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Identifying key barriers to joining an energy community using AHP

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ABSTRACT

Energy communities (ECs) offer a promising solution for achieving sustainable and decentralized energy systems. However, the successful establishment and operation of ECs requires overcoming barriers that can hinder stakeholder participation. Existing research has primarily focused on incentives and motivations to join ECs, thus neglecting a comprehensive understanding of the key barriers affecting EC stakeholders in European Union (EU) countries. This paper aims to fill this research gap by identifying and ranking the barriers to joining ECs in the EU context with focus on Spain and Italy. To accomplish this, a framework of barriers was developed based on 20 in-depth interviews with diverse stakeholders of established ECs and a survey (n = 56). The barriers identified were categorized into four types: (a) financial, (b) regulatory and bureaucratic, (c) technical and practical, and (d) social and cultural. The analytical hierarchical process (AHP) methodology was employed to estimate and rank these barriers. The findings highlight that the most significant barrier categories are regulatory and bureaucratic, and financial. Specifically, regulatory complexity and legal limitations emerge as the top-ranked barriers among the obstacles identified to joining ECs by research participants.

1. Introduction

Climate change and threats to global energy security through military action and natural disasters are shifting the European research agenda towards understanding how to create a radically more sustainable and robust energy system. Most literature suggests that a sustainable energy future can be achieved by increasing the prevalence and productivity of local decentralized energy alternatives [1]. A key element in this strategy is reducing energy consumption through conservation and efficiency measures through community-based renewable energy projects [2]. Community groups can contribute to solutions by increasing energy efficiency, lowering electricity bills, and reducing carbon emissions. Their contributions can support the local economy through local job creation that addresses climate change, while reducing dependency on fossil fuels and centralized power generation [3]. The number of community initiatives facilitating energy sharing and promoting renewable energy in Europe is growing in response to pressure from energy costs and the climate emergency.

To achieve the energy transition, strong stakeholder engagement and participation are crucial as stakeholders are the core of energy communities (ECs) [4–8].However, local opposition to the deployment of renewable energy technologies has been high and community participation in energy projects remains low [9]. Despite growing recognition of the need for civil society participation in achieving sustainability objectives, there is a lack of understanding about how to best harness and shape extant sentiments to reach a common goal. More empirical evidence on community participation in the energy sector is needed to place citizens at the centre of the energy transition. This can be achieved by investigating the barriers to stakeholder engagement and understanding the motivation for citizens to organize opposition [10, 11].

Scholarly attention focuses on assessing the lack of ECs in a country [12] and analysing their financing [13–15]. Other literature develops measuring constructs via quantitative research, analyses theoretical concepts, barriers to entry into the energy market, or financial and legal aspects of community-based energy projects [16,17]. Another research direction focuses on the residential sector. [18] stressed the need for a greater understanding of citizen energy initiatives, including citizens' motivations to participate in them, and strategies to overcome barriers to unlock the full potential of energy communities. Citizens, however,

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are only one of the many stakeholder groups (e.g., policymakers, local authorities, non-governmental organizations, research centres, investment companies, and energy service providers) that can contribute to the initiation and development of ECs. In general, there is a lack of focus on this important aspect of ECs—the stakeholder perspective—and the barriers they face to participate in ECs. The present paper addresses this gap in the literature. We combine qualitative and quantitative approaches to provide insights into the barriers limiting the participation of stakeholders in energy communities. We categorize and rank barriers according to their importance to provide insight into the factors influencing the decisions of diverse stakeholders about their participation in ECs. This study also develops policy recommendations aimed at enabling citizen engagement, including ways of simplifying the process of joining an EC. Additionally, our research encompasses an examination of the current state of the energy transition and analysis of the barriers that hinder stakeholder involvement in this process in the EU with special focus on Spain and Italy.

2. Theoretical framework and literature review

2.1. Energy communities

The transition towards a more democratic and decentralized energy system focused on renewable energy (RE) has led to the emergence of energy communities as key actors. ECs organize collective energy actions, often in the form of cooperatives. They rely on open participation and prioritize economic, social, and cultural benefits for their members and the local communities in which they are based through fostering democratic governance [19,20]. ECs address the challenges posed by the energy transition [21], play a major role in promoting RE, and increasing energy awareness among end users [21,22]. The term "community" in the energy context denotes collective governance and equitable access to decision-making processes and outputs [23,24]. Through this approach, ECs aim to engage members as proactive citizen prosumers in energy transitions, fostering energy citizenship [25,26].

Scholars developed various typologies to categorize energy communities based on social arrangements, geographical location/anchorage, the actors involved, and ownership models in the relevant literature [27–31]. These typologies highlight the diverse governance structures and financing mechanisms used by ECs, emphasizing value creation for multiple stakeholders ([32,33]; F.G. Reis et al., 2021; [15,34,35]). However, further empirical evidence is needed to understand the potential of ECs in fostering active citizen engagement [36].

ECs involve citizens, local public authorities, private commercial developers, and crowdfunding platforms, reflecting diverse motivations and interests [37–39]. Collaboration between energy communities and these actors can provide alternative financing, risk sharing, decarbonization opportunities, and fewer objections towards projects [38]. Ownership models vary from community-owned structures, where citizens have complete ownership of production assets, to shared ownership models that require long-term relationships between local communities, commercial developers, or/and public entities [38,40]. The idea of "civic ownership" expands the inclusivity of energy communities by incorporating not only citizen, community, and cooperative ownership, but also the municipal ownership of energy systems [26,29].

In this research, ECs are defined as local initiatives that facilitate sharing of energy among prosumers and/or consumers, while at the same time promoting a bigger share of RE within the system. Since national and regional definitions were not available during this study, any local initiatives that align with these characteristics are considered ECs.

2.2. Stakeholder engagement and barriers to joining an EC

Renewable energy is widely recognized as a valuable solution to social and environmental challenges, including climate change and energy poverty. Energy communities can play an important role towards a greener energy transition, however, the transition and integration of renewable energy into the broader energy portfolio requires significant effort. To achieve this transition and integration, strong stakeholder engagement and participation are valuable. This involves active participation in decision-making starting at the early stages [4–8].

The decisions, options, and outcomes related to renewable energy development are influenced by various socio-economic and environmental factors, which can differ significantly, even among regions within the same country. Additionally, the perceived reputations of developers play a vital role in shaping these decisions. Given the multifaceted impact of renewable energy projects, it is important to have a comprehensive understanding of the stakeholders involved and their contributions to the decision-making process to ensure reliable and accountable project development [4,6–8,41].

Access to relevant information held by national authorities, including information on products and activities with significant environmental impact, is pivotal for individual groups, and organizations [41]. Additionally, to achieve a sustainable future, comprehensive involvement from all energy stakeholders is key. This means fostering collaborations across governments, industries, businesses, and citizens. There is a need to transition from mutual distrust to lasting partnerships that prioritize public welfare, ensuring that policies holistically address the social, environmental, and economic facets of energy [6]. Studies have shown that individuals who are familiar with renewable energy technologies, such as wind turbines in their region, tend to be more supportive of such initiatives [7].

According to O'Neill-Carrillo et al. [6] ensuring effective stakeholder engagement in the realm of renewable energy resources necessitates dependable mechanisms for communication and dialogue among energy stakeholders. It can also lead to better-informed decision-making and the creation of value for stakeholders [8]. Providing transparent and timely information to all stakeholders is critical before making any final policy decisions. Cuppen et al. [4], argued that inclusive and participatory processes involving stakeholders at various stages can strengthen engagement and should replace traditional top-down approaches in energy decision-making.

Assessing different stakeholder groups can be challenging as they vary based on social, technical, and environmental factors. Public education plays a key role in eliminating misinformation and misconceptions surrounding RE and fostering constructive dialogue among stakeholders. Prior studies [6,7] also recommend interdisciplinary approaches that include non-technical information and social factors in energy policy communication.

2.3. Barriers to joining an EC

Public participation plays a significant role in the widespread adoption of new energy technologies. Several factors influence individual participation in initiatives such as ECs [42]. Existing research focuses on the objectives of individuals and citizen communities when joining an EC, creating a gap in understanding the motivations and barriers of the other stakeholders [42]. Since not all ECs primarily consist of citizens and involve various stakeholders with specific needs, a comprehensive understanding of the range of barriers that may arise during their implementation is important.

Establishing and joining ECs involves various complexities. For example, according to Walker [43] in the UK, excluding Scotland, government policy does not fully support community ownership, primarily due to its resistance to feed-in tariffs, which some view as catalysts for growth in other European countries. Additionally, these complexities include legal requirements, economic and technical feasibility, and the need for extensive collaboration [44,45]. Other challenges are policy support, financing, social acceptance, limited awareness, and appropriate management structures [46,47]. Further, renewable energy technologies vary in their economic viability and risk and have been described as the most commercially feasible [48]. Funding subsidies have been necessary, and there is high competition for funds, often requiring multiple sources [43].

Market failures and barriers to connecting to the energy grid can hinder the income-generating potential of community projects [47,48]. Watson & Myers [49] discussed these barriers in detail, including the lack of incentive for network operators, trading costs, and the difficulty in obtaining green energy certificates. Unfamiliarity with collective management, billing, and metering arrangements can further limit the establishment of local heat networks (Watson & Myers,2006). Controversies may also arise at the local level regarding the level of community involvement and benefits [43].

Since ECs encompass various collective energy actions that benefit their members and local areas [46], key individuals and supporting local institutions are essential for the success of such initiatives [43]. Identifying what prevents the various stakeholders from joining and actively engaging in these initiatives is of utmost importance for ECs to be effective in their role in energy issues. However, there is a lack of empirical evidence when it comes to barriers and their relative importance. The goal of our studies is to fill this gap and provide insights for taking the next step to increase the number of ECs.

