social participation in the energy sector. Aid will be granted in the form of a non-refundable subsidy, which beneficiaries will receive once the project execution and investment have been verified. *CE IMPLEMENTA* is managed by the Spanish Institute for Energy Diversification and Saving (*Instituto para la Diversificación y Ahorro de la Energía, IDAE*), which also manages *CE OFICINAS*. This programme provides funding for Community Transformation Offices to promote and activate RECs. Moreover, Spain has a National Strategy Against Energy Poverty 2019-2024[14]. Between 3.5 and 8.1 million people are affected by energy poverty, according to different calculation methods.

Moving from the national to the regional levels, still referring to the problem of energy poverty, it must be observed that the "social bonus", i.e. the public aid addressed to families to pay energy bills, is an insufficient mechanism in some regions. Andalusia is one of these regions. The Andalusian regional government has approved the first Comprehensive Strategic Plan for the Elderly in Andalusia 2020-2023,[15] financed by ERDF funds and the European Interreg Europe program. This plan requires a prior diagnosis of energy poverty in the elderly group, carried out by the Andalusian Energy Agency[16], which prioritises the development and promotion of RECs, as stated in the Andalusian Energy Strategy 2030 approved by the Governing Council on 7 June 2022. The Agency provides technical advice to Andalusian energy communities and local entities that are trying to set up REC projects. Within the Andalusian Self-consumption Board, the Agency participates in the Local Energy Communities Working Group, which focuses on RECs' promotion and collective self-consumption.

The Region of Andalusia is a partner in the *Powerty* Interreg Europe project,[17] which is aimed at increasing the use of renewable energies in vulnerable social groups. Throughout its participation in the *Powerty* project, the Region of Andalusia is refining an existing policy instrument[18] that could be used to promote the RECs' establishment and development in vulnerable contexts where families may suffer from energy poverty.

Moving from the regional to the local level, this is the case of the Energy and Educational *Torreblanca* Community,[19] which was originally established to combat energy poverty

[12] https://sede.idae.gob.es/lang/modulo/?refbol=tramites-servicios&refsec=comunidades-energeticas&idarticulo=146972
[13] https://www.idae.es/ayudas-y-financiacion/comunidades-energeticas/programa-de-incentivos-proyectos-piloto-singulares-de
[14] https://www.miteco.gob.es/es/ministerio/planes-estrategias/estrategia-pobreza-energetica.html
[15] https://www.juntadeandalucia.es/organismos/transparencia/planificacion-evaluacion-estadistica/planes/detalle/208782.html
[16] https://www.agenciaandaluzadelaenergia.es/es
[17] https://projects2014-2020.interregeurope.eu/powerty/
[18] ERDF 2014-2020. Objective T.O.4. Priority Line 4.c.: Support the energy efficiency, smart energy management and renewable energy use in public infrastructure, including in public buildings, and the housing sector.
[19] http://www.torreblancailumina.com/

(Bouzarovski, 2014; Parreño-Rodriguez et al, 2023)[20]. Torreblanca Illumina is located in the Barrio Torreblanca in the municipal area of Seville and is supported by the Region of Andalusia within the aforementioned *Powerty* project. These European funds were channelled through a collaboration agreement signed at the beginning of 2022 between the Agency and the *Torreblanca Ilumina* Association, which was set up to create an energy and learning community in the Torreblanca neighbourhood of Seville. This agreement made it possible to finance a study of the various key aspects necessary to materialise and execute this pilot action. This included the legal assistance required to overcome all the legal challenges associated with the implementation of this type of collective self-consumption initiative.

In Barrio Torreblanca, a vulnerable[21] neighbourhood with more than 18.000 inhabitants, the roofs of two municipal infant and primary schools were covered with PV panels by the municipality. Starting from scratch, the Organising Committee of Torreblanca Illumina has been formed through an incremental process involving the educational communities of the two schools, the Civic Centre Juan Antonio González Caraballo, the Centre of Community Social Services, the Local Group of Som Energía Energy Cooperative, the research group ADICI[22] of the University of Seville, and the Ecosocial Workshop.

In February 2021, the non-profit association Torreblanca Illumina was created (see Agencia Andaluza de la Energía, 2023). It encompasses the energy self-consumption groups, with a total capacity of 15 kW, one for each school. Each group is composed of one school and a group of local families in partial energy poverty (11-13 families). This REC also manages – but does not own – a third PV installation, equivalent to 50 kW, owned by one of its members: the Seville Autism Association[23]. The initiative received financial support from the municipality, the Andalusian Energy Agency and the *Som Energia* Energy Cooperative. As interviewees pointed out, the electricity distributor obstructed the REC's connection to the grid due to unclear regulations, decelerating the project implementation. The role of the municipality has also proven to be critical because the Municipality of Seville was not prepared to sign an agreement for such an initiative, and the granting of public surfaces over the school roof took a long time.

Besides, Torreblanca is currently included in the Neighbourhood Plan and was designated a Disadvantaged Area by the Andalusian Regional Government. In Andalusia, the participation of civil society organisations in REC development is detectable not only in the Torreblanca experience. In fact, the Region finances the School of Social Economy[24] in Seville, which offers a traineeship programme for REC creation based on the social economy

[20] The factors that affect energy poverty levels are household income, price of energy and degree of energy efficiency achieved in households among others. No just one indicator measures energy poverty, which not only impacts the functionality of homes but also it affects several other aspects, including health and social stigma. Solidarity and participation are levers that must be integrated, along with initiatives to improve the quality of life for urban dwellers living in energy poverty (Parreño-Rodriguez et al, 2023).
[21] The National Statistics Institute's Urban Indicators 2021 rank it as the fourth most disadvantaged area in the country, with one of the lowest average annual net incomes per inhabitant in Spain.
[22] Aula digital de la ciudad
[23] https://www.autismosevilla.org/
[24] https://escueladeeconomiasocial.es/

principles. Despite such a remarkable institution, there is still a lack of an adequate regional ecosystem of SMEs, cooperatives and third-sector entities committed to activating and developing RECs, is missing. Similarly, entrepreneurial capacity in the renewable energy sector is not widespread.

