Masterpiece

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MASTERPIECE - Multidisciplinary Approaches and Software Technologies for Engagement, Recruitment and Participation in Innovative Energy Communities in Europe

Deliverable 2.2

BUSINESS REQUIREMENTS, BARRIERS AND REGULATORY ANALYSIS FOR ENERGY COMMUNITIES UPDATE

Title	Business requirements, barriers and regulatory analysis for energy communities – update
Document description	The deliverable aims to identify and evaluate the key barriers—economic, institutional, technical, and socio-behavioural—as well as the impacts—environmental, social, and economic—of Energy Communities at the EU scale. The deliverable also provides an updated overview of the EU and National policy frameworks addressing Energy Communities.
Nature	PU - Public
Task	Task 2.1 "Multilevel regulatory frameworks, administrative/operational barriers, market and financial requirements"
Status	Draft
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Lead Partner	UB
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1 EXECUTIVE SUMMARY

The deliverable aims to identify barriers (including economic, institutional, technical/technological and social/behavioural aspects) and impacts (including environmental, social and economic impacts) of Energy Communities (EC) and evaluate their relevance at the EU scale. The document is structured into distinct sections, each contributing to a broader understanding of ECs' development.

The first section provides an updated overview of the EU policy framework addressing ECs and highlights relevant updates to national policies and regulations, compared to the previous version submitted in Month 6. The regulatory evolution at both the EU and national levels reflects the novelty of the topic and the significant ongoing efforts to address it. The analysis highlights different progress speeds among European countries as regulations evolve in tandem with the growing understanding of this emerging concept.

The methodology section explains the approach used to gather data, combining an extensive literature review, a validation process, and the design and dissemination of a detailed survey targeting EC initiatives across Europe. The survey aimed to assess the relevance of various barriers identified during the literature review, ranking them based on their relevance, along with the impacts generated by ECs. 456 EC initiatives have been collected and engaged for the survey. This database is continually updated with new EC contacts to further enlarge the data collection and understanding of EC phenomena and impacts.

The result section focuses on the main findings from the literature review and the survey. By December 1, 2024, out of over 100 responses has been received. However, only 51 were considered valid and analysed. The survey shows that Italy, France, and Sweden host the highest number of ECs in our sample, while regions like Eastern Europe remain underrepresented. A second survey round will target these gaps to expand the analysis.

Results focus on the relevance of economic, institutional, technical, and socio-cultural barriers. These findings are further enriched by country-specific analyses, with examples from various European states to demonstrate the diversity of ECs challenges. The findings show that Institutional barriers are the most significant (including lack of policy stability and coherence, slow and unclear administrative procedures), followed by Economic (insufficient public funds and limited access to tailored financing options), and Socio-cultural barriers (low awareness of EC benefits, limited knowledge of the EC concept, and lack of trust). In contrast, Technical and Technological barriers appear to have a relatively lower impact on EC establishment and operation. Results focus also on the capacity of ECs to generate economic, environmental and social impacts. Considering the economic impacts, those mostly refer to economic returns for members, primarily through energy savings and community benefit redistribution, though job creation remains limited. Environmental impacts are perceived as low, except for climate change, which aligns with ECs' focus on green energy. Socially, ECs show strong participation and engagement, inclusivity of vulnerable groups, and positive impacts on community trust and cohesion, despite persistent gender imbalances.

The report also delves into the impacts of ECs, emphasizing their potential to promote energy democracy, reduce energy poverty, and strengthen local economies. However, it also highlights

areas requiring improvement, such as ensuring equitable access and enhancing stakeholder engagement.

The final section discusses future steps, including plans for a second dissemination campaign to gather more comprehensive data. This effort aims to refine the findings and deepen the understanding of barriers and impacts to support future academic publications and policy recommendations.

This deliverable is part of MASTERPIECE project. MASTERPIECE aims to build up a digital coordination and cooperation arena that will facilitate the creation and operation of ECs throughout Europe. The project's objectives are: i) to develop technical and social innovations to empower energy consumers and to make them active agents of collaborative ECs, paving the way towards a new energy market paradigm; ii) to create user-centric solutions that are based on participatory approaches such as co-creation and accelerate citizens' involvement; iii) to propose new business strategies and incentive mechanisms; iv) to configure a standardised and sound cyber-security infrastructure so the active citizens are protected against cyberattacks, at the same time that privacy is defended in accordance with the EU regulation; and v) to demonstrate the applicability and replicability of methodological, technical and business innovations in a variety of real-life pilots (France, Italy, Sweden and Turkey) in different geographical locations, with heterogeneous social and economic environments and different regulatory/administrative frameworks.

2 ENERGY COMMUNITY POLICY FRAMEWORK UPDATES

Energy systems worldwide are undergoing a significant transformation to meet sustainability goals and combat climate change. A key innovation in this context is the establishment of ECs, where individuals, businesses, and public entities collectively engage in energy production, consumption, and sharing. These communities prioritize Renewable Energy Sources (RES), fostering social, economic, and environmental benefits. ECs operate on the principle of consumers, local producers and prosumer engagement. The last one, represents one of them most crucial renovation in this transition towards energy democratization, decentralization, and decarbonization. Projections for 2050 (CE Delft, 2021) suggest that prosumers will significantly contribute to decentralized energy generation by covering up to 60% of RES production in EU-27, engaging around half of EU households with the potential to produce energy.

An EC is a legally recognized entity that enables collective production and management of energy resources (Masterpiece D2.1). Its primary objectives include promoting local energy production and sharing by enhancing local sustainability and citizen engagement. These communities emphasize collective decision-making, voluntary participation, and inclusivity. ECs are defined by 5 key characteristics: value proposition, membership, functions, governance, and value capture mechanisms (Masterpiece D3.3). They operate as legal entities with structures designed to ensure active member involvement in governance and decision-making processes. Their scope ranges from single buildings to entire neighbourhoods or rural areas. These communities might offer a set of energy services from energy production, energy sharing, energy storage, ancillary energy services as grid balancing, and Electric Vehicle (EV) charging stations of sharing mobility services.

The concept of ECs has evolved over the past century. Early cooperative models emerged in Denmark, Germany, Italy, and Spain during the early 20th century. The energy crises of the 1970s and the Chernobyl disaster brough high interest in decentralized energy systems. Denmark and Germany led the development of modern ECs, with Denmark pioneering collective investment in renewable energy in the 1970s. Today, over 10,000 ECs are active across Europe (Schwanitz et al., 2023). These initiatives are primarily citizen-led, focusing on energy production and management to achieve social and environmental benefits.

The European Clean Energy Package has provided a robust regulatory framework by introducing comprehensive policies to facilitate the growth and expansion of ECs in the EU. In Europe, ECs were initially promoted by the Renewable Energy Directive 2009/28/CE (REDI) and then improved by the Directive 2018/2001/EU (REDII) and the Internal Energy Market Directive 2019/994/EU (IEMD) on common rules for the internal electricity market. These directives promote the establishment of two different types of ECs: Renewable Energy Communities (RECs) and Citizen Energy Communities (CECs). Both the RECs and CECs are legal entities based on open and voluntary participation, effectively controlled by shareholders or members, with the purpose of achieving environmental, economic, and social benefits rather than financial profits (Masterpiece D2.1).

The second phase of the EU policy framework on ECs starts with the Green Deal strategy - which includes the Fit for 55 package - and the REPowerEU plan (Regulation (EU) 2023/435), which sets a target of establishing one EC in every municipality with a population of more than 10,000 by 2025. Whiting this second phase, the updated REDIII Directive (EU) 2023/2413 asks Member States to adopt measures that support RECs and renewable self-consumption with the aim to achieve the EU target of 42.5% of RES in final energy consumption and at least 49% or RES in the building sector by 2030. The directive also seeks to simplify permission/licences for renewable energy installations, especially for small-scale solar panels. Moreover, Member States are encouraged to modernize grid infrastructure and collaborate closely with distribution system operators (DSO) to mitigate grid constraints in terms of RES accommodation and management within the energy infrastructure. Additionally, the revised Energy Efficiency Directive (EU) 2023/1791 highlights the role of ECs in achieving energy-saving targets and combat energy poverty, with a focus on local and household levels and in public buildings. The recast of Energy Performance of Buildings Directive (EU) 2024/1275 (EPBD) further strengthens the role of ECs by explicitly including them as a solution for NZEBs. The new EPBD mandates the installation of rooftop solar panels on all new public and commercial buildings over 250 square meters by the end of 2026, on all new residential buildings and roofed car parks by 2029, and on existing public and commercial buildings by 2027-2030, depending on size and other factors. Lastly, the revised EPBD requires Member States to include strategies and measures to reinforce ECs within their National Building Renovation Plans.

ITALY

The policy framework governing ECs in Italy has undergone a significant evolution in the last 5 years. This evolution began with the Decree 162/2019, commonly referred to as the Milleproroghe Decree, and later expanded through Legislative Decrees 199/2021 and 210/2021 which converted REDII and IEMD into the national law. Among its initial provisions, Article 42-bis of the Milleproroghe Decree introduced transitional measures aimed at regulating an experimental phase of ECs (including both CEC and REC concepts). During this phase, renewable energy installations were limited to a

maximum capacity of 200 kW each, and their aggregation perimeter was restricted to systems connected to the same secondary transformer substation.

In 2022, the regulatory framework was further refined with the adoption of the ARERA Resolution, known as the Integrated Text for Distributed Self-Consumption (TIAD). This resolution, developed in compliance with Legislative Decrees 199/2021 and 210/2021, governs the requirements and procedures to implement and manage distributed self-consumption initiatives. These encompass various configurations, including collective self-consumption, RES, CEC, and individual self-consumers. Recent developments have further transformed Italy's regulatory approach to ECs. On January 2024, the CACER Decree (Configurazioni di Autoconsumo per la Condivisione dell'Energia Rinnovabile) came into force, introducing measures designed to accelerate energy sharing initiatives, including the development of ECs. The focus is no longer on self-production and self-consumption of energy, but on the ability to share energy locally with other members/actors belonging to the same market area (primary electrical transformation substation). This requirement preserves the local character of ECs in Italy, while allowing for the efficient use of existing distribution networks. Shared energy refers to the minimum, on an hourly basis, between the energy produced by renewable energy installations within the EC and the energy injected into the grid, and the energy consumed by the EC members. The energy shared is intended as virtual (it does not require a private smart grid) and based on hourly calculations (it does not require the installation of advanced metering devices). The Decree also established financial incentives, including a grant of up to 40% for renewable energy installations in municipalities with fewer than 5,000 inhabitants. Additionally, it introduced a variable premium tariff for renewable energy produced and shared within the community.

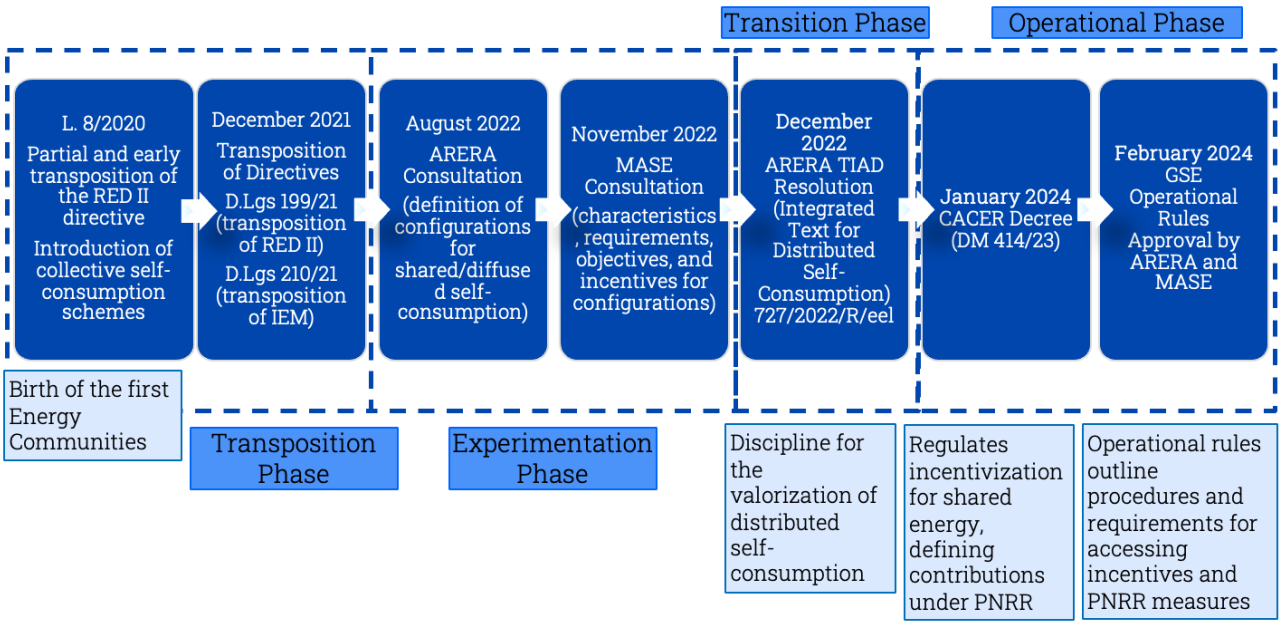

Figure 1 The evolution of the Italian policy framework

According to the new regulatory framework, ECs members can assume various roles in Italy, such as producers, prosumers, or consumers. ECs members retain their status as final consumers and have the freedom to withdraw from the community at any time. The Decree has also removed the

200-KW capacity limit for individual production, thereby enhancing the scalability of these communities.

Italy's legislative advancements reflect a deliberate effort to foster the development of renewable energy and energy sharing models while promoting community-driven energy solutions. By providing clear guidelines, financial incentives, and simplified procedures, the CACER Decree and related measures aim to enhance the economic and environmental sustainability of distributed energy production.

Operating incentives (Premium Tariff)	Capital incentives	Compensation for self-consumed energy	Dedicated withdrawal
Incentives for energy produced and shared among members from renewable sources until December 31, 2027, or for a total capacity of 5 GW.	PNRR financing mechanism for ECs in municipalities with fewer than 5,000 inhabitants for renewable energy for a total capacity of up to 2 GW within the limit of allocated financial resources amounting to 2.2 billion euros.	For each kWh of self-consumed energy, the authority recognises a unitary compensation defined as a valorization contribution. This value is determined annually by the national regulation authority (ARERA).	Plant owners are granted minimum guaranteed tariffs for the energy thesy sold to the authority, which help reduce market price fluctuations.

Figure 2 Set of incentives for ECs in Italy

The regulatory framework not only facilitates broader participation in ECs but also supports Italy's commitment to achieving its renewable energy targets. Indeed, Italy's ECs have grown significantly in recent years. By mid-2023, 109 EC configurations were operational, including collective self-consumption and RECs. Italy aims to achieve 5 GW of installed renewable capacity by 2026 and 7 GW by 2030, reflecting its commitment to decentralized energy systems. This integrated approach underscores the importance of local engagement and cooperative energy models as essential components of a successful energy transition.

For more detailed information, refer to the official CACER Decree DM 414/2023 and the GSE annex called “Regole operative per l’accesso al servizio per l’autoconsumo diffuso e al contributo PNRR” published in 2024.

FRANCE

The integration of RECs and CECs into the French Energy and Climate Law in 2019 marks a pivotal moment in aligning national policies with the European Clean Energy Package. Their first adoption and subsequent updating with Ordinance 236/2021 converged into the French Energy Code under a new section named “Energy Communities and Participatory Investment”. This provided guidelines on EC governance, membership, and project development. The policy framework was finalized with Decree 1287/2023, which introduced Title IX, “Energy Communities”, into the regulatory section of the Energy Code, detailing Articles R. 291-1 to R. 293-1. These articles outline permissible legal forms for ECs, including Société Anonyme (SA), Société par Actions Simplifiée (SAS), Société Coopérative d'Intérêt Collectif (SCIC), and associations under the 1901 law. The Decree also clarifies conditions for autonomy and establishes geographic proximity requirements between EC members and their renewable energy projects.

The 2023 Decree brought notable changes to proximity rules, expanding the allowable distance between members to 20 Km in rural areas and 10 Km in peri-urban regions. Municipalities are classified as rural or peri-urban based on population density and geographic features. These adjustments aim to broaden participation while retaining the local nature of ECs. Additionally, the decree introduced financial incentives through preferential network tariffs for RECs, with energy generation capped at 3 MW. Contracts between producers, consumers, and the DSO are required to streamline operations and ensure equitable infrastructure access. Withdrawal conditions were also formalized, ensuring that members exiting ECs are protected by consumer laws governing the termination of energy supply contracts. This provision fosters trust and transparency within ECs.
To further support ECs, the Decree mandates cooperation with network operators. Article L.293-2 of the Energy Code stipulates that electricity, natural gas, and heating or cooling network operators must facilitate energy sharing within ECs. Specific cases for compensating network operators are defined, with payments determined based on transmission, distribution, and ancillary service tariffs.

France's APRE Law complements these efforts by promoting renewable energy production. Article 40 mandates the installation of photovoltaic panels on shading systems for outdoor parking lots larger than 1,500 square meters as of July 1, 2023, with at least 50% coverage of the parking surface. This measure aligns with broader national objectives to optimize surface use for renewable energy generation.

Over the past 15 years, France has seen the emergence of more than 360 ECs, reflecting a growing grassroots movement in renewable energy. These initiatives highlight the potential of local participation in complementing national energy policies. However, achieving France’s ambitious renewable energy targets requires enhanced strategic planning and robust political commitment. While advancements in offshore wind energy are evident, there is an urgent need to establish more ambitious goals for onshore wind and other renewable technologies to ensure balanced sectoral growth. The consolidation of a robust policy and regulatory framework demonstrates France’s commitment to empowering local actors and fostering sustainable energy systems. Nonetheless, achieving the broader energy transition goals will necessitate ongoing policy innovation, strategic investments, and collaborative stakeholder efforts to ensure inclusivity and long-term success.

For more detailed information, refer to the official publication of the decree on Legifrance: Decree 1287/2023 on ECs, Official Journal of December 28, 2023, text No. 96.

SWEDEN

In Sweden, the government has not formally finalized the energy community’s transposition regulations (REScoop, 2024), since Sweden already had a targeted regulation on collective self-consumption. The Swedish Energy Regulator has proposed recommendations on how to transpose the law, entailing definitions of REC and CEC (Dorian et al., 2020; Fina & Monsberger, 2022). In 2021, the Energy Market Inspectorate proposed a bill that stated that ECs should be economic associations with a protected name that indicates their nature compared to other collective self-consumption initiatives. The Energy Market Inspectorate concludes that Sweden does not require new legislation to regulate ECs since there are currently no obstacles for ECs to participate in the energy market (Palm, 2021). Thus, the two EC configurations suggested by EU directives, i.e., REC and CEC, now converge under the Swedish Law on Economic Association. Existing energy

cooperatives and associations can decide to become ECs and continue to conduct their businesses (Dorian et al., 2020).

As Sweden did not formally transpose EU Directives, it does not have any special policies and measures to promote or finance ECs (REScoop, 2024). ECs are economic association that can profit from state incentives through tax relief and reduced real estate tax as all others micro-producers of RES. Energy sharing is possible but limited to a single grid connection point. Prosumers are exempted from some grid connection fees or are subject to lower rates than larger energy producers and suppliers.

Acconrding to Magnusson and Palm (2019) there are 140 active EC initiatives. Wind cooperatives, eco-villages, and communities based on small-scale heating systems or solar power are by far the most common form of ECs in Sweden (Palm, 2021). In Sweden, certain challenges still exist for the widespread implementation of ECs, partly due to the centralized market structure of the Swedish energy system. This market is largely dominated by hydro and nuclear power, technologies primarily controlled by a few national or multinational companies. This concentration can create some obstacles for the development of decentralized initiatives. Additionally, municipalities in Sweden play a significant role as providers of gas, electricity, and district heating. While this strong municipal involvement offers opportunities for local energy management, it may also partly explain the relatively modest presence of citizen-led initiatives. These dynamics highlight the importance of creating a more inclusive framework to support diverse EC initiatives (Palm, 2021).

TURKEY

The regulation of renewable energy in Turkey began with the enactment of Law No. 5346 on the Utilization of Renewable Energy Sources for the Purpose of Generating Electrical Energy in 2005 and was further strengthened by the Electricity Market Law No. 6446, passed in 2013. These laws provided the initial legal foundation for renewable energy development in Turkey, setting the stage for subsequent advancements in the framework for ECs.

While Turkey is not a member of the EU and does not formally transpose EU directives, it has permitted community-driven collective energy generation and consumption since 2016. However, this allowance is limited to individuals, cooperatives, or legal entities within the same tariff group system and connection point, or those whose energy consumption can be monitored by a single meter (Biresselioglu et al., 2021). ECs in Turkey are primarily organized as energy cooperatives, regulated under the Regulation on Unlicensed Electricity Generation in the Electricity Market (2016). This regulation allows individuals and cooperatives to generate electricity without obtaining a license from the Energy Market Regulatory Authority. Members of these cooperatives are permitted to self-consume the energy they generate and sell any surplus to the grid. This legal framework aligns with the EU's definitions of RECs and CECs and has facilitated the creation of approximately 50 electricity-generating cooperatives in Turkey (Biresselioglu et al., 2022). In 2019, the regulatory framework was modified with Presidential Decree 30770/2019, which removed the unlicensed privilege for energy cooperatives exceeding 5 MW of installed capacity. Nevertheless, ECs continue to benefit from public incentives available to other renewable energy generation plants.

A further significant milestone in Turkey's energy legislation was achieved in December 2022 through amendments to the Electricity Market Law passed in 2013. These amendments introduced the concepts of “aggregators” and “aggregation activities” into Turkey's energy market framework. Aggregators were defined as entities managing the collective energy production or consumption of multiple participants, including households, small businesses, and communities. This created opportunities for ECs to organize effectively and participate in balancing energy demand and supply within the grid (Acar et al., 2024).

Moreover, regulatory progress was made in November 2022 with the publication of energy storage regulations in the Official Gazette. These regulations established a legal framework for integrating energy storage systems into renewable energy projects. This development is particularly advantageous for ECs, as it allows the combination of local renewable energy generation, such as solar or wind power, with battery storage systems. The integration of energy storage solutions strengthens the operational autonomy of ECs and supports their ability to contribute to grid stability (Acar et al., 2024).

Turkey has demonstrated its commitment to fostering ECs through financial incentives outlined in the National Energy Efficiency Action Plan (UEVEP II) for the period 2024–2030. The plan allocates $20.2 billion to support energy efficiency and renewable energy projects, including those led by ECs. These incentives significantly lower financial barriers, enabling the establishment and scalability of renewable energy systems in local communities. Additionally, under the Renewable Energy Support Mechanism, Turkey provides feed-in tariffs for renewable energy generation by both licensed and unlicensed power plants, covering wind, solar, biomass, hydro, and geothermal energy. Plants using locally manufactured components receive additional financial support. The feed-in tariffs are fixed in US dollars, protecting investors from currency risk (IEA, 2020).

Municipalities, as the major local administrative units in Turkey, also play a role in EC development. While legislative power resides with the national government, municipalities are permitted to join energy cooperatives. However, they lack independent authority to initiate energy transition activities unless explicitly authorized by law (Biresselioglu et al., 2022).

3 ENERGY COMMUNITY BARRIERS ASSESSMENT

3.1 Methodology

The deliverable employs a three-step approach. The first step aims to identify the main barriers emerging in academic papers and policy reports through a semi-structured literature review and desk research. Barriers identifies are then categorized into different categories (economic, institutional, technical and technological, socio-cultural and behavioural) and classes. The second step aims to validated barriers identified and, eventually, add any additional ones through a systematic literature review by using the Prisma technique. Finally, the third step aims to assess the relevance of barriers identified and validated in the previous two steps by conducting a survey. To this intent, we develop a questionnaire targeting EC initiatives in the EU. The survey asks participants to evaluate the significance of a predefined set of barriers on a scale from 0 to 5, where 0 represents the absence of the barrier (or the respondent's lack of knowledge on the issue) and 5

indicates a high level of relevance in hindering the development and operation of the EC. We also ask respondents about the EC maturity phase. Based on the literature we consider three maturity phases: the development phase, the operation and management phase, and the refinancing and expansion phase. In details:

- **The development phase** represents the initial stage of an EC, during which the initiative is conceptualized, and a strategic plan is formulated to achieve the intended objectives. This phase typically involves various technical and economic assessments to ensure the viability and effectiveness of the proposed EC and the effective launch of the initiative.
- **The operation and management phase** refers to a stage in which an EC is fully established and functional. During this phase, the focus shifts towards organizational and managerial activities that are essential for the ongoing operation and long-term sustainability of the EC.
- **The refinancing and expansion phase** occurs after the successful implementation and management of the EC. At this stage, the focus shifts towards assessing the outcomes of the current operations and exploring opportunities for future expansion in terms of members, activities and services to ensure sustained growth and development of the EC.

The following table (1) shows our database of 456 ECs from 17 EU countries, both in northern and southern Europe, to which we sent the questionnaire. The EC dataset is continuously being updated, with new EC contacts regularly added to the list. Additionally, we have reached out to several organizations and networks to request their support in disseminating the survey.

Countries	Numbers
Austria	1
Belgium	27
Bulgaria	1
Croatia	1
Denmark	4
Estonia	1
France	130
Germany	27
Greece	61
Ireland	9
Italy	39
Netherlands	127
Poland	3
Romania	1
Spain	12
Sweden	5
UK	7
Total	**456**

Table 1 Countries in which the ECs in our survey are active.

3.1.1 Energy Community barriers' identification and categorization

The first research step aims to investigate the barriers that mostly hinder the development and operation of ECs by reviewing the existing literature. The final aim is to synthesize and categorize these barriers into distinct groups. For this purpose, a semi-structured literature review and desk research was conducted to identify papers and policy reports addressing EC barriers. We retrieved academic papers and reports from Google Scholar, Scopus, and the Web of Science database using the following keywords: "energy community", "community energy", "renewable energy community", "citizen energy community", "barriers", "challenges", "hindering factors", and "constraints". The rationale for selecting different keywords stemmed from the diversity of terms used in academic literature regarding the topic of the ECs (Gruber et al., 2021).

