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Financing energy communities: Actors, instruments, builders, and ESG ecosystem expectations in Italy

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ABSTRACT

This paper examines the financing of energy communities in Italy, focusing on the roles of key actors, financial instruments, and project builders. It also analyses the economic and ESG impacts that financing actors expect from energy communities. These expectations are shaped by Italy's progressive regulatory framework, which has already supported more than 422 energy communities. We conducted 19 semi-structured interviews with stakeholders involved in financing and building energy communities, supplemented by extensive desk research. Our descriptive analysis identified the financing instruments used by different actors and their recipients both within and beyond the ECs. Thematic analysis highlights the crucial role of municipalities and technical partners in successful project implementation, though municipalities often face significant challenges. Mixed funding, a balanced energy production-consumption ratio, and scalable installations are essential to attract private investment; however, social fund regulations substantially prolong payback periods. Therefore, private actors are primarily driven by indirect economic (e.g., cross-selling, territorial presence) and strategic benefits, while public stakeholders focus on social outcomes. Nonetheless, ECs' potential to address energy poverty is limited by incentive tariff design and modest private-sector engagement. These factors, along with low economic returns, risk undermining ECs viability once subsidies end. The article concludes with stakeholder and policy recommendations aimed at enhancing private investment while advancing the social objectives of energy communities.

Glossary

EC	Energy community
ECs	Energy communities
REC	Renewable energy community
CEC	Citizen energy community
EU	European Union
RED-II	2018/2001 Renewable Energy Directive
IEM	2019/944 Internal Electricity Market Directive
UK	United Kingdom
US	United States
PV	Photovoltaic
CAPEX	Capital expenditures
NGO	Non-governmental organization
ESG	Environment, society, governance
OECD	Organization for Economic Cooperation and Development
AI	Artificial intelligence
RE	Renewable energy
JARSC	Jointly acting renewable self-consumers
PA	Public administration
SIV	Special investment vehicle
ESCO	Energy service company
NPO	Not for profit organization
EPC	Energy performance contract
BESS	Battery Energy Storage System
EMS	Energy Management System

1. Introduction

The energy transition pathway can be realized not only through large, centralized renewables but also by involving consumers who can co-generate and co-manage energy. Decentralized, community-based

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energy initiatives could be a crucial tool to combat global warming (Poupeau, 2020). Through this, consumers could gain greater benefits and power within national and transnational processes of energy transition (Sovacool, 2016). Both the supply and demand sides of the issue can be addressed by local communities through organized and coordinated inter-institutional action. Energy communities (ECs), as consumer aggregations and technological schemes, can facilitate this innovation process. In this way, consumer demand and supply activities could become more efficient,[1] capitalizing on economies of scale provided by communities (Moroni and Tricarico, 2018). Despite the accelerated deployment of ECs, their proliferation has not yet reached its full potential. For example, ECs have installed 1.471 GW of generation capacity since 2021 in Italy (Koltunov et al., 2025), which corresponds to 1.12% of the total generation mix and 4% of the total solar capacity installed in the country (TERNA, 2025). Currently, the EC capacity represents approximately 10.1% of the entire photovoltaic growth since 2021 in Italy. Nevertheless, self-consumption and energy sharing within ECs could contribute to the energy transition equally or even more than their renewable generation. Furthermore, it may be easier for consumers to decide upon demand flexibility as well as energy efficiency efforts when they are united into an energy community, especially if these activities are coordinated by the Energy Service Companies (ESCOs) (Koltunov, 2025b, p.166). Importantly, EC deployment makes energy transition fairer by providing economic and social benefits to EC members and their respective communities. Eventually, the emergence of ECs creates new market agents while pushing existing agents to innovate obsolete business models, which, in turn, is a logical process of capitalistic growth through innovation coined by Schumpeter as 'creative destruction' (Schumpeter, 1942).

Alongside technical, legal, and social considerations, successful financing of feasibility studies and infrastructure is a crucial factor for the success of emerging energy communities. De Vidovich et al. (2021) found that most energy communities are initiated and designed by partnerships of actors with heterogeneous expertise where the main actor is commonly a public administration, ESCO, or non-for-profit organization, or rarely a group of private citizens. One of the first challenges such partnerships face is securing financing: identifying appropriate financiers, determining suitable financing options for each EC, and aligning with financiers' expectations without compromising the EC's autonomy and long-term stability. Similarly, financiers seek tailored instruments and partnerships that align with both economic and ESG objectives for EC construction.