Andalusia presents further REC experiences spread across the regional territory. Among the others, in the Province of Granada, composed of the Granada metropolitan area (35 municipalities), and a rural area (174 municipalities, of which 135 have fewer than 5,000 inhabitants and only eight have more than 20,000), at least seven RECs have been activated by 2024. In 2019, the Granada Provincial Council launched a Climate Change Adaptation Plan in 2019 to better assess impacts and possible solutions, as well as to implement the 'Local Programme for the Just Energy Transition' that foresees a Community Transformation Office dedicated to the promotion of RECs in 2024-25. These offices are designed to provide information, advice and support to individuals, SMEs and local authorities in setting up and managing energy communities.

The Granada Energy Agency provides municipalities with free technical support for energy transition and SECAP preparation and has participated in the EU-funded Shared Green Deal project[25]. While half of the municipalities have approved a SECAP primarily to secure EU funding, they have also adopted the Climate Change Municipal Plan, which is mandatory under regional law. Consequently, the Government of Andalusia finances the preparation of the Municipal Climate Change Plan (Plan Municipal contra el Cambio Climático, PMCC) for all the municipalities with fewer than 50,000 inhabitants.

In Granada province, the *Río Monachil* Energy Community[26] was created in 2020, based on a cooperation agreement with the Municipality of Monachil. This agreement permits the use of the Miraflores Sporting Centre roof to install a 10kW plant. This installation provides energy for 15 residential buildings, including the municipal building in which it is located. Around 5% of the energy produced will be made available to families in energy poverty at a nominal price. The activation procedures are being implemented, and the REC currently includes 56 families and two SMEs. Finally, based on *Project POCITYF*[27] regarding the development of REC in protected heritage areas, in the historical Granada the *Barrio de l'Alambra Energy Community* was established in May 2023, in order to settle an installation outside the protected area and to connect it to families located inside the area.

To sum up, the Spanish national government recognises the role of RECs by means of the INECP, in line with the NextGenerationEU fund, and provides incentives for them through the *CE IMPLEMENTA* programme. Furthermore, a national strategy has been developed to combat energy poverty, recognising the relevance of the problem. In this regard, the

[25] https://sharedgreendeal.eu/hubs/granada-community-visions-community-energy
[26] https://cesocial.es/
https://cermonachil.org/
[27] https://pocityf.eu/

Andalusian regional level engages in dialogue with the national level and has developed a strategy for the elderly, who are among those most often affected by energy poverty. This strategy is implemented by the Andalusian Energy Agency, which operates within the regional energy strategy (Andalusian Energy Strategy 2030). The regional level, which concentrates its efforts on the agency and dialogues with the local level through its active participation in the *Powerty* Interreg Europe project. The latter contributed to the start-up process of Torreblanca Illumina; a REC created with the intention of reducing energy poverty in an extremely vulnerable neighbourhood. In fact, the REC's establishment is supported by the agency, and the municipality merely grants use of the areas above the schools. Furthermore, the recognition of Torreblanca as a disadvantaged area is a regional responsibility.

The Region should coordinate initiatives within its regional territory, as well as ensure cooperation between the regional and the national levels, even in collaboration with the other Spanish Regions.

Regional law 8/2018[28], regarding measures against climate change and for the transition to a new energy model in Andalusia, obliges municipalities to approve climate change plans to replace fossil fuels for municipal consumption with locally produced renewable energies and building energy retrofitting, art. 15. Although the plan does not mention energy communities, it allows for the adoption of regulatory measures that favour energy self-consumption of renewable energy and the participation of local actors in the production and distribution of renewable energy, art. 34 (Revuelta Pérez, 2022).

Therefore, in Andalusia, municipalities have to comply with the regional government's mandate to prepare municipal climate change plans, as well as with the SECAP approval, which is one of the legal conditions for receiving European grants. This means that each municipality has two parallel and distinguished tools for the same topics: one to comply with the national planning framework, and another to comply with the European policies. This creates an unjustified and misleading duplication. However, the Andalusian regional government's planning instrument takes precedence over the SECAP in technical terms, despite European funds being collected within the SECAP framework. This creates a discrepancy between regional regulation and project implementation.

Canton of Geneva, Switzerland

Switzerland is a Confederation divided into Cantons and Communes. The Federal Energy Strategy 2050[29], endorsed in a referendum in 2018, serves as the primary roadmap for the national energy transition, encompassing the phasing-out of nuclear power, the expansion of RES and RECs, and improvements in building efficiency.

[28] https://www.boe.es/eli/es-an/l/2018/10/08/8
[29] https://www.bfe.admin.ch/bfe/en/home/policy/energy-strategy-2050.html/

At the federal level, the Swiss Federal Energy Law (2016)[30] allows and promotes the self-consumption of locally produced electricity, particularly from solar energy, enabling the sale of surplus energy to the national grid (art. 16), and the establishment of RECs, whether at the level of a single building, plot, or neighbourhood (art. 17). Once they have been grouped, end consumers have a single metering point with the grid operator. Therefore, they must be treated as a single end-user (art. 18) with a single billing connection to the main grid, in order to sell the locally produced surplus energy or purchase electricity not supplied by the local energy installation. A prerequisite for REC is that the electricity generated on-site can be consumed directly via a dedicated microgrid, bypassing without using the distribution grid. In other words, solar PV production can be shared among multi-family residences or clusters of neighbouring buildings. Such RECs can be managed either by the owners of the surfaces or by third-party entities such as energy suppliers. The microgrid is connected to the main grid to sell the surplus of solar energy production or, conversely, to buy electricity from the grid when the solar production is insufficient.

Until recently, buildings connected to a solar microgrid had to be adjacent to each other. However, this obstacle was overcome following the referendum on 9 June 2024, which resulted in the passing of the new "Federal Act on the Security of Electricity Supply from Renewable Energy Sources"[31]. This new law (art. 17) introduces the concept of shared solar energy production between distant and non-contiguous buildings through the establishment of Local Electricity Communities. End consumers, renewable electricity producers, and storage operators can form groups that independently manage their electricity supply throughout the distribution network, within a single municipality.