In the literature, there are many papers focus on EC barriers; however, we only considered review papers and articles that have already conducted a detailed analysis of EC barriers. Our goal is to develop a comprehensive conceptual framework of the main EC barriers. Additionally, we conducted our search exclusively using "authors' keywords" to ensure the inclusion of papers that explicitly address the topic of the EC barrier, while excluding those that merely mention it as a minor topic. To avoid barriers associated with country-specific contexts, and to ensure clarity and consistency of our research we exclusively considered papers published in English. Finally, we focus our analysis on papers and reports published in the last decade, excluding earlier research and policy reports. The reason is to ensure that papers selected capture the most relevant and up-to-date barriers to the development and operation of ECs. This approach allows us to avoid outdated barriers that may no longer be applicable due to the evolution of policies and the changes occurred in the energy market.

We retained a total of 26 articles and review papers from the Web of Science and Scopus databases. The analysis also included six reports from EU-funded projects and European public agencies that are extracted from the Google Scholar database. Thus, 32 scientific works were analysed to identify ECs barriers. Since the terms used to describe EC barriers do not coincide across all studies, we conducted a terminological harmonization process to merge terms with equivalent meanings into a unified conceptual framework. In total, 26 unique barriers were identified.

Barriers have been categorized and grouped based on their thematic relationships. Utilizing a bottom-up perspective, we developed a novel three-tier categorization system (see Figure 1) not derived from existing frameworks in the literature. This system (Table 2) comprises: (i) categories, representing the higher-order classification of barriers sharing fundamental attributes (e.g., Economic barriers category); (ii) classes, grouping together barriers with significant thematic relationships (e.g., Lack of access to finance); and (iii) barriers, representing specific and tangible challenges that ECs face in their development and operation (e.g., Lack of access to traditional finance). See In total, we identified 26 barriers, 10 classes, and 4 categories of EC barriers (see Table 3).

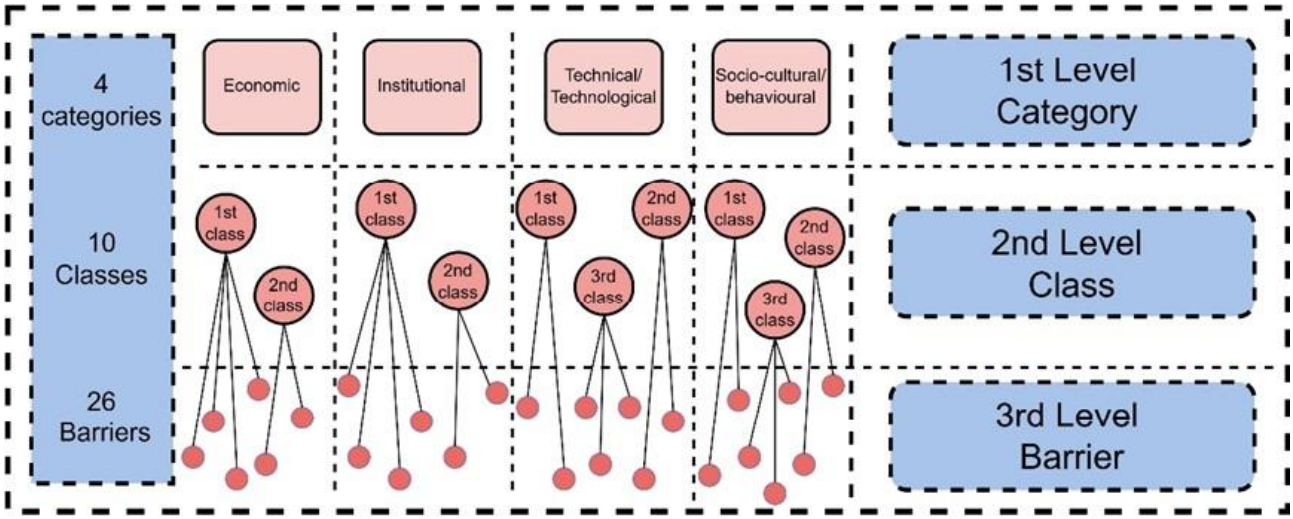

Figure 3 The three-level categorization in our study

Level	Definition
Level 1 - Category	It represents the primary level of classification for ECs barriers and refers to broad characteristics.
Level 2 - Class	This refers to a sub-categorization level based on strong thematic relationship. Classes represent a more focused aggregation of barriers.
Level 3 - Barrier	This refers to distinct issues that hinder the development and/or operation of an EC. Barriers are specific and tangible challenges for ECs.

Table 2 Definition of the three-level categorization of EC barriers

Category	Class	Barrier
Economic	Financial Barriers	Lack of access to traditional finance
		Difficult to access finance from members
		Lack of tailor-made finance options
		Lack of public funds for ECs
	Market Barriers	Lack of a level playing field (i.e. economy of scale)
		Presence of market incumbents
Institutional	Policy and Regulatory Barriers	Absence or lack of a clear and uniform definition for ECs
		Lack of a clear scope of EC's activities
		Lack of policy stability and coherence
	Administrative and Bureaucratic Barriers	Lack of simple and clear administrative procedures
		Slow administrative procedures plants
Technical/Technological	Technical Barriers	Lack of space to build RES
		Lack of technical skills (skilled personnel)
		Lack of technical expertise
	Lack of efficient infrastructures	Lack of efficient and suitable energy infrastructure
		Lack of IT infrastructure
	Lack of enabling technologies	Low diffusion of smart technologies
		Data management issues
		Cybersecurity and protection issues

Socio-cultural and Behavioral	Lack of Knowledge and awareness of ECs	Lack of knowledge regarding the EC concept
		Lack of awareness about ECs' benefits
	Lack of Trust	Lack of trust in private or public actors
		Lack of trust towards peers in the EC
	Lack of Socio-cultural conditions	NIMBY syndrome and local backlash against RES and ECs
		Lack of cooperative tradition in the country or the region your EC is operating
		Lack of Environmental awareness in the country or the region your EC is operating

Table 3 Barriers of ECs' development, and classification into different categories and classes

The first category refers to economic barriers. Those are associated to challenges faced by ECs in obtaining financing and/or entering the energy market due to unfair competition with other market players. Therefore, we provided two classes: (i) lack of access to finance, which encompasses four barriers, and (ii) market barriers, which includes two barriers. (See Table 3).

The second category includes institutional barriers, and we split it into two different classes: (i) the policy and regulatory barriers, which refer to issues related to EC policy frameworks and the lack of public funds; and (ii) the administrative and bureaucratic barriers related to complex or slow daily operations for EC establishment and operation.

The third category refers to technical/technological barriers, which includes issues arising from the limited availability and diffusion of technologies, such as energy storage, smart appliances, and smart meters, or from outdated and inefficient energy infrastructure, as well as issues with data security and protection. We identified three classes: (i) technical barriers, which refer to a lack of space to build RES and a lack of technical skills necessary for the development and operation of ECs; (ii) lack of proper infrastructure; and (iii) lack of enabling technologies.

The final category, the socio-cultural/behavioural, refers either to problems stemming from the wider socio-cultural environment in which ECs operate or from individuals' knowledge and interests. Three categories were identified: (i) lack of knowledge or awareness about ECs; (ii) lack of trust; and (iii) lack of socio-cultural conditions, which refer to barriers related to NIMBY syndrome or the cooperative tradition that facilitates the development and operation of ECs.

3.1.2 Energy Community barriers validation

To validate the barriers defined at the first stage, we conducted a semi-systematic literature review aimed at quantifying the occurrence of barriers documented in academic literature. Keywords are essential for conducting a semi-systematic literature review in order to include all academic papers related to the topic without missing any important research areas. We identified the most pertinent keywords associated with the EC topic. Additionally, we utilize keywords beyond the term "barrier", such as "challenges" and "hindering factors". that have similar meaning. The table below presents the keyword search terms used (see table 4).

Set of Keyword for search term (ST)	Search Term
ST-1	("Energy communit*" OR "Community energy" OR "Local Energy Communit*" OR "Renewable Energy Communit*" OR "Energy Cooperative*" OR "Citizen Energy Communit*" OR "Renewable Energy Cooperative*" OR "Community Renewable Energy" OR "Smart Energy Communit*" OR "Community Solar" OR "Solar Communit*")
ST-2	("Barrier*" OR "Obstacle*" OR "Challenge*" OR "Hurdle*" OR "Constraint*" OR "Hindering factor*")
Final ST	(ST-1) AND (ST-2)

Table 4 Search terms

We utilized the above-mentioned search terms in two databases, Scopus and Web of Science (WOS), to ensure a comprehensive coverage of all academic papers on EC barriers. We established inclusion and exclusion criteria for the selection of papers. We limited our review to papers published after 2014 to focus on the most recent barriers, thus excluding potentially outdated ones. We included a variety of document types, specific articles, review articles, early access documents, and procedural documents to capture as many barriers as possible. Nevertheless, we excluded editorial material, letters, data documents, and corrections to maintain a focus on the most relevant and highest quality works. Additionally, we included only documents written in English to ensure consistency in terminology and avoid country-specific barriers.

We followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA1) guidelines to conduct semi-systematic literature review on EC barriers. The PRISMA guidelines involves four phases of decision-making: Identification, Screening, Eligibility, and Inclusion. In the Identification phase, we found 789 papers in the WOS database and 848 papers in Scopus using the specified search terms (see Table 4). This resulted in a total of 1,637 identified documents. Additionally, 22 documents were added to the review from Google Scholar and Google using search keywords and the snowball approach from reports and research papers. We identified 599 duplicates, which were subsequently excluded from the analysis.

During the screening phase, we read and analysed the titles, abstracts, and keywords of 1,060 documents to select those for full-text screening. At this stage, 545 papers were removed as they were not related to the research focus of this study. Consequently, 515 papers were downloaded and prepared for full-text assessment.

At the eligibility phase, 420 projects were excluded after screening the whole document, due to irrelevance to the topic. Thus, in the last phase, i.e., the inclusion phase, we keep 95 papers and 6 reports (6 reports are included later from outside of searching as those are quite crucial) for analysis.

[1] Prisma is the structure that usually applies to reporting systematic reviews.

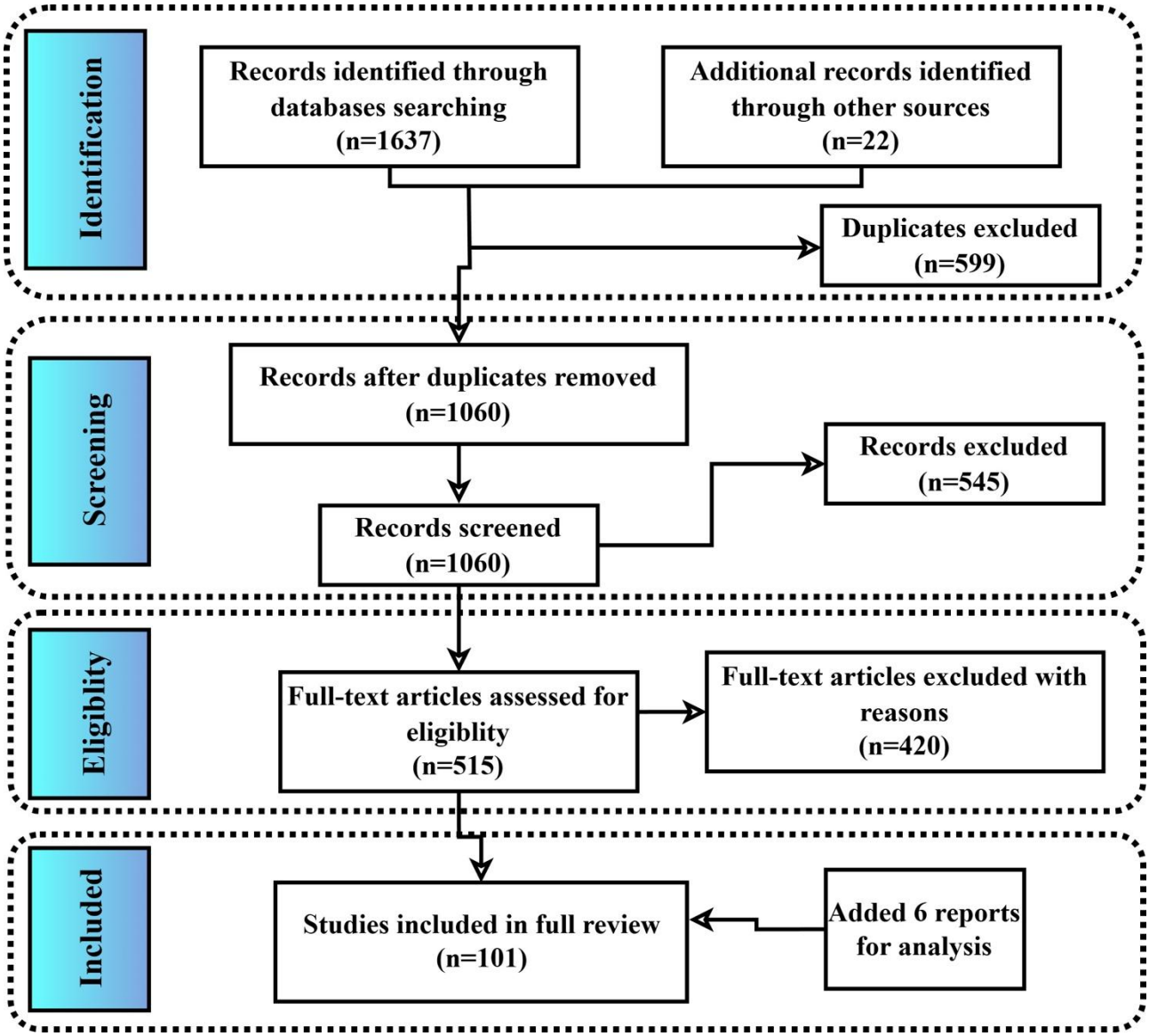

Figure 4 Illustrates the PRISMA diagram of paper selection

After selecting the relevant scientific works, the validation process of EC barriers entails analysing each paper using NVivo software. Each of the identified barriers listed in Table 3 was transformed into a code and assigned to barriers emerging in the set of selected papers to evaluate barrier occurrence and validate their relevance.

3.1.3 Energy Community barriers assessment

The last step entails the design and launch of a survey addressing EC initiatives located in the EU. The survey aims to gather novel quantitative and qualitative data on:

- The relevance of Economic, Institutional, Technical/Technological, and Socio-cultural and Behavioural barriers in setting up, developing and operating EC initiatives in the EU
- EC impacts, including environmental, social and economic impacts.

The survey is created using the Qualtrics software and will target "EC representatives", defined as individuals holding management and/or organizational roles within the EC initiative. These representatives have participated in or are currently involved in the development, implementation, and management of the EC and have access to technical, administrative, or financial data. In selecting the EC sample, there are no constraints on the scale of the ECs, the number of members, the energy generation technology, the energy sources, or the legal forms. Different degrees of EC maturity will be considered to assess the relevance of the barriers and the quantity and quality of impacts at various stages of EC development.
For assessing the barriers, respondents have to rate the relevance of barriers by ranking them from 1 to 5, where 1 means very low relevance and 5 means very high relevance. Respondents have also the option to select "0" when the barriers do not exist at all, or they do have not enough clue on the relevance of the specific barrier. Barriers to assess come from the previous two research steps. Each barrier identified, classified and validated through the literature will be the basis for a query.

The survey will consist of 3 thematic blocs:

- EC characteristics (including location, maturity, N. and type of members, activities performed, etc.)
- EC barriers: List of barriers, break down into 4 categories (Economic, Institutional, Technical/Technological, and Socio-cultural and Behavioural barriers)
- EC impacts: List of indicators (qualitative and quantitative) to assess EC impacts including environmental, social and economic impacts. Questions will be structured to gather data on the existence and the relevance of impacts as well as their quantitative and/or qualitative measurement, where possible.

Results are anonymized. Sensitive and personal data are not requested by the questionnaire. All collected data is held securely until the end of this initiative. Once the retention period has expired, the data will be deleted, unless we are subject to any other statutory retention obligations or if any other legal grounds exist to continue to store the data.

The deliverable reports and analyses the responses collected up to December 1, 2024. However, the survey will remain open to enable a more comprehensive investigation into the relevance of identified barriers and ECs impacts. In the coming months, an extended dissemination campaign will be conducted to reach ECs that did not participate in the initial survey phase and to include newly identified ECs in our growing database of initiatives across Europe. This effort aims to enhance the analysis and support the development of a publication that contributes valuable insights to the project and the broader scientific community.

4 ENERGY COMMUNITY IMPACT ASSESSMENT

4.1 Methodology

As anticipated, beside barriers' assessment we decided to include an additional section to the survey, to gather some initial evidence on the impacts of ECs' activities. This is a field of research still quite unexplored to date, yet of increased interest both among academic scholars and policy makers, including European institutions (Energy Communities Repository, 2023).

EC are deemed and characterized as relevant actors along the energy value chain, but also as a form of social innovation in the European energy transition (Lupi V. et al., 2021). They allow citizens and local communities to play an active role in the energy transition and often have a wider scope than the development of energy projects and provision of energy services. This social connotation has also informed the first formal definition of EC introduced by two EU Directives (REDII, IEMD). REC and CEC have been designed and outlined in the EU Directives as new actors in the European energy systems serving a "dual purpose": an "energy purpose" and a "social purpose" (Candelise and Ruggieri, 2020). They have been framed as a solution to increase local self-consumption in order to reduce grid exports and related impacts, thus facilitating higher integration of renewable and intermittent generation into European energy systems ("energy purpose"). But they are also conceived as entities committed to delivering social, environmental, and economic benefits to their members and local communities ("social purpose").

The large majority of the literature on EC of the last decade has been focusing on understanding the phenomenon, characterizing the heterogeneity of the initiatives and studying the conditions underlying their development, both from a socio-economic and policy perspective. Since the progressive transposition of the EU Directives into EU member states, EC, RECs and CECs have a recognised formal role in the European energy systems and have begun to receive policy support through dedicated incentives schemes. This shift calls for a higher attention to monitoring their activities, with the view of informing not just the research debate, but also policy makers in order to support evidence-based policy making. This is where the need of assessing the impacts of their activities comes in. Beside their contribution to the energy transition, their role as social innovation actors, i.e. responding to the "social scope", should be assessed and analysed, along with their development and diffusion across EU member states.

However, existing evidence on impacts of EC is still very limited, particularly on their social impacts (Berka and Creamer, 2018, Bielig et al., 2022). Contributions on the topic tend to either review emerging methodological approaches (Bielig et al., 2022) or to provide some initial evidence on a case study basis (Dudka and Magnani, 2024, Lacey-Barnacle, 2020, Mundaca et al., 2018). Some survey based studies are emerging, which tend to be focused on specific connotations of EC's social impacts, e.g. Hanke et al. survey based study on evidence of EC contribution to energy poverty alleviation (Hanke et al., 2021), or Radtke which have analysed citizens participation and involvement using a survey circulated among EC members (Radtke, 2014). In our knowledge, comprehensive survey-based analysis of EC activities impacts across EU, addressed directly to ECs, have not been developed to date or, at the very least, results have not been published yet.

To provide an initial contribution to fill this knowledge gap, we have introduced a block of questions within our survey dedicated to evidence gathering on ECs' impacts considering three dimensions: economic, environmental and social dimension (Candelise et al., 2021). These dimensions are also coherent with the definitions of REC and CEC provided by the two EU directives which define them, among other things, as legal entities "the primary purpose of which is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits".

This approach has also been more recently adopted by the Energy Communities Repository (ECR) of the EU Commission in developing their methodology for EC impacts assessment (Energy Communities Repository, 2023). Indeed, when one of our identified impacts was in common with the ECR methodology, we drafted the relative question using the same definition, measure and value ranking of the ECR questionnaire, for the sake of homogeneity in data gathering on EC at EU level. To provide an example, for question 36, on share of female members, we have used exactly the same percentage ranges of ECR questionnaire, which would potentially allow comparability of results. We also got in contact with EU Commission representatives to check about any ongoing data gathering based on such methodology, but we could not find any available or published results to date. The list of questions on impacts is structured as follows:

- Questions on economic impacts: they refer to economic benefits for CE members, jobs creation and possible economic spillovers to the wider community
- Questions on environmental impacts: aim at assessing GHG emissions reduction potential and possible wider impacts on the local environment.
- Questions on social impacts: refer to levels of participation in governance, community empowerment, recognition of vulnerable people, implementation of measures for energy poverty alleviation and of educational/social activities, and achievement of wider social impacts.

5 RESULTS

5.1 List of barriers, categories, and classes

This section identifies and categorizes the barriers to EC as documented in the literature. The barriers are classified into four primary categories: Economic, Institutional, Technical and Technological, and Socio-cultural and Behavioural. Within each category, specific classes and individual barriers that impact EC implementation and operability are defined. Due to the variety of terminologies and concepts used in the literature, a comprehensive content analysis was performed to establish standardized barrier definitions. The following list presents the finalized classification of barriers and provide our conceptual framework for assessing them.

Category 1: Economic barriers: It refers to ECs difficulties in accessing financing and in entering the energy market.

Class 1: Financial barriers: It refers to difficulties in financing activities for ECs.

Barrier 1: Lack of access to traditional finance: It refers to difficulties in accessing finance from traditional market actors, such as commercial banks, development banks, investors, cooperative funds etc.

Barrier 2: Difficult to access finance from members: It refers to the difficulties in raising money from EC members through equity capital, membership fees, community bonds, etc.

Barrier 3: Lack of tailor-made finance options: It refers to the lack of financial instruments dedicated to ECs. For instance, specialized public tariffs, subsidies, tax breaks, ethical loans, sustainability loans, sustainability linked bonds, sustainability linked grants, etc.

Barrier 4: Lack of public funds for ECs: It refers to absence of public grants directed to ECs. For instance, lack of national or regional grants for EC projects.

Class 2: Market barriers: It refers to the difficulties faced by ECs in acting within the energy market compared to commercial and traditional energy players. These challenges can be inherent to ECs' characteristics, such as their small size, or caused by asymmetric market dynamics, considering traditional energy players and incumbents.

Barrier 5: Lack of a level playing field: It refers to the lower competitiveness of ECs compared to traditional actors in the energy market. For example, ECs lack economies of scale due to their smaller size compared to other market actors.

Barrier 6: Presence of market incumbents: It refers to the difficulties in accessing energy markets due to the presence of incumbents that create lock-in mechanisms, preventing ECs from developing. For example, incumbents maintain strategic dominance.

Category 2: Institutional barriers: Institutional barriers are related to political obstruction, conflicting guidelines, lack of policy coordination as well as bureaucratic and administrative issues.

Class 1: Policy and regulatory barriers: It refers to either the lack of policies and regulations or the presence of unclear and/or conflicting policies and regulations related to ECs.

Barrier 7: Absence or lack of a clear and uniform definition of ECs: It refers to the absence of a formal definition of ECs or the lack of related policy and regulations. For example, a definition that is too broad allows for the misapplication of the concept of EC, while a definition that is too narrow might discourage newcomers from starting an EC.

Barrier 8: Lack of a clear scope of EC's activities: It refers to the lack of a clear scope and list of allowed activities that ECs can perform, following or partially following the RED and IEMD directives, which state that ECs can participate in and develop activities in the whole energy value chain, including energy production, flexibility services, P2P trading, energy storage, bioenergy, etc.

Barrier 9: Lack of policy stability and coherence: It refers to the lack of continuity in legislation (i.e., constant changes in legislation and regulations on EC) and the lack of vertical and horizontal governance coherence. For example, conflicting regulations between different governance levels (national and regional ones), or between different sectors of ministries or public departments at the same level.

Class 2: Administrative and bureaucratic barriers: It refers to complexities or slow day to day operation due to administrative or bureaucratic issues

Barrier 10: Lack of simple and clear administrative procedures: It refers to the absence of clear administrative procedures supporting ECs projects setup and implementations. Lack of clear administrative procedures creates confusion, increases administrative costs, and discourages people from starting new projects.

Barrier 11: Slow administrative procedures: It refers to the difficulties that arise when administrative procedures for setting up an EC or energy projects are slow. For example, very slow permitting procedures for renewable energy projects discourage investments, slow down project development, and increase costs.

Category 3: Technical/Technological barriers: It refers to difficulties generated by lack of skills and resources, limited availability and spread of technologies, i.e., smart meters, energy storage, and smart devices), inefficient and old energy infrastructures, and data protection and security issues.)

Class 1: Technical barriers: It refers to the lack of land/space to build RES plants/infrastructures or the lack of skills.

Barrier 12: Lack of space to build RES plants: It refers to lack of space to build specific renewable energy plant. For example, wind turbines are difficult to accommodate in urban areas whereas PV is more suitable.

Barrier 13: Lack of technical Skills (skilled personnel): It refers to the lack or limited availability of technically skilled personnel who can perform the installation, operation, or maintenance of different energy systems.

Barrier 14: Lack of technical Expertise: It refers to the lack of technical expertise required to deal with administrative and legal procedures and to apply for public funds, grants, etc.

Class 2: Lack of efficient infrastructures: It refers to the lack of efficient and suitable energy and IT infrastructures.

Barrier 15: Lack of efficient and suitable energy infrastructure: It refers to the lack of an efficient energy infrastructure suitable to accommodate increasing levels of decentralized generation. For example, grid access can be restricted to EC's due to grid management issues and saturation.

Barrier 16: Lack of IT infrastructure: It refers to the lack of an IT infrastructure that could allow for proper and suitable data collection, usage, validation, and sharing.

Class 3: Lack of enabling technologies: It refers to the lack of specific enabling smart technologies and data processing tools that are necessary for the operation, optimization and management of ECs, such as smart meters, smart control systems, digital twins, etc.