3. Methods

Qualitative and quantitative data collection examined the factors hindering participation in ECs through in-depth interviews and a survey.

3.1. Description of the study: interviews

The first stage of research was part of an EU-funded Horizon 2020 project, which aimed at promoting the adoption of RE through the development of ECs. Other objectives in the project covered the aspects of: scaling up and replication potential at EU level; reducing resistance, boosting demand and start de-risking EC investments; making EC development easier, further cutting down time and cost effort; empowering policy to transfer the community energy momentum to bioenergy heating. Between 1 March and April 30, 2021, 20 structured interviews were conducted with EC members, focusing on understanding their perceptions about existing challenges and barriers to joining ECs. The interviews were primarily conducted online due to pandemic restrictions.

The interview process involved the following steps.

1. Selection of Cases for Further Analysis: The initial phase of the EU project included 70 established ECs. From this pool, 20 cases (Table 1) were chosen for in-depth analysis. The selection process was a collaborative effort among the field experts, comprising academia, technical, and business. This approach ensured a comprehensive evaluation of each case's relevance to the project's scope of promoting the adoption of ECs, and their potential contribution to uncovering key aspects related to establishing and maintaining EC across Europe [50]. The selection process applied a mix of purposive and snowball sampling, which required the project partners to first evaluate the relevance of the cases according to the objectives of the EU project and the significance of each EC in their field (solar, wind, biomass, etc.). Second, the project partners and local experts assessed the ability to gain research access to each EC case. The most relevant to the project objectives and most accessible cases became the final sample of 20 ECs. Due to language barriers (many of the respondents did not speak English), therefore, local interviewers were trained to carry out the interviews in the local languages.
2. Interviews: We interviewed ECs stakeholders, with the most prevalent types of RE sources being biomass, solar, and wind. The interviews were structured to gather insights into challenges and barriers affecting the development of ECs. We developed a standardized interview guide to ensure consistency across all the interviews.

Table 1
Examples of EC projects and sampling process.

Country/ Sample	First EC sample	EC sample for in-depth interviews
Belgium	Emissions-zero; Ecopower; ESCoop Wallonie	Ecopower
Germany	UrStrom; Energiegenossenschaft Odenwald eG REScoop; Kappel Energy Cooperative	
Austria	Our power; Margarethen am Moos	
Spain	Suno; CMVMC Tameiga, Galicia; Ecoenergies Barcelona; Txantrea, Pamplona; Navarra Social Housing; Okina and Sabando, Araba; Bera; Tudela (Barrio San Juan Bautista); Ultzama; Asparrena; Atea Verdea, Lekeitio; Destilerias San Valero; Cooperativa de San Miguel; COREN and COVAP; Ayuntamiento de Serra; Calanda municipaly; UR BEROA; Ispaster; Energy autonomy of Sifnos; Electra Energy; Vineyards4heat	Ecoenergies Barcelona; Txantrea, Pamplona; Okina and Sabando; Bera, Navarra; Tudela (Bario San Juan Bautista); UR BEROA; Ispaster; Vineyards4heat
Greece	Minoan Energy; DHCA; Laconic Bioenergy; Energy4all; Woolhope Dome Community Woodfuel, Woolhope; Energy autonomy of Sifnos; Electra Energy	Electra Energy
Poland	GS Energia; Raciborz	
Luxembourg	Energy revolt; Energy Revolt s. c., Biekerech	
Portugal	Coopérnico	Coopérnico
Croatia	ZEZ, Green Energy Cooperative	ZEZ, Green Energy Cooperative
Italy	La foresta SCRL; FHW Toblach; EW PRAD; SEG Schluderns; LEEG LAAS; Förderungsgenossenschaft Ulten; Eurobios; Società Elettrica SEM – Morbegno; SEV Federazione Energia Alto Adige; Susa Valley	FHW Toblach; EW PRAD; SEG Schluderns; Förderungsgenossenschaft Ulten; Eurobios
Denmark	Danish District Heating Association; Biogas association Denmark; Solrodbiogas; Nordlys Energy association; Coop	Danish District Heating Association; Biogas association
France	Combrailles Dubrailles REScoop; Energie Partagée	
UK	Westmill Solar Cooperative; Springbok Wood heat COOP; Energy4all; Green Fox Community Energy; Shareenergy; Woolhope Dome Community Woodfuel; Edinburgh Community Solar Co-op; Shareenergy	Springbok Wood heat COOP
Ireland	Tipperary Cooperative	
Sweden	Luleå	

1. Qualitative Data Analysis: We transcribed, analysed and coded the interviews in NVivo 1.0 (2021) This enabled us to identify recurring themes across the dataset. Throughout the coding process, we rigorously verified that codes were consistently attributed within the dataset. This iterative verification ensured data integrity.

Country/ Sample	First EC sample	EC sample for in-depth interviews	Number of interviews
Belgium	Emissions-zero; Ecopower; ESCoop Wallonie	Ecopower	1
Germany	UrStrom; Energiegenossenschaft Odenwald eG REScoop; Kappel Energy Cooperative		0
Austria	Our power; Margarethen am Moos		0
Spain	Suno; CMVMC Tameiga, Galicia; Ecoenergies Barcelona; Txantrea, Pamplona; Navarra Social Housing; Okina and Sabando, Araba; Bera; Tudela (Barrio San Juan Bautista); Ultzama; Asparrena; Atea Verdea, Lekeitio; Destilerias San Valero; Cooperativa de San Miguel; COREN and COVAP; Ayuntamiento de Serra; Calanda municipaly; UR BEROA; Ispaster; Energy autonomy of Sifnos; Electra Energy; Vineyards4heat	Ecoenergies Barcelona; Txantrea, Pamplona; Okina and Sabando; Bera, Navarra; Tudela (Bario San Juan Bautista); UR BEROA; Ispaster; Vineyards4heat	8
Greece	Minoan Energy; DHCA; Laconic Bioenergy; Energy4all; Woolhope Dome Community Woodfuel, Woolhope; Energy autonomy of Sifnos; Electra Energy	Electra Energy	1
Poland	GS Energia; Raciborz		0
Luxembourg	Energy revolt; Energy Revolt s.c., Biekerech		0
Portugal	Coopérnico	Coopérnico	1
Croatia	ZEZ, Green Energy Cooperative	ZEZ, Green Energy Cooperative	2
Italy	La foresta SCRL; FHW Toblach; EW PRAD; SEG Schluderns; LEEG LAAS; Förderungsgenossenschaft Ulten; Eurobios; Società Elettrica SEM – Morbegno; SEV Federazione Energia Alto Adige; Susa Valley	FHW Toblach; EW PRAD; SEG Schluderns; Förderungsgenossenschaft Ulten; Eurobios	4
Denmark	Danish District Heating Association; Biogas association Denmark; Solrodbiogas; Nordlys Energy association; Coop	Danish District Heating Association; Biogas association	2
France	Combrailles Dubrailles REScoop; Energie Partagée		0
UK	Westmill Solar Cooperative; Springbok Wood heat COOP; Energy4all; Green Fox Community Energy; Shareenergy; Woolhope Dome Community Woodfuel; Edinburgh Community Solar Co-op; Shareenergy	Springbok Wood heat COOP	1
Ireland	Tipperary Cooperative		0
Sweden	Luleå		0

The distribution of interviews weighted Spain with eight and Italy with four among lower numbers in other countries (Table 1). This distribution was primarily due to the extensive network and connections of the Spanish and Italian pilots, who represented the EC and RE producers within these two countries.

We developed a barrier analysis framework by drawing on existing literature on barriers to joining ECs and the findings from the initial stage of our research (see Table 2) [29]. This framework encompasses four distinct groups of barriers and considers 14 indicators that are relevant for engaging various stakeholders in ECs within the EU.

The four barriers are (a) financial, (b) regulatory and bureaucratic, (c) technical and practical, and (d) social and cultural challenges. Each barrier presents unique indicators, highlighting specific obstacles within the respective category. These barriers and their indicators are described below in more detail.

1. Financial (FNC): Financial challenges including high capital costs, ongoing operational expenses, and market uncertainties.
   a. Low profitability (LP): The potential low profitability of such initiatives can prevent potential investors from participating.
   b. Investment risk (IR): The high investment risk in some projects (e.g., bioenergy) can discourage potential investors/members from joining an EC.
   c. High initial cost (HIC): The high cost of joining an EC can hinder growth by limiting the number of new members.
   d. Lack of support and funding (LSF): Limited access to development funds and support necessitates the need for alternative sources. Reliance solely on national funds is not sufficient, despite the presence of certain incentives.
2. Regulatory & bureaucratic (RB): Rules, regulations, and administrative procedures that organizations or individuals must navigate to enter an EC.
   a. Legal limitations (LL): Restrictions on virtual net metering in some countries can hinder the ability of people to collectively generate and trade energy within a building. This can limit the potential for ECs to engage in self-consumption and exclusively serve households.
   b. Regulatory complexity (RC): Navigating complex regulatory frameworks and bureaucracies can pose challenges in complying with laws and regulations.
   c. Lack of precedents and models (LPM): lack of lighthouse cases of ECs.
3. Technical & practical (TP)*:* Technical obstacles arise due to limitations in technology, design, materials, or infrastructure, while practical barriers arise due to stakeholder management and engagement issues.
   a. Low community engagement (LCE): Challenging coordination of volunteers and EC members due to differing viewpoints. Time-consuming process.
   b. Challenging EC management (CECM): Limited competencies and capacities in EC management, space limitation, and lack of driving forces or incentives.
   c. Complex RE technology (CRET): Technologies are becoming more efficient, but also riskier or more complex. RE systems need uninterrupted operation and ongoing maintenance. Limited customer understanding of RE models.
4. Social & cultural (SC): Social and cultural barriers include factors such as limited access to information, lack of knowledge, perceptions around renewable energy, etc.
   a. Lack of knowledge (LK): Lack of confidence in RE supply. RE may be considered as something new and experimental.
   b. Individualism (ID): Preference for individualism and private installations
   c. Mistrust towards community energy projects (MTCEP): Lack of transparency, e.g., regarding the environmental impact of

Table 2
Barrier rankings.