Energy Cooperatives can also manage remote solar communities where individuals self-organise to finance local projects, such as solar installations, in the form of capital shares. A notable example in the region of Nyon (Canton de Vaud, 2023) is Optima Solar La Côte[32]. Citizens, public authorities, companies, associations, and other organisations can purchase a share in the cooperative's capital (with an initial nominal value of 1,000 Swiss francs). Each person thus becomes a co-producer of solar-generated electricity. All the shares are used to finance the solar power plants. The cooperative does not take out bank loans. From the third year after installation, the annual remuneration of each share is determined based on the previous year's financial results (up to a maximum of 2%). Any additional profits are reinvested in new installations. The value of the shares is guaranteed for 25 years. Each share can be transferred, resold or redeemed. The cooperative's activities promote the local production of renewable, ecological and traceable electricity. To date, 20 solar communities

[30] Loi sur l'énergie (LEne) du 30 septembre 2016 https://www.fedlex.admin.ch/eli/cc/2017/762/fr
Ordonnance sur l'énergie (OEne) du 1er novembre 2017 https://www.fedlex.admin.ch/eli/cc/2017/763/fr
[31] https://www.fedlex.admin.ch/eli/fga/2023/2301/fr
[32] https://optimasolar-lacote.ch/

utilising this model have been initiated in Switzerland, often based on solar installations on school roofs.

At the regional level, each Canton maintains its own energy legislation, which is expected to align with federal guidelines and contribute to the implementation of the federal Energy Strategy 2050. The Energy Act of Geneva is one of the most ambitious in Switzerland. Based on the Energy Master Plan 2020-2030, it is implemented through the Cantonal Energy Act and ordinances. It promotes, among other actions, a significant increase in building renovations, the development of district heating and cooling networks based on Lake Geneva and geothermal energy, and the recovery of heat from wastewater treatment plants. It also aims to massively increase solar energy production, from 60 MW in 2020 to over 300 MW by 2030 (120 MW by 2024). Accordingly, the Energy Act requires the installation of PV solar panels in all new and renovated buildings, with a minimum capacity of 10 W/m² of floor area. It also explicitly prohibits the use of fossil fuels in new buildings and boiler replacements, except in district heating networks that may contain a partial fossil fuel component.

At the local level, municipalities play a pivotal role in implementing federal and cantonal regulations. Several cities (482 by May 2025) have been awarded the "*Cité de l'énergie*" label (Energy European Award). This is the case of many small- and medium-sized municipalities. Satigny (3,300 inhabitants) located in the Canton of Geneva, is one such municipality. It was first certified as a "*Cité de l'énergie*" in 2011. Satigny is a mainly rural municipality comprising a village centre and three industrial sites, including the Bois-de-Bay Industrial Zone (ZIBAY)[33], which will be presented afterwards. In Geneva's communes, a territorial energy policy is implemented through communal energy master plans. Satigny's municipal energy master plan (Desthieux et al, 2018), drawn up in 2018, aims to define the levers of action and strategies to reduce the territory's energy consumption and induced GHGs; increase the share of local RES in the energy supply; identify opportunities for developing energy infrastructure and facilitate coordination between the various players in the energy sector. The valorisation of the potential of such industrial sites as ZIBAY is therefore strategic for the municipal energy policy.

The ZIBAY is one of the industrial areas in the canton of Geneva, located in the municipality of Satigny. ZIBAY covers an area of 79 ha and brings together up to 200 companies (approximately 1,800 jobs) mainly in the construction, automotive mechanics, recycling, and logistics sectors. In ZIBAY, the FTI grants building rights to companies wishing to set up in the area. The FTI is a public company owned by the Canton of Geneva and is responsible for developing the industrial estate and promoting business development in the Canton of Geneva.

[33] This case study was presented in Task 63 - Solar Neighbourhood Planning (International Energy Agency) among other case studies worldwide (https://task63.iea-shc.org/case-studies), and its content has been updated for the present paper.

As a public company owned by the Canton of Geneva, FTI is committed to supporting the energy transition of industries that have building rights on their land. A solar microgrid project was implemented by a consortium made up of FTI and SIG. In addition, SIG has a service contract for the technical installation, maintenance and operation of the microgrid. A consortium has been established, associating the six industrial partners, has been established to consolidate the self-consumption of solar energy under the Federal Energy Act. Specific regulations have been drawn up to govern the contractual aspects between the partners. The REC is represented by the FTI/SIG consortium. In accordance with the Energy Act, electricity price for all companies connected to the microgrid is more favourable than the market price, with tariffs adapted to the type of consumer.

In 2014, FTI launched the Bois-de-Bay EcoPark initiative to identify and promote synergies between industrial companies and the sustainable development of their economic activities, with a particular focus on energy efficiency and low carbon impact. Consultations with local companies and partners confirmed the need for local energy planning. This culminated in the 2017 project for a major solar installation (1.38 MWp) on one of the new buildings, implemented by a consortium associating FTI and SIG. The solar installation came into service in August 2021, intending to create a micro-grid by 2026, pooling the solar energy produced by the new buildings on neighbouring plots, to form thus a REC.

These buildings are essentially warehouses with limited energy demand, except for the green waste methanisation plant (biogas), which requires a very large amount of electricity (30-40% of REC's total demand) for the process[34]. Ultimately, the project will have a total solar capacity of 3 MWp (1.6 MWp by 2024) and a self-consumption rate of 60% through the microgrid (12% in 2024).

This considerable self-consumption rate will be achieved by installing a storage plant for the truck charging stations, or by changing the orientation of the solar panel domes (east-west or south-north).

This development was led by FTI, which owns the industrial land and invested in a project with no minimum profitability requirement, with financial risks that a private investor could not take on. Initially, the investment decision was based on a single guaranteed customer: the hall in which the main solar installation is located has a maximum self-consumption potential of only 10%. However, FTI, as the landowner, can require other companies to connect to the microgrid as part of the land rights, which is an important legal lever. Ultimately, the risk-taking paid off: other large consumers joined the project, including the biogas plant and the road company with its fleet of electric trucks. The result is a highly satisfactory profit for the investors and an attractive electricity price for all. This pilot case demonstrates the importance

[34] The buildings are spread over six plots belonging to different owners, encompassing (a) a road construction company, including electric trucks with solar recharging potential, and planning to optimize recharging in phase with the production of panels; (b) a storage hall hosting the main solar installation (1,38 MWp); (c) logistics and transport centre with electric trucks; (d) storage centre and workshop; (e) a private plot (not belonging to the FTI), whose owner has the economic interest to connect to the network; (f) cantonal green waste methanisation centre, called Pôle Bio with another large solar installation (800 kWp).

of solid public partnerships between FTI, SIG and companies, and highlights the potential for developing solar projects on industrial estates and large rooftops, and for grouping consumers around microgrids. On the other hand, it proves the difficult implementation of such a microgrid for three factors: (a) the ability to attract companies, particularly those with high consumption, which often benefit from attractive electricity prices; (b) ensuring a substantial level of self-consumption and, therefore, profitability, given that at the project's inception, the type and profile of future consumers were unknown, so the project was initiated without any guarantee of finding customers. Many companies, such as warehouses, have low electricity consumption; and (c) synchronising the solar installations and developing the microgrid alongside companies' construction projects.