Barrier 17: Low diffusion of smart technologies: It refers to the lack of smart technology arrangements in ECs, including smart metering, smart control systems, digital twins, cyber-physical systems, and smart energy monitoring systems, which are necessary to improve the operation and maintenance of ECs.

Barrier 18: Data management issues: It refers to difficulties in managing data from EC's members and energy systems (es. generation, distribution, sharing). Without proper data management tools, monitoring the energy flow and exchange would be challenging.

Barrier 19: Cybersecurity and data protection issues: It refers to the complexities faced in protecting data of the EC and its member from cyber attackers.

Category 4: Sociocultural and behavioural barriers: It refers to barriers that arise from either issue within the broader socio-cultural context in which ECs operate, or from a lack of information or awareness among individuals about ECs and energy-related issues in general.

Class 1: Lack of knowledge and awareness of EC: It refers to lack of understanding and/or awareness among potential EC members about benefits and opportunities of EC initiatives, which leads to low engagement and hinders the growth of ECs.

Barrier 20: Lack of knowledge regarding the EC concept: It refers to the lack of knowledge and information regarding how an EC works. For example, the decision-making and governance of ECs.

Barrier 21: Lack of awareness about EC's benefits: It refers to people's lack of awareness of the social, economic and environmental benefits generated by ECs, affecting their willingness to participate.

Class 2: Lack of trust: It refers to the lack of or low mutual trust among EC members and collaborative actors, reducing citizens' willingness to participate in ECs.

Barrier 22: Lack of trust in private or public actors: It refers to the lack of trust that EC members have towards external partners, private or public, such as investors, banks, municipalities, or commercial entities. For instance, previous negative experiences on the

implementation of a project, lack of transparency regarding on the decision-making, conflict of interest, etc.

Barrier 23: Lack of trust towards peers in the EC: It refers to the lack of mutual trust among different individuals or potential members of the EC. This results in the collective action problem, which is the unwillingness of individuals to collaborate and share with one another.

Class 3: Lack of socio-cultural conditions: It refers to barriers resulting from the lack of socio-cultural conditions favouring the development of ECs.

Barrier 24: NIMBY syndrome and local backlash against RES and EC: It refers to the opposition of local communities to projects related to the installation of RES. This opposition may come from the NIMBY syndrome or other conflicting interests at the local level that do not prioritize the installation of RES in their area.

Barrier 25: Lack of cooperative tradition in the country or the region your EC is operating: It refers to the lack of a strong and deep-rooted tradition of cooperativism, which instead exists in some communities or regions, facilitating the creation of EC.

Barrier 26: Lack of environmental awareness in the country or the region your EC is operating: It refers to the lack of environmental awareness and strong commitment to environmental issues among citizens, which affects their willingness to participate in initiatives such as the ECs.

5.2 Energy Community barriers validation

This section aims to validate the EC barriers identified in the literature through a systematic review. Papers were analysed to verify the recurrence and recognition of the barriers defined and categorized in the previous section. This approach enables us to validate and confirm the consistency of barriers within our conceptual framework (see section 5.1) and make necessary adjustments. Using standardised terms as coding elements in a qualitative research analysis tool, we were able to assess the following: the validity of barriers by examining their recurrence, any evolution of barriers over time, the geographical distribution of barriers identified across studies, evidence of barriers linked to EC maturity, among other aspects. After the validation process, we established a final list of verified barriers to design and assess the barriers relevance through a survey. An analysis of the literature reveals barriers across all four categories of our conceptual framework. Economic barriers are the most frequently identified, appearing in 89 papers, followed by technical-technological barriers, which are discussed in 77 papers. 74 papers highlight institutional barriers, while 64 papers identify socio-cultural and behavioural barriers. The systematic literature review conducted reveals that all 26 barriers outlined in our conceptual framework are well present and recognised, although at varying frequencies.

Barriers	Recurrence
Category: Economic barriers	
Class: Financial barriers	
Lack of access to traditional finance	23
Difficult to access finance from members	21
Lack of tailor-made finance options	35
Lack of public funds for ECs	24

Class: Market barriers	
Lack of a level playing field	29
Presence market incumbents	38
Category: Institutional barriers	
Class: Policy and regulatory barriers	
Absence or lack of a clear and uniform definition of ECs	9
Lack of a clear scope of EC's activities	13
Lack of policy stability and coherence	35
Class: Administrative and bureaucratic barriers	
Lack of simple and clear administrative procedures	11
Slow administrative procedures	26
Category: Technical/ Technological barriers	
Class: Technical barrier	
Lack of space to build RES plants	13
Lack of technical skills (skilled personnel)	36
Lack of technical expertise	46
Class: Lack of efficient infrastructures	
Lack of efficient and suitable energy infrastructure	32
Lack of IT infrastructure	9
Class: Lack of enabling technologies	
Low diffusion of smart technologies	14
Data management issues	16
Cybersecurity and protection issues	10
Category: Socio-cultural and behavioural barriers	
Class: Lack of knowledge and awareness of ECs	
Lack of knowledge regarding the EC concept	17
Lack of awareness about ECs' benefits	12
Class: Lack of trust	
Lack of trust in private or public actors	9
Lack of trust towards peers in the EC	13
Class: Lack of socio-cultural conditions	
NIMBY syndrome and local backlash against RES and ECs	21
Lack of cooperative tradition in the country or the region your EC is operating	19
Lack of environmental awareness in the country or the region your EC is operating	12

Table 5 Barriers' recurrence in the literature

5.2.1 Economic barriers - Financial barriers

People frequently highlight financial barriers as a significant obstacle to the viability of ECs. However, many discussions fail to clarify whether these challenges originate internally, from the EC's inability to mobilize investment among its members, or externally, due to insufficient government support or lack of access to tailor-made finance. Our data reveal 35 articles discuss the lack of tailor-made finance options, referring to issues such as the lack of state bank loans at subsidized interest rates provided to ECs (Leonhardt et al., 2022; Brummer 2018), or the implementation of specific tax and fee relief policies for ECs (Honarmand et al., 2021; Müller & Welpe, 2018; Augustine & 2016). The most occurring tailor-made finance option that has been reported (15 out of 35 articles) as a barrier that ECs face is the absence or the cancellation of feed-in tariffs (FiT). Inês (2020) refers to the reduction or removal of FiT as a major obstacle. Furthermore, the absence of tailored financial mechanisms, including FiT and targeted financing options, reduces public willingness to engage in EC initiatives (Özgül, 2020; Leonhardt, 2022). This issue is particularly acute for marginalized or vulnerable households, who may lack the resources to participate without such support (Hanke, 2020).

Nevertheless, ECs appear to encounter significant challenges in raising capital also from traditional finance—such as capital from market actors, commercial banks, and investors. This barrier was highlighted in 23 articles within our dataset. Additionally, difficulties in accessing finance from EC members were identified in 21 articles. These findings underscore the dual constraints ECs face in mobilizing both external and internal financial resources, which could hinder their operational and developmental potential.

Numerous studies highlight that commercial banks often perceive EC projects as high-risk investments, leading to reluctance in offering loans (Strachan 2015; Barriers and Action Drivers EU repository; Reinsberger 2014). Some studies have underlined that many projects face problems, especially at the outset of their implementation, because the return on investment is not attractive enough for external for-profit organizations (McCabe 2018; Botsaris 2021) or because of the "weak balance sheets of community groups" (Curtin 2018, p. 49). To lower their risk, banks often need collateral, like a residence, which makes it harder for low-income and marginalized households to access EC programs. This contradicts the objectives of ECs, which aim to foster inclusivity and actively involve a broad spectrum of participants, including economically disadvantaged households and socially marginalized groups. (Tongsopit 2016). The perceived insecurity of private actors toward EC leads to a lack of access to traditional finance (Chaudhry, 2022). The lack of access to traditional finance represents a significant barrier particularly for small-scale initiatives.

Additionally, numerous studies report that ECs face challenges in mobilizing funds from members (Koch 2018; Vallecha 2019; Hearn 2021; Gui 2018; Proka 2018), particularly during the early, pre-planning stages (Sebi, 2020). This issue arises not only from citizens' reluctance to invest in EC projects but also from the limited financial capacity of low-income households. Hanke (2020) noted a demographic imbalance in Germany, where approximately 70% of EC members are high-income males. Such trends undermine the inclusion of vulnerable and low-income citizens, impeding progress toward reducing energy poverty—a key objective outlined in the EU directive for ECs.

To address these challenges, ECs often lower entry capital fees; however, this approach further reduces the equity capital available to the community, exacerbating financial constraints (Brummer 2018).

In light of this, public funding for ECs is crucial for both their establishment and growth; however, our review found that 24 out of 103 articles reported a lack of public funding for ECs.
Insufficient government financial support or the periodic and one-off nature of many grant programs is a persistent barrier to the long-term viability of EC initiatives (Leonhardt, 2022). Other studies show that the high initial investment required for EC projects remains a significant obstacle, making many projects economically unfeasible without external public support (Dong, 2020; Özgül, 2020).

5.2.2 Economic barriers - Market barriers

Financial support for ECs is crucial, especially because of their unique characteristics such as their relatively small scale, which puts them at a competitive disadvantage compared to larger commercial energy market actors (Barriers and Action Drivers EU Repository). In our analysis, we identified 29 articles explicitly addressing the absence of a level playing field as a barrier to EC development, highlighting the systemic inequalities that hinder ECs from competing effectively.

The presence of market incumbents exacerbates the lack of a level playing field; our study found 38 articles addressing this issue. Market incumbents hold a dominant position in the energy market, utilizing their political and economic power to achieve their objectives and maintain their strategic dominance within the system (Gui 2018; Hoicka 2021). The incumbents' strategic dominance manifests through various mechanisms, including political, economic, technological, and regulatory ones (Van Summeren, 2021). As Busch et al. (2021) argue, market incumbents shape the vision and targets of the energy sector, creating barriers that hinder the development of renewable, small-scale, and decentralized energy production—essential prerequisites for advancing ECs.

Grid infrastructures, historically designed for centralized power systems (Sebi, 2020), remain inadequate for decentralized renewables. Incumbent pressures and insufficient incentives for grid operators to invest in upgrades further hinder necessary transformations (Brisbois, 2020; Nolden, 2020).

5.2.3 Institutional barriers - Policy and regulatory barriers

According to the literature, not all EU member states have implemented the REII and IEMD directives, and in some cases, there is a lack of legal definition of ECs. In this study, we identified 9 articles that cite the lack of a clear and uniform definition of ECs as a barrier. Although the issue of a legal definition for ECs has evolved with ongoing changes in legal frameworks, and many countries that previously lacked legal recognition for ECs now have such provisions, it remains a recurring topic in the literature. Several studies highlight that certain EU Member States have either not yet implemented the relevant EU directives or have done so ambiguously (Bisselioglou et al., 2021; Bostsaris et al., 2021).

Another issue is the tendency to narrowly define ECs around specific activities, such as energy sharing (Roberts, 2020), which limits their potential to develop innovative business models (Barriers and Action Drivers EU Repository). This study identified 13 articles highlighting the lack of a clear scope of EC's activities as a significant barrier.

According to 35 articles in our dataset, the lack of policy stability and coherence is a major barrier to the establishment and growth of ECs. A significant body of research indicates that communities face significant challenges due to ongoing policy changes, uncertainty, and the complexity of regulations involved in setting up and operating an EC (Tuerk 2021; Ahmed 2024; Capellán-Pérez 2018; Horstink 2020; Özgül 2020). Mirzania et al. (2019) state that 10% of the ECs that were in the development stage failed to set up their renewable energy schemes due to policy uncertainty, while 69% of ECs who participated in the study reported that they had decided to not develop new projects but instead to focus on the management of the existing ones because of institutional changes.

5.2.3 Institutional barriers - Administrative and bureaucratic barriers

The absence of clear administrative procedures significantly hampers the development, operation, and expansion of ECs. In this study, we found that 26 articles mention the absence of simple and clear administrative procedures, and 11 articles refer to slow administrative procedures as a barrier that ECs face.

Due to regulatory ambiguities in EU countries and the novel nature of the concept of EC, national procedures often remain undefined (Barriers and Action Drivers). As highlighted in the Netherlands and Belgium (Horstink, 2020), ECs encounter significant administrative challenges in project implementation, including complex and inconsistent licensing (Mey, 2016) and planning application processes (Haf, 2019; Busch et al., 2021). The standardization of procedures, along with fixed timeframes for authorization and certification, is critical to minimizing procedural delays and reducing administrative barriers (Biresselioglu, 2021). However, administrative procedures are often time-intensive and come with excessive reporting requirements, particularly for new market entrants (Barriers and Action Drivers; Sebi, 2020). Moreover, administrative and legal uncertainties, limited technical capacity, and disparities in expertise across municipal departments further hinder the viability of ECs (Biresselioglu, 2021).

5.2.4 Technical/Technological barriers - Technical barriers

In this study, we identified technical barriers faced by ECs in many research works. However, researchers often described these barriers in broad terms, failing to specify the specific challenges that ECs faced. For instance, Mirzania (2019) identified technical barriers during the construction phase of EC projects, while Brisbois (2020) noted that REC groups faced difficulties mostly in managing the EC's operation phase due to technical barriers.

One significant barrier identified in 13 studies is the lack of space for constructing renewable energy systems (RES). As Brummer (2018) highlights, finding suitable locations for photovoltaic (PV) installations is challenging due to the occupation of most optimal sites. Koch (2018) further notes

that individuals face obstacles in setting up PV systems, particularly if they are renters or lack sufficient rooftop space to install systems capable of meeting their electricity demands.

A significant barrier identified in 36 studies is the lack of technical skills and knowledge among both professionals and citizens. This knowledge gap extends to citizens, as highlighted by Ceglia (2022), who found that uncertainty around EC projects is often linked to inadequate technical expertise. Madriz-Vargas (2018) further notes that local technicians often lack training on such innovative initiatives leading to mistrust and unwillingness to proceed.

A lack of technical expertise necessary for handling administrative, legal, and planning procedures is a barrier identified in 46 studies. Brummer (2018) emphasizes the importance of understanding market conditions for various technologies, alongside expertise in planning and project development. Similarly, Mirzania (2019) highlights the critical need for technical knowledge to operate appropriate business models for EC projects. Streimikiene (2021) underscores that this challenge is particularly pronounced in rural communities, where technical experience is often absent.

5.2.5 Technical/Technological barriers - Lack of efficient infrastructures

“Lack of efficient and suitable energy infrastructure” was discovered as a hindrance to EC in 32 research works. Madriz-Vargas (2018) highlighted the impact of outdated infrastructure, which leads to frequent blackouts. Honarmand (2021) emphasized structural restrictions in the power grid that reduce overall system efficiency. Augustine (2016) explained that utilities frequently choose not to invest in updating or modernizing energy infrastructure systems. This reluctance stems from financial considerations, operational constraints, or a lack of long-term planning. As a result, outdated systems remain in use, which significantly restricts the overall efficiency and capacity of the infrastructure to accommodate advancements such as renewable energy integration or distributed energy systems

In addition to energy infrastructure, the lack of IT infrastructure was flagged in nine studies as a significant limitation for ECs. Horstink (2020) noted that the absence of essential IT systems, such as advanced meters, impedes EC operations. Shaffer (2018) stressed the need for investment in Internet of Things (IoT) and Information and Communications Technology (ICT) to enhance EC functionality. Ahmed (2024) emphasized the need to integrate modern IT systems to enhance grid management and facilitate the use of Renewable Energy Certificates. Gjorgievski (2021) highlighted that developed nations are increasingly focusing on advanced ICT infrastructure alongside traditional energy systems. Despite these efforts, inadequate enabling technologies at both physical and virtual levels continue to hinder the progress of ECs.

5.2.6 Technical/Technological barriers - Lack of enabling technologies

14 research studies identified the limited adoption of smart technologies as a significant barrier to the development and operation of ECs. Ahmed (2024) highlighted that the lack of smart meters complicates data collection, making it harder to monitor and manage energy usage. Similarly, Proka (2020) pointed out that the absence of innovative technologies hampers the development of local energy storage solutions, further slowing the progress of ECs.

16 research studies listed data management issues as barriers that EC face. Tuerk (2021) conducted a study that identified challenges related to interoperability and data security, crucial considerations when establishing ECs. Proka's (2020) study also highlighted privacy concerns associated with smart meters. Moreover, community members express significant concerns over privacy and security related to data use and management inside smart grids (Streimikiene 2021). Indeed, 10 research studies identified cybersecurity and protection issues as barriers.

5.2.7 Sociocultural and behavioural barriers - Lack of knowledge and awareness about ECs

A significant barrier to the development of ECs is the widespread lack of understanding and awareness among potential members regarding the benefits and opportunities these initiatives offer. Specifically, 12 studies report a lack of awareness about EC's benefits, which undermines public willingness to participate, while 17 studies identify a broader lack of knowledge regarding the EC concept as a fundamental barrier to their establishment and growth.

While the main goal of ECs is to democratize the energy system and provide benefits to the wider society, it seems that a key barrier is the lack of citizen participation in these initiatives because of a lack of understanding of potential benefits (Reis 2021; Ruggiero 2021). Koch et al. (2018) found that in Switzerland, low participation is due to a perceived lack of added value compared to existing energy products. Studies (Streimikiene 2021; Lazdins 2021; Parra 2017) highlight that inadequate knowledge of the economic benefits is a major obstacle, with Ahmed et al. (2024) emphasizing the lack of understanding of financial advantages. This issue is especially pronounced among vulnerable households, where limited awareness of available support further restricts engagement (Barriers and Action Drivers EU repository).

As previously mentioned, citizens often lack knowledge about the concept and operations of ECs (Koch 2018; Hearn 2021; Proka 2018; Prehoda 2019). This issue is particularly prevalent in southeastern European countries, where awareness of ECs is minimal. The lack of publicly available information exacerbates the problem, leaving many individuals unaware of how to start or participate in an EC. This knowledge gap is not limited to citizens but extends to other key stakeholders, including municipalities, financial institutions, and potential partners, who also have limited understanding of ECs (Capellán-Pérez, 2018). Additionally, Brummer et al. (2018) describe a "saturation effect", where individuals already familiar with ECs have joined, making it more challenging to attract new members.

5.2.8 Sociocultural and behavioral barriers - Lack of trust

A lack of knowledge and understanding of the EC concept often results in diminished trust, either among EC members or towards public and private partners (Hearn, 2021; Bertheau, 2020). In this study we found that 9 articles refer to the lack of trust in private or public actors while 13 articles refer to the lack of trust towards peers in the EC.

EC members often perceive developers and other private actors as primarily profit-driven, which undermines their trust in these stakeholders (Goedkoop, 2016; Botsaris 2021). Similarly, McCabe et

al. (2018) highlight that divergent goals between EC members and private actors foster mistrust. Members often express distrust toward municipalities and public institutions. This lack of trust has resulted in missing out valuable opportunities, as demonstrated by Van Veelen (2020).

Moreover, ECs often experience a lack of trust among their members. Bertheau et al. (2020) argue that the success or failure of ECs or cooperatives in general heavily depends on the level of trust and cooperation among individuals. However, the level of trust towards peers varies significantly across EU countries, closely reflecting the general trust people have towards others. Northern European countries, such as the Netherlands and Sweden, exhibit high levels of interpersonal trust, which contributes to the success of community projects. In contrast, Southern European countries tend to have lower levels of trust, which may hinder the success of similar initiatives in these regions.

Brummer et al. (2018) emphasize the importance of involving EC members in decision-making processes to enhance trust and ensure the successful implementation of projects. A high degree of member participation in governance and decision-making fosters transparency and accountability, which in turn strengthens trust among members and supports the long-term viability of the community (McCabe 2018; Busch 2021; Goedkoop 2016).

5.2.9 Sociocultural and behavioral barriers - Lack of socio-cultural conditions

The broader socio-cultural context of the country in which ECs operate is a critical determinant of their success. Studies indicate that a lack of cooperative traditions or a general trust in technology (Reinsberger, 2014) serves as a significant cultural barrier to the adoption of RES and the advancement of ECs (Mey, 2016; Streimikiene, 2021). In this study, we identified the presence of the NIMBY (Not in My Backyard) syndrome and local backlash against RES and EC in 21 articles. Additionally, the lack of cooperative tradition and the lack of environmental awareness in the country or region where ECs operate were noted in 19 and 12 articles, respectively.

Many scholars have analysed the NIMBY syndrome, where citizens oppose the development of projects, such as renewable energy installations, in their local area. This behaviour also negatively affects EC projects (Ahmed, 2024; Heaslip, 2016; Brummer, 2018). Concerns over perceived negative impacts on property values, aesthetics, or quality of life often drive the NIMBY syndrome (Streimikiene, 2021; Krietemeyer, 2021). However, it is important to note that resistance is frequently associated with large-scale projects (Proke, 2018), particularly wind energy developments (Heaslip, 2016; Sciullo, 2022; Süsser, 2017), rather than smaller-scale initiatives like PV installations (Hearn, 2021). Additionally, local communities engage in specific economic activities, such as tourism, are mostly against to RE technologies due to negative effects over territorial attractiveness (Heaslip, 2018). See for example the case of Sardina region in Italy. Such constrains and oppositions may limit engagement of the local community in EC projects (Krietemeyer 2021; Prehoda 2019; Petersen 2018).

Several studies have identified the absence of a cooperative tradition in a country as a significant barrier to the successful development of EC projects. The concept of cooperativism, which is closely associated with the notion of EC, has historically been subject to misuse, particularly in Eastern European countries, though this issue is not limited to that region (Ruggiero, 2021; Sciullo, 2022). For instance, a study conducted by Özgül (2020) highlights that the failure of housing cooperatives

in Turkey during the 1990s contributed to a generally negative perception of cooperatives, which has adversely impacted ECs. Similarly, research by Parra et al. (2017) indicates that countries such as Germany and Denmark, with a strong tradition of local cooperativism, have developed more robust, decentralized, locally owned energy systems compared to other countries.

Furthermore, a lack of environmental awareness and motivation to address climate change is a significant barrier to the development of ECs. 17 studies in our review highlight this issue as a critical challenge. Many individuals possess limited knowledge of sustainability issues, particularly energy-related topics, and often show little interest in understanding how their electricity is produced (Koch, 2018). Proka et al. (2020) similarly emphasize that inadequate public awareness of energy matters poses a substantial obstacle to advancing EC projects. This highlights the need for increased education and outreach to foster greater engagement and support for EC initiatives.

5.3 Survey statistics

In total we collected 456 contacts of EC initiatives from 17 EU countries, both in northern and southern Europe. The survey has been launched in the second half of September 2024. By December 1, 2024, we received more than 100 responses. However, only 51 of these were considered valid for the analysis. Many responses were incomplete or contained inaccuracies, while others were fake and compromised the reliability of the results. All responses were carefully reviewed and validated by a team of four experts to ensure that no valid answers were excluded. In the coming months, we will launch a second dissemination campaign for the survey to gather additional data. The survey questions are reported in the Annex.

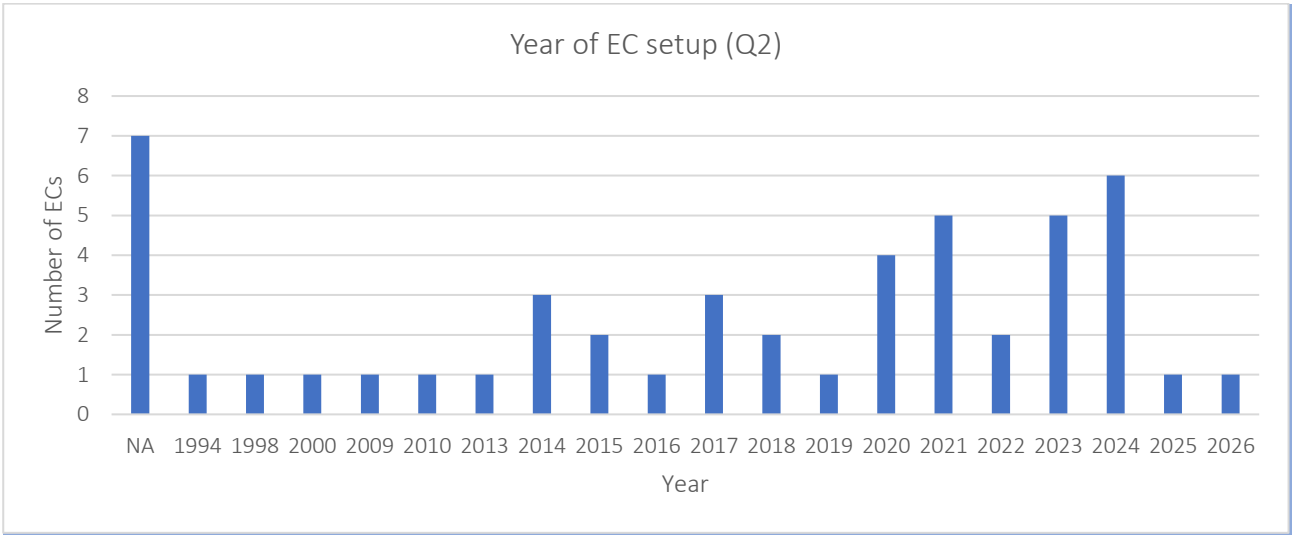

Figure 5 Year of ECs set-up

Figure 5 presents the distribution of ECs establishment years as recorded in our dataset. The largest proportion of responses falls under the "NA" category, indicating that many participants either chose not to disclose this information due to privacy concerns or that the ECs are still in the process of being established, and the year of setup cannot yet be declared (see figure 6). Furthermore, 2 ECs currently in the development phase have indicated expected establishment years of 2025 and 2026, respectively. The year 2024 shows a significant activity level with 6 ECs, while 2023 and 2021

each record 5 ECs. In contrast, earlier years such as 2018, 2010, and prior to 2000 display minimal activity, with only one EC each.