Barriers	Priority Weight	Priority Weight (%)
Regulatory and bureaucratic	0.321975	32.197456
Financial	0.257548	25.754769
Social and cultural	0.218214	21.821428
Technical and practical	0.202263	20.226347

Consistency Ratio (CR) = 0.006470.

biomass and incomplete project development considering a technology's life cycle.
d. Cultural norms and beliefs (CNB): Bad reputation of cooperative models. The deep-rooted culture around fossil fuels.

3.2. Survey design and analytical hierarchy process

In the second stage, we used the analytical hierarchical process (AHP) to estimate and rank the barriers identified. AHP assigns weights to compare criteria or alternatives and offers a flexible decision-making model with tailored hierarchy formulation. Combining qualitative and quantitative aspects, AHP is a powerful tool for multi-criteria decision-making (R. W. [51]).

Researchers have successfully applied AHP in various domains, including technology transfers, decentralized electricity options, and energy-related projects. Moreover, AHP has proven beneficial in advanced manufacturing technology selection, policy setting problems, power market structure determination, and energy conservation policy prioritization ([52,53]; T. L. [54]; T. L. [55]). AHP is a suitable approach considering the multiple criteria of barrier prioritization and the need for qualitative analysis [53,56,57].

This study utilized AHP to rank barriers by employing a hierarchical structure that classified and specified barriers within each group. From the interviews, four groups of barriers and fourteen indicators were identified. Utilizing these insights, the problem was decomposed into a hierarchical tree, as depicted in ([52,53]; T. L. [54]; T. L. [55]).

Based on the interview results, the next step in this study involved creating a pairwise comparison survey specifically designed for different groups of EC stakeholders, allowing them to provide opinions on a 100-point scale [42,58]. As outlined and illustrated in Fig. 1, each barrier group consists of multiple indicators. We developed a survey to identify key indicators within each barrier group, which we used to assess the relative importance of each barrier. Survey respondents were asked to rate the barrier groups using itemized rating scales from 1 to 100. The most important criterion was given by the highest number. All other criteria were then rated in comparison to the most important one. The rated scores then were normalized [42,58].

The survey was conducted through the online platform Qualtrics, and the surveys were distributed through email requests between the 27th of April and till July 11, 2023. The survey was available in 7 languages (English, Danish, Italian, Greek, Polish, Spanish, and German) in total, and 93 datasets were collected from various groups of stakeholders. However, 37 of these datasets were determined invalid due to incompleteness. Consequently, the survey questionnaires yielded a complete set of 56 responses from EC stakeholders in 16 EU countries accounting for 61 % of the total respondents (Fig. 2) (see Fig. 3).

The exact number of respondents needed for reliable AHP analysis is undetermined, as evidenced by varying practices in the literature. For instance, a study by Ref. [59], utilized 13 and individual responses respectively, while Singh & Nachtnebel [60] advocated for at least 50 responses [53]. This suggests that AHP can be applied to a range of respondents.

Citizen members of ECs comprise 27 % of the 56 respondents, while research centres and universities account for 21 %. Potential EC members, including associations and investment companies, represent 13 % of the total. Technical experts, NGOs, and consultancy companies consisting of energy service providers and RE owners, make up 10 % each of the total stakeholder, a. Policymakers constitute 6 % of all the stakeholders who participated in the survey, while the public represents 3 % of the total stakeholders.

Using the data collected from the survey, a pairwise comparison matrix for each category was created. The comparative judgments provided by survey respondents were combined using the Aggregation of Individual Priorities to satisfy the Pareto principle, considering the diverse representation of survey respondents from various EU countries and EC stakeholder groups [61].

In the next phase of analysis, we computed the weights for each category and their respective barriers using the formula $\mathbf{Aw} = \lambda\mathbf{max}^* \mathbf{w}$. Here, $\mathbf{A}$ is the comparison matrix of size $\mathbf{n} \times \mathbf{n}$, commonly known as the priority matrix, while w denotes the Eigenvector of size $\mathbf{n} \times \mathbf{1}$, also

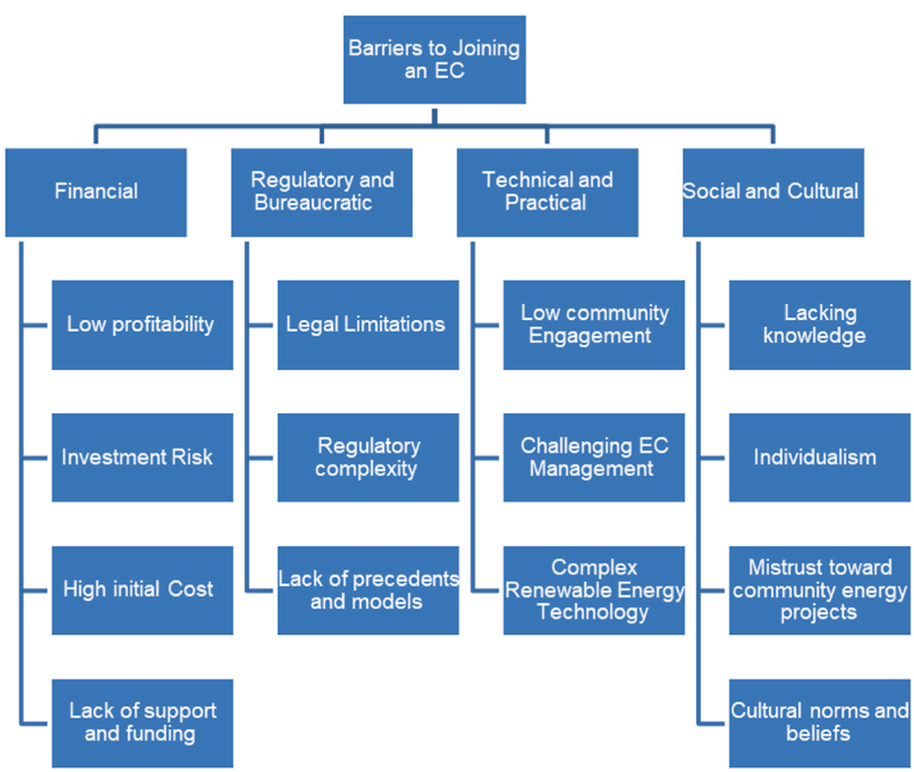

Fig. 1. Hierarchical tree of barriers to joining an EC.

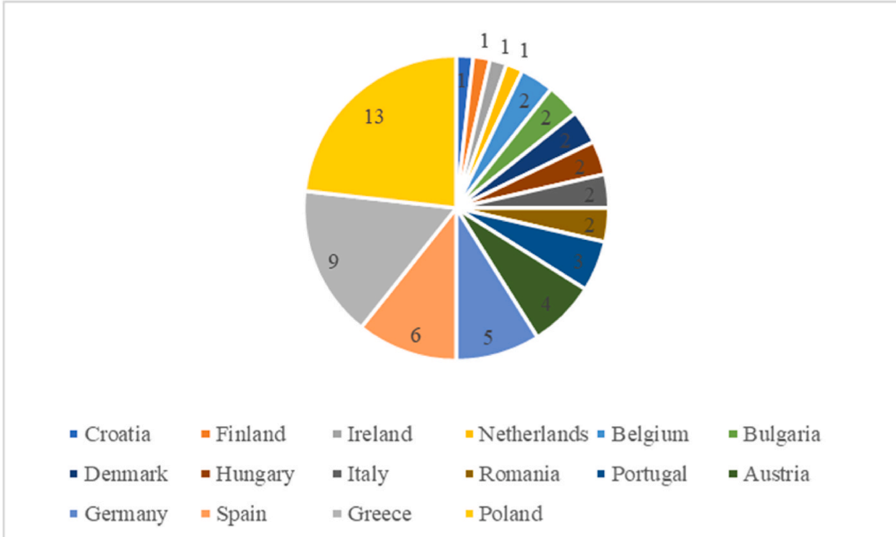

Fig. 2. Country Representation in the Survey (colour should be used for figure in print). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

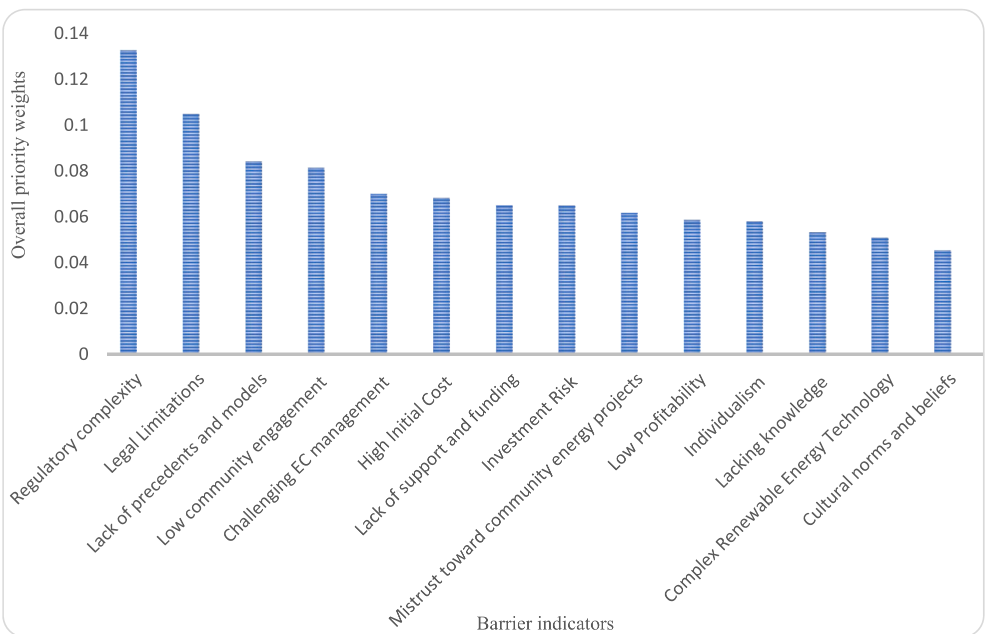

Fig. 3. Overall barrier ranking.

referred to as the priority vector, which signifies the weights. The maximum Eigenvalue, denoted as λ_{max} was obtained according to the works of Saaty [62].