FTI and SIG were pivotal actors in facilitating the public-private partnership in the creation of the REC. The FTI is a public foundation that locally represents the interests of the Canton of Geneva and the municipalities in the use of industrial sites. As the landowner of the industrial sites, it can require companies to participate in and connect to the solar microgrid through land use contracts and rights. Consequently, both the Canton of Geneva and the municipalities involved in industrial development are members of the Foundation Council, including the municipality of Satigny. In addition, SIG is the canton's industrial arm for developing energy projects. This company is jointly owned by the Canton of Geneva and its municipalities.

This means that cantonal and municipal interests are represented in the REC consortium by FTI and SIG. This has contributed to the development of an exemplary project not only profit-oriented.

In addition, territorial development legally requires the elaboration of a formal energy strategy defining key drivers for energy transition and low-carbon and concrete actions. Consequently, the energy master plan of ZIBAY has proven to be a central instrument in the development of the solar microgrid. All stakeholders were involved in the formulation of this vision: Canton of Geneva (through its Energy department), FTI, SIG and the Municipality of Satigny.

Establishing the ZIBAY solar microgrid community demonstrates the interaction between local, regional and national levels.

At the national level, the Federal Energy Act encourages self-consumers to form groups, bringing together self-producers and self-consumers from one or more neighbouring buildings to act as a single customer for the grid operator. The development of microgrids is allowed on adjacent land plots, even if they are separated by roads. The main financial lever is ensured by the Swiss government, which provides subsidies that generally cover 20% to 30% of the investment and have proved to be essential. In the case of ZIBAY, the project would not have been possible without this subsidy. The Federal Energy Act also obliges the grid operator

to purchase excess solar power at a minimum price (market price + guarantee of origin), which helps to make REC projects profitable.

The regional level plays an important role in the establishment of the ZIBAY solar microgrid community in three respects. Firstly, the Canton controls the application of the law, in particular, regarding the PV solar installations, which are mandatory for all new constructions. In the case study, although the solar installations are shared between the six industrial estates, no exemption was granted by the Canton to the individual industrial owners who had to meet the 10 W/m² requirement individually. Secondly, it issues building permits, provided that all legal requirements are met. Thirdly, in the specific context of this case study, the Canton is represented in the consortium through FTI (a cantonal foundation) and SIG, which is jointly owned by the canton (50%) and the municipalities (50%).

At the local level, the highly centralised Canton of Geneva leaves local municipalities with little room to influence the energy transition. They develop energy master plans that align with federal and cantonal energy policies. Some of them provide additional incentives for solar energy. They also play a key role in raising awareness among private actors on energy transition and facilitating public-private partnerships in energy projects. In the case of ZIBAY, for example, the municipality of Satigny has actively promoted and facilitated the energy transition strategy of this industrial area, which led to the creation of the solar microgrid project.

In conclusion, the Swiss Confederation clearly defines the responsibilities between the national, regional (cantonal) and local levels, providing a consistent regulatory framework for the implementation of RECs at the local level and proving the importance of public-private partnerships in facilitating such processes. The fact that this project is being carried out by public companies (FTI and SIG), which represent both regional (cantonal) and local (communal) interests, makes it an exemplary and successful project.

The ZIBAY REC project was made possible through a combination of bottom-up and top-down processes. On the one hand, there was the initiative of FTI and SIG in partnership with the industrial stakeholders. On the other hand, this project was aligned with the Geneva Energy Master Plan and was locally realised through the ZIBAY Energy Transition Master Plan. This project received support from both the Canton and the Municipality of Satigny.

Findings

The multilevel framework related to RECs in three European Regions

Based on a cross-cutting analysis of the three European regions presented in the previous section, it was possible to draw up a multilevel framework of authorities, regulations and tools related to the establishment and management of RECs in each region, as shown in *Table 1*.