The data also shows periods of notable activity, such as 2015 and 2014, with 3 ECs established per year, and 2019, which recorded 4 ECs. Overall, the trend suggests a gradual increase in the formation of ECs, particularly from 2019 onward, likely driven by the publication of EU directives and growing interest in sustainable energy practices. The presence of ECs in the development phase (indicated by "NA" or future years) further suggests ongoing efforts to expand these initiatives.

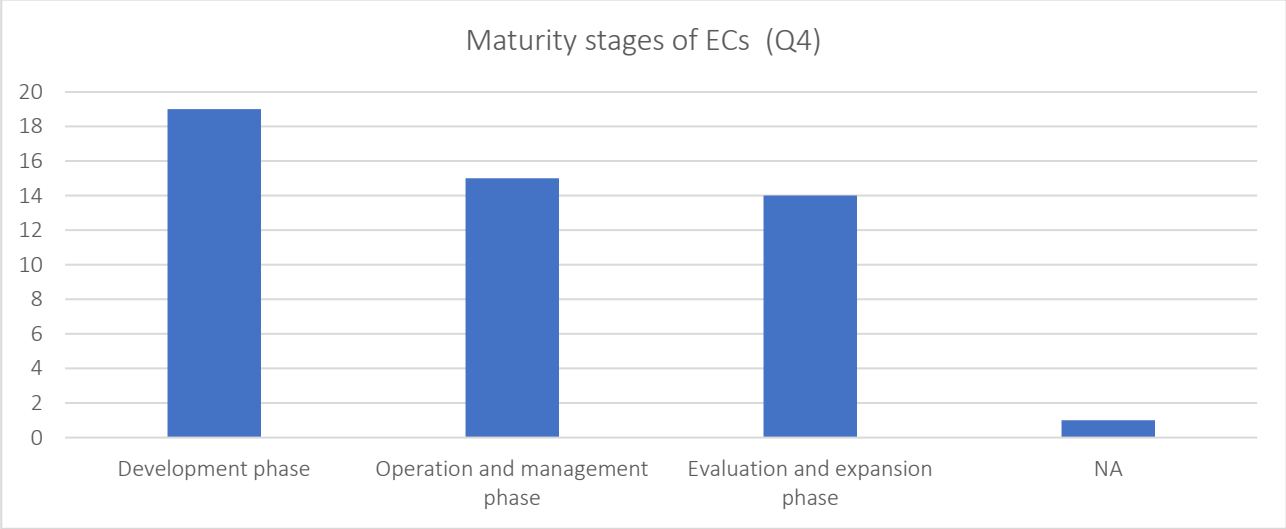

Figure 6 Maturity stages of ECs

Figure 6 presents the maturity stages of ECs, highlighting the recent growth of EC initiatives. This trend aligns with the timeline presented in Figure 5, which demonstrated increased activity following the publication of EU directives. Specifically, 19 ECs in the dataset are currently in the development phase, indicating the ongoing expansion of the EC concept. Additionally, 15 ECs have progressed to the operation and management phase, while 14 ECs are in the evaluation and expansion phase. These results underscore the dynamic nature of EC establishment and the gradual progression of these initiatives through various stages of development.

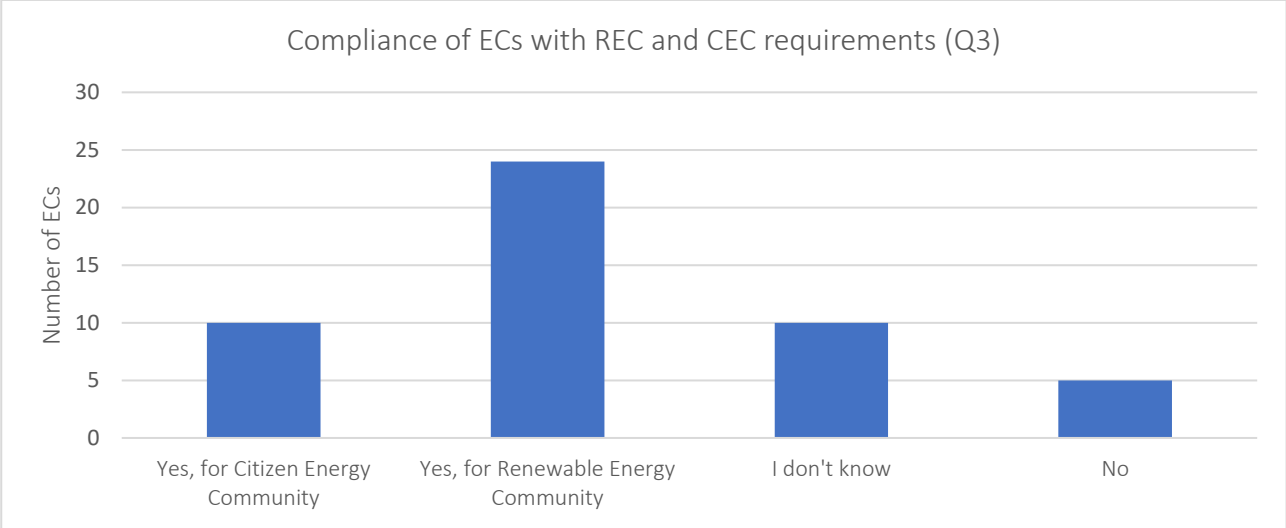

Figure 7 Compliance of ECs with EU REDII and IEMD

Figure 7 illustrates the compliance of ECs with EU REDII (Directive 2018/2001) - REC and EU IEMD (Directive 2019/944) - CEC requirements of our sample of ECs. A majority of ECs, specifically 24 out of 50, identify themselves as RECs, while 10 ECs classify themselves as CECs. Notably, 10 ECs selected the option "I don't know", likely reflecting their current developmental phase and the absence of a finalized strategic plan, which delays the selection of an appropriate legal form. This result is in line with responses reported in figure 5 and 6, regarding the year of ECs setup and the maturity stage. Additionally, 5 ECs chose the response "No", potentially due to the lack of integration of the two EU directives into national legislation in some countries. This distribution highlights both the prominence of RECs within the dataset and the uncertainties or legislative barriers faced by ECs in adopting formal classifications.

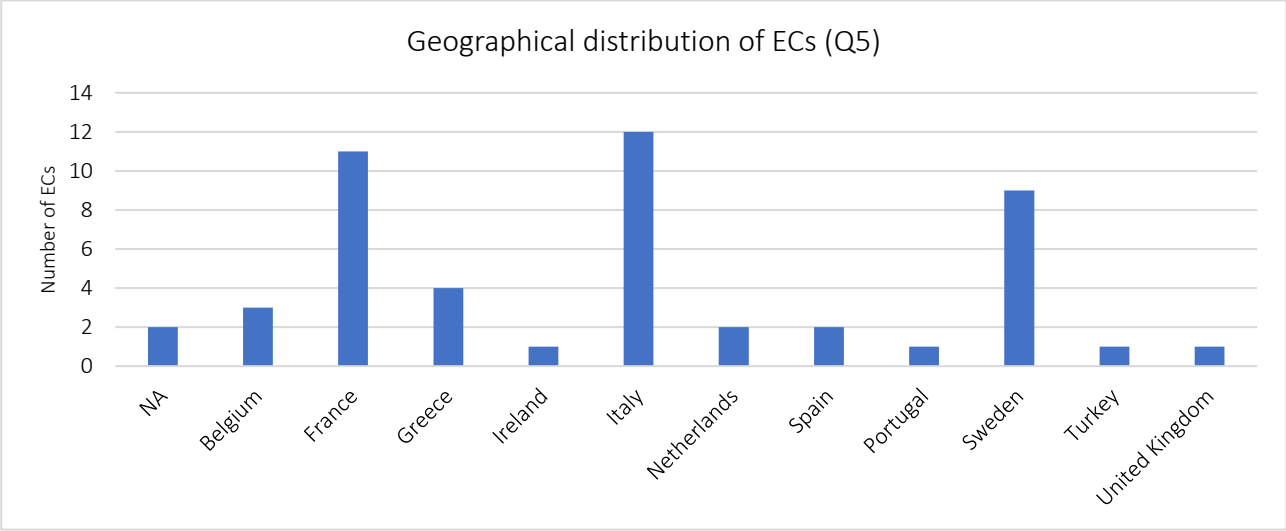

Figure 8 Geographical distribution of ECs

The geographical distribution of ECs in our survey reveals that Italy hosts the largest number of ECs, with 12 identified, followed closely by France with 11 and Sweden with 9. Greece accounts for 4 ECs, while Belgium hosts 3. The Netherlands and Spain each report 2 ECs, while Ireland, Portugal, Turkey, and the United Kingdom each account for 1 EC. Notably, 2 ECs in the dataset did not specify

their geographical location. The absence of data from other regions, such as Eastern Europe, may reflect either a lower presence of ECs in our current database or limited participation in the survey. To address this gap and further analyze how barriers vary across different countries, a second round of survey dissemination will be launched, specifically targeting countries underrepresented in this initial phase.

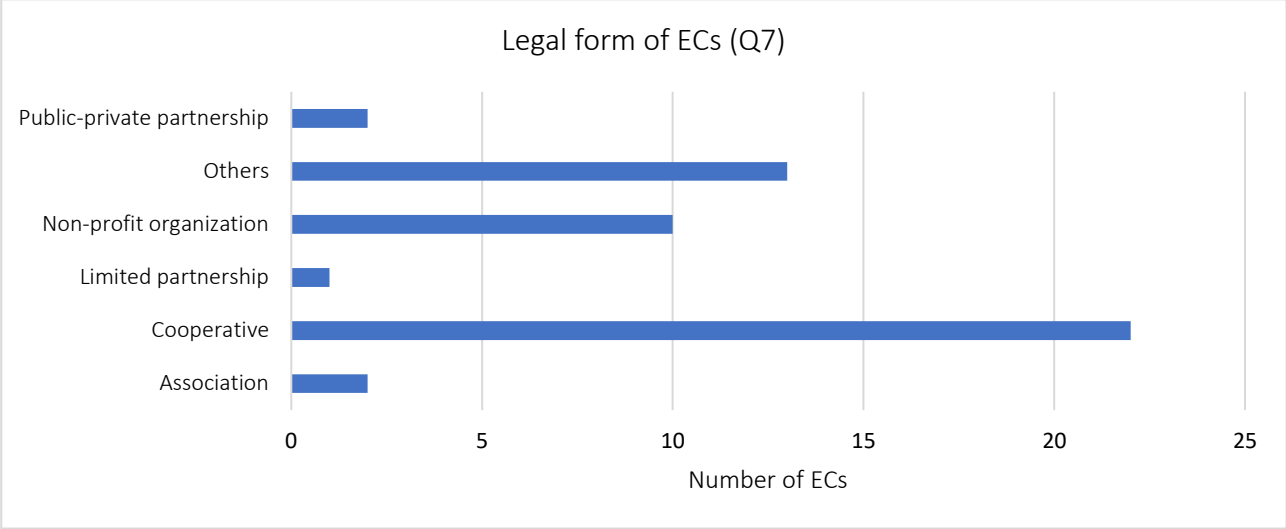

Figure 9 Legal forms of ECs

Figure 9 depicts the legal forms of surveyed ECs. Approximately 22 ECs adopt the "Cooperative" legal form, which is the most common. The "Others" category, which includes various unspecified legal forms, comes next, accounting for approximately 12 ECs. The high number of unspecified legal forms stems from the fact that many ECs in our dataset are still in the development phase and have not yet specified their legal forms. The non-profit organizations count for approximately 9 ECs. Other legal forms, such as public-private partnerships, associations, and limited partnerships, are relatively less common, with each category involving 1–2 ECs. These results indicate a strong preference for cooperative models among ECs, highlighting their emphasis on shared ownership and collaborative governance

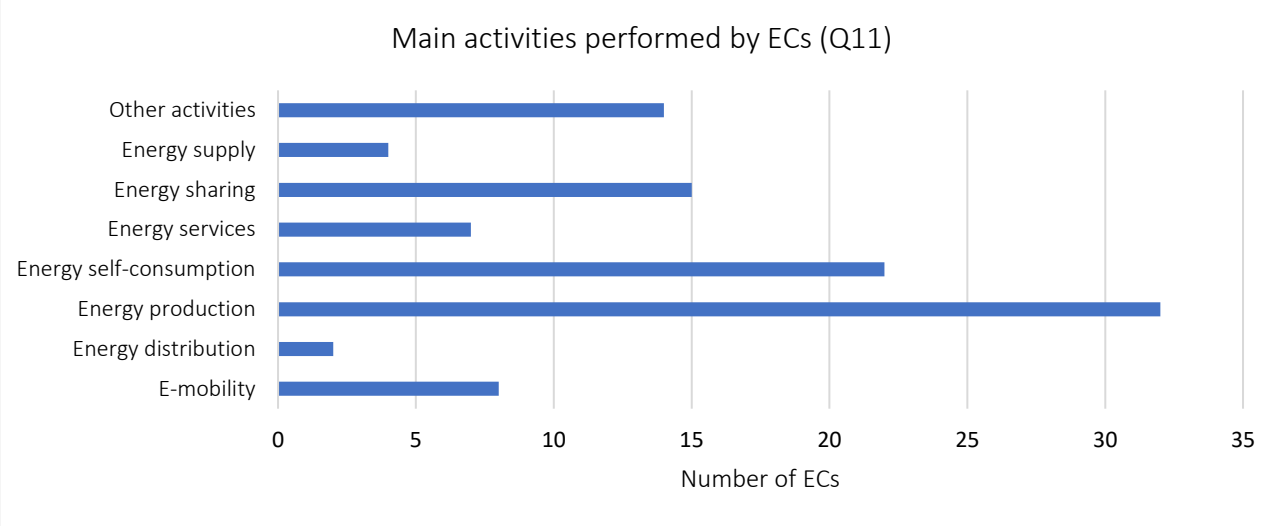

Figure 10 Main activities performed by ECs

Figure 10 illustrates the primary activities performed by ECs. The most prevalent activity is energy production, with approximately 30 ECs engaged in this domain among the respondents. Energy self-consumption follows involving more than 20 ECs. Energy sharing and e-mobility also constitute notable activities, undertaken by 15 and 8 ECs, respectively. Other activities such as energy services, energy supply, and energy distribution play smaller roles, with fewer than 7 ECs participating in each. These findings highlight the primary importance of energy production and self-consumption activities within the operations of ECs.

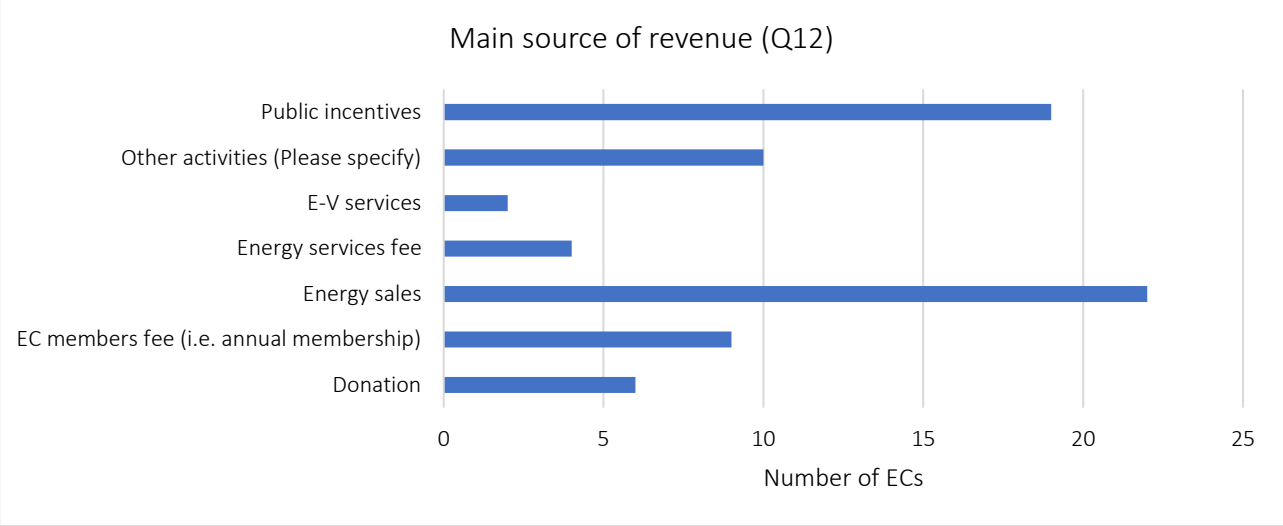

Figure 11 Main source of revenue of ECs

Figure 11 highlights the primary revenue sources for ECs in our sample. The primary source of revenue is "energy sales," selected by 22 respondents, followed closely by "public incentives", chosen by 19 cases. "Membership fees" contribute to the revenue streams of about 10 ECs, while "other activities" and "energy services fees" represent significant but smaller sources, involving around 8 and 5 ECs, respectively. "Donations" and "E-V services" constitute minimal sources of income, each reported by less than 5 ECs. These results suggest that ECs rely heavily on market-

based income (via energy sales) and governmental support (via public incentives) to sustain their activities.

5.5 Survey results on ECs barriers

In the following sections, barriers are evaluated based on their perceived relevance as reported by our sample. Barriers to ECs are categorized into five levels of relevance, ranging from "Very Low Relevance" to "Very High Relevance". The frequency of responses corresponding to each ranking level provides insights into the relative importance of these barriers. Responses marked as "0", indicating either the absence of a barrier or insufficient knowledge by the respondent, are excluded from the analysis to ensure clarity and focus. Furthermore, to maintain transparency and analytical consistency, invalid responses have been excluded. For each barrier, the final number of valid responses considered in the analysis is explicitly reported.

5.5.1 Economic barriers

The first Economic barriers considered refer to Financial barriers. Over 51 answers received, 40 responses were considered for this barrier class.

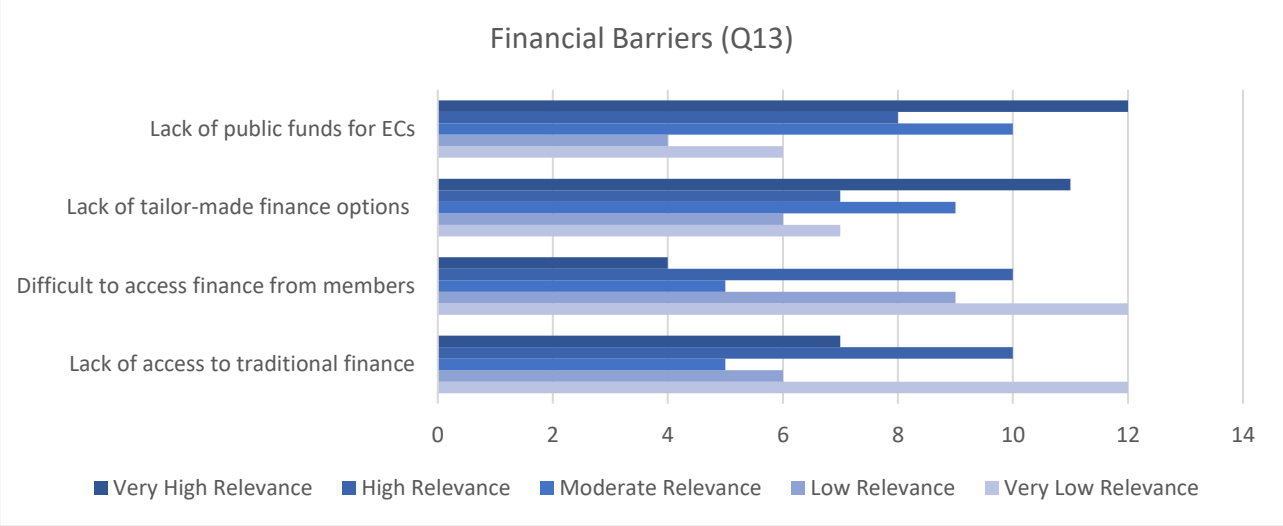

Figure 12 Financial barriers

Four distinct barriers are analysed: "Lack of public funds for ECs", "Lack of tailor-made finance options", "Difficult to access finance from members", and "Lack of access to traditional finance".

The findings reveal that the "Lack of public funds for ECs" is the most frequently identified barrier with very high relevance. Public funds are often crucial for covering initial capital expenses, especially in community-driven renewable energy projects, which typically require significant upfront investment. The absence of adequate public financial support forces ECs to rely on private investments or contributions from members, which can be insufficient or unsustainable. The high relevance of this barrier is also related to results reported in figure 11 on primary revenue sources which indicates that most of ECs in our sample rely on public incentives.

This barrier is closely followed by the "Lack of tailor-made finance options", highlighting the central role that funding availability and customized financial mechanisms play in the development of ECs. A substantial number of respondents also rated these two barriers as highly relevant, reinforcing their status as significant challenges to the proliferation of ECs. This barrier is particularly relevant for small-scale initiatives, where the difficulties in gathering adequate finance from members are further exacerbated by the lack of tailor-made financial options designed to meet the unique needs of small ECs, which are often less attractive for accessing traditional finance.

In contrast, "Difficult to access finance from members" and "Lack of access to traditional finance" are more frequently associated with moderate and low relevance rankings. The former is particularly pronounced in low-income or economically disadvantaged areas, where community-driven projects may offer the most benefits but are least likely to secure sufficient financial contributions from members. This outcome can also be linked to the niche nature of ECs, which remain predominantly accessible to high-income citizens with strong environmental commitments (see section 5.2.2). This contrasts with the aims of ECs as defined by the EU in its descriptions of RECs and CECs, which emphasize the ambition to combat energy poverty and ensure open participation for all citizens in the energy democratization process. The last barrier is strongly linked with the high-risk perceived by financial institutions in investing in ECs due to their relatively small scale, limited credit history, and reliance on community participation. These factors can result in unfavourable borrowing terms or outright rejection of loan applications. Additionally, the complexity of energy market regulations and the need for specialized knowledge in assessing renewable energy projects can further discourage traditional financial institutions from engaging with ECs.

This analysis underscores the critical importance of addressing financial barriers, particularly the need for public funding and tailored financial solutions, to support ECs. Addressing these barriers requires a multifaceted approach that combines policy interventions, innovative financing mechanisms, and increased awareness among financial institutions. Public funding initiatives, such as grants or subsidies, could alleviate the upfront cost burden, while the development of tailored financial products, such as green loans or community bonds, could enhance accessibility to capital.

The second Economic barriers considered refer to Market barriers. Over 51 answers received, 41 responses were considered for this barrier class.

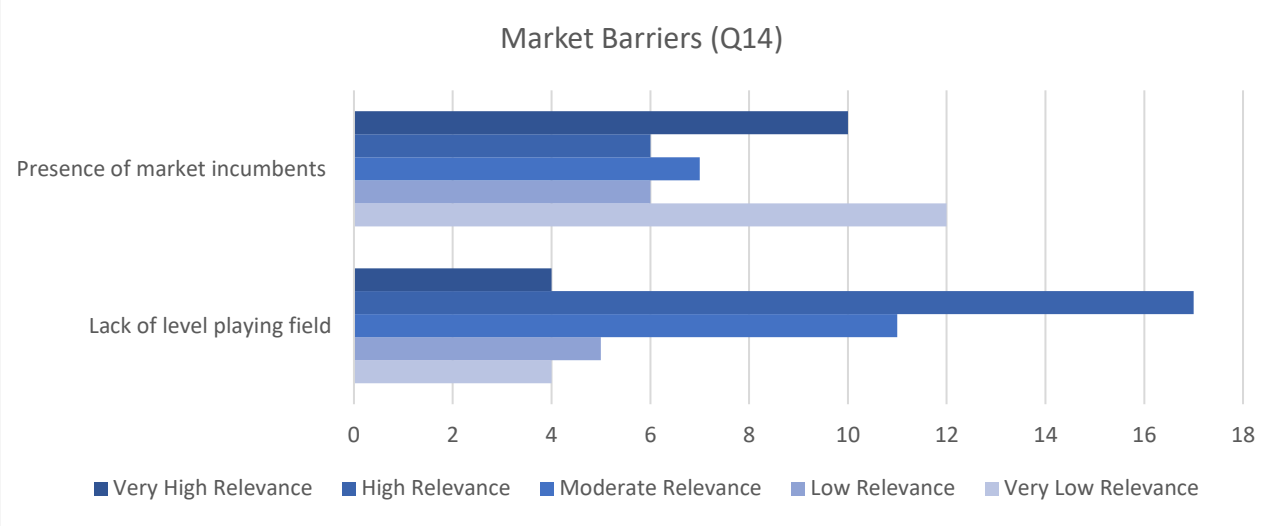

Figure 13 Market barriers

The graph illustrates the perceived relevance of market barriers focusing on two specific obstacles: the "Presence of market incumbents" and the "Lack of a level playing field".

The "Lack of a level playing field" is widely recognized as a significant obstacle, with the majority of respondents rating it as having "High Relevance" or "Very High Relevance". This indicates that many participants believe that the current market environment is unfairly structured, favouring energy providers over community-based initiatives. For example, large energy companies may have better access to resources such as financing, infrastructure, or regulatory support, which ECs often lack. Furthermore, administrative processes such as permitting, grid access, and compliance with regulations can be more complex and costly for ECs (see Institutional Barriers' section), putting them at a disadvantage. These structural inequities limit the ability of ECs to grow and compete effectively, particularly in markets dominated by traditional energy providers.

On the other hand, the "Presence of market incumbents" shows a more varied distribution across the relevance categories, with responses spanning from "Very Low Relevance" to "Moderate Relevance". While some respondents view incumbent actors as a major challenge due to their dominance, others perceive their impact as less critical, suggesting that the barrier is context-dependent and varies based on regional or project-specific factors. In competitive markets with supportive policies for renewable energy, market incumbents might be less of an issue, as ECs are given space to innovate and grow. On the other hand, in markets where a few companies dominate energy production and distribution, market incumbents are likely to pose more significant challenges for ECs.
To address these barriers, policymakers could introduce measures to create fairer competition and reduce market entry challenges for ECs. Additionally, fostering collaborations between ECs and larger energy providers could help balance competition and create opportunities for knowledge-sharing and innovation.