The last phase involves determining the level of consistency in the estimate. To estimate the consistency index (CI) for each n-order matrix, we utilized Eq. (1) to assess the relationship between the elements in the pair-wise comparison. Ensuring consistency is crucial for validating the AHP output. Afterwards, the consistency ratio (CR) was computed, incorporating the CI and random consistency index (RI) through Eq. (2). The definitions of CI and CR are as follows:

The consistency index (CI) is calculated using the formula: **CI=(max-n)/(n-1).** The consistency ratio (CR) is determined by using the formula: **CR=CI/RI**. The validity of stakeholders' judgements is established if **CR > Rin**; otherwise, the pair-wise comparison process for rejections or preferences should be repeated. If the CR is 10 % or lower, the level of inconsistency is considered acceptable. However, if the CR exceeds 10 %, it signals the need to re-evaluate or eliminate the questionnaire form of decision-makers' subjective preferences [63].

4. Results and analysis

4.1. Category hierarchy results

The results presented in Table 3 demonstrate the outcomes of the analytical assessment. According to the data gathered from survey results, the impact of regulatory and bureaucratic barriers (32.2 %) is the most evident when it comes to the integration of ECs in EU countries. Following closely are the financial barriers (25.8 %), social and cultural barriers (21.8 %), and technical and practical barriers (20.2 %).

It is essential to acknowledge that the unique political landscapes, economic conditions, and geographic factors of each EU country may contribute to variations in the findings of this study. Consequently, overcoming these barriers would require customized approaches that align with each country's specific needs and circumstances.

Barriers	Priority Weight	Priority Weight (%)
Regulatory and bureaucratic	0.321975	32.197456
Financial	0.257548	25.754769
Social and cultural	0.218214	21.821428
Technical and practical	0.202263	20.226347

4.2. Ranking results of barriers within categories

The hindrance level of each barrier within its respective category, concerning engagement in EC projects, was determined through weight calculations, and subsequently, the barriers were ranked based on the results. Within the financial barriers in Table 3, high initial cost (26.6 %), lack of support and funding (25.4 %), and investment risk (25.3 %) are the greatest obstacles to participating in EC in the EU countries. The results are close, especially close between ranks 2 and 3. Our confidence in our final ranking is high, but as a matter of policy discussion these barriers should be targeted through interlocking levers. However, financial barriers do not rise to the top overall. In the context of regulatory and bureaucratic barriers, as indicated in the results presented in Table 4, regulatory complexity (41.2 %) was identified as the primary barrier hindering involvement in EC projects in EU countries. This was followed by legal limitations (32.7 %) and lack of precedents and models (26.1 %).

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Low profitability	0.227559	22.755930	4
Investment risk	0.253074	25.307437	3
High initial cost	0.265760	26.575974	1
Lack of support and funding	0.253607	25.360659	2

The analysis in Table 5 reveals that within the technical and practical barriers, low community engagement (40.2 %) emerged as the most significant obstacle to participating in ECs. It was closely followed by challenging EC management (34.7 %) and complex RE technology (25.2 %).

Barriers	Priority Weight	Priority Weight (%)	Rank
Low community Engagement	0.402055	40.205496	1
Challenging EC management	0.346469	34.646944	2
Complex renewable energy technology	0.251476	25.147560	3

As indicated in Table 6, the most influential barrier hindering participation in ECs within the social and cultural barriers is mistrust toward community energy projects (28.3 %). It is closely followed by individualism (26.6 %), lacking knowledge (24.4), and cultural norms and beliefs (20.8 %).

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Lacking knowledge	0.243640	24.364032	3
Individualism	0.265674	26.567402	2
Mistrust toward community energy projects	0.282744	28.274402	1
Cultural norms and beliefs	0.207942	20.794163	4

Table 3
Financial barriers rankings.

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Legal Limitations	0.327028	32.702837	2
Regulatory complexity	0.411885	41.188473	1
Lack of precedents and models	0.261087	26.108690	3

Consistency Ratio (CR) = 0.041366.

Table 4
Regulatory and bureaucratic barriers rankings.

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Legal Limitations	0.327028	32.702837	2
Regulatory complexity	0.411885	41.188473	1
Lack of precedents and models	0.261087	26.108690	3

Consistency Ratio (CR) = 0.0335498.

Table 5
Technical and practical barriers rankings.

Barriers	Priority Weight	Priority Weight (%)	Rank
Low community Engagement	0.402055	40.205496	1
Challenging EC management	0.346469	34.646944	2
Complex renewable energy technology	0.251476	25.147560	3

Consistency Ratio (CR) = 0.025249.

Table 6
Social and cultural barriers rankings.

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Lacking knowledge	0.243640	24.364032	3
Individualism	0.265674	26.567402	2
Mistrust toward community energy projects	0.282744	28.274402	1
Cultural norms and beliefs	0.207942	20.794163	4

Consistency Ratio (CR) = 0.021463.

4.3. Results of overall ranking

The overall hindrance levels and rankings of the barriers regarding participation in EC projects were determined by multiplying the weight of each category by the priority weight of the barriers. The resulting overall ranking of the barriers is depicted in Table 3. Regulatory complexity (13.3 %) was identified as the most significant barrier hindering joining EC projects, placing it in the top position in the overall ranking. It was followed by legal limitations (10.5 %), lack of precedents and models (8.4 %), low community engagement (8.1 %), and challenging EC management (7 %). In the overall ranking, high initial cost, lack of support and funding, high investment risk, mistrust toward community energy projects, and low profitability were ranked sixth through tenth, respectively, in terms of their impact on hindering participation in EC projects.

In the following part, we present the results for Spain and Italy, as we interviewed the most representatives from those two countries in the first stage of our research.

Highlighting the key barriers to joining EC in Spain, the hierarchy results emphasize regulatory complexity as the foremost challenge (overall priority weight 13.3 %). This is closely followed by legal limitations (10.5 %) and the lack of precedents and models (8.4 %) (Appendix A, tables A1-5). Conversely, complex RE technology (5 %) and cultural norms and beliefs (4.5 %) were relatively less rated barriers.

Similarly, legal limitations (16.47 %) were top top-ranked barrier to joining ECs in Italy. Regulatory complexity closely follows (15.52 %). Notably, mistrust toward community energy projects was also among top-ranked barriers here (10.3 %). On the contrary, barriers such as complex RE technology (2.7 %) and investment risk (16 %) were ranked lower as hindrances to joining ECs in Italy (Appendix A, tables A.6-A.10). The results from Spain and Italy align with the overall aggregated ranking results, with regulatory complexity standing out as a key barrier.

There are consistent themes across all EC stakeholder groups, participated in the survey. Regulatory complexity emerges as an important barrier (rank 1, overall priority weight ranging 11.7 %–17.3 %), indicating its unanimous importance. Legal limitations also hold significance (rank ranging 2–4, overall priority weight ranging 10.5 %–15.6 %), underscoring the shared challenges in navigating legal frameworks. Some distinctions exist; for example, the lack of precedents and models is consistently highlighted as top ranked barrier by potential EC members, research centre, NGO, and EC citizen members (rank ranging 2–3, overall priority weight ranging 8 %–10.4 %). While policy makers and technical experts perceive it as less important barrier (rank 9, overall priority weight ranging 5.1 %–6.8 %). While there were varying degrees of emphasis on low community engagement, low profitability, and high investment risk, the overarching focus remains on addressing the regulatory and bureaucratic barriers (Appendix B, table B.1-B.26).

5. Discussion and policy recommendations

5.1. Discussion

We employed a mixed-methods approach to provide insights on an important but rather under-researched issue of the EC literature, the existing barriers preventing various stakeholder groups from engaging in ECs. The results of our two studies provide insights into the different type of barriers as well as their importance. The results of our qualitative study identified four major categories of barriers: (a) financial, (b) regulatory and bureaucratic, (c) technical and practical, and (d) social and cultural. Each major category includes different sub-obstacles. The results provided us with further insights into the relative weight and importance of obstacles. A limitation to our study is the over-sample of Spain and Italy. Our findings are especially relevant to these two national contexts, yet our limited results from other countries agree with our findings. A representative sample across Europe is an important step for future research.

According to our results, one of the greatest obstacles is regulatory and bureaucratic barriers. The legal framework in several EU countries currently lacks adequate support for the establishment and operation of energy communities, and in some cases, there is a complete absence of specific legal rules for energy communities. Additionally, private law regulations, such as those related to housing or property, have not been sufficiently adapted to accommodate community-based energy production, thereby hindering their establishment, or posing risks to their future operation. Another significant issue is the absence of legal rules concerning peer-to-peer trade in most countries. These challenges, arising from either the lack of rules or inadequate adaptations of existing ones, can only be addressed by legislators and not by citizens themselves [64].