Level	Piedmont, Italy	Andalusia, Spain	Geneve, Switzerland
National	Authorities • *Ministry for Environment and Energy Security* • *Regulatory Authority for Energy, Networks and Environment, 'ARERA'* • *Energy Services Manager, 'GSE'* Regulations and tools • *Integrated National Energy and Climate Plan (INECP), 2020* • *National Recovery and Resilience Plan (NRRP)* • *LD 199/2021 and LD 210/2021* • *Ecological Transition Plan, 2022* • *MD 414/2024*	Authorities • *Ministry for Ecological Transition and the Demographic Challenge* • *National Institute for Energy Diversification and Saving* Regulations and tools • *Royal Decree-Law 23/2020* • *Law 24/2013 on the Electricity Sector* • *Integrated National Energy and Climate Plan 2021-2030 (INECP)* • *Incentive Programme for Singular Pilot Projects of EC (CE IMPLEMENTA)* • *National Recovery and Resilience Plan (NRRP)* • *Programme of national financial support to community transformation offices (CE OFICINAS)* • *National Strategy against Energy Poverty 2019-2024*	Authorities • *Federal Department of the Environment, Transport, Energy and Communication (DETEC)* • *Federal Office of Energy* Regulations and tools • *Federal Energy Strategy 2050* • *Swiss Federal Energy Law and Swiss Ordinance on Energy CO2 Act* • *Federal Act on the Security of Electricity Supply from Renewable Energy Sources* • *Outreach activities from Federal Office of Energy* • *Incentives from Pronovo (one-off payment for solar installations)*
Regional	**Piedmont Region** Authorities • *Regional council* • *Sustainable Energy Development Department* Regulations and tools • *Regional Energy and Environmental Plan, 'PEAR'* • *Regional Strategy for Climate Change 'SRCC'* • *ROP ERDF, TO4 - Supporting the shift towards a low-carbon economy in all sectors* • *LR 12/2018 on energy communities* • *DGR 18-8520/2019* • *Next Generation You private fund* • *LR 13/2021 on community cooperative*	**Autonomous Community of Andalusia** Authorities • *Regional Ministry of Industry, Energy and Mines* • *Andalusian Energy Agency* Regulations and tools • *Andalusian Energy Strategy Horizon 2030 (including REC programmes)* • *Comprehensive Strategic Plan for the Elderly in Andalusia 2020-2023* • *Powerty Interreg Europe project* • *ERDF 2014-2020. Objective T.O.4. Priority Line 4.c.*	**Canton of Geneva** Authorities • *Canton Council* • *Department of Youth, Environment and Safety* • *Department of the Environment* • *Directorate of Energy* Regulations and tools • *Cantonal Energy Law* • *Cantonal Land Use Master Plan* • *Climate plan* • Cantonal incentives from the *Building Program* (for energy efficiency)
Provincial / inter-municipal	**Turin Metropolitan City** Authorities • *Metropolitan City of Turin* • *Unions of municipalities* Tools • *Sustainable Energy Action Plan of the Province of Turin* • *(Metropolitan General Territorial Plan)* • *'Oil Free Zone' memorandum of understanding* • *Temporary Association of Municipalities, 'ATS'* • *Municipal SECAP*	**Granada** Authorities • *Provincial Council* • *Granada Energy Agency* Tools • *Climate Change Adaptation Plan* • *Shared Green Deal EU project* • *Local Programme for the Just Energy Transition - Community Transformation Office* • *National financial support to community transformation offices*[35]	*Neither intermediate nor regional institutional level in the Canton of Geneva*
Municipal	**Scalenghe (Turin)** Authorities • *Municipal council* • *ATS Pinerolese* REC • *Pinerolese Renewable Energy Community* Tools • *SECAP* • *(Municipal Master Plan)* **Sangano (Turin)** REC • *Sangano Common Energy Cooperative* Tools *(Municipal Master Plan)* *(SECAP under construction)* *Urban Strategy, 'SUA'*	**Seville** Authorities • *Municipal Department of Environment* REC • *Torreblanca Illumina* Tools • *SECAP* • *Climate Change Municipal Plan* • *Neighbourhood Plan – Zoning of Disadvantaged Areas* **Monachil and Granada** REC • *Río Monachil Energy Community* • *Barrio de l'Alambra Energy Community* Tools *Project POCITYF – heritage contexts*	**Satigny** *Authorities* • *Municipal council* REC • *ZIBAY* Tools • *Municipal land use master plan* • *Municipal energy and climate master plan* • *Energy master plan of ZIBAY* **Nyon (Canton of Vaud)** REC • *Optima Solaire La Côte (solar cooperative)*

Table 1 – Multilevel framework related to RECs in three European Regions, elaborated by the authors

[35] It is also present in the provinces of Cadiz, Cordoba, Almeria and in a group of small municipalities in the province of Sevilla.

The three countries analysed have national policies and regulations that focus on the relationship between energy and climate change as well as financial tools to incentivise the energy transition within the respective national development strategy. Despite the different political and administrative organisations, authorities, regulations and tools can be identified in all cases at the regional and municipal levels. In Switzerland, the provincial level is not directly represented, with the Cantonal level corresponding to both the regional and provincial levels, as will be widely illustrated later.

The interplay of local, regional and national levels in the establishment of RECs in the three case studies

As a result of the research on the three case studies, this section presents the interplay between the local, regional and national levels in the establishment of RECs in each region by highlighting the variable geometry of the common conceptual framework, in the different trajectories of REC establishment already introduced in *Figure 1*.

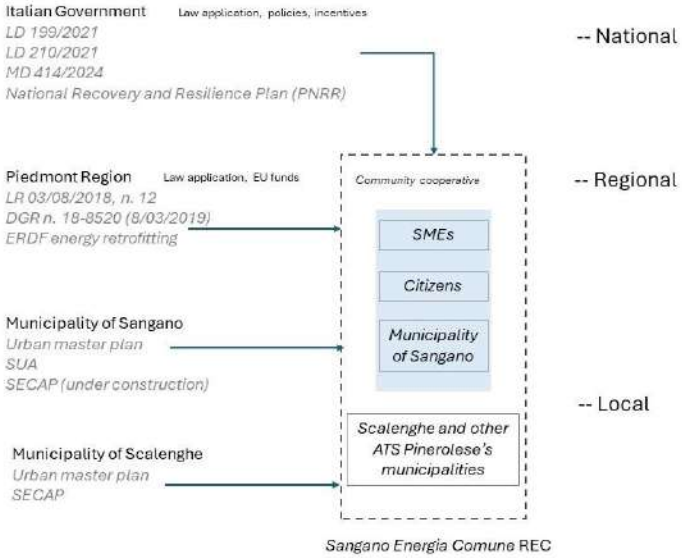

Figure 2 – Diagram of the multilevel framework in the Italian case. Elaborated by the authors

As shown in *Figure 2*, the Italian current national legal, regulatory and financial framework is complemented by the Piedmont Region's measures for the energy retrofitting of public buildings utilising the ERDF. Although the Piedmont Region has been a pioneer in setting up a regional legal framework for RECs, its role has ultimately proven to be technically and economically limited, supporting dissemination and commitment tasks. At the local level, municipalities may have a SECAP, which is often not coordinated with urban planning tools. Therefore, RECs emerge thanks to the bottom-up efforts of the local economic actors (mainly SMEs) and the civil society, as in the case of Sangano, or thanks to the institutional bottom-up efforts leading to soft intermunicipal cooperation, as exemplified by the *ATS Pinerolese*. It is worth mentioning that the cooperation between the municipalities of the Pinerolese area and their common energy transition and climate goals has been integrated into the joint SECAP (including 41 municipalities), which represents a common climate policy framework.

Conversely, the willingness of municipalities to collaborate as a REC has been disenchanted by the current legal and economic barriers, with integrated ESCO solutions proving more attractive to many municipalities. RECs are nationally incentivized, and their role can be further secured by municipalities, whose multifaceted role remains a subject of extensive debate.