With respect to these problematics, our study intends to respond to the following research questions:

- What are the EC financing instruments and their recipients?
- What are the economic and ESG expectations of financing and building actors?
- What strategies and policies can enhance ECs' access to private capital without compromising their social objectives?

Italy was selected as the reference context due to the absence of dedicated research examining the financial ecosystem surrounding ECs in the country. While the financing models and policy frameworks of countries such as Germany and the United Kingdom have been widely explored (e.g., Cairns et al., 2023; Hanke and Guyet, 2023), and a few studies have provided multi-country analyses (Tarpani et al., 2022), an in-depth investigation of Italy remains missing. The Italian case is particularly relevant because of its distinctive regulatory transition following the experimental transposition of EU directives and the presence of a diversified set of financial actors—including philanthropic foundations, cooperative utilities, and impact investors—shaping a hybrid and still-evolving ecosystem for EC financing.

Below, we present a concise literature review that follows the sequence of the research questions. First, we discuss the importance of public subsidies for ECs and review the limited literature on specific financial instruments used in Italy. A broader analysis of financial instruments for ECs beyond the Italian context is provided in Appendix A. We then examine studies on the Italian energy community–building actors, who are key recipients of EC financing. Second, we review evidence from grey literature on the ESG expectations of financing and building actors toward Italian ECs, including governance aspects. Third, we review the barriers to private financing of ECs. Fourth, the related theories are briefly discussed. We end the section by highlighting the novelty of our study.

1.1. Literature review

Financial support schemes such as green tariffs, premium tariffs, and quota obligations are acknowledged as key drivers behind ECs. Studies for the UK and Germany indicate that without government support, the ECs could barely survive (Braunholtz-Speight et al., 2020; Brummer, 2018; Klagge et al., 2016). By 2027, subsidies are expected to disappear in Italy too. The deployment and sustainability of ECs could be jeopardized due to the often limited "economy of scale" of these initiatives. In 72% of ECs in Italy photovoltaic technology of less than 100 kWp was used in 2023 (Franzo et al., 2023). Therefore, private investors with an interest in green and ethical finance could help facilitate the smooth scaling up in the medium to long term. Whilst community shares, loans and bonds are pivotal to later stage project development, it is soft loans and non-repayable finance such as grants and donations that are most critical to the earlier, higher risk, stages of project development (Cairns et al., 2023). Study by Lupi et al. (2021) reports on a survey[2] conducted in six European countries, among which is Italy. The study found that citizen members were the main investors in Belgium, Italy, the Netherlands, and Spain. Given the limited availability of public grants, Italian ECs frequently relied on loans to complement member contributions and support their projects. During the last 10 years, the Italian supporting schemes changed almost every year, creating a particularly unstable and uncertain environment for private investors and funders (REScoop.eu, 2020). In this article, we examine only the earlier financing needs, which include feasibility studies, establishing the legal entity, and purchasing physical infrastructure such as PV panels. Such focus is motivated by the previous works which have found that raising capital funding for a feasibility and/or development needs is a key issue for the sector in the UK (Braunholtz-Speight et al., 2021; Cairns et al., 2023; CEE CES & CEW, 2021), whilst authors are not aware of similar investigations for Italy. For simplicity, we refer to these initial financing requirements as CAPEX financing.

De Vidovich et al. (2021, 2023) identify three main organizational models for building ECs in Italy: public-led, pluralistic, and energy community builder (EC-builder). The public-led model, often seen in early EC development, features public administrations as key stakeholders driving the process from a top-down approach. The pluralistic model prioritizes bottom-up, grassroots initiatives where informed citizen members, prosumers, NGOs, energy service companies, and third-sector actors collaborate. This approach emphasizes horizontal community involvement, leveraging local knowledge and relationships to establish partnerships and generate collective benefits. The

[1] Here, we mean systemic efficiency and not energy efficiency in separate buildings. The Italian policy on "energy sharing" stimulates the immediate self-consumption of the self-produced energy within primary substation, which makes local energy supply and demand more aligned with each other.