Furthermore, many countries have complex and opaque legal frameworks that further exacerbate the situation [65]. To address this, Bertel et al. [64], recommend implementing institutionalized mechanisms for providing free information and assistance to all citizens. This can take the form of central points of information or personalized support from energy experts, such as energy coaches, for individuals in need. Additionally, specific legislative measures should be implemented to simplify and enhance the transparency of the legal situation in each member state.

EC stakeholders often face financial barriers that prevent them from initiating or participating in energy communities. To address this issue, governments can empower citizens by offering financial support in the form of funding, tax reductions, or accessible loans. Furthermore, governments can play a vital role in promoting citizens' engagement by actively involving municipalities in supporting and facilitating community-based energy initiatives [64].

Social and cultural barriers were reported as the third highest-ranked obstacles. Technical and practical barriers identified in our study were reported as the least important. Among the social and cultural barriers, the lack of knowledge about ECs, and lack of trust in the EC's system/organization, where the lack of regulatory systems might also have an impact. Therefore, for a wider uptake of ECs initiative, both awareness campaigns and other related initiatives are needed towards creating a better understanding of how these cooperatives operate, including their governance structures and responsibilities, including how the cooperatives integrate (or not) with the existing grid.

Next, the ranking of the barriers within each category showed that several barriers need to be addressed for the engagement of new stakeholders to EC in the EU context. Analysis results revealed the lack of support and funding was the highest-ranked barrier and the low profitability the lowest-ranked within the financial category. Likewise, regulatory complexity was identified in our research as the greatest barrier and lack of precedents and models was the most insignificant barrier within the regulatory and bureaucratic category. Currently, energy policy matters have not received sufficient attention in policy debates, emphasizing the need for stakeholder participation in the formulation process of energy policies. Such participation is essential to ensure effective policy formulation and implementation.

Similarly, in the technical and practical barriers category, low community engagement is the biggest barrier to joining EC. Complex renewable energy technology was the lowest-ranked barrier. Correspondingly, mistrust toward community energy projects was the highest-ranked barrier to joining EC in the social and cultural category. Cultural norms and beliefs were ranked as the least significant barrier within this group.

The main objective of this study is to identify and prioritize the obstacles to participating in ECs within the European Union. Subsequently, the study aims to explore strategies for overcoming these barriers. The methodology includes gathering input from EC stakeholders through surveys and interviews, enabling valuable insights to be gained. Ultimately, this research empowers policymakers by enhancing their understanding of the identified barriers, thereby facilitating informed policy actions.

This paper can serve as a reference for examining the barriers to joining EC in countries or regions outside of the EU. However, rather than relying solely on the findings of this study, it is recommended to adapt the research to the specific context of the country or region being studied. It is important to acknowledge that the nature, depth, and quantity of barriers may differ, and unique measures may be required to address them effectively. Additionally, given the diverse forms of ECs, such as rural and urban variations, barriers can vary accordingly. It should be noted that this study focuses on ECs in the EU context overall and does not delve extensively into technology-specific barriers to establishing and joining new ECs. Further research could explore these aspects in greater depth.

5.2. Preliminary policy recommendations

Based on the research results we suggest some preliminary policy recommendations towards mitigating some of the identified barriers. Our preliminary policy recommendations focus on the top four overall barriers.

5.2.1. Regulatory complexity and legal limitations

Streamlining and support: Solutions to regulatory complexity can be found both in streamlining the regulatory process by legislators at national and EU levels, and other regulatory bodies, in addition to some of the knowledge-building and support recommendations discussed in more detail below. That is, knowledge, support, and shepherding may ease the regulatory burden and be easier than legal changes. However, policymakers should work towards simplifying and harmonizing regulatory frameworks related to ECs across different regions and countries within the EU. This could involve creating standardized guidelines and removing legal barriers to ease participation in ECs. For this to take place, standard legal definitions of ECs need to be agreed upon.

Legislative attention should also address legal limitations that hinder stakeholders from forming ECs. For instance, none of the countries studied has a streamlined procedure for both establishing the legal structure and obtaining permits for the EC's facilities. Consequently, stakeholders must navigate separate legal processes to establish the legal structure for the EC and to obtain administrative approvals for the facilities they intend to utilize [64].

5.2.2. Lack of precedents and models

Facilitating collaboration with established entities: assistance for collaboration between ECs and established energy companies or utilities. Partnerships can help address financial, technical, and regulatory challenges while also promoting a more diversified and sustainable energy sector.

Cross-border cooperation: foster collaboration and knowledge sharing between ECs across different countries. Cross-border partnerships might enable the exchange of experiences, technologies, and ideas, promoting a more integrated and efficient approach to sustainable energy initiatives. Furthermore, the knowledge of close geographical conditions could be an opportunity towards establishing regional exchanges and foster new energy markets.

Facilitating knowledge sharing: Establish local platforms or networks in both international and local languages that facilitate the sharing of best practices, experiences, and knowledge among existing ECs. This is an untapped opportunity that could help boost and encourage peer-to-peer learning, helping overcome barriers by learning from successful models.

5.2.3. Low community engagement

Community engagement and inclusivity: promote active community engagement in the decision-making processes of ECs. ECs steering the community need to ensure inclusivity and transparency in project planning, allowing community members to have a stake in determining the direction and goals of the ECs.

Capacity building and training: due to the pace of technology advancements and novel opportunities, there should be a dedicated investment in training and capacity-building programs for community members involved in ECs. This could enhance their ability to effectively manage, operate, and maintain renewable energy projects, addressing practical and technical barriers.

Public awareness and education: a clear strategy towards implementing public awareness campaigns and educational programs to address misconceptions and lack of knowledge about renewable energy sources and the benefits of ECs need to be in place. These initiatives could target both the public and stakeholders involved in the energy sector.

Lastly, financial support through grants, subsidies, tax breaks, or low-interest loans to mitigate the high initial costs, may help increase the number of ECs. However, financial assistance or incentive structures should be considered through a cost-benefit framework after thorough analysis of the effectiveness of the type of incentive in reducing CO2 emissions or following another climate metric [66].

6. Conclusions, limitations and future work

Establishing and developing ECs is a top priority for governments in developed countries [65]. However, the achievement of EC development is contingent upon addressing the existing barriers regarding both their uptake, a key aspect, and further establishment. Therefore, this study aimed to identify and rank the diverse barriers to joining EC within the context of the EU. The identification process involved reviewing relevant literature, conducting qualitative interviews, carrying out and analysing survey results, and applying the Analytic Hierarchy Process methodology to the EC stakeholders opinions gathered from the survey. These efforts resulted in the classification of barriers into four categories: (a) financial, (b) regulatory and bureaucratic, (c) technical and practical, and (d) social and cultural. In total 14 barriers were identified and explained within these top-level categories. While previous researchers identified these barriers, their focus did not involve ranking them based on their impact on participation in EC within the EU context. Hence, the main objective of this study was to rank these barriers accordingly.

Regulatory complexity has emerged as the primary barrier hindering the development and establishment of EC in EU countries. By ranking these barriers, it becomes possible to focus efforts on addressing the most significant obstacles to joining EC within the EU context. This study offers a fundamental framework for prioritizing these barriers, aiding decision-makers, and policymakers in making informed and efficient decisions. Consequently, the study provides stakeholders with an analytical and theoretical foundation, enhancing their understanding of the barriers to joining EC.

Relevant government agencies have a critical role to play in bolstering policies aimed at actively involving EC stakeholders in a transparent manner to address existing barriers. By comprehending these barriers and implementing appropriate measures, the decision-making body can effectively tackle them. Frequent discussions among political leaders at both central and local levels are essential prerequisites for expediting the development of EC. The approach employed in this study can serve as a valuable reference for future researchers, who may utilize techniques to contribute further to the study of barriers in the energy sector.

While our findings are especially relevant to Italian and Spanish contexts, the results, albeit limited, from other countries, agree with our findings. A representative sample across Europe is an important step for future research. The research sample can be considered a shortcoming, as not having equal numbers from across the European countries, may not adequately represent each country's unique circumstances. This aspect highlights the need for broader research with larger, global samples to obtain new insights and better generalize the phenomenon of EC. Additionally, the AHP method employed has its drawbacks, including its subjective nature and the challenge of translating into numerical judgments [67]. In future research, Discrete Choice Experiments, may be used to complement our findings [68]. Future research employing diverse methodologies can provide varied perspectives on ECs. Lastly, since the scale was developed within the EU framework, its applicability should be further tested in other developed countries to determine its relevance and adaptability in different contexts.

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CRediT authorship contribution statement

Albina Dioba: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Formal analysis, Conceptualization. **Amalia Giannakopoulou:** Writing – review & editing, Methodology, Investigation. **David Struthers:** Writing – review & editing, Conceptualization. **Angelos Stamos:** Writing – review & editing. **Siegfried Dewitte:** Conceptualization. **Isabel Fróes:** Writing – review & editing, Methodology, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

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

Data availability

Data will be made available on request.

Appendix A. Ranking results for Spanish and Italian Cases

Table A. 1
Barrier Rankings - Spain

Barriers	Priority Weight	Priority Weight (%)
Financial	0.257547	25.754769
Regulatory and Bureaucratic Barriers	0.321974	32.197456
Technical and Practical	0.202263	20.226346
Social and Cultural	0.218214	21.821427

CR = 0.030331.

Table A. 2
Financial Barriers Rankings - Spain

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Low Profitability	0.227559	22.755930	4
Investment Risk	0.253074	25.307437	3
High Initial Cost	0.265760	26.575974	1
Lack of support and funding	0.253607	25.360659	2

CR = 0.033977.