5.5.2 Institutional barriers

The first Institutional barrier considered refer to Policy and regulatory barriers. Over 51 answers received, 41 responses were considered for this barrier class.

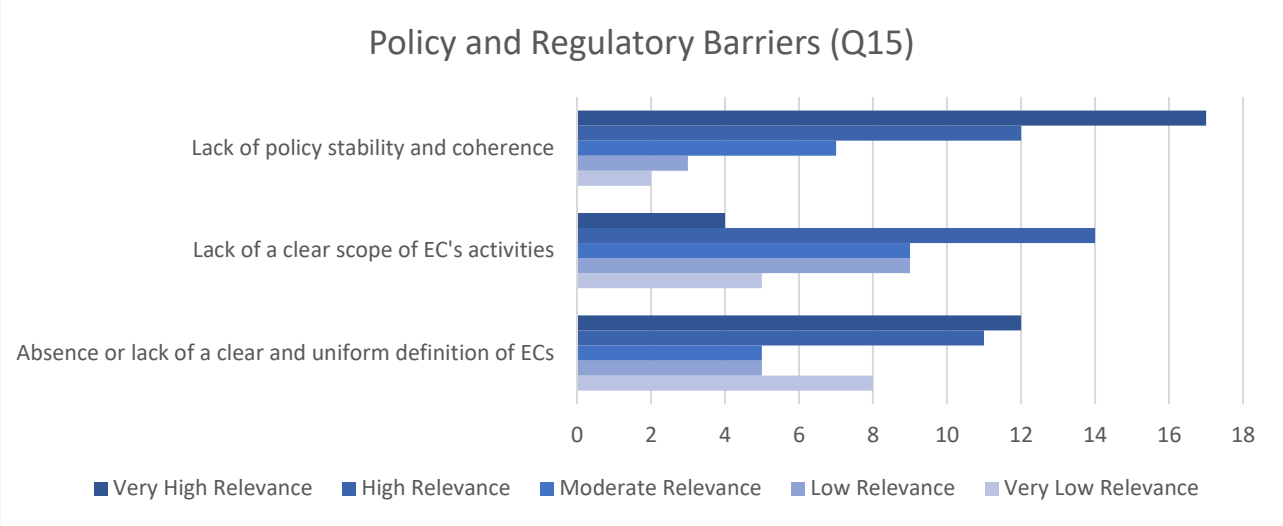

Figure 14 Policy and regulatory barriers

The graph presents the perceived relevance of policy and regulatory barriers affecting the development and functioning of ECs. Three specific barriers are evaluated: "Lack of policy stability and coherence", "Lack of a clear scope of ECs' activities", and "Absence or lack of a clear and uniform definition of ECs".

The "Lack of policy stability and coherence" emerges as the most significant barrier, with the highest number of respondents identifying it as "Very High Relevance". This reflects widespread concerns about the unpredictability or inconsistency of regulatory frameworks that govern ECs. Unstable or incoherent policies may discourage investments, delay project implementation, and create uncertainty about long-term viability (also in terms of incentives, see the Italian Premium tariff assures till 2027). For instance, frequent changes to energy policies can undermine trust and confidence in the system, making it challenging for ECs to plan and execute their projects effectively.

The "Lack of a clear scope of ECs' activities" is also a highly ranked barrier, with many respondents perceiving it as either "High Relevance" or "Moderate Relevance". This indicates that there is confusion or ambiguity about what activities ECs are allowed to undertake under current regulations. For example, some ECs may wish to expand their roles beyond renewable energy production to include energy efficiency services or sharing services (i.e., EV-charges or EVs sharing), but unclear rules can restrict such initiatives.

The "Absence or lack of a clear and uniform definition of ECs" is another critical issue, though it is slightly less frequently rated as "Very High Relevance" compared to the other barriers. It is important to note that this barrier has been addressed in many countries, such as Italy and France, where clear laws defining ECs have been established in alignment with EU directives (see section 2). However, in many other countries, the full transposition of these directives is still ongoing, leading to a blurred understanding of the EC concept (see figure 7). This lack of uniformity can also make it more challenging for ECs to collaborate across regions or scale.

The distribution of responses highlights the relevance of location of respondents. For example, ECs operating in countries with well-developed energy policies may experience fewer difficulties related

to policy stability or definitions (like Netherlands, Belgium and UK among our sample), whereas those in emerging markets may encounter significant challenges. Further analyses are needed to better understand the relation between policy framework maturity and the relevance of this barrier, since our sample is not enough to identify proper correlations.

The second Institutional barriers considered refer to Administrative and bureaucratic barriers. Over 51 answers received, 41 responses were considered for this barrier class.

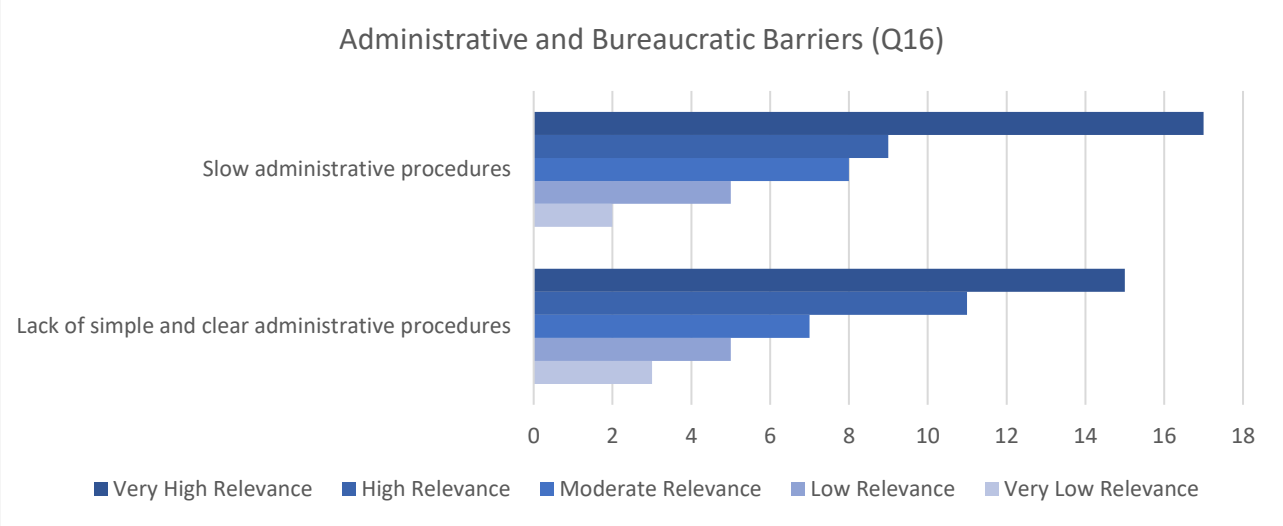

Figure 15 Administrative and bureaucratic barriers

The graph presents the perceived relevance of administrative and bureaucratic barriers affecting ECs, specifically focusing on "Slow administrative procedures" and the "Lack of simple and clear administrative procedures".

The "Slow administrative procedures" barrier stands out as the most critical issue, with the highest number of respondents assigning it "Very High Relevance". This indicates that delays in processing permits, licenses, and other administrative requirements are a major obstacle for ECs. These delays can significantly hinder project timelines, increase costs, and discourage stakeholders from participating in or initiating EC projects. For example, lengthy approval processes for renewable energy installations or grid connection agreements can result in missed opportunities to implement energy projects in a timely manner. When the timeframe for obtaining public finance is also strict (see the Italian time limits for accessing PNRR funds for ECs), a slow administrative architecture can completely reduce the capability to start an EC, affecting its capacity to access public funds. This barrier is also related to the "Lack of policy stability and coherence" seen above.

The "Lack of simple and clear administrative procedures" also received substantial recognition as a significant barrier, with a high proportion of respondents rating it as "High Relevance". This issue highlights the complexity and opacity of the regulatory environment, which often requires specialized knowledge. For ECs, especially for smaller initiatives, unclear administrative requirements can create additional burdens, increasing the likelihood of errors or compliance failures. For instance, vague guidelines for project approval or discrepancies between local and national regulations can further complicate administrative processes, discouraging potential EC

participants. This barrier is also crucial in the context of home energy renovation practices. A solution proposed by the European Commission, as outlined in Directive 2018/844/EU on the Energy Performance of Buildings (EPBD), Directive 2018/2002/EU on Energy Efficiency (EED), and the strategy "Renovation Wave for Europe" (COM(2020)662), is the One-Stop-Shop (OSS). This model provides a centralized physical or virtual location, or a combination of both, where customers can access multiple products and services in a single point (Bagaini et al., 2022). A similar approach is now being applied to promote, support, and guide ECs by pooling expertise and knowledge in order to reduce the amount of time and effort required to non-expert. Indeed, through the recast of EPBD (Directive (EU) 2024/1275), Member states are required to provide information, technical assistance and training to all relevant actors including ECs in line with an integrated and multi-services OSS concept. Other solutions to overcome this barrier involve introducing standardized guidelines, reducing paperwork, and leveraging digital platforms to expedite processes.

It is important to highlight that at the EU level many initiatives and support services for ECs have been implemented in the last few years to overcome barriers. These services aim to inform, support and empower citizens, local authorities, and businesses toward the formation of EC initiatives. The most important initiative was the Energy Communities Repository (ended in 2024), which collected EC experiences across the EU and provided a comprehensive analysis on policy, governance systems, investments, and impacts. Another significant service is the Rural Energy Community Advisory Hub, designed to accelerate the development of sustainable EC projects in the EU's rural areas. The hub identifies best practices and offers technical assistance and networking opportunities to support local authorities, businesses, farmers, and citizens in setting up their own rural ECs. The Support Service for Citizen-led Renovation is an EU Commission initiative aimed at empowering ECs to lead energy-saving renovation projects. By assisting selected pilot projects in overcoming financial, legal, technical, and informational barriers, this service facilitates the delivery of future-proof residential buildings and encourages citizen participation in the energy transition. Additionally, the European Energy Communities Facility in 2024 with a budget of €7 million, aims to support the development of at least 140 local projects focusing of business plans. The first call for grant support is expected in 2025, providing financial resources to bolster citizen-driven energy initiatives.

5.5.3 Technical/Technological barriers

The first Technical/Technological barrier considered refer to Technical barriers. Over 51 answers received, 41 responses were considered for this barrier class.

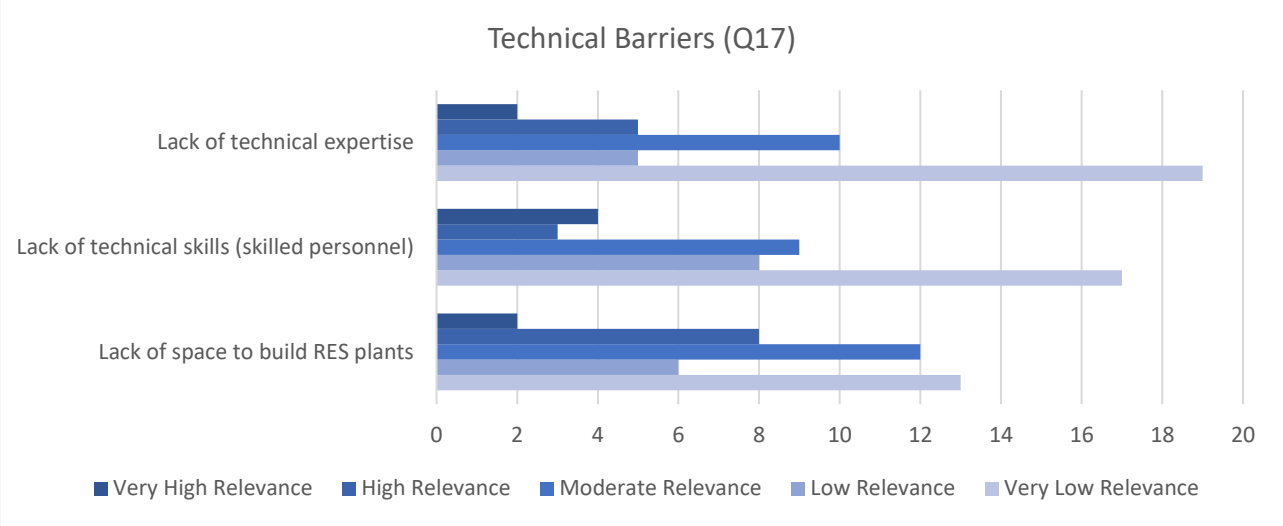

Figure 16 Technical barriers

The graph illustrates the perceived relevance of technical barriers impacting ECs, focusing on three specific challenges: “Lack of technical expertise”, “Lack of technical skills (skilled personnel)”, and “Lack of space to build RES plants”.

The “Lack of technical expertise” is rated as “Very Low Relevance” by the majority of respondents, indicating that it is not widely seen as a critical obstacle for ECs. This suggests that in many cases, ECs have access to sufficient general knowledge or external technical guidance to support their activities. However, for a smaller number of respondents, this barrier holds moderate to high relevance, potentially reflecting variations in local contexts or the complexity of administrative procedures to get access to funds or licences. Indeed, this barrier is well connected to the Institutional one called “Lack of simple and clear administrative procedures”, since when the administrative procedures are blurred and unclear the relevance of technical skills to deal with this complexity and confusion rise.

The “Lack of technical skills (skilled personnel)” is more evenly distributed across the relevance categories, with a significant portion of respondents assigning it “Moderate Relevance” or higher. This reflects the challenge of securing adequately trained personnel to manage EC operation, considering maintenance, or energy management. For ECs in less developed regions or those operating on a small scale, the availability of skilled workers may be limited, impacting their ability to implement and sustain EC initiatives. To deal with this barrier is crucial to rely on external experts and managers (maybe by setting a collaboration with third parties) who can provide technologies, maintenance services, or advanced energy management platforms to optimize energy production and consumption. Those types of services provided by utilities and energy providers are rising in the EU.

The “Lack of space to build RES plants” stands out as a low relevant barrier, suggesting that space constraints are generally not a major issue for most ECs. However, for a subset of respondents, this barrier holds high or very high relevance, likely tied to specific geographic or regulatory conditions. For example, densely populated urban areas or regions with strict land-use policies may face difficulties in allocating space for renewable energy installations, such as solar panels or wind

turbines. This limitation can hinder the scalability of ECs, particularly in areas with high energy demand but limited physical resources.

The second Technical/Technological barrier considered refer to Lack of efficient infrastructures. Over 51 answers received, 41 responses were considered for this barrier class.

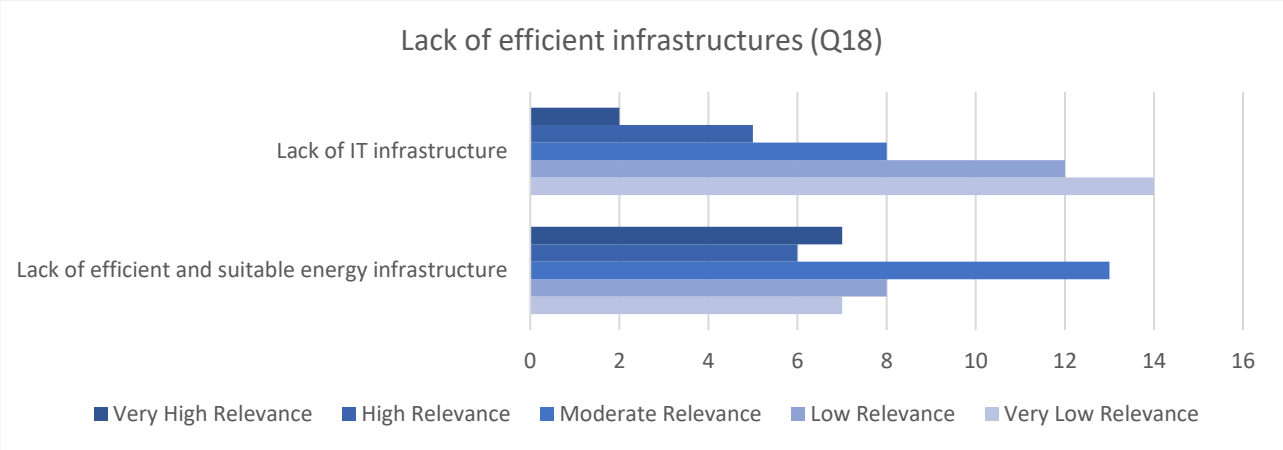

Figure 17 Lack of efficient infrastructures

The graph illustrates the perceived relevance of infrastructure-related barriers to ECs, specifically focusing on the "Lack of IT infrastructure" and the "Lack of efficient and suitable energy infrastructure".

The "Lack of efficient and suitable energy infrastructure" emerges as a critical challenge. This barrier is particularly pronounced for ECs, where grid access may be restricted due to management issues or grid saturation. A large proportion of respondents rated this barrier as "Moderate Relevance" or higher, emphasizing its impact on the ability of ECs to implement renewable energy projects. For example, overloaded grids or outdated infrastructure can delay the integration of decentralized energy systems, limiting both scalability and operational efficiency. Addressing this challenge requires investments in modernizing the grid, expanding capacity to accommodate RES, and implementing advanced grid management systems to reduce bottlenecks and inefficiencies.

The "Lack of IT infrastructure" is rated predominantly as "Very Low Relevance". However, advanced energy management systems, such as digital monitoring platforms, rely on robust IT infrastructure to ensure accurate data flows and optimized decision-making. In areas with limited digital connectivity or outdated IT systems, ECs may face operational challenges, such as delays in responding to system issues.

Le last Technical/Technological barrier considered refer to Lack of enabling technologies. Over 51 answers received, 41 responses were considered for this barrier class.

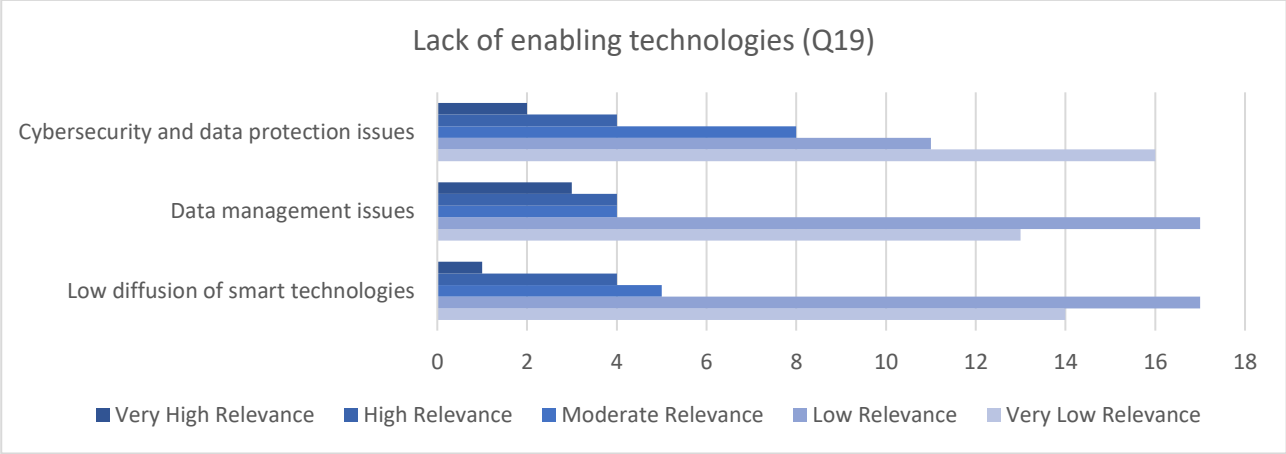

Figure 18 Lack of enabling technologies

The graph highlights the relevance of technological barriers faced by ECs, particularly the "Low diffusion of smart technologies", "Cybersecurity and data protection issues", and "Data management issues".

Among these, the "Low diffusion of smart technologies" is perceived as the most significant barrier. This finding underscores the slow adoption of essential technologies, such as smart meters and automated control systems, which are critical for optimizing energy management. Smart meters can provide close to real time feedback on energy consumption, enabling consumers to better manage their use, save energy and lower their bill, for example, by adapting their energy usage to different energy prices throughout the day. According to EU Agency for the Cooperation of Energy Regulators (ACER, 2023) only 54% of European households had an electricity smart meter at the end of 2022, while in 13 EU countries, the penetration rate was over 80% at the end of 2022.

In contrast, "Cybersecurity and data protection issues" are rated as less critical overall but remain a significant concern for some ECs, particularly those relying on advanced digital platforms for energy management. These systems are vulnerable to data leakage or system attacks, which can disrupt operations and increase the fear of ECs members.

"Data management issues", involving the challenges of data collection, processing, and utilization, present varying degrees of relevance. These issues are particularly significant for ECs seeking to implement advanced data-driven solutions, such as demand-response mechanisms or predictive analytics. Inadequate data quality, fragmented datasets, and a lack of proper digital tools hinder the ability of ECs to make informed decisions and optimize energy usage.

5.5.4 Socio-cultural and behavioural barriers

The first Socio-cultural and behavioural barrier considered refer to Lack of knowledge and awareness of EC. Over 51 answers received, 41 responses were considered for this barrier class.

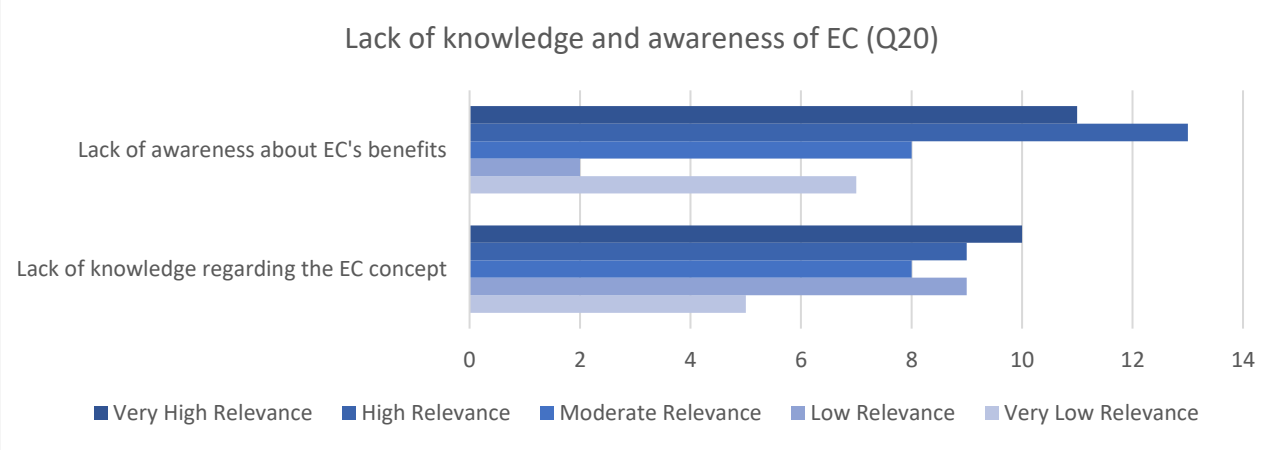

Figure 19 Lack of knowledge and awareness of EC

The graph highlights the relevance of barriers related to knowledge and awareness about ECs. It examines two specific challenges: the "Lack of awareness about EC's benefits" and the "Lack of knowledge regarding the EC concept".

The "Lack of awareness about EC's benefits" is identified as a significant barrier, with many respondents assigning it "High Relevance" or "Very High Relevance". This finding underscores the challenge of communicating the advantages of ECs, such as economic savings, environmental benefits, and community empowerment. Many potential participants and stakeholders may be unaware of how ECs operate or the direct and indirect benefits they offer. The lack of understanding can limit people engagement, reduce support for ECs, and diminish participation in renewable energy initiatives. As seen before, an EC requires effort (economic resources, time, and commitments) from its members. Thus, well understanding the benefits generated by being part of one of those initiatives can make a difference in scaling up and rolling out EC initiatives around Europe. In countries where there is a strong and maybe historical background on environmental matters, this barrier appears less prominent than in other countries where economic disadvantages and crises limit the commitments of citizens toward environmental issues. However, EC can contribute to fighting energy poverty and become a driver for low-income people who face economic limitations. This opportunity, for reasons that intercept financial and market barriers, along with institutional ones, might be lost.

Similarly, the "Lack of knowledge regarding the EC concept" is also perceived as highly relevant by respondents. This indicates that beyond the benefits, a fundamental understanding of what ECs are and how they function is often missing among potential members stakeholders. Moreover, a high lack of a clear and uniform definition of ECs (see the Institutional barriers section) strongly contributes to this barrier. Misunderstandings about what an EC is, requires and provides can create resistance, particularly in regions where ECs are a relatively new concept.

Addressing these barriers requires a concerted effort to improve information, education and awareness about ECs. Public awareness campaigns can play a key role in highlighting the benefits of ECs, particularly their potential to reduce energy costs, enhance sustainability, and foster public-private partnerships and collaboration among local stakeholders and community engagement in energy transition. It is crucial to increase awareness also in terms of EC operational structures, legal

aspects and technical and administrative requirements towards citizens, local stakeholders and even public authorities at the local level that might lack knowledge about this topic. This is particularly crucial to avoid rebound effects within institutional and technical barriers as seen before.

The second Socio-cultural and behavioural barrier considered refer to Lack of trust. Over 51 answers received, 41 responses were considered for this barrier class.