[2] The survey was conducted before the transposition of EU Directives (IEM, 2019; RED-II, 2018).

EC-builder model bridges the gap between public and private sectors, employing expert intermediaries like energy cooperatives[3] or consultancies specializing in sustainable development. Musolino et al. (2023) highlight the crucial role of municipalities in the development of ECs in Italy. They observe that municipalities often act as catalysts, taking a top-down approach by initiating projects and providing resources such as access to public buildings for installations. A balance between a top-down and bottom-up approach to constructing ECs is vital for maximizing the social and economic benefits. Roelich and Knoeri (2015) highlight the crucial role of municipalities in facilitating polycentric governance, bridging the gap between national policies and local community needs.

The primary purpose of ECs should be the provision of environmental, economic or social community benefits for its shareholders or members or for local areas where it operates, rather than financial profits (RED-II, 2018). In this context, ESG evaluation can be a useful tool assisting financing actors not only in assessment during the pre-investment stage but also in effectively monitoring the investment's performance. For example, in the last four years several community energy projects were already financed in Italy through loans or equity participation conditioned upon attainment of ESG targets (Chiti and Quatraro, 2023; Bellotti, 2021; Coopfond, 2022). A study by Grignani et al. (2021) explores the governance aspect, legal forms of ECs in Italy, under the transitional legislation. Authors say that lack of rigid legal structures allows for adaptability to local contexts, but it also makes it difficult to standardize successful models and scale up the legal form of a cooperative nationally. Despite many advantages of a cooperative form for ECs, Yildiz (2014) argues that high transaction costs and a high degree of time effort to control the management body of a cooperative constitute its significant flaw for ECs.

Barriers and opportunities for financing ECs have been the focus of several other studies. Yildiz (2014) focuses on Germany; Bauwens (2019) and Bauwens et al. (2016) on Belgium; Braunholtz-Speight et al. (2020) and Cairns et al. (2023) on the UK. In turn, REScoop.eu (2020) and Cohen et al. (2021) draw their results from a multi-country analysis. Main barriers to citizen financing of ECs include:

- Low economic incentives may undermine larger financial contributions from citizens (Bauwens, 2019).
- Equity crowdfunding alone is limited in its ability to provide finance for larger-scale projects (Cairns et al., 2023).
- Lack of knowledge about the cooperative model and, therefore, lack of legitimacy (REScoop.eu, 2020).
- Publishing a public offering prospectus, mandated by regulation, may hinder fundraising from citizens (REScoop.eu, 2020).
- Citizens prefer not to invest large sums in EC shares. Therefore, a greater number of shareholders are required to finance large facilities (Cohen et al., 2021).
- A long share retention period before complete payback adversely impacts citizens' willingness to invest (Cohen et al., 2021).
- If an EC were administered by a utility company, it would diminish citizens' willingness to invest and would require higher profits as compensation (Cohen et al., 2021).
- A lot of time and effort is needed from citizen investors to participate in a cooperative legal form (Yildiz, 2014).

The barriers to private institutional financing of ECs are numerous. We categorized them as scale-related, legal form-related, RES technology-related, and energy market access-related. Table 1 lists them.

Our main approach is inductive and exploratory, which is useful considering the absence of prior comprehensive research on institutional financing of ECs in Italy. Nonetheless, the stated problems could also be addressed deductively using theoretical lenses. From the legitimacy theory perspective (Suchman, 1995), we assume that ECs can become legitimate drivers of citizen empowerment in a just transition process outlined in the EU Green Deal. From the stakeholder theory perspective (Freeman, 1984), financing ECs may help stakeholders discover common interests, resulting in improved overall efficiency instead of conflict. From the Principal–Agent theory (Akerlof, 1970), we assume that governance mechanisms (e.g., provision or refusal of financing, percentage rate of a financing tool, etc.) are supported by control mechanisms (e.g., business plan's economic indicators, ESG report) to ensure that the Principal's (financing actor's) objectives concerning the Agent (EC) will be realized. We hypothesize that the ESG report might stand as a crucial control mechanism due to the non-profitable nature of ECs, hence reducing information asymmetry. Based on signaling theory (Spence, 1973), financiers may expect that ECs might signal their competitive advantage, such as a strong social objective, by disclosing ESG information. Based on CPR theory (Ostrom, 1990), heterogeneous, polycentric governance—exhibited by a new wave of Italian ECs—may be crucial for managing common energy resources effectively.