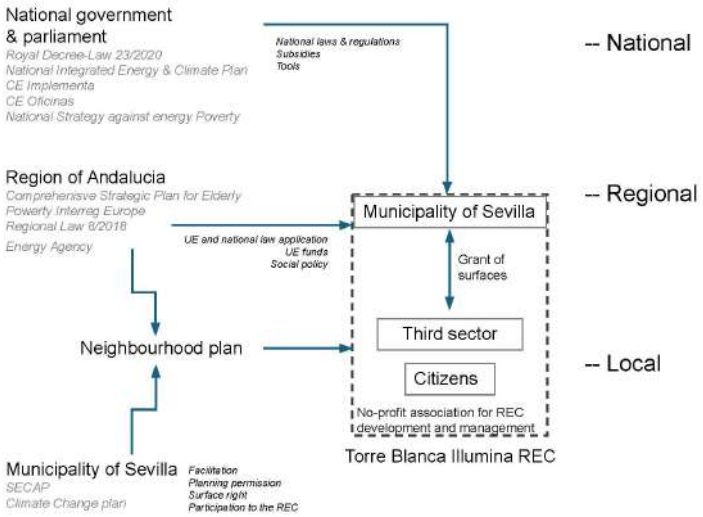

Figure 3 – Diagram of the multilevel framework in the Spanish case. Elaborated by the authors

As shown in *Figure 3*, Spain has established a legal, regulatory and financial framework for RECs, which also targets vulnerable neighbourhoods that necessitate urban regeneration and the alleviation of energy poverty. The Spanish national level is in dialogue with the regional level, which is committed to energy and climate planning, protection of the elderly and vulnerable neighbourhoods. The region of Andalusia is a partner in European projects that provide funding for the implementation of actions with a social impact. On the other hand, at the local level, municipalities such as Seville, which has adopted a SECAP and is committed to achieving climate neutrality by 2030, lack the administrative capacity to participate in a REC with private entities. However, public surfaces for solar installations can be allocated as part of social initiatives. Several RECs are being activated by civil society organizations, directly involving residents in collective self-consumption configurations. The Spanish case shows that there is considerable cooperation between the national and regional levels. Indeed, the regions play a relevant role in the management of funds and in planning decisions, while the role of municipalities is still under debate, but to date it seems to be rather weak with respect to the development of RECs.

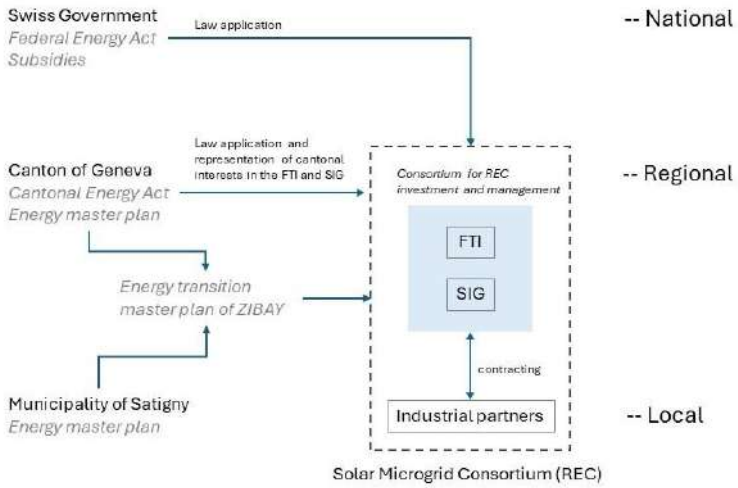

Figure 4 - Diagram of the multilevel framework in the Swiss case. Elaborated by the authors.

Based on *Figure 4*, Switzerland has a legal, regulatory and financial framework for RECs at the federal level, which is embedded in cantonal energy policy and related plans. These plans are combined with energy planning tools such as the municipal energy master plan, resulting in detailed energy master plans, as in the case of ZIBAY. Such a detailed master plan creates the conditions for the establishment of a multistakeholder consortium for REC investment and management, within a microgrid. At the local level, the REC is implemented and managed by the consortium of FTI, SIG and industrial partners, as foreseen by the decarbonisation of the industrial strategy implemented by both the canton and the municipality. The Swiss case clearly shows that effective multilevel governance of the establishment of RECs establishment and the energy transition can ensure the successful implementation of projects.

As RECs are defined and regulated at the European level and at the federal level in Switzerland, unsurprisingly, the national governments always provide comprehensive legal, financial and regulatory frameworks for their development and implementation.

The regional level proves to be more influential in countries where regions also possess a greater degree of autonomy. For example, in Spain, the Autonomous Community of Andalusia has a regional policy for energy transition, for the elderly and vulnerable neighbourhoods. In the Swiss Confederation, the cantons have cantonal laws and master plans for the energy transition, while in Italy, in regions with limited autonomy such as Piedmont, the main competence is focused on ERDF management, but not directly on energy planning.

The most diverse role in the establishment of RECs is that of the municipalities. Municipalities can play a leading role or be confined to a supporting role. Municipalities may or may not be REC members, and they may or may not provide public surfaces for solar installations. Furthermore, municipalities may or may not integrate energy transition policy in urban planning and support RECs within predefined policy frameworks such as SECAPs or Climate Neutrality 2030 initiatives.

Discussion

The multilevel framework

At the regional level, the three cases show a range of planning, legal and regulatory provisions related to energy, environment, climate change and low-carbon economy, with an active role of agencies, active departments and directorates focused on energy. This proves that energy issues typically require a regional dimension, although the energy and climate planning tools identified at the regional level, may or may not be consistent with regional spatial planning tools.

The provincial level is rather differentiated. In fact, for Italian cities such as Turin, which are regional capitals, the province coincides with the metropolitan city, which has a metropolitan Sustainable Energy Action Plan (SEAP) and a metropolitan strategic spatial plan. In Andalusia, the provincial level can play an influential role such as in the case of Granada, where the Provincial Energy Agency provides direct support to municipal initiatives, including pioneering projects such as the establishment of RECs in historic neighbourhoods. In terms of the tools at their disposal, the city of Granada has a Climate Change Adaptation Plan, and the Community Transformation Offices are working on a just energy transition. As already mentioned, the Swiss case lacks the provincial level.

At the municipal level, all cases show direct municipal involvement in energy action planning. This is evident in the definition and implementation of SECAPs in Italy and Spain, and in communal energy master plans in Switzerland. Municipalities can back RECs by providing support in their definition and start-up, directly with the participation in a REC, or placing public surfaces at their disposal for installations dedicated to collective self-consumption.

As *Table 1* clearly demonstrates, higher levels typically support the creation of RECs by allocating financial resources and establishing overall regulations, whereas intermediate levels are expected to play a significant role in aligning climate and energy policy at the territorial level. As direct contributors to climate and energy policy, municipalities play an active role in promoting, establishing and setting up RECs, including legal establishment, localisation, and building installations.