Table A. 3
Financial Barriers Rankings - Spain

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Legal Limitations	0.327028	32.702837	2
Regulatory complexity	0.411885	41.188473	1
Lack of precedents and models	0.261087	26.108690	3

CR = 0.0335498.

Table A. 4
Technical and Practical Barriers Rankings - Spain

Barriers	Priority Weight	Priority Weight (%)	Rank
Low Community Engagement	0.402055	40.205496	1
Challenging EC Management	0.346469	34.646944	2
Complex Renewable Energy Technology	0.251476	25.147560	3

CR = 0.014644.

Table A. 5
Social and Cultural Barriers Rankings - Spain

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Lacking knowledge	0.243640	24.364032	3
Individualism	0.265674	26.567402	2
Mistrust toward community energy projects	0.282744	28.274402	1
Cultural norms and beliefs	0.207942	20.794163	4

CR = 0.016843.

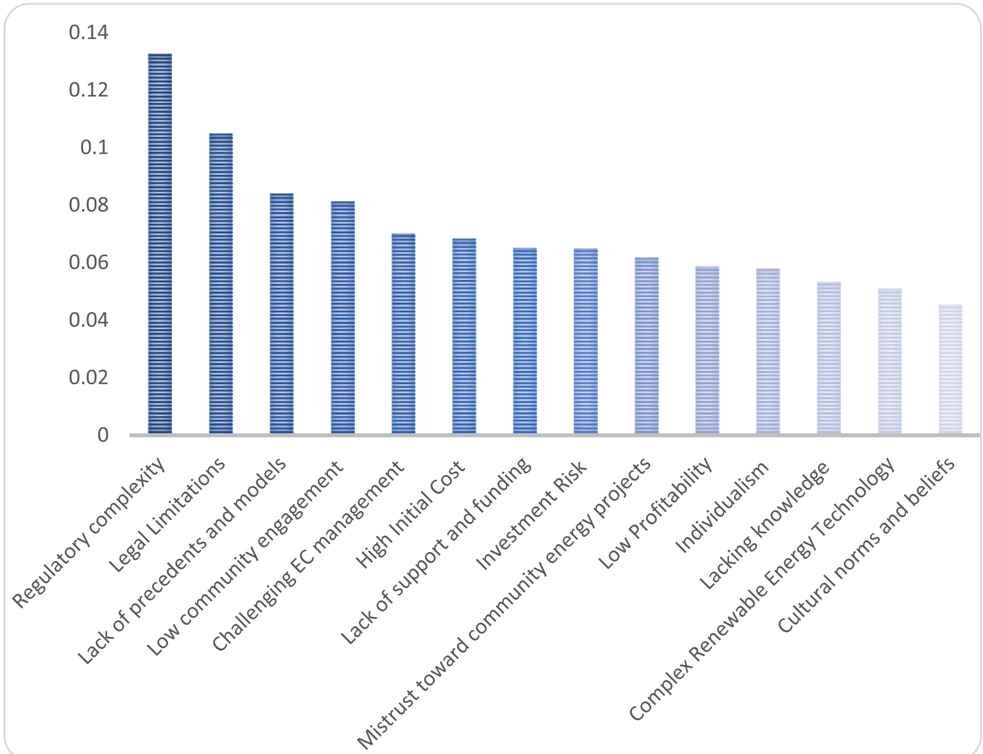

Fig. A. 1. Overall Barrier Ranking - Spain

Table A. 6
Barrier Rankings – Italy

Barriers	Priority Weight	Priority Weight (%)
Financial	0.147215	14.721509
Regulatory and Bureaucratic	0.413987	41.398721
Technical and Practical	0.128223	12.822263
Social and Cultural	0.310575	31.057508

CR = 0.015676.

Table A. 7
Financial Barriers Rankings - Italy

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Low Profitability	0.359512	35.951223	4
Investment Risk	0.146770	14.677025	3
High Initial Cost	0.284776	28.477612	1
Lack of support and funding	0.208941	20.894139	2

CR = 0.060186.

Table A. 8
Regulatory and Bureaucratic Barriers Rankings - Italy

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Legal Limitations	0.397935	39.793503	1
Regulatory complexity	0.374913	37.491318	2
Lack of precedents and models	0.227152	22.715179	3

CR = 0.022151.

Table A. 9
Technical and Practical Barriers Rankings - Italy

Barriers	Priority Weight	Priority Weight (%)	Rank
Low Community Engagement	0.507427	50.742738	1
Challenging EC Management	0.281470	28.147007	2
Complex Renewable Energy Technology	0.211103	21.110255	3

CR = 0.020588.

Table A. 10
Social and Cultural Barriers Rankings - Italy

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Lacking knowledge	0.281629	28.162907	3
Individualism	0.229949	22.994917	2
Mistrust toward community energy projects	0.331637	33.163741	1
Cultural norms and beliefs	0.156784	15.678434	4

CR = 0.007148.

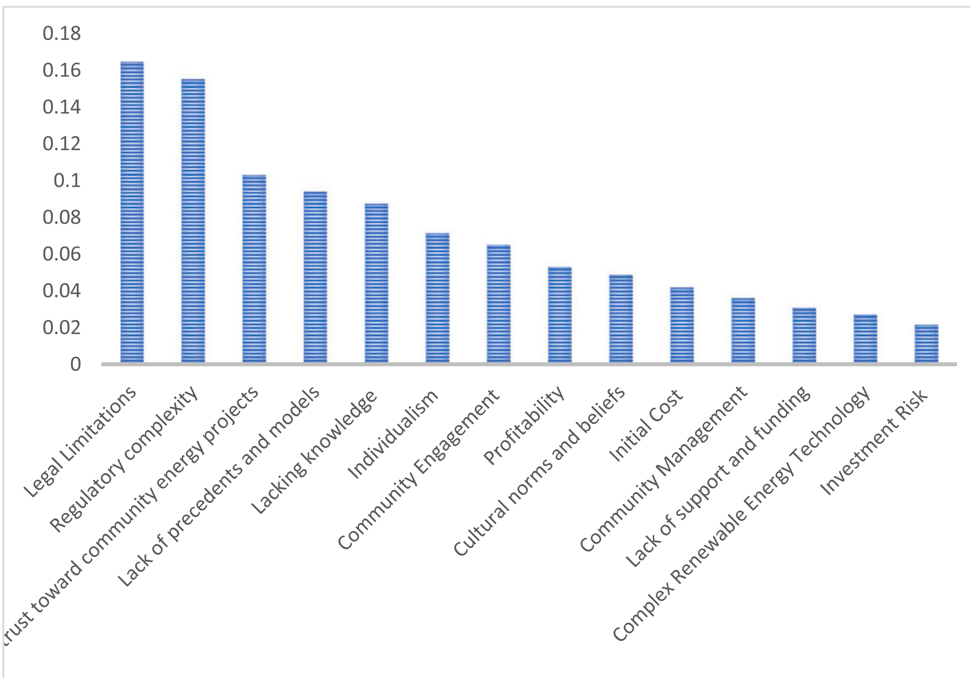

Fig. A. 2. Overall Barrier Ranking - Italy

Appendix B. Ranking Results for EC Stakeholder Groups

Table B. 1
Barrier Rankings - Potential EC Members

Barriers	Priority Weight	Priority Weight (%)
Financial	0.209413	20.941313
Regulatory and Bureaucratic	0.327609	32.760884
Technical and Practical	0.209132	20.913236
Social and Cultural	0.253846	25.384567

CR = 0.020547.

Table B. 2
Financial Barriers Rankings - Potential EC Members

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Low Profitability	0.287724	28.772396	1
Investment Risk	0.277767	27.776699	2
High Initial Cost	0.159069	15.906915	4
Lack of support and funding	0.275440	27.543990	3

CR = 0.040699.

Table B. 3
Regulatory and Bureaucratic Barriers Rankings - Potential EC Members

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Legal Limitations	0.337714	33.771357	2
Regulatory complexity	0.358653	35.865327	1
Lack of precedents and models	0.303633	30.363316	3

CR = 0.027793.

Table B. 4
Technical and Practical Barriers Rankings - Potential EC Members

Barriers	Priority Weight	Priority Weight (%)	Rank
Low Community Engagement	0.399829	39.982889	1
Challenging EC Management	0.378914	37.891399	2
Complex Renewable Energy Technology	0.221257	22.125712	3

CR = 0.020669.

Table B. 5
Social and Cultural Barriers Rankings - Potential EC Members

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Lacking knowledge	0.206808	20.680790	4
Individualism	0.247297	24.729744	2
Mistrust toward community energy projects	0.318770	31.877048	1
Cultural norms and beliefs	0.227124	22.712417	3

CR = 0.035056.

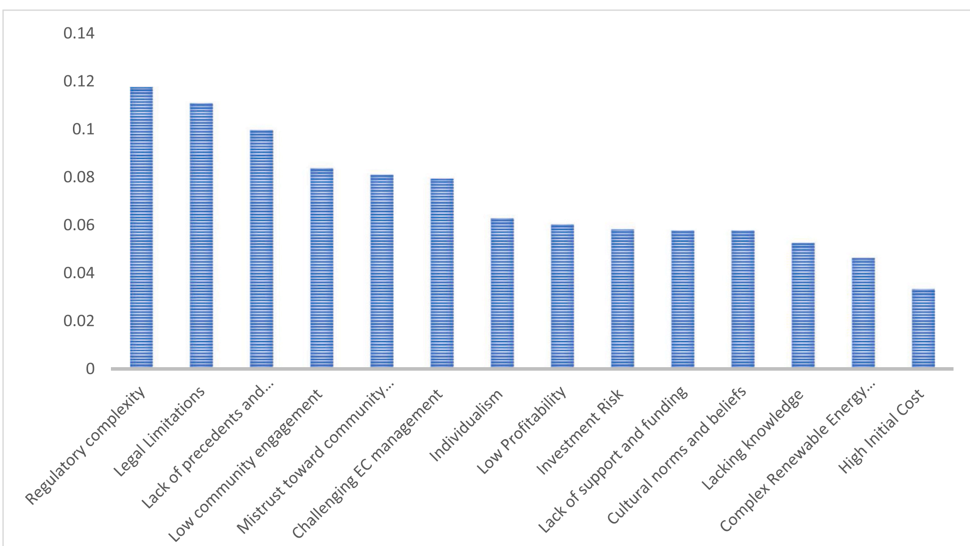

Fig. B. 1. Overall Barrier Ranking - Potential EC Members

Table B. 6
Barrier Rankings - Research Centres

Barriers	Priority Weight	Priority Weight (%)
Financial	0.301846	30.184564
Regulatory and Bureaucratic	0.285699	28.569929
Technical and Practical	0.224856	22.485556
Social and Cultural	0.187600	18.759951

CR = 0.002762.