1.2. Novelty of the study

Comprehensive studies on the EC financing for Italy are scarce, with several works briefly mentioning financial mechanisms for enabling separate cases (Arcudi et al., 2023; Candelise and Ruggieri, 2017; De Vidovich et al., 2021; Eroe and Polci, 2022; Franzo et al., 2023; Koltunov et al., 2022; Magnani et al., 2017; Wirth, 2014), but do not investigate financing barriers and ways to overcome them. Additionally, prior research has mainly focused on private citizens' motivations for participating and financing ECs (Arias et al., 2025; Centgraf, 2018; De Simone et al., 2025; Dóci and Vasileiadou, 2015; Hackbarth and Löbbe, 2020; Hicks and Ison, 2018; Cohen et al., 2021; Bauwens, 2019; Yildiz, 2014) and the benefits these energy communities bring to individuals and their locales (Koltunov and De Vidovich, 2025). In contrast, our study investigates institutional stakeholders—banks, financial intermediaries, impact investors, utilities, foundations, sector associations and regional authorities—examining their roles in financing and establishing ECs and the benefits they anticipate. To the best of our knowledge, only Cairns et al. (2023) have previously partly drawn their results from interviewing institutional financiers (7 interviews out of 32), although they have not explored the expected benefits to these financiers. Other authors investigated EC financing through surveys and interviews only with EC officials, members, and sectoral associations (REScoop.eu, 2020; Braunholtz-Speight et al., 2020; Yildiz, 2014). Instead, by focusing on institutional non-member actors' expectations, we offer a novel perspective to the academic debate on community energy financing.

The remainder of this article is structured as follows. Section 2 describes data collection and methodology. Section 3 provides details of the Italian regulation on ECs, which is crucial for understanding the background of this case study. Section 4 illustrates the results and consists of two parts. In the first part, financial instruments and their recipients are presented. In the second part, the thematic framework is portrayed, and each theme is elaborated in detail. Section 5 discusses the results. Section 6 explains contradictions that hinder ECs' access to private capital while they seek to maintain their social objectives. The section concludes by recommendations to stakeholders and policymakers for overcoming these contradictions.

[3] Here, we refer to energy cooperatives, which were established long before the transposition of the EU Directives into Italian legislation. Because of their great experience in innovative energy business models, albeit neither their own recognition as ECs nor their ability to participate as members in new ECs due to the specific transposition of the EU Directives in Italy, they often act as third-party producers and/or expert intermediaries to benefit from the new EC proliferation phase.

Table 1
The barriers to private institutional financing of ECs.

Scale-related	Legal form-related
● Private institutional finance has typically focused on larger-scale projects (Cairns et al., 2023). ● Bonds and project finance remain reserved for larger EC projects (Cairns et al., 2023). ● Ethical investors may still pursue a commercial ethos (e.g., preference for debt seniority, using EC assets as collateral) that could undermine ECs' autonomy and thus make financing from these investors burdensome (Cairns et al., 2023). ● Equity participation in ECs is minimally attractive to private investors because such shares cannot be traded with third parties and cannot increase in value. In addition, they are often restricted by a cap (Cairns et al., 2023). ● The liquidity, scale, and high return on investment—characteristics that make investments in fossil fuel companies attractive to mainstream private investors—are not normally associated with the EC sector (Cairns et al., 2023). ● The financing requested by ECs may be either too small for commercial investors or too large for ethical investors (REScoop.eu, 2020). ● The small scale of EC projects may even hamper substantial public funding in the sector (Cairns et al., 2023). ● Loan interest rates were a significant barrier to project development in the UK (CEE CES & CEW, 2021).	● Most private investors are disinterested in community ventures due to unfamiliarity with the social enterprise legal form as well as the small scale of EC projects (Cairns et al., 2023). ● The cooperative model of most ECs does not allow institutional investors to claim majority control and thus reduces their willingness to invest (Cairns et al., 2023). ● Obtaining loans is extremely difficult or impossible at the pre-planning phase of an EC establishment. Therefore, the only available financing options at this phase are grants and venture capital (REScoop.eu, 2020). ● Lack of guarantees to finance ECs (REScoop.eu, 2020).
RES technology-related	**Energy market access-related**
● Lack of expertise in EC organization when built exclusively by citizens (REScoop.eu, 2020). ● Financiers do not finance ECs that have not obtained authorization for RES installation (REScoop.eu, 2020). ● Grid connection costs and lengthiness may increase dramatically during the pre-investment stage, thus jeopardizing initial economic estimates (REScoop.eu, 2020).	● Price-guarantee implicit subsidies (FiT, tax reliefs) remain crucial for de-risking private EC financing (Braunholtz-Speight et al., 2020; Cairns et al., 2023). ● System-efficient support schemes, such as Contract-for-Differences for standalone facilities, remain the reserve of multinational utilities (Cairns et al., 2023). ● Intermediary organizations (e.g., umbrella associations) may inhibit ECs' autonomy, thereby preventing their organizational growth, which could otherwise unlock larger institutional financing (Cairns et al., 2023). ● Unstable regulation (REScoop.eu, 2020).