The activation of RECs

Although RECs can be activated without the participation of public local authorities, this paper presents evidence to suggest that the role of public entities is substantial for at least two reasons: (i) REC activation is facilitated by clear, consistent and complete regulations, as well as effective planning and financial tools, (ii) as local development initiatives, RECs unavoidably interact with municipal policies and urban planning. Arguably, a bidirectional relationship exists between RECs and the local public policy sector resulting in a convergence between institutional provisions and bottom-up initiatives. From this perspective, the public

role, and eventually, the public leadership in the establishment process of RECs, is expressed in a number of ways: (i) in terms of inter-municipal cooperation dedicated to creating such a territorial REC as with the ATS Pinerolese, (ii) the late integration of the municipal authority in a REC created by local economic actors, as with Sangano, and (iii) the leading of the regional and provincial energy agencies in Sevilla Torreblanca and Granada, respectively, particularly with regard to technical issues, as opposed to municipalities being confined to providing public surfaces for PV installations.

The Italian case demonstrates the pivotal role of national financial support for small municipalities in energy initiatives. The small size of many Italian municipalities is important for several reasons. (i) Firstly, a single municipal government may lack the financial, technical and human resources necessary for energy and climate initiatives beyond traditional land-use and environmental municipal management. (ii) Secondly, small size often makes it impossible to achieve economies of scale. (iii) Soft interinstitutional arrangements, such as territorial memoranda of understanding or temporary associations of public authorities, are essential to ensure territorial cooperation and synergies. Such cooperation enables more compelling results to be achieved, not least for technical reasons such as the inclusion of more than one municipality in the same electricity substation. In both the *ATS Pinerolese* and *Sangano Energia Comune* case studies, the municipalities have played a crucial role in stakeholder engagement and dissemination by raising awareness of the benefits of establishing a REC. However, current legal barriers and the uncertain Italian legal framework have limited the possibility of a public-led REC initiative in both cases. In Sangano, this ended in a community cooperative led by private SMEs, and the *ATS Pinerolese* is an association with no current or potential REC activities.

Regardless of the size of the municipality, the Italian case also highlights a mismatch between climate/energy and spatial planning policies. In other words, urban plans do not consistently or widely integrate energy and climate actions. This is partly because the boundaries of the implementation of different sectoral policies do not coincide. This lack of integration undermines the achievement of climate goals, which would require the implementation of more comprehensive territorial development projects.

Although less lucrative in terms of social benefits, one viable option is the participation foundation chosen by the Municipality of Villafranca, eventually supported by an ESCO. Another option is the community cooperative, as in the case of Sangano. This option is closer to REC's common goals and social purposes, allows for the subsequent participation of the municipality, and does not require municipal leadership. However, Piedmont Region has decided not to shoulder the cost of technical and legal feasibility studies, unlike other Italian Regions[36]. Instead, this expense has been entrusted to private sponsors such as the Compagnia

[36] Emilia Romagna and Veneto, for example, acknowledged the need and issued a call for funding to financially support the public and/or private RECs' activation process within the regional territories.

di San Paolo. This is happening despite Piedmont being a pioneer in regional support for REC activation, as it was the first regional jurisdiction to pass legislation on this subject. However, none of the modalities introduced by the regional law have been implemented. Regardless of the regional guidelines, which remain on paper, all RECs under construction merely adhere only to the national rules and guidelines.

In terms of addressing the social issue of energy poverty, Spain is the only country with a national strategy, namely the National Strategy Against Energy Poverty 2019-2024. Italy established the National Observatory for Energy Poverty in 2022; however, the Observatory plays no active role in the promotion and activation of RECs. Switzerland does not have a relevant energy poverty policy, but it is possible that energy vulnerability is underestimated and more widespread than previously thought (Hearn et al, 2022).

Consistent with the national strategy against energy poverty, the Andalusian region plays a fundamental role in social policies targeting the elderly, supported by European funds. Unsurprisingly, *Torreblanca Ilumina* was established to reduce energy poverty. At the national level, the NIECP acknowledges the role of RECs and, in line with the NextGenerationEU fund, ensures national incentives (*CE IMPLEMENTA*) and financial aid for Community Transformation Offices to promote and activate RECs (*CE OFICINAS*). These policies are implemented by the Andalusian Energy Agency within the Andalusian Energy Strategy 2030. Regional participation occurs through the agency, which engages with local stakeholders via the *Powerty Interreg Europe*, a key driver in the activation of the Torreblanca Illumina. The designation of the Torreblanca neighbourhood as a vulnerable area is a regional responsibility.

Notably, in Torreblanca, the electricity distributor prevented solar installations from being connected to the grid due to an unclear regulatory framework that made the process uncertain. In Switzerland, such criticality can affect solar cooperatives. For example, Demain la Côte, located in the Canton of Vaud, developed independently from electricity distributors. This illustrates a duality of bottom-up processes from the private sector and top-down processes from institutions. The question that arises is to what extent RECs should depend on the regulatory framework, and whether this framework should evolve to include such local initiatives. In Switzerland, for example, Local Electricity Communities (LECs) have emerged and could potentially replace cooperatives. Arguably, the regulatory framework should evolve in line with the development of new initiatives.

Furthermore, the Spanish case considers collective self-consumption plants at the neighbourhood level. Installing one large plant to provide energy to adjacent consumers optimises investment and enables families and groups who cannot afford to install their own plants to benefit as consumers. Moreover, this plant could be funded through public funds or crowdfunding, enabling low-income families to be consumers at a discounted price or even for free. Indeed, in Spain, several families are vulnerable to energy poverty, which is a significant

social problem for civil society organisations that typically operate in vulnerable contexts. Consequently, these organisations play a pivotal role in promoting community-based renewable energy production and consumption, achieving the redistribution of social benefits. Notably, Seville's Torreblanca neighbourhood, which is undergoing urban regeneration, has been recognized as a disadvantaged area in local planning. This development creates the fundamental conditions for the legitimate establishment of a REC as a driver of urban regeneration and development.