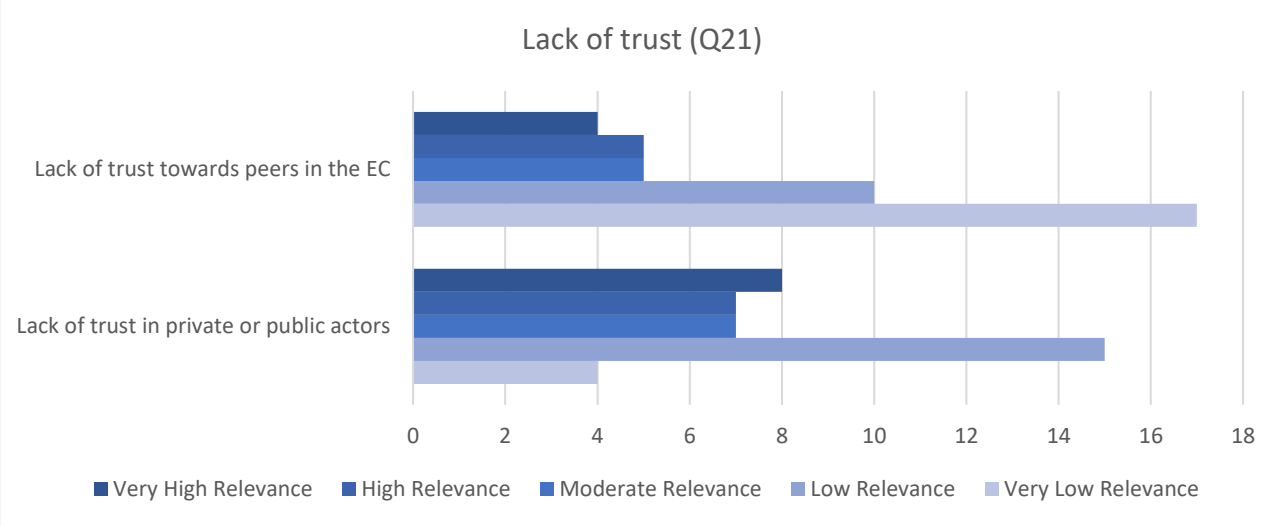

Figure 20 Lack of trust

The graph examines trust-related barriers to ECs, focusing on "Lack of trust towards peers in the EC" and "Lack of trust in private or public actors".

The "Lack of trust in private or public actors" emerges as a significant barrier. This reflects a perception that external stakeholders, such as private companies, local authorities, or national governments, may not act in the best interests of ECs or their members. Concerns about profit-driven motives, mismanagement, or lack of transparency in regulatory and operational processes contribute to this distrust. For example, ECs may hesitate to collaborate with energy utilities or public authorities if they perceive that their interests will be overshadowed or ignored. Trust in public actors is critical for ECs to access regulatory support and funds. However, in many cases, as seen before, public authorities at the local scale are not aware of ECs and are not able to give proper support and enhance those initiatives leading to a sense of exclusion and isolation for EC members. On the other hand, trust in private actors is necessary for partnerships involving technology providers or investors, which can strongly reduce technical and technological barriers as seen before.
In contrast, the "Lack of trust towards peers in the EC" is generally rated as having "Low Relevance" or "Very Low Relevance" by most respondents. This suggests that EC members largely trust one another, likely due to shared goals and a collective interest in the community's success. However, internal conflicts, unequal contribution of resources and revenues, or differing priorities among members can erode trust and disrupt the collaborative nature of ECs. Mechanisms such as transparent EC governance structures and regular communication among members can enhance cohesion within ECs. Building trust also requires demonstrating competence. Members must have

confidence that the EC has the technical, administrative, and financial expertise to achieve its goals. Training programs, external advisory support, and partnerships with experienced organizations can enhance the EC's capabilities and reassure members of its potential for success. This is also crucial to reduce the financial barriers called "Difficult to access finance from members" seen before. Indeed, many ECs, especially small-scale initiatives, strongly rely on member finance resources to operate. Lack of trust might hinder the willingness to invest capital in such initiatives exacerbating the limitation of accessing credit.

Le last Socio-cultural and behavioural barrier considered refer to the Lack of socio-cultural conditions. Over 51 answers received, 41 responses were considered for this barrier class.

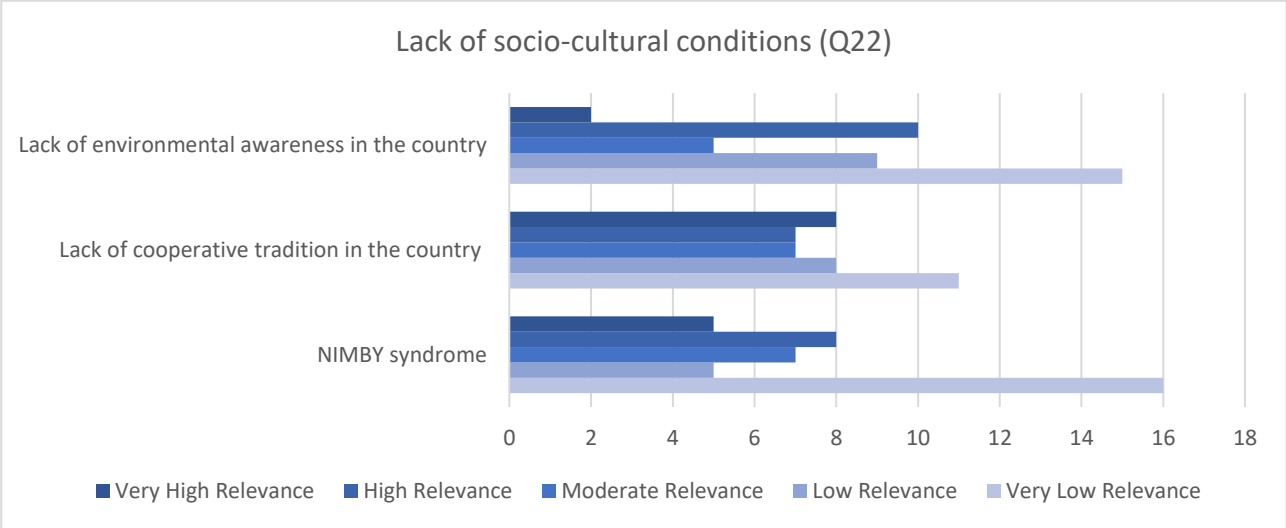

Figure 21 Lack of socio-cultural conditions

The graph explores socio-cultural barriers, focusing on three main challenges: "Lack of environmental awareness in the country or region where the EC is operating", "Lack of cooperative tradition in the country or region", and "NIMBY syndrome and local backlash against RES and ECs".

The "Lack of environmental awareness" emerges as a significant barrier, with a notable proportion of respondents assigning it "High Relevance" or "Moderate Relevance". This highlights the critical role that environmental awareness plays in fostering support for ECs. In regions where awareness of environmental issues, such as climate change and renewable energy, is low, individuals may lack the motivation to participate or support EC initiatives. Without a clear understanding of the long-term benefits, ECs may struggle to engage stakeholders and citizens. This lack of awareness not only hinders participation but may also perpetuate scepticism or resistance to change.

The "Lack of cooperative tradition" is another key barrier. This suggests that while it is not universally perceived as a critical issue, it can have a profound impact in certain contexts. Cooperative traditions, which involve collaborative decision-making, resource-sharing, and mutual support, are essential for the success of ECs. In countries or regions where such traditions are weak or absent, communities may face difficulties in forming the social bonds and organizational structures necessary to sustain ECs. In contrast, countries with a long history of collective practices,

such as cooperatives and associations, like Scandinavian countries, tend to easily accept and better understand the benefits generated by community-driven initiatives as ECs.

The “NIMBY syndrome” and local backlash against RES and ECs is predominantly rated as “Very Low Relevance”. This phenomenon reflects resistance to the development of renewable energy infrastructure, such as wind turbines or solar farms, due to perceived local inconveniences or aesthetic concerns. Addressing this barrier requires careful project planning and community involvement. Engaging residents early in the planning process and incorporating their feedback can help mitigate opposition. Transparent communication about the benefits of ECs, along with efforts to address specific local concerns, can build trust and reduce resistance. Compensation mechanisms, such as offering discounted energy rates or direct financial benefits to affected communities, may also help garner support.

Looking at all barriers, we can make a list of the most relevant barriers across technical, regulatory, financial, and socio-cultural categories of barriers according to our sample of respondents. Based on this analysis, the ten most relevant barriers are:

1. Lack of policy stability and coherence
2. Slow administrative procedures
3. Lack of simple and clear administrative procedures
4. Lack of public funds for ECs
5. Absence or lack of a clear and uniform definition of ECs
6. Lack of tailor-made finance options
7. Lack of awareness about EC’s benefits
8. Presence of market incumbents
9. Lack of knowledge regarding the EC concept
10. Lack of trust in private or public actors

The analysis indicates that the majority of highly relevant barriers fall within the Institutional category, followed by the Economic and Socio-cultural categories. In contrast, Technical and Technological barriers appear to have a relatively lower impact on the establishment and operations of ECs. To deepen the understanding of these findings, further analysis will be carried out by expanding the sample of respondents in the coming months.

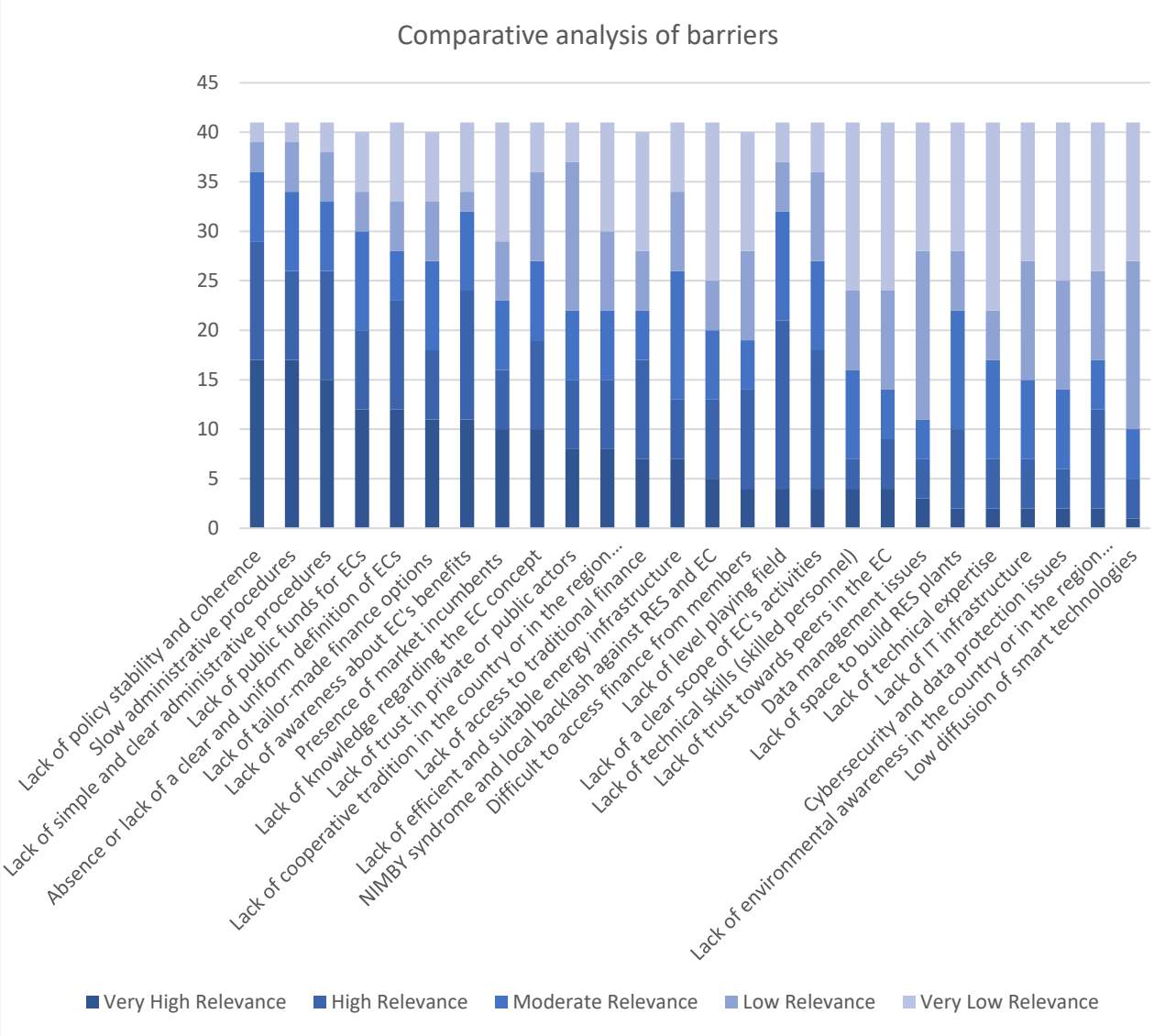

Figure 22 Comparative analysis of barriers

5.6 Survey results on EC impacts

The following section presents survey results on EC impacts, grouped in economic, environmental and social impacts.

5.6.1 Economic impacts

Questions on economic impacts refer to economic benefits for EC members, jobs creation and possible economic spillovers to the wider community. Economic benefits for members surveyed are savings on energy bill and return on investment.

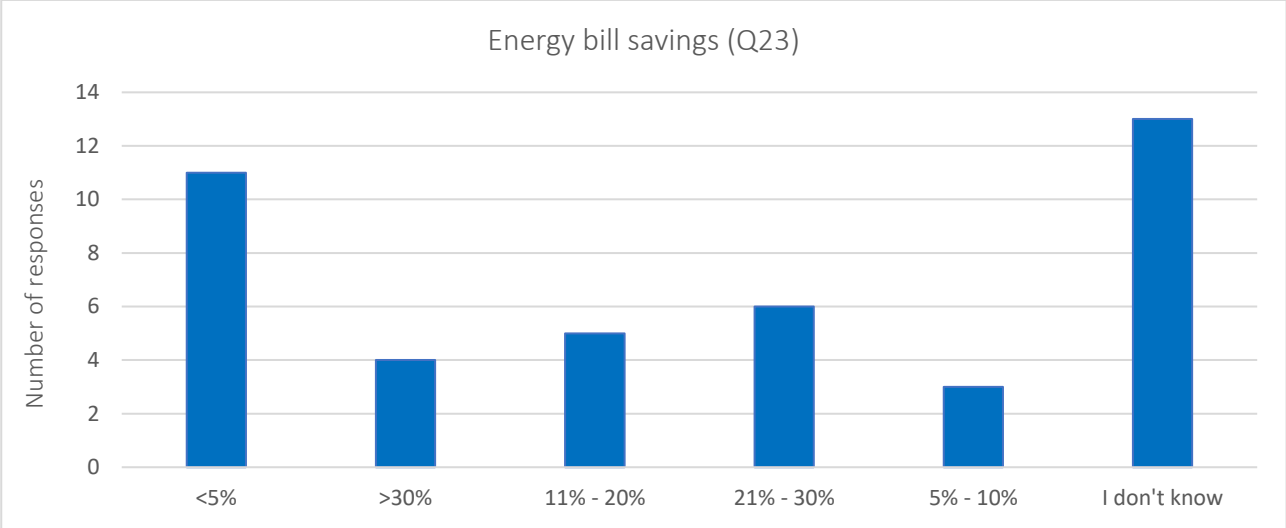

Figure 23 Energy bill savings

Figure 23 shows results on the declared energy bill saving achieved by the members of the ECs. The majority of the 42 respondents considered for this question do not have an answer (i.e. 13 "I don't know"). Saving below 5% receive the second highest number of responses (11 responses), followed by 3 to 6 responses for percentages between 5% and 30% of energy savings. Four respondents declared saving on bills above 30%.

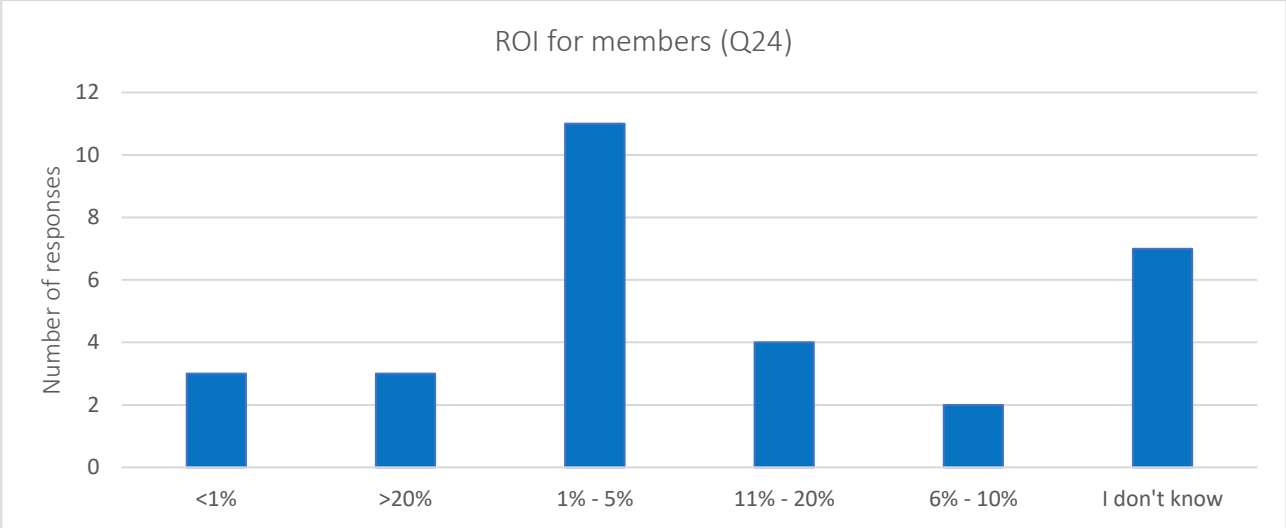

Figure 24 Return on investment (ROI) for members

Figure 24 presents the range of return on investments (ROI) offered to members by surveyed ECs. Most of the initiatives, 11 out of 30 responses, declared to offer ROI below 5%, while few initiatives offer ROIs above 20% (3 out of 30 responses).

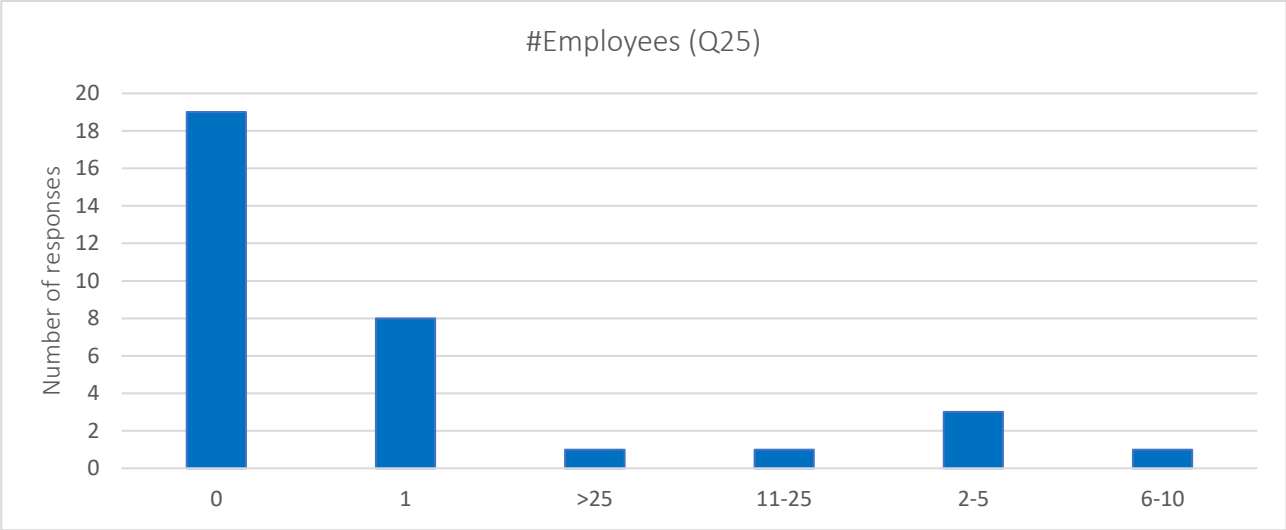

Figure 25 Number of employees

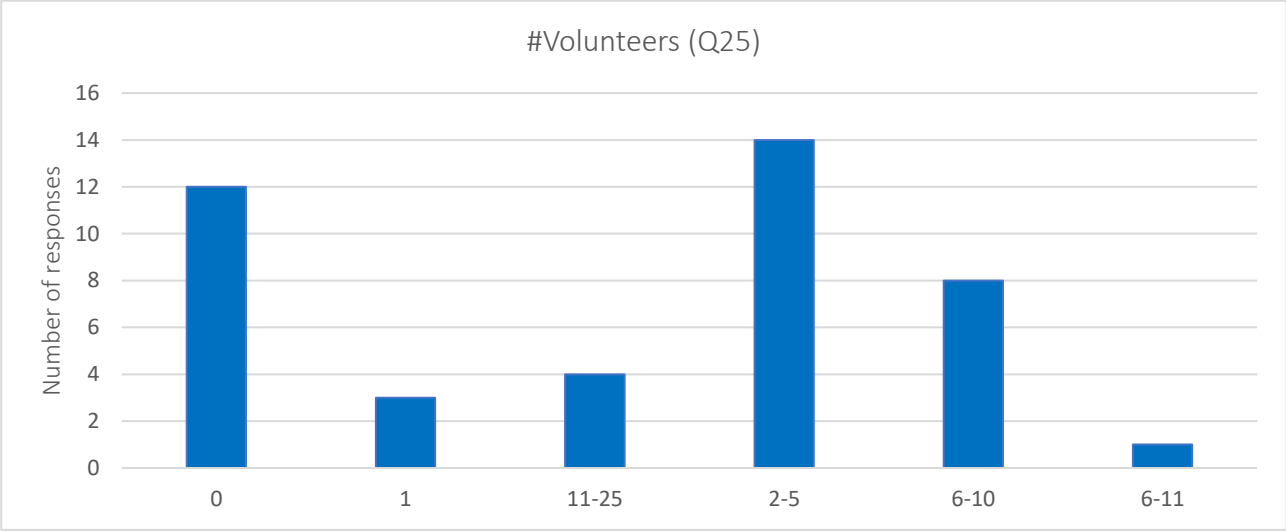

Figure 26 Number of volunteers

Figures 25 and 26 presents responses respectively on the number of employees and of volunteers working within the initiatives. Results show a clear prevalence of volunteers dedicated to the daily functioning of the EC compared to employees.

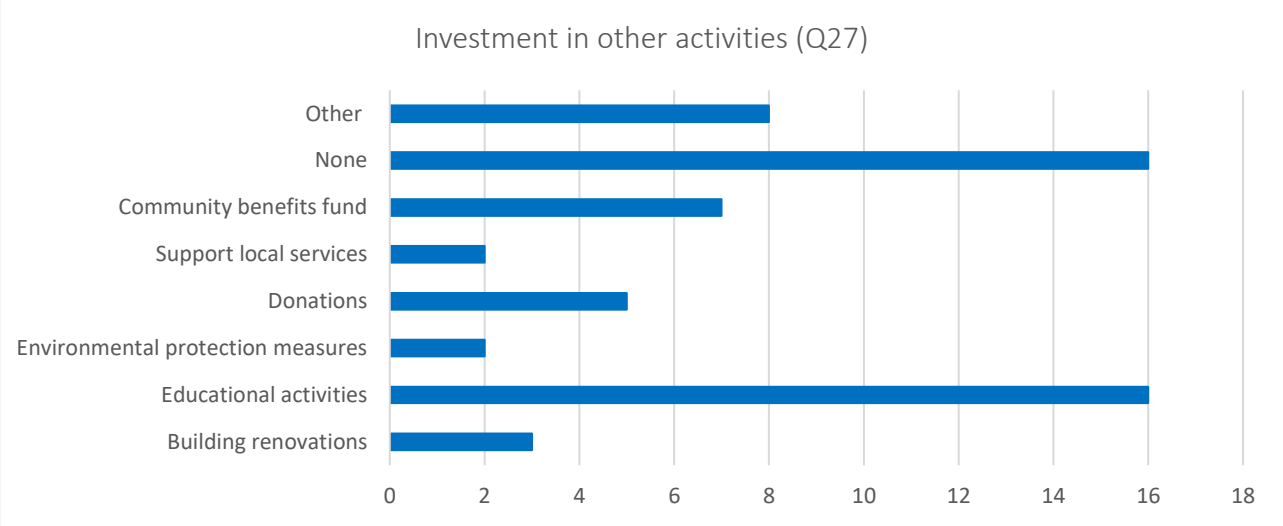

Figure 27 Investments in other activities

Figure 27 presents the ECs' investments in other activities, beyond the core energy related ones, on which ECs have invested surplus budget. The figure presents number of responses for each option provided in the question, accounting for the fact that several respondents have selected more than one option. Educational activities are the mostly recurrent (16 responses), followed by the constitution of a community benefits fund (7 responses). Many initiatives have declared not to invest any surplus in additional activities (16 responses), but several of those that have answered "Other", have declared they plan to do it in the future. Among the other activities declared there are: 1. investments in other projects and support to local projects, and 2. support to vulnerable households.

Overall, responses on economic impact section highlight some form of economic return to members (either through reduction of energy bills or by providing return on the investment) and of economic redistribution through activities targeted to enhance community benefits. Economic spillovers in terms of job creation seem to be quite limited. Further analysis, including comparison of these results with EC characteristics (such as country, maturity stage, typology etc.) will be carried out while expanding the sample of respondents in the coming months.

5.6.2 Environmental impacts

Questions on environmental impacts aim at assessing GHG emissions reduction potential and possible wider impacts on the local environment.

In order to assess GHG emission reduction of ECs surveyed, questions 28 and 29 have been designed to gather evidence on both, installed capacity of energy production technologies (in kWp) and total output for each type of source of energy (in MWh). The latter aims at gathering evidence also for ECs that do not have energy production among their activities (see also Figure 10). This evidence would then be used to calculate the GHG emission reduction potential accounting for GHG emission intensity of power generation in each country. However, the size of the available sample does not allow meaningful calculations, yet, which will be done in the future while expanding the sample of respondents in the coming months.