2. Methodology and data

Bhattacherjee (2012) argues that interpretative research is often helpful for theory construction in areas with no or insufficient priori theory. It becomes especially relevant in the areas with a limited prior existent knowledge such as new ECs in Italy. Therefore, we chose a case study methodology, adopting web investigation, document analysis, survey, and semi-structured interview methods. Case study research is particularly useful in situations where the boundaries between the phenomenon and context are not clearly evident (Yin, 1994), such as the financing of emerging energy communities, where the opportunities to overcome barriers may arise from multiple directions—including specific financing instruments, EC characteristics, stakeholder expectations, or nuanced policy measures. Below, we explain in detail our methodological steps, while Fig. 1 visualizes them.

2.1. Data collection

We identified key Italian stakeholders with an interest or potential interest in financing energy communities. Initially, we categorized them based on their likely strategies toward ECs, as adapted from OECD (2019): public and philanthropic, impact investing, sustainable financing, fully commercial companies. Public and philanthropic actors focus on social returns, impact investors balance social and financial market rate returns, and sustainable financiers, such as banks, prioritize financial market rate returns, whereas companies have limited or no interest in ESG aspects. Table 2 presents the modified OECD taxonomy, where we also added sector associations, and utilized it for the selection of interviewees. Next, we conducted exploratory desk research to identify all actors who have financed or may be interested in financing ECs. We validated each actor's interest through a review of their websites, publicly available reports, and the authors' prior knowledge. This research resulted in a comprehensive database, containing information on the type of actor, relevant persons, contact details, and a description of each actor's connection to ECs. The database included 59 actors across the four main OECD (2019) categories but is not limited to them. We gathered information on EC-builders, major energy equipment manufacturers, financial intermediaries (such as crowdfunding platforms), and various sectoral networks and associations. Among EC-builders, we identified ESCOs associated with traditional utility groups, as well as energy cooperatives. In this article, we refer to ESCOs affiliated with traditional utilities simply as "traditional utilities." We refer to energy cooperatives that build ECs and also engage in retail activities as "cooperative utilities," highlighting both their cooperative roots and their participation in the energy market.

We had created a customized letterhead and sent 59 email requests to conduct interviews. The requests included details about the project, its relevance for each specific actor, and our personal information. After the first round of requests, we received 12 agreements to participate in the interviews. However, after further communication, it was determined that only 11 of these participants had sufficient experience with ECs to meet the study's objective. In the second round, we sent follow-up emails to those who had not yet responded, this time directed to a new contact person. From this follow-up, we obtained only one additional interview. The remaining seven interviewees were reached through the authors' personal connections, interactions at industry events and conferences, and snowball sampling (Noy, 2008). In total, 19 semi-structured interviews were accommodated, and all interviewees belonged to the initial database. The financing actors and EC-builders interviewed can be categorized as follows: three sustainable financiers (banks), four philanthropic and public actors (two philanthropic foundations, one banking foundation, one regional energy agency), three impact investors (one venture capital fund, one ethical fund, one cooperative fund), five companies (two traditional utilities, two cooperative utilities, company engaged into energy infrastructure sector), two financial intermediaries (crowdfunding platforms), two sector associations (a regional federation of cooperatives, an advocacy network). Of the 19 interviews, 18 were conducted orally (five in person and 13 online), while one interview was conducted in written format. Table 3 presents interviewed actors.