In terms of policy implementation, Andalusia exemplifies the pivotal role of technical entities such as public energy agencies. In Granada, for example, the energy agency is responsible for liaising with municipalities and the region, as well as ensuring consistent information dissemination among municipalities. This is particularly relevant for smaller municipalities, which lack the internal resources to effectively implement energy and climate policies, including the preparation of SECAPs, as was observed also in the Italian case. Finally, the Andalusian experience highlights a critical issue: municipalities must comply with the regional request to prepare municipal climate change plans and SECAPs to ensure they meet the legal conditions to receive European grants. This means that each municipality has two parallel tools for the same topics: one to comply with the national planning framework and another to comply with European policy. This creates an unnecessary and misleading duplication.

By contrast, Switzerland demonstrates that the structured integration of urban and energy/climate actions can be achieved through planning tools. Specifically, municipal master plans cover energy-related issues alongside urban planning for climate change adaptation. Within the Swiss multilevel integrated framework, it is the municipalities that drive the energy transition through small-scale solar energy production and community initiatives. The Swiss case demonstrated that energy communities can be a powerful local response to the overall challenge of energy transition. On the other hand, cooperatives are trans-local energy-sharing organisations. These cooperatives facilitate the formation of distant/virtual solar communities, where all produced energy is fed into the Distribution System Operator (DSO) grid, with any additional profits being reinvested in new installations. Citizens, public authorities, companies, associations and other organisations can participate in such projects by purchasing a share in the cooperative's capital.

The Swiss case is particularly significant due to the possibility of organising an energy community within a microgrid. This is essentially an island placed just inside one municipal area and set up within the national electricity grid. It is devoted to the functioning of a specific energy community. More generally, the current Swiss political debate highlights a critical factor: the degree of proximity among REC participants. Swiss regulation is evolving to facilitate mutualization among distant buildings.

In Geneva, SIG is responsible for the technical installation, maintenance and operation of the microgrid under a service contract. A consortium has been set up, bringing together six industrial partners to pool their self-consumption of solar energy, and specific regulations have been drawn up to handle the contractual aspects between the partners. This development was made possible by the public leadership of FTI, which owns the industrial land and invested independently of financial risk compensated by such legal constraints. As the landowner, FTI can require other companies to connect to the microgrid as part of the land rights, providing significant legal leverage. FTI and SIG have been identified as pivotal actors in facilitating the public-private partnership that led to the creation of the REC. The Canton of Geneva, as well as the municipalities involved, such as Satigny, are members of the Foundation Council. SIG is owned by the Canton of Geneva and its municipalities for the development of energy projects at the territorial level.

Conclusion and avenues for future research

This paper provides critical insights into the role of RECs as emerging policy instruments within the broader framework of the European energy transition. Drawing on comparative case studies from Piedmont (Italy), Andalusia (Spain), and Geneva (Switzerland), the analysis underscores the significance of multilevel governance and institutional design in enabling or constraining the development of RECs.

RECs are not merely technical solutions for local energy generation, i.e. they represent complex, multi-actor governance mechanisms that embody the principles of decentralization, participatory democracy, and social innovation. As policy instruments, RECs function through a combination of agreement-based governance mechanisms and incentive structures, positioning them as tools that link state policy objectives with grassroots initiatives. RECs operate at the intersection of energy policy, spatial planning, and social equity. Their design and implementation are shaped by legal, institutional, and fiscal frameworks that vary significantly across national and regional contexts. In this light, RECs can be understood as flexible instruments of public policy, whose effectiveness depends on several interlocking factors. The implementation of the energy transition requires territorial public action, with the diverse European institutional arrangements exerting a significant influence on this process. These arrangements demonstrate that greater regional autonomy is associated with a higher degree of RECs' implementation.

Regions and municipalities are progressively assuming the role of primary energy and climate policymakers, as evidenced by Poupeau & Boutaud (2021). However, an in-depth investigation of their role reveals a multifaceted array of possibilities that necessitate further comprehensive analysis in subsequent research endeavours. This is also demonstrated by Urban et al (2025), who revised 433 abstracts inquiring about the dominant perspective over RECs used by researchers. They found that a technical perspective dominates over a social and

institutional one. Further studies on the capacity of RECs in reducing energy poverty, increasing social equality and hampering energy segregation are highly recommended.

More in general, the paper builds on a comparative analysis of institutional influences from different regions, bridging governance dynamics with the practical challenges of energy transition, offering insights that are broadly applicable across governance contexts. Therefore, this study has contributed to discuss (i) to what extent RECs can be developed just as the local implementation of a national policy, given a widely varied configurations of regional and municipal power structures, i.e. authorities and policy instruments; (ii) the potential development of RECs in the absent or insufficient integration of spatial and energy planning tools, given the contribution that RECs could ensure to the achievement of sustainable development objectives; (iii) the role of different stakeholders in promoting the social benefits produced by RECs, and their fair and equal redistribution; (iv) to what extent it is acceptable to include the reduction of energy poverty among the potential social benefits achievable by the establishment of a REC; (v) the setting of proper financial investments for different scales and organisation of RECs' initiatives, with public or private leadership; and (vi) a varied policy regulating the RECs' establishment and development, given the coexistence of radically diverse agents, ranging from the industrial to the third sector over the European regional territories.

Drawing from three distinct cases in terms of governance structures, this study paves the way for future research, particularly exploring the interplay between energy transition processes and governance frameworks. Empirical evidence has demonstrated that decentralised governance arrangements have been more effective in integrating spatial planning with climate and energy strategies. This, in turn, has enabled the achievement of critical energy transition objectives through the activation of RECs, as illustrated by the Swiss case.

Municipal governments play a pivotal role in facilitating the establishment of RECs, however, their effective activation is significantly dependent on supportive national and regional funding mechanisms as well as enabling regulations. Furthermore, citizen participation is identified as a fundamental element in the successful activation of RECs, ensuring that the social dimension of the energy transition is not only acknowledged but also strengthened.

From a policy perspective, the strategic activation of RECs as a policy instrument offers a promising pathway to accelerate the overall energy transition policy while fostering community empowerment and inclusivity. To this end, policymakers should focus on creating frameworks that encourage collaboration among multiple levels of government, provide accessible funding instruments, and promote citizen engagement to maximize the potential of RECs. By aligning governance models with the principles of decentralization, inclusivity, and sustainability, RECs can serve as transformative policy instruments to address the dual

challenges of energy transition and social equity and, in so doing, the achievement of a range of environmental and social development objectives.

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Conflict of interest

None.

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