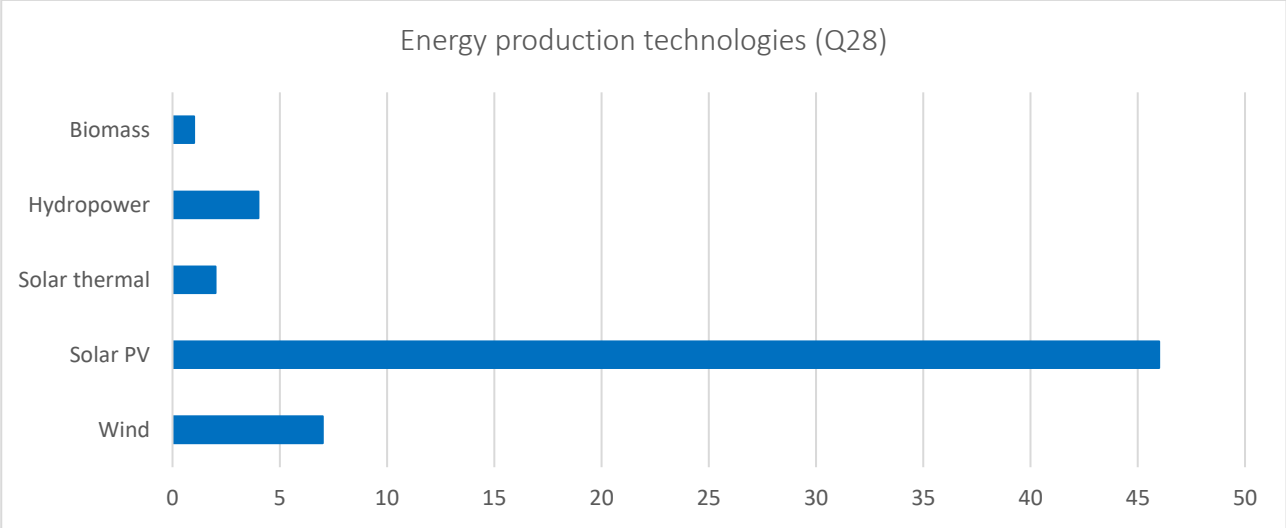

Figure 28 Energy production technologies

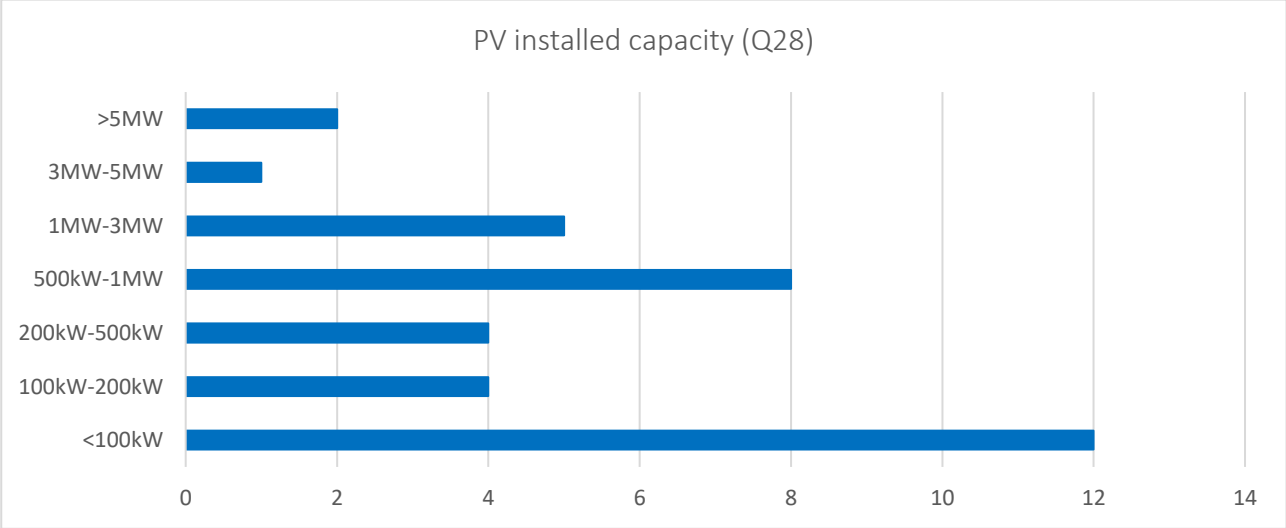

Figure 29 Solar PV installed capacity

Figure 28 presents result on energy production technologies, showing a high prevalence of PV technologies (46 responses out of total 60). In Figure 29 PV installed capacity spans between small to larger systems (in the MW range), with a prevalence of system size below 100kW (12 responses out of 36 valid responses).

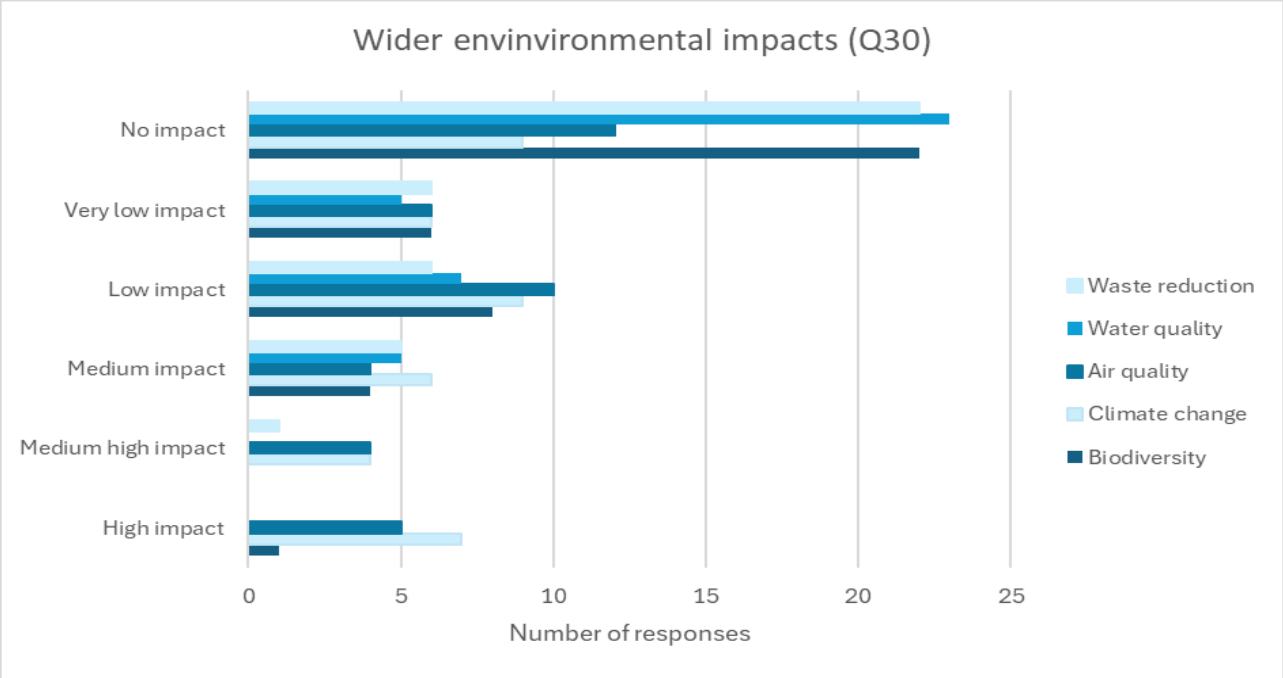

Figure 30 Wider environmental impacts

Figure 30 presents result of a self-reported assessment of wider environmental impacts of ECs activities. Respondents have been asked to rank between "No impact" and "High impact" implications in terms of waste reduction, water quality, air quality, biodiversity and climate change. Over 51 answers received, 43 responses were considered valid for this question. Results show a perceived low to no impact for all the dimensions considered. Only the climate change dimension receives responses for each impact level, a result which is coherent with the fact that EC have green energy as a main activity.

5.6.3 Social impacts

Social impacts refer to levels and forms of participation in governance, the recognition and inclusion of minorities and vulnerable people, the implementation of measures for energy poverty alleviation and of educational/social activities, and the achievement of wider social impacts.

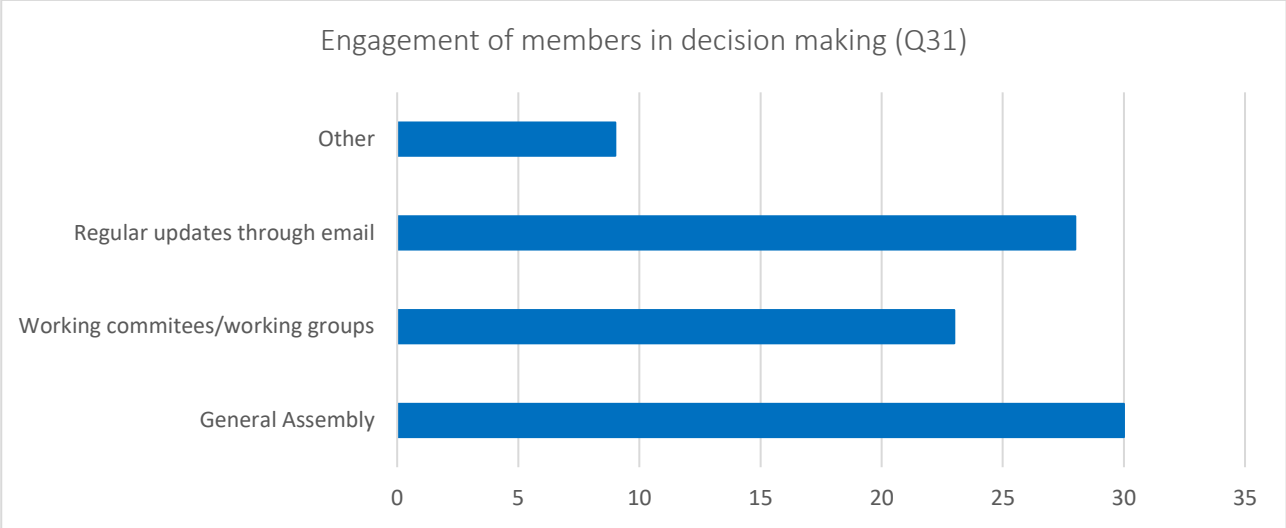

Figure 31 Engagement of members in decision-making

Figure 31 presents the number of responses for each option provided to respondents as possible ways to engage members in the EC decision making process. The question is multiple choice, so the results in Figure 31 present counts for the total number of responses for each option provided (90 responses in total), selected by 41 respondents. Figure 31 presents a fairly high level of engagement of members in the decision-making process. Each respondent has selected at least one of the provided options for engagement, and the majority has selected at least two. Those selecting "Other" have indicated the following additional means of communication and engagement of members: whatsapp, facebook groups, newsletters, a bar, meetings, surveys (for data gathering or online decision making), reflexion days for strategic topics. The General Assembly receives the highest number of responses, confirming its centrality in the relationship between ECs and their members.

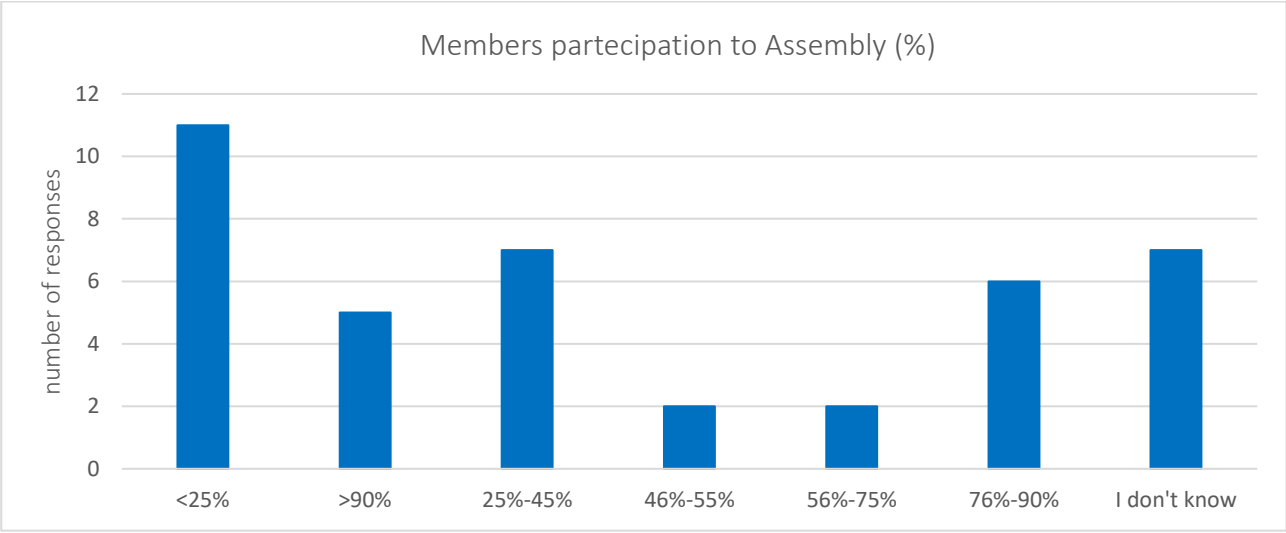

Figure 32 Members participation to the Assembly (%)

However, levels of members participation in the Assembly varies significantly among ECs surveyed, with a prevalence of participation below 25%. Figure 32 presents levels of participation of members to the Assembly in the last year. Most of responses report participation below 25% (i.e. 11 responses

out of a total of 40 valid responses) and more than 50% of the responses indicate a level of participation below 50% (i.e. in total 17 out of 40 valid responses and excluding "I don't know").

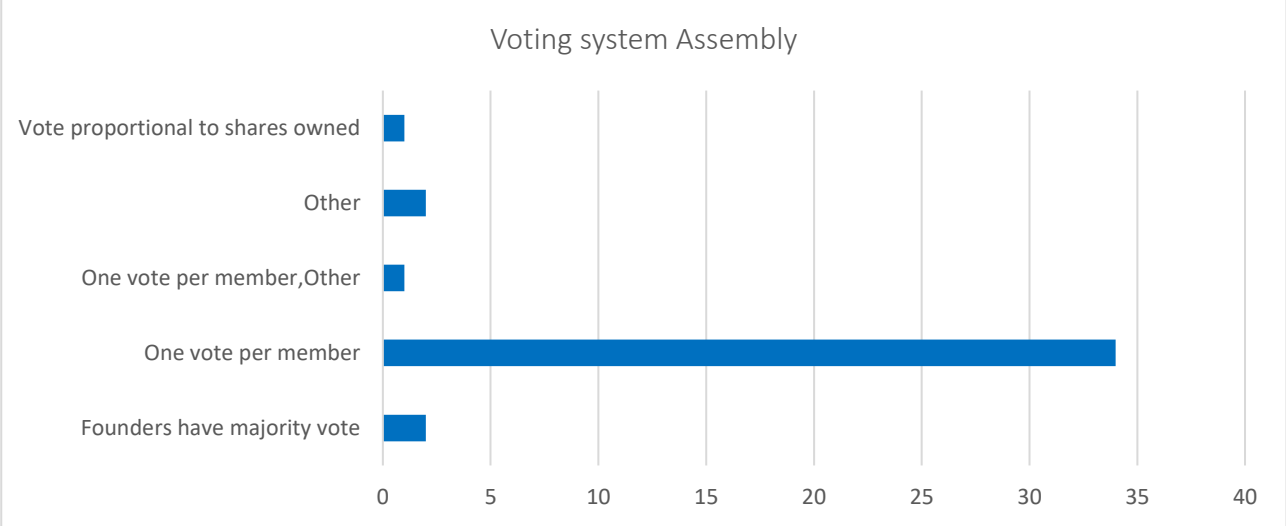

Figure 33 Voting system in Assembly

The voting system mostly used in the Assembly is "one vote per member" (34 responses out of 40 valid responses), showing a prevalence for high representation of members' voice in the assembly (Figure 33). This is partly related to the relative prevalence of the cooperative as a legal form (see also Figure 9), which follows the "one head one vote" rule for Assembly voting system. Respondents selecting "Other" have provided the following additional voting systems options: vote share according to member type (e.g. 35% for citizens, with one vote per citizen member within this 35% total), no voting system (it is a corporate-run REC), one vote per household.

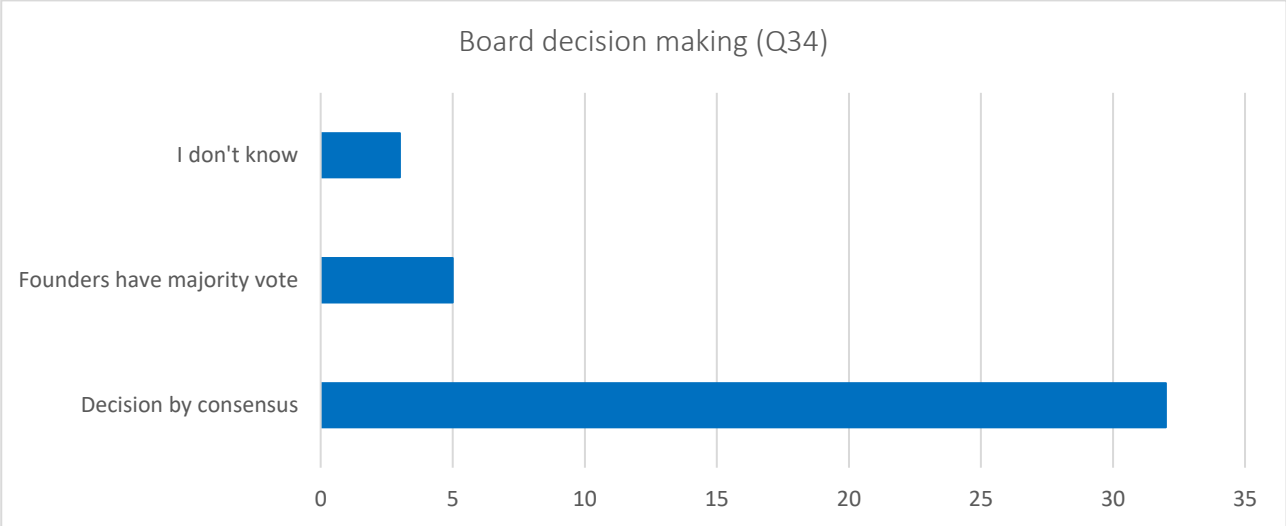

Figure 34 Decision making in the board

Figure 34 presents responses for the decision-making process in the board. Most of the initiatives adopt decision by consensus (32 out of 40 responses) and only in few cases (5 out of 40 responses) founders have majority vote. This further highlight the prevalence of democratic and participatory decision-making processes within the EC initiatives surveyed.

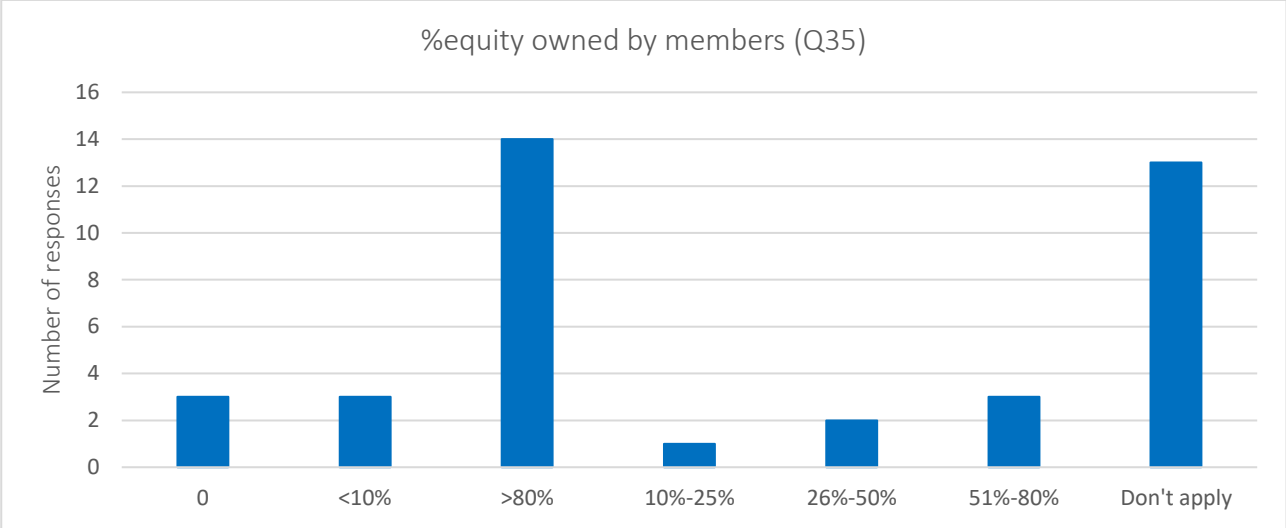

Figure 35 Percentage equity owned by members

Most of the EC initiatives declare members participation to the equity capital (26 initiatives, i.e. 39 valid responses minus 13 "Don't apply" responses) state high levels of members ownership: 14 EC out of 26 declare a percentage of equity owned by members above 80% (Figure 35). This metrics is an indication of a high level of participation and empowerment of citizen members in EC initiatives surveyed.

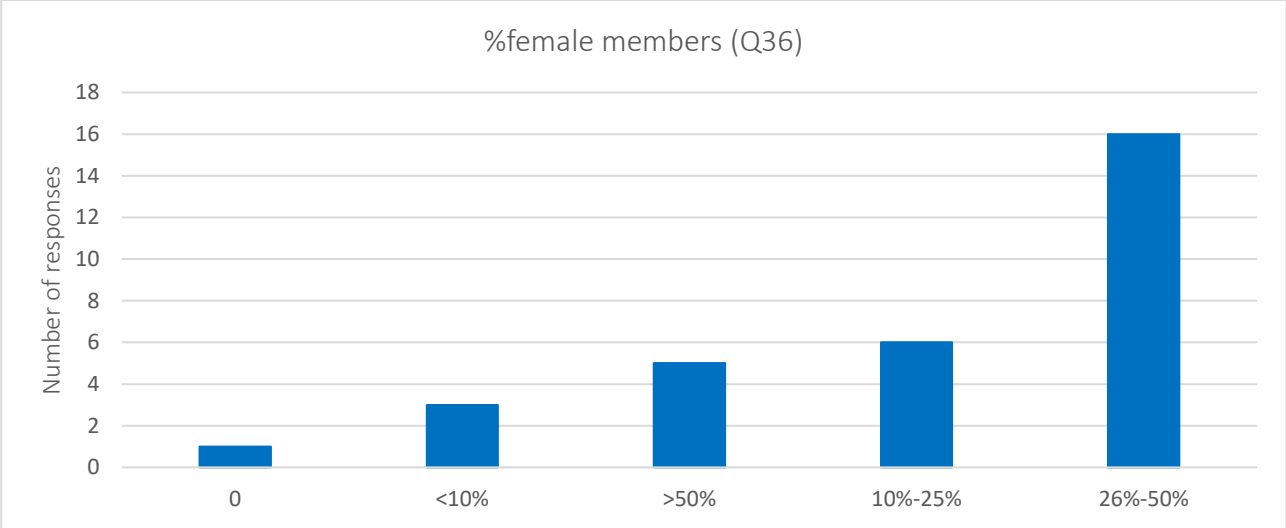

Figure 36 Percentage of female in membership

Moving to recognition and inclusion of minorities and vulnerable people, Figure 36 presents responses for percentages of female members in the ECs' membership base. Females are less represented than males, with most of the answers stating a female participation below 50% (i.e. 26 out of 31 valid responses fall in the 0 and 50% range).

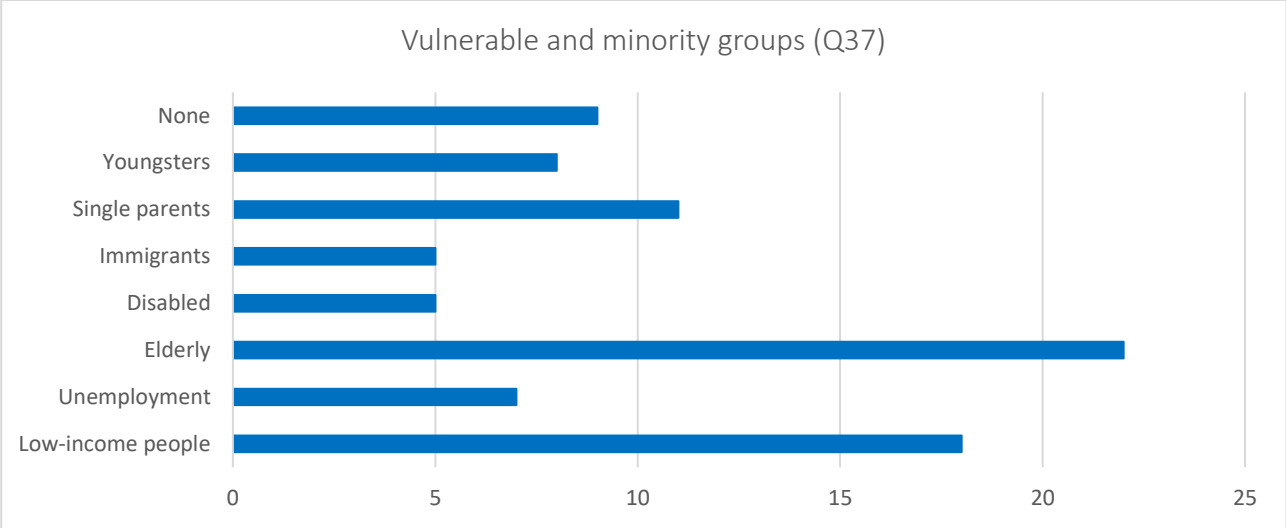

Figure 37 Representation of minority and vulnerable people

Figure 37 presents relatively high levels of representation of the identified vulnerable and minority groups. Apart from 9 initiatives (which have selected "None"), 31 out of 40 valid responses have selected at least one minority/vulnerable group. Most of them have selected at least two groups. Elderly and low-income people are the vulnerable groups mostly represented, counting respectively 22 and 18 responses over a total of 76 responses (multiple answers were allowed).