The development of the interview guideline was aligned with our research questions and was guided by key domains and constructs emerging from the literature on financing and building of energy communities. In particular, we outlined nine domains, including seven from the literature, one exploratory domain, and one stemming from the theory. Literature-based domains and sub-domains include:

- Financing instruments [functionality, financing actors, recipients] (Herbes et al., 2017; Lupi et al., 2021; Bauwens, 2019; Braunholtz-Speight et al., 2020; Arcudi et al., 2023; Franzo et al., 2023)

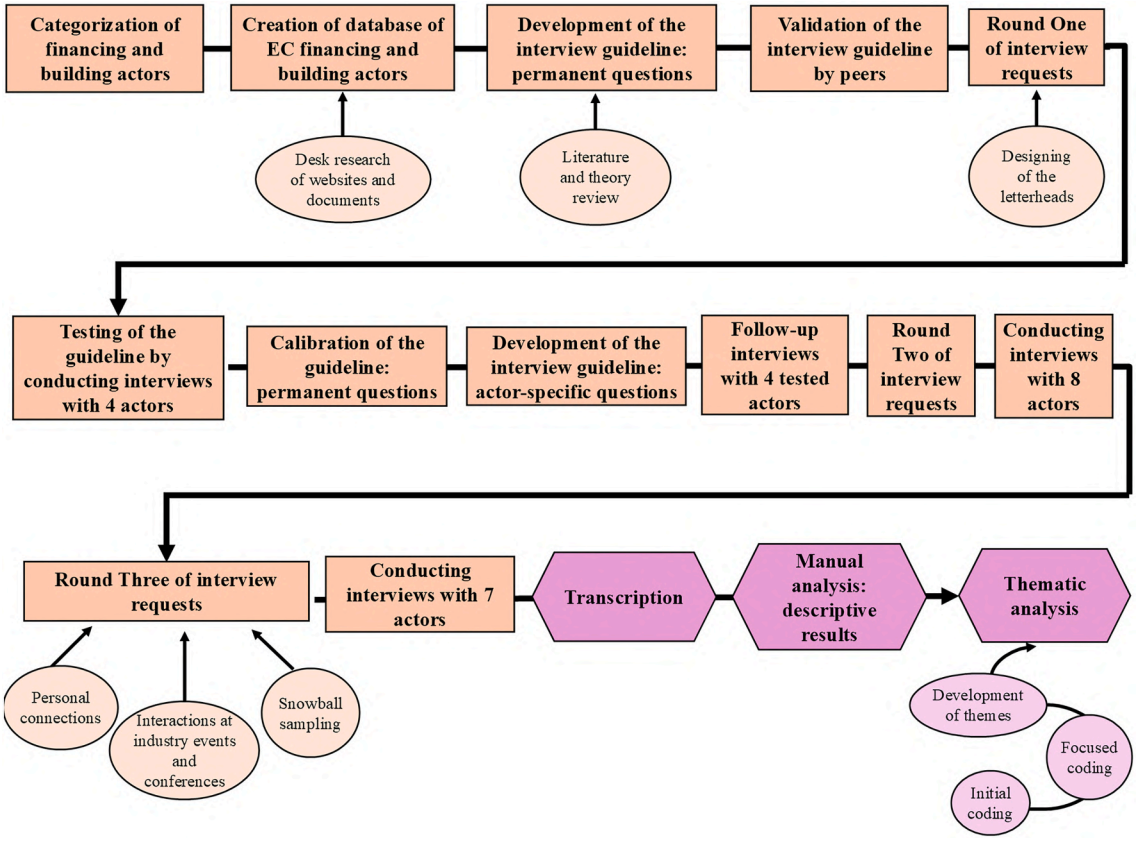

Fig. 1. Methodological steps.
Legend: brown – data collection; violet – data analysis; circles – sub-steps.

Table 2
Taxonomy of EC financing.