Table B. 7
Financial Barriers Rankings - Research Centres

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Low Profitability	0.234642	23.464230	2
Investment Risk	0.221971	22.197129	4
High Initial Cost	0.316509	31.650936	1
Lack of support and funding	0.226877	22.687705	3

CR = 0.042624.

Table B. 8
Regulatory and Bureaucratic Barriers Rankings - Research Centres

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Legal Limitations	0.297670	29.767008	3
Regulatory complexity	0.383172	38.317180	1
Lack of precedents and models	0.319158	31.915811	2

CR = 0.028225.

Table B. 9
Technical and Practical Barriers Rankings - Research Centres

Barriers	Priority Weight	Priority Weight (%)	Rank
Low Community Engagement	0.433521	43.352124	1
Challenging EC Management	0.369170	36.917032	2
Complex Renewable Energy Technology	0.197308	19.730845	3

CR = 0.018910.

Table B. 10
Social and Cultural Barriers Rankings - Research Centres

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Lacking knowledge	0.303417	30.341745	1
Individualism	0.198981	19.898099	4
Mistrust toward community energy projects	0.295953	29.595280	2
Cultural norms and beliefs	0.201649	20.164876	3

CR = 0.042003.

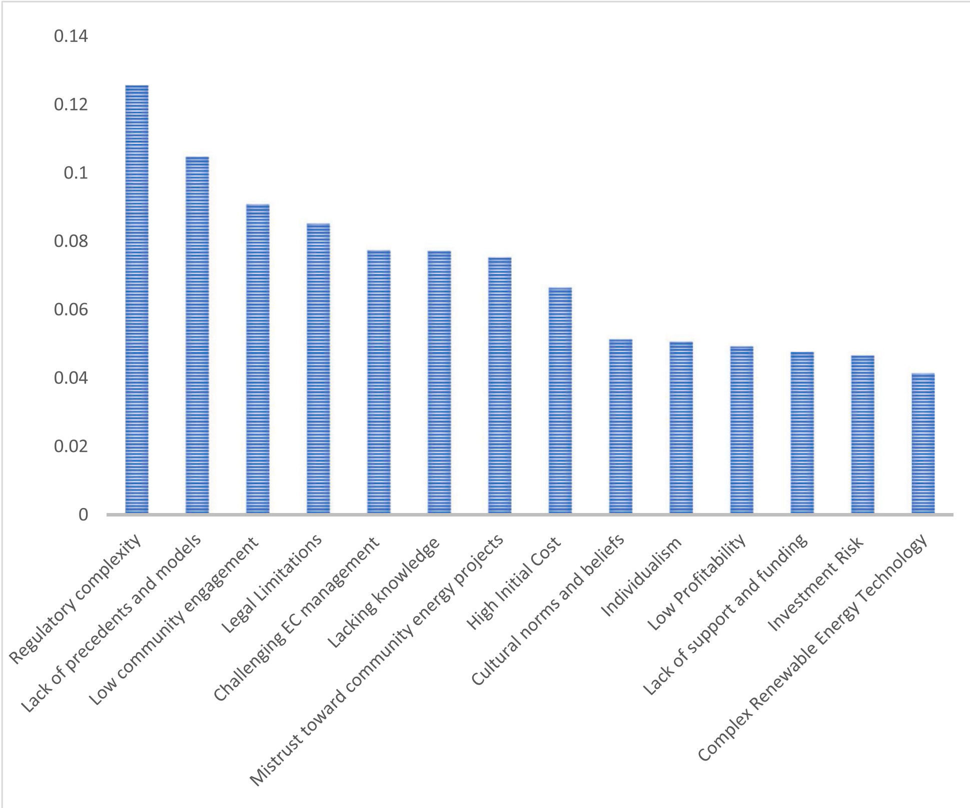

Fig. B. 2. Overall Barrier Ranking - Research Centres

Table B. 11
Barrier Rankings - Policymakers

Barriers	Priority Weight	Priority Weight (%)
Financial	0.193348	19.334812
Regulatory and Bureaucratic	0.380084	38.008361
Technical and Practical	0.198830	19.883007
Social and Cultural	0.227738	22.773819

CR = 0.008904.

Table B. 12
Financial Barriers Rankings - Policymakers

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Low Profitability	0.372469	37.246860	1
Investment Risk	0.197406	19.740579	3
High Initial Cost	0.279174	27.917395	2
Lack of support and funding	0.150952	15.095166	4

CR = 0.042624.

Table B. 13
Regulatory and Bureaucratic Barriers Rankings - Policymakers

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Legal Limitations	0.409414	40.941399	2
Regulatory complexity	0.455315	45.531519	1
Lack of precedents and models	0.135271	13.527083	3

CR = 0.026991.

Table B. 14
Technical and Practical Barriers Rankings - Policymakers

Barriers	Priority Weight	Priority Weight (%)	Rank
Low Community Engagement	0.517623	51.762306 %	1
Challenging EC Management	0.334568	33.456768 %	2
Complex Renewable Energy Technology	0.147809	14.780926 %	3

CR = 0.031206.

Table B. 15
Social and Cultural Barriers Rankings - Policymakers

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Lacking knowledge	0.221986	22.198625	3
Individualism	0.361151	36.115136	1
Mistrust toward community energy projects	0.277754	27.775446	2
Cultural norms and beliefs	0.139108	13.910793	4

CR = 0.093546.

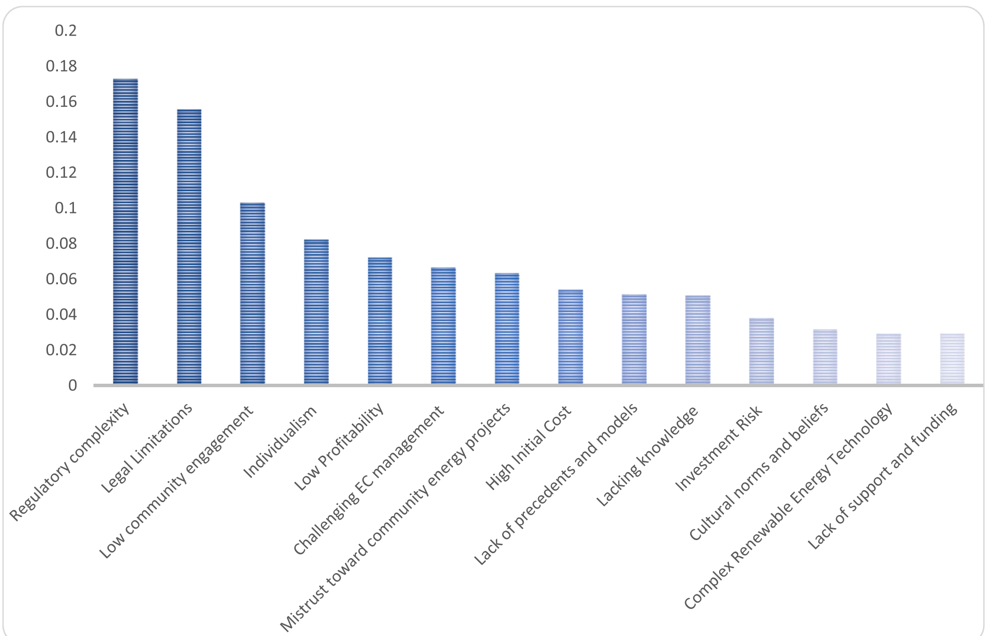

Fig. B. 3. Overall Barrier Ranking - Policymakers

Table B. 16
Barrier Rankings - Technical Experts

Barriers	Priority Weight	Priority Weight (%)
Financial	0.348726	34.872603
Regulatory and Bureaucratic	0.274907	27.490691
Technical and Practical	0.192384	19.238385
Social and Cultural	0.183983	18.398321

CR = 0.005012.

Table B. 17
Financial Barriers Rankings - Technical Experts

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Low Profitability	0.266783	26.678300	1
Investment Risk	0.205914	20.591420	3
High Initial Cost	0.294931	29.493129	2
Lack of support and funding	0.232372	23.237151	4

CR = 0.048730.

Table B. 18
Regulatory and Bureaucratic Barriers Rankings - Technical Experts

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Legal Limitations	0.296350	29.634995	2
Regulatory complexity	0.453118	45.311826	1
Lack of precedents and models	0.250532	25.053179	3

CR = 0.020426.

Table B. 19
Technical and Practical Barriers Rankings - Technical Experts

Barriers	Priority Weight	Priority Weight (%)	Rank
Low Community Engagement	0.379582	37.958155	1
Challenging EC Management	0.254170	25.417012	3
Complex Renewable Energy Technology	0.366248	36.624833	2

CR = 0.032258.