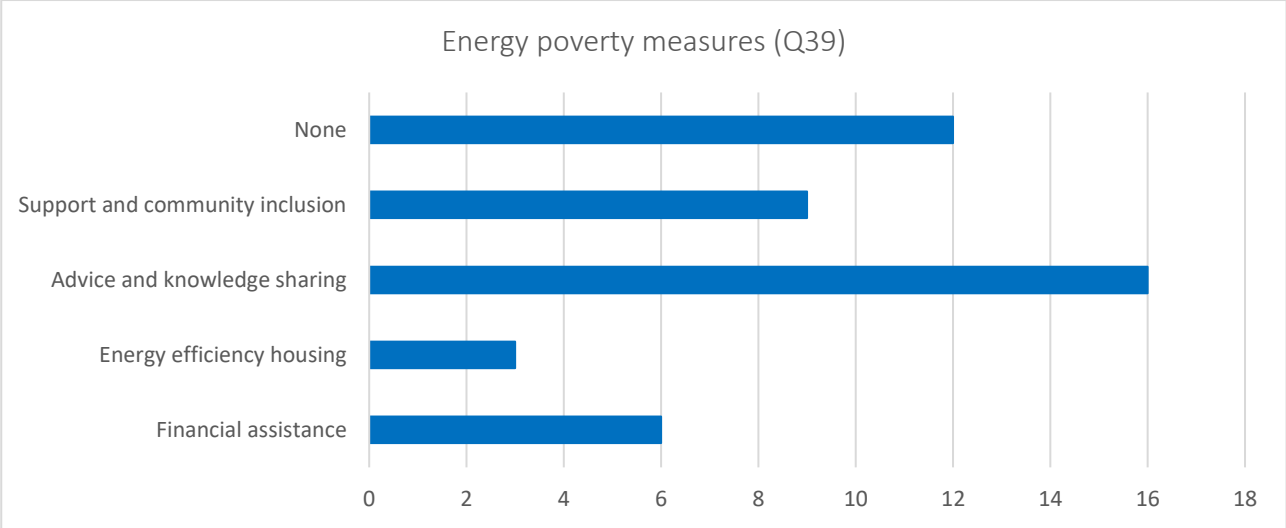

Figure 38 Energy poverty measures implemented

Figure 38 confirms energy poverty as an issue of concern for EC initiatives. Most of the initiatives have implemented a measure to alleviate energy poverty (27 out of 39 valid responses). Of those, 9 have implemented more than one alleviation measure. Providing advice and knowledge sharing on energy efficiency, energy saving and support with bureaucratic issues are the most common energy poverty alleviation measures implemented by EC surveyed, followed by wider activities for community inclusion and recognition of energy poor.

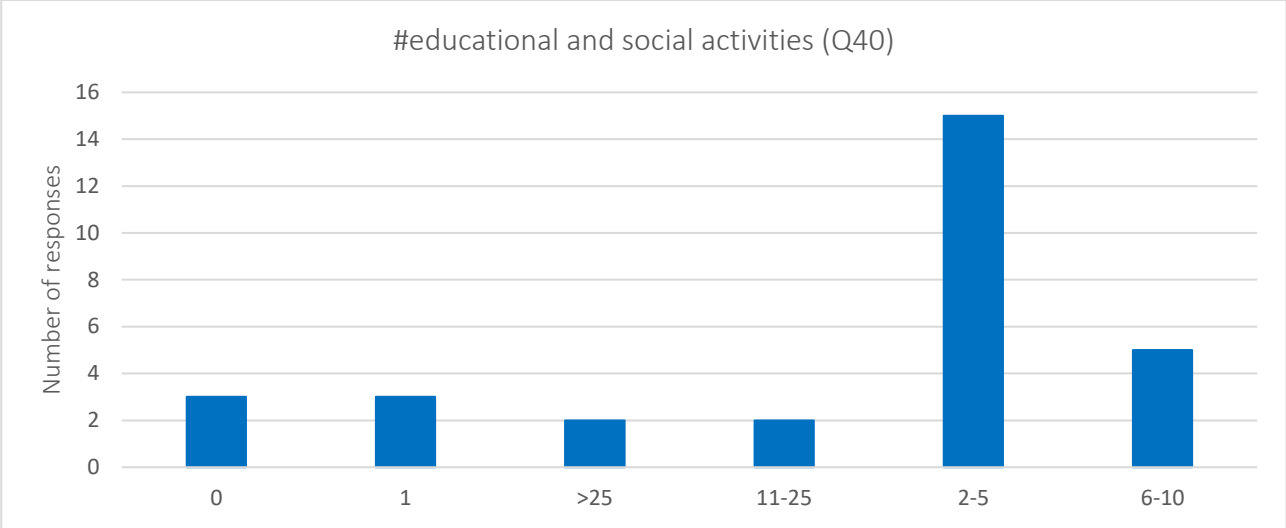

Figure 39 Number of educational and social activities

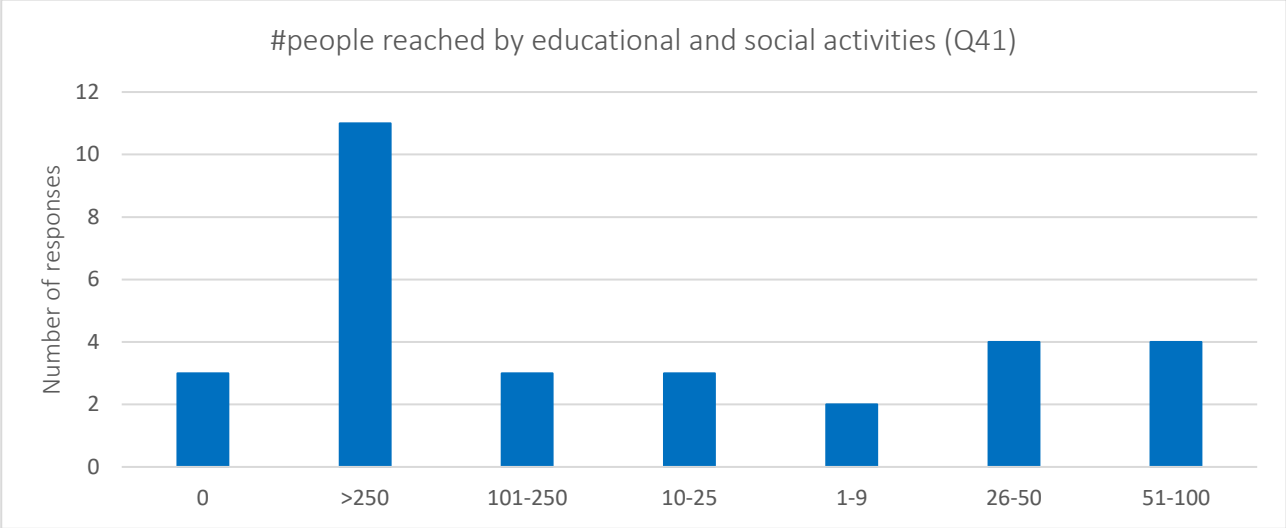

Figure 40 Number of people reached by educational and social activities

The number of educational and social activities implemented by EC surveyed in the last year is relatively low, with 15 out of 30 valid responses falling between 2 and 5 per year (see Figure 39). However, the number of people reached by these activities is relatively high, with most of the responses falling in the >250 range (see Figure 40).

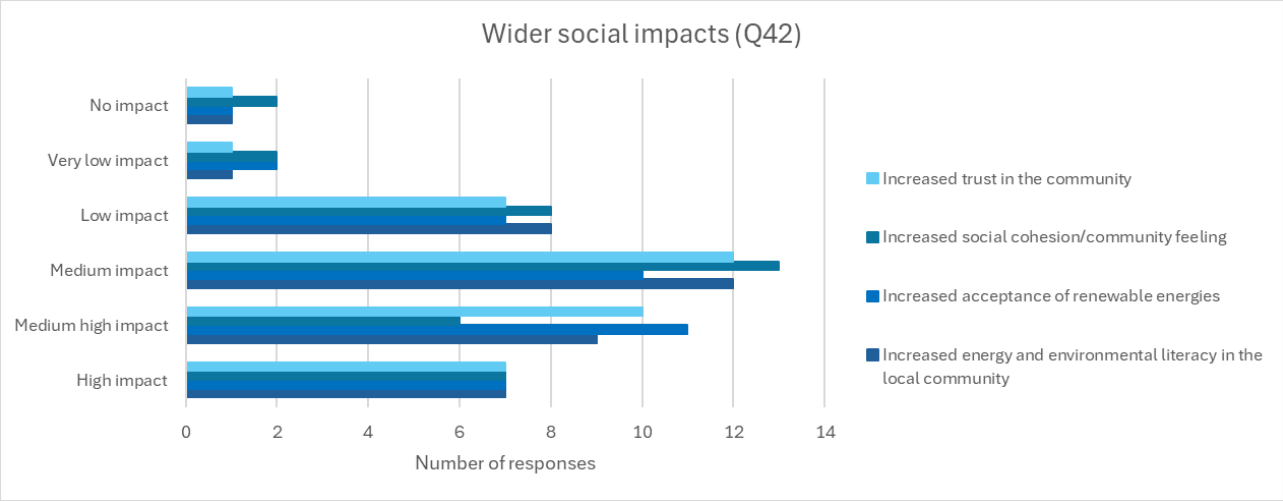

Figure 41 Wider social impacts

As self-reported assessment of wider social impacts of EC activities, respondents have been asked to state whether they have perceived an increase over four dimensions of social capital within their reference community: community trust, social cohesion, energy and environmental literacy and renewable energy acceptance. Figure 41 presents the results of ECs respondents. Over 51 answers received, 38 responses were considered valid for this question. Overall respondents declare medium to high positive impact on all social capital dimensions surveyed.

Respondents declare medium to high positive impact on trust and social cohesion within the community, which is coherent with results presented in Figure 20, i.e. low to very low relevance of "Lack of trust towards peers in the EC" barrier. This result seems to not only indicate the presence of trust in the community, but also a positive causality between EC activities and trust itself, i.e. an increase in trust due to EC development and activities within the community. However, further evidence gathering and analysis will be needed to validate this causality, for example through semi-structured interviews on a case study basis.

Respondents also report medium to high positive impact on energy/environmental literacy in the local community and acceptance of renewable energies. These results seem to indicate that, despite lack of environmental awareness as well as lack of awareness on EC concept and benefits are perceived as highly relevant barriers to EC diffusion (see Figure 19 and Figure 21), once involved in EC activities citizen members tend to become more informed on energy related issues and more environmentally aware.

Overall, responses on social impacts questions present good levels of participation and engagement of members in the governance of ECs and in their decision-making processes. ECs also seems to recognise minority and vulnerable people, in particular elderly and low-income people, by including them in the membership base. Gender imbalances remain evident, with females accounting overall for less than 50% of the membership base. Results further show some evidence of ECs engaged in developing social and environmental activities as energy poverty alleviation measures within their communities. ECs also report medium to high positive impact of their activities on wider social capital dimensions, such as community trust and cohesion, environmental literary and renewable

energy acceptance. Further analysis, including comparison of these results with ECs characteristics will be carried out while expanding the sample of respondents in the coming months.

6 CONCLUSION

This deliverable provides an updated analysis of policy frameworks at the EU and National levels regarding ECs, along with the results of ECs' barriers and impacts assessment. Through a systematic review of literature and a survey, the report highlights the key obstacles affecting the establishment and operation of ECs, offering insights also in terms of their impacts.

The analysis reveals that Institutional barriers represent the most critical challenges, particularly the lack of policy stability and coherence. Slow and complex administrative procedures, coupled with the absence of clear and uniform definitions of ECs, hinder their development and create uncertainty for stakeholders. Economic barriers, such as insufficient access to public funds and a lack of tailored financial mechanisms, limit the financial viability and scalability of ECs, particularly for smaller and emerging initiatives. Socio-cultural challenges, including low public awareness of EC benefits, limited trust in public or private actors, and a lack of knowledge about EC concepts, further impede progress. While technical barriers, such as outdated infrastructure and insufficient enabling technologies, are less prominent, they remain relevant in specific contexts, particularly in rural and underdeveloped areas.

To address these barriers, specific actions are required to unlock the full potential of ECs. There is an urgent need for policymakers to establish stable and coherent regulatory frameworks that simplify administrative processes and provide clear, uniform definitions for ECs, as it has been done in Italy and France. Financially, greater access to funding mechanisms tailored to ECs is crucial, including low-interest loans, and incentives that support both emerging and mature initiatives. However, it is essential to ensure the long-term lasting of these financial measures to increase the willingness to start an EC by guaranteeing economic sustainability. This is crucial for Italy, where the limited timeframe for the Premium tariff might generate long-term issues. In Sweden, the incentives linked with RES production, regardless of the EC nature of an initiative, ensure the viability and long-term stability of public economic support mechanisms. Special attention should be given to smaller initiatives, which often face greater financial constraints. Additionally, encouraging private sector engagement through partnerships and innovative financing schemes can further strengthen the economic sustainability of ECs and enable their scalability. In parallel, raising public awareness through targeted campaigns and educational initiatives is essential for fostering trust and engagement. Capacity-building programs for local authorities, citizens, and other stakeholders will strengthen their understanding of EC operations and governance. Investments in energy infrastructure and enabling technologies, such as smart grids, energy storage systems, and digital tools, will further support the technical needs of ECs, especially in underserved areas.

Regarding ECs impacts, the findings highlight key insights into the economic, environmental, and social impacts. On the economic front, there is evidence of economic returns for members, primarily through energy bill reductions or returns on investment, as well as some degree of economic redistribution aimed at enhancing community benefits. However, economic spillovers, such as job creation, appear to be limited. In terms of environmental impacts, responses indicate a perceived

low to no impact across most dimensions, such as waste reduction, water quality, air quality, and biodiversity. Climate change stands out as the only dimension with responses spanning all impact levels, reflecting the core focus of ECs on green energy activities. Social impacts demonstrate encouraging levels of participation and engagement in EC governance and decision-making processes. Notably, ECs recognize and include vulnerable groups, such as elderly and low-income individuals, within their membership base. Gender imbalances, however, remain evident. Additionally, ECs report medium to high positive impacts on broader social dimensions, including community trust, cohesion, environmental literacy, and renewable energy acceptance. Evidence also suggests that some ECs actively address social and environmental challenges, such as energy poverty alleviation.

The limited data collection and the heterogeneous geographic distribution of ECs answering the survey highlight the need for further targeted efforts to gather more comprehensive data and better understand the regional disparities in EC implementation. The limited participation from certain areas may reflect either a lack of active EC initiatives or low awareness and engagement in survey processes. The next steps will focus on expanding the survey dissemination to collect additional data, particularly from underrepresented regions. This will enable a more thorough evaluation of the barriers and impacts, strengthening the analysis presented in this deliverable. Furthermore, targeted efforts to engage stakeholders, share knowledge, and support EC initiatives will be essential to overcome existing challenges and unlock their full potential.

7 ANNEX

FIRST BLOCK: ENERGY COMMUNITY CHARACTERISTICS

Q1Please provide the name of your Energy Community / Website of the Energy community

Q2 Please indicate the year of the EC set-up, if applicable

Q3 Does your EC meet the requirements for a Renewable Energy Community (EU Directive 2018/2001) or Citizen Energy Community (EU Directive 2019/944)?

- Yes, for Renewable Energy Community
- Yes, for Citizen Energy Community
- No
- I don't know

Q4 Please specify what is the current state of your EC

- Development phase
- Operation and management phase
- Evaluation and expansion phase

Q5 Please indicate the country, the city and the size of the city where your EC is located

- Country
- City/Town/Village

Q6 Please indicate the type of urban/rural context where your EC is located

- Urban
- Rural

Q7 Please indicate the legal form of your Energy Community

- Limited partnership
- Cooperative
- Public-private partnership
- Non-profit organization
- Public utility company
- Community trust and foundation
- Housing association
- Social enterprise
- Other (please indicate)

Q8 Please indicate the size of your EC, in terms of numbers of members

- Less than 50 members
- From 51 to 200 members
- From 201 to 1000 members
- From 1001 to 5000 members
- Above 5000 members

Q9 Please indicate the type of EC members

- Citizens (If yes provide the % of the total members)
- NGOs (If yes provide the % of the total members)
- Municipality
- Other public authority (Please specify) (If yes provide the % of the total members)

Q10 Please Indicate the role of your EC members

- Consumers (If yes provide the % of the total members)
- Prosumers (If yes provide the % of the total members)
- Producers (If yes provide the % of the total members)
- Aggregator
- Facilitator/Promoter
- Manager
- Provider

Q11 Please indicate the main activities that your EC is performing

- Energy Production
- Energy Sharing
- Energy Supply
- Energy distribution
- Energy Services
- E-mobility
- Other activities

Q 12 Please select the main sources of revenue, if any, of your EC

- Public incentives
- Public subsides
- Donation
- Energy retail
- EC members fee (e.g. annual membership)
- Energy services fee
- E-V services
- Other activities (Please specify)

SECOND BLOCK: ENERGY COMMUNITY BARRIERS

Economic barriers

Q13 Financial barriers. Use a scale from 0 to 5, where 0 means “no relevance” and 5 means “high relevance”

	Scale 0 indicates no importance, 5 indicates high importance					
Barriers	0	1	2	3	4	5
Lack of access to traditional finance						

Difficult to access finance from members						
Lack of tailor-made finance options						
Lack of public funds for ECs						

Q14 Market barriers. Use a scale from 0 to 5, where 0 means “no relevance” and 5 means “high relevance”

	Scale 0 indicates no importance, 5 indicates high importance					
Barriers	0	1	2	3	4	5
Lack of a level playing field (i.e. economy of scale).						
Presence of market incumbents						

Institutional barriers

Q15 Policy and regulatory barriers. Use a scale from 0 to 5, where 0 means “no relevance” and 5 means “high relevance”

	Scale 0 indicates no importance, 5 indicates high importance					
Barriers	0	1	2	3	4	5
Absence or lack of a clear and uniform definition of ECs						
Lack of a clear scope of EC’s activities						
Lack of policy stability and coherence						

Q16 Administrative and bureaucratic barriers. Use a scale from 0 to 5, where 0 means “no relevance” and 5 means “high relevance”

	Scale 0 indicates no importance, 5 indicates high importance					
Barriers	0	1	2	3	4	5
Lack of simple and clear administrative procedures						
Slow administrative procedures						

Technical/Technological barriers

Q17 Technical barriers. Use a scale from 0 to 5, where 0 means “no relevance” and 5 means “high relevance”

	Scale 0 indicates no importance, 5 indicates high importance					
Barriers	0	1	2	3	4	5
Lack of space to build RES plants						
Lack of technical skills (skilled personnel)						
Lack of technical expertise required to deal with administrative, legal procedures and to apply for public funds, grants, etc.						

Q18 Lack of efficient infrastructures. Use a scale from 0 to 5, where 0 means “no relevance” and 5 means “high relevance”

	Scale 0 indicates no importance, 5 indicates high importance					
Barriers	0	1	2	3	4	5
Lack of efficient and suitable energy infrastructure						
Lack of IT infrastructure						

Q19 Lack of enabling technologies. Use a scale from 0 to 5, where 0 means “no relevance” and 5 means “high relevance”

	Scale 0 indicates no importance, 5 indicates high importance					
Barriers	0	1	2	3	4	5
Low diffusion of smart technologies						
Data management issues						
Cybersecurity and data protection issues						

Socio-cultural and behavioural barriers

Q20 Lack of knowledge and awareness of ECs. Use a scale from 0 to 5, where 0 means “no relevance” and 5 means “high relevance”

	Scale 0 indicates no importance, 5 indicates high importance					
Barriers	0	1	2	3	4	5
Lack of knowledge regarding the EC concept						
Lack of awareness about ECs’ benefits						

Q21 Lack of trust. Use a scale from 0 to 5, where 0 means "no relevance" and 5 means "high relevance"

	Scale 0 indicates no importance, 5 indicates high importance					
Barriers	0	1	2	3	4	5
Lack of trust in private or public actors						
Lack of trust towards peers in the EC						

Q22 Lack of socio-cultural conditions. Use a scale from 0 to 5, where 0 means "no relevance" and 5 means "high relevance"

	Scale 0 indicates no importance, 5 indicates high importance					
Barriers	0	1	2	3	4	5
NIMBY syndrome and local backlash against RES						
Lack of cooperative tradition in the country or the region your EC is operating						
Lack of environmental awareness in the country or the region your EC is operating						

THIRD BLOCK: ENERGY COMMUNITY IMPACTS

Economic impacts

Q23 Please provide an indication of the average annual energy bill saving for your member

- Less than 5%
- Between 5% and 10%
- Between 10% and 20%
- Between 20% and 30%
- Above 30%
- I don't know

Q 24 Please indicate the main sources of finance of EC

- Members
- Finance institutions (i.e. Commercial banks, Development banks, Funds, Cooperative funds)
- Public bodies (i.e. grants and support by local and regional authorities, public foundations, EU funding)
- Third parties (e.g. energy companies, utilities or other actors financing generation plants or other assets made available to EC)

If YES to members. What is the expected/distributed average return on the investment for members?

- Less than 1%
- Between 1% and 5%
- Between 5% and 10%
- Between 10% and 20%
- Above 20%
- I don't know

Q25 How many employees and volunteers are dedicated to the day-to-day functioning of your energy community?

- Number of employees/consultants (full-time equivalent)
- 0
- 1
- 2-5
- 6-10
- 11-25
- >25

- Number of volunteers
- 0
- 1
- 2-5
- 6-10
- 11-25
- >25

Q26 Please indicate whether you have invested any surplus into projects beyond your immediate membership (i.e. broader local community)?

- None
- Building renovations (i.e. improvements/insulation in social housing)
- Educational activities (i.e. in schools)
- Environmental protection measures
- Donations
- Supporting local services (i.e. setting up a public transport network)
- Community benefits fund
- Other

Q27 What was the volume invested in projects supporting the broader community in the last year?

Environmental impacts

Q28 Please compile the following table with information regarding the energy production technologies utilized by your EC.

Please specify the main energy production technologies utilized by your EC	Please specify the size of generation plant or the energy production utilized by your EC (kW).
Wind Solar PV Solar thermal Geothermal Hydropower Biomass Biodegradable fraction of waste No production (Not apply)	<100 kW 100 kW-200kW 200kW-500kW 500 kW-1MW 1MW-3MW 3MW-5MW 5MW<

Q29 Please indicate what was your total output for each type of production in MWh in the last year

- Electricity (MWh)
- Heating (MWh)
- Gas (MWh)
- I don't know

Q30 Please indicate whether your activities have had an impact on the local environment since its foundation. Please rate the relevance of specific impacts on a scale of 0 to 5, where 0 indicates "no impact" and 5 indicates "high impacts"

	Scale 0 indicates no impact, 5 indicates high impact					
Impact	0	1	2	3	4	5
Impact on biodiversity						
Impact on climate change						
Impact on air quality						
Impact on water quality						
Impact on waste reduction						

Social impacts

Q31 Please indicate how do you engage your members in decision-making

- General assembly
- Working committees / working groups
- Regular updates through e-mail
- Other

Q32 Please indicate how many of your members participated in last year's general assembly

- <25%
- 25-44%
- 45-55%
- 56-75%
- 76-90%
- >90%
- I don't know

Q33 Please indicate what is your voting system in the assembly

- One vote per member
- Vote proportional to shares owned
- No voting rights for members
- Shares without voting rights
- Founders have majority vote
- Other

Q34 Please indicate how decisions are taken in the board

- Decision by consensus
- Founders have majority vote
- I don't know

Q35 Please indicate what is the % of equity owned by members

- 0%
- <10%
- 10 - 25%
- 25 - 50%
- 50 - 80%
- >80%
- Don't apply

Q36 Please indicate the share of female members in your membership

- 0%
- <10%
- 10 - 25%
- 25 - 50%
- >50%

Q37 Please indicate which of the following vulnerable or minority people are represented in your membership

- Low-income people
- Unemployed
- Elderly
- Disabled
- Immigrants
- Single parents
- Youngsters
- None

Please indicate their share of the total membership

- 0%
- <10%
- 10 - 25%

- 25 - 50%
- >50%

Q38 Please indicate how you support or include vulnerable households or minority groups in your energy community's activities in the last year?

- No specific actions
- Discounts for vulnerable groups
- Establishment of a dedicated fund
- Empowerment through supporting energy literacy
- Prioritizing hiring from under-represented groups
- Donations to associations supporting vulnerable households or underrepresented groups
- Support to caregivers (i.e. babysitter service, set up of a time bank in the community)
- Other

Q39 Please indicate if you have implemented measures for energy poverty alleviation among your community

- None
- Financial assistance (i.e. discount on energy bill, reduction in membership fee, vouchers, loans.)
- Improvement in energy efficiency of housing (i.e. refurbishment, provision of energy efficient appliances)
- Advice and knowledge sharing (e.g. on energy efficiency, energy savings, support with bureaucracy.)
- Support and community inclusion (i.e. social activities)
- Other

Q40 Please indicate how many educational or social activities have you organized in the last year

- 0
- 1
- 2-5
- 6-10
- 11-25
- >25

Q41 Please provide an indication of how many people were reached by these activities

- <10
- 10-25
- 26-50
- 51-100
- 101-250
- >250

Q42 Please indicate whether you have achieved wider social impacts so far via your activities

Please rate the relevance of specific impacts on a scale of 0 to 5, where 0 indicates “no impact” and 5 indicates “high impacts”

	Scale 0 indicates no impact, 5 indicates high impact					
Impact	0	1	2	3	4	5
Increased social cohesion/community feeling						
Increased acceptance of renewable energies.						
Increased energy and environmental literacy in the local community						
Increased trust in the community						

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