Table B. 20
Social and Cultural Barriers Rankings - Technical Experts

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Lacking knowledge	0.161792	16.179198	4
Individualism	0.307312	30.731191	1
Mistrust toward community energy projects	0.290936	29.093600	2
Cultural norms and beliefs	0.239960	23.996011	3

CR = 0.021268.

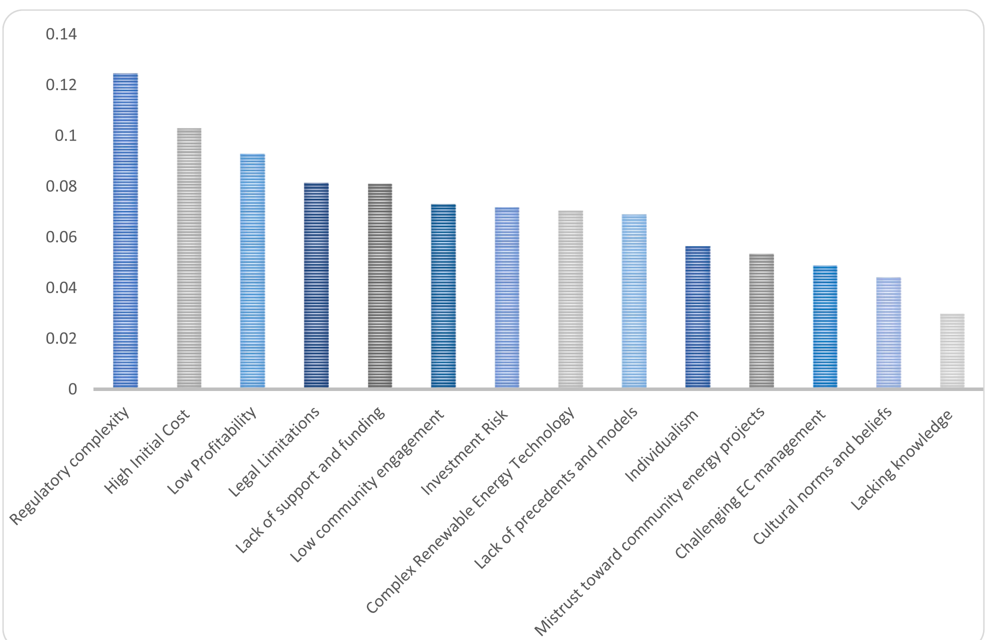

Fig. B. 4. Overall Barrier Ranking - Technical Experts

Table B. 21
Barrier Rankings - NGO

Barriers	Priority Weight	Priority Weight (%)
Financial	0.266401	26.640057
Regulatory and Bureaucratic	0.348203	34.820275
Technical and Practical	0.180187	18.018735
Social and Cultural	0.205209	20.520933

CR = 0.011180.

Table B. 22
Financial Barriers Rankings - NGO

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Low Profitability	0.194662	19.466166	4
Investment Risk	0.293460	29.345961	1
High Initial Cost	0.235654	23.565446	3
Lack of support and funding	0.276224	27.622426	2

CR = 0.036994.

Table B. 23
Regulatory and Bureaucratic Barriers Rankings - NGO

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Legal Limitations	0.346400	34.640030	2
Regulatory complexity	0.367755	36.775545	1
Lack of precedents and models	0.285844	28.584425	3

CR = 0.016426.

Table B. 24
Technical and Practical Barriers Rankings - NGO

Barriers	Priority Weight	Priority Weight (%)	Rank
Low Community Engagement	0.317063	31.706341	2
Challenging EC Management	0.379781	37.978132	1
Complex Renewable Energy Technology	0.303155	30.315527	3

CR = 0.028258.

Table B. 25
Social and Cultural Barriers Rankings – NGO

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Lacking knowledge	0.215970	21.596999	3
Individualism	0.249035	24.903537	2
Mistrust toward community energy projects	0.334165	33.416537	1
Cultural norms and beliefs	0.200829	20.082927	4

CR = 0.024214.

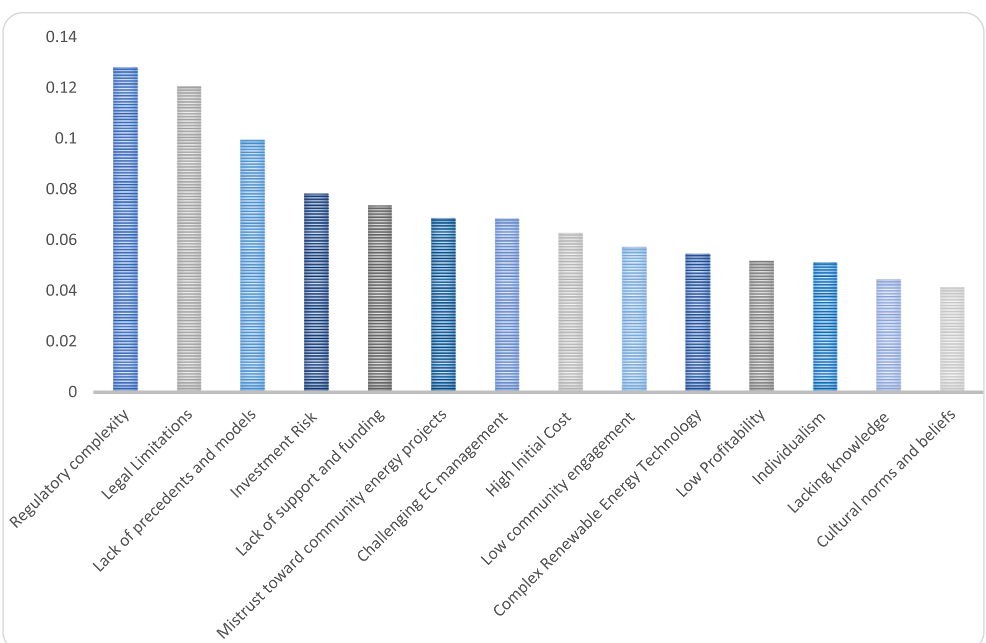

Fig. B. 5. Overall Barrier Ranking - NGO

Table B. 26
Barrier Rankings - EC Citizen Members

Barriers	Priority Weight	Priority Weight (%)
Financial	0.240880	24.088035
Regulatory and Bureaucratic	0.338443	33.844338
Technical and Practical	0.186607	18.660664
Social and Cultural	0.234070	23.406963

CR = 0.008765.

Table B. 27
Financial Barriers Rankings - EC Citizen Members

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Low Profitability	0.187711	18.771142	4
Investment Risk	0.258309	25.830925	3
High Initial Cost	0.280339	28.033871	1
Lack of support and funding	0.273641	27.364062	2

CR = 0.045026.

Table B. 28
Regulatory and Bureaucratic Barriers Rankings - EC Citizen Members

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Legal Limitations	0.337899	33.789915	2
Regulatory complexity	0.425276	42.527595	1
Lack of precedents and models	0.236825	23.682490	3

CR = 0.021434.

Table B. 29
Technical and Practical Barriers Rankings - EC Citizen Members

Barriers	Priority Weight	Priority Weight (%)	Rank
Low Community Engagement	0.393000	39.299963	1
Challenging EC Management	0.342477	34.247740	2
Complex Renewable Energy Technology	0.264523	26.452297	3

CR = 0.024407.

Table B. 30
Social and Cultural Barriers Rankings - EC Citizen Members

Barrier indicator	Priority Weight	Priority Weight (%)	Rank
Lacking knowledge	0.290999	29.099914	1
Individualism	0.276706	27.670563	2
Mistrust toward community energy projects	0.230441	23.044053	3
Cultural norms and beliefs	0.201855	20.185470	4

CR = 0.014495.

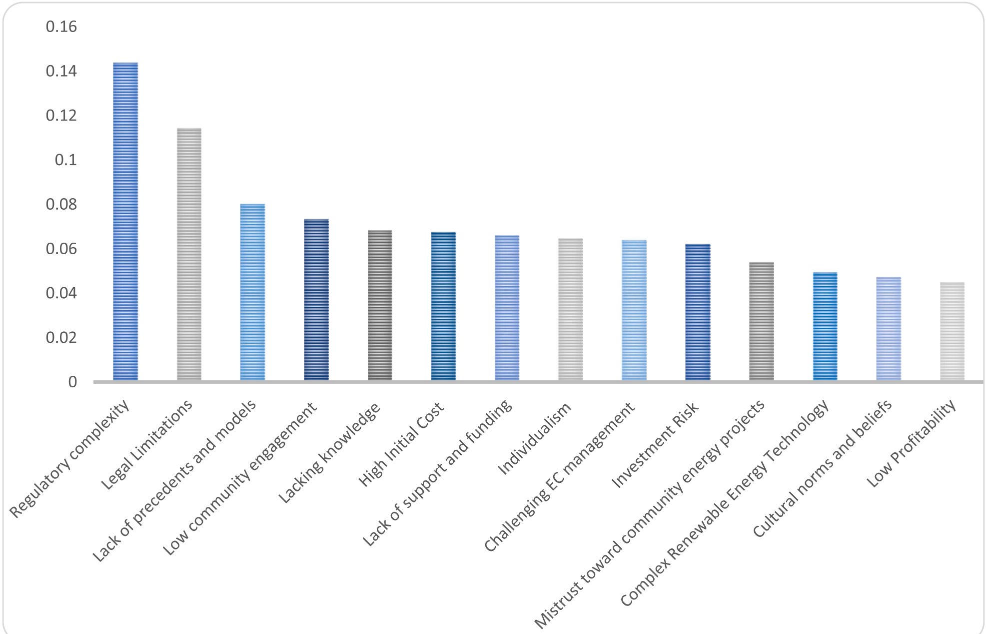

Fig. B. 6. Overall Barrier Ranking - EC Citizen Members

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