Type	*Grants, Non-performing loans, Philanthropy, and Venture philanthropy*	*Impact investing*	*Sustainable investing, financial intermediaries*	*Fully commercial companies/investors*	*Sector associations*
Focus	Addresses social challenges through the provision of grants or venture capital	Investments with an intent to have a social and/or environmental as well as a financial return	Adapt environmental/social and governance practices to enhance value or mitigate practices in order to protect value	Limited regard for environmental, social or governance practices	Assisting association members in building and financing ECs
Return expectation	*Social return focused*	*Social return and financial market rate equally focused*	*Financial market rate focused*	*Financial market rate only*	*No return expectation*

Source: own design, adapted from OECD (2019).

- Financing process [pre-investment assessment, quality of recipient data, comparison of actors' approaches] (Braunholtz-Speight et al., 2020; Arcudi et al., 2023; Franzo et al., 2023)
- Partnerships and stakeholders [building process, stakeholders' perspective] (Heldeweg and Saintier, 2020; Tricarico, 2018; De Vidovich et al., 2023; Musolino et al., 2023).
- Expectations [motivation to finance, economic expectations, social and environmental benefits and detriments, member composition, legal form, deployment, energy poverty as an EC objective] (Dóci and Vasileiadou, 2015; Cohen et al., 2021; Hackbarth and Löbbe, 2020; Vernay and Sebi, 2020; Centgraf, 2018; Hicks and Ison, 2018; Grignani et al., 2021)
- Impacts [social and economic impacts, monitoring of ESG performance, impact evaluation] (Berka and Creamer, 2018; Okkonen and Lehtonen, 2016; Entwistle et al., 2014; Koltunov and Bisello, 2021)
- Barriers to private capital access [barriers, geographical differences, heterogeneity of governance as a barrier, difficulties in collecting data from ECs] (Cairns et al., 2023; REScoop.eu, 2020; Braunholtz-Speight et al., 2020; Yildiz, 2014; Brummer, 2018)
- Opportunities to overcome barriers [new EC policy and incentives, possible solutions to overcome barriers, assistance in data collection, other assistance, stimulation of ECs through targets] (Schiavo et al., 2022; Cairns et al., 2023; REScoop.eu, 2020; Braunholtz-Speight et al., 2020; Yildiz, 2014)

Based on these domains, the preliminary questions were designed to explore issues recurrently discussed in prior research. In turn, the exploratory domain of questions concerned the business model of the interviewed actor, which helped us to position the financing of ECs within the actor's general strategy. The theory-based domain included questions related to the value, resources and frameworks for ESG reporting of ECs. This domain is based on the principal-agent and signaling theories, which are discussed in Introduction. The preliminary questions were pre-tested by two academic peers who provided useful

Table 3
Interviewed actors.

Actor	Type
1. Banca Etica	Sustainable financing (ethical finance institute)
2. Volksbank	Sustainable financing
3. Intesa San Paolo	Sustainable financing
4. Fondazione Con il Sud	Philanthropic & Public
5. Fondazione Cariplo	Philanthropic & Public
6. Fondazione Banco dell'energia	Philanthropic & Public
7. APE FVG	Philanthropic & Public
8. ForGreen	Company (coop. utility)
9. E'Nostra	Company (coop. utility)
10. Iren Smart Solutions	Company (trad. utility)
11. Edison Next	Company (trad. utility)
12. Avanzi SICAF	Impact investing
13. Coopfond	Impact investing
14. Etica SGR	Impact investing
15. Ecomill	Financial intermediaries
16. Ener2Crowd	Financial intermediaries
17. Maire Tecnimont	Company
18. Raiffeisenverband	Sector association
19. Forum per la Finanza Sostenibile	Sector association

feedback. Moreover, the relevance of the questions was supported by attending several sectoral events on emerging ECs in Italy. After this, the guideline was tested by interviewing the four actors from our sample, hence eliminating irrelevant questions, re-ordering the sequence, adding several questions, and adjusting to the language of each actor type (Table 2). The validated guideline included 18–25 open-ended questions. We reached the four actors who participated in the initial testing to answer the newly added questions via email and received written responses from three out of the four. Eighteen permanent questions can be found in Appendix B. The additional 2–7 actor-specific questions were designed based on each actor's profile and experience with ECs to collect richer data. These actor-specific questions were developed through a careful review of each actor's publicly available documents, including calls for proposals for funding ECs and ESG reports. They can be found in the Supplementary Material (Appendix G). While the structure of our guideline was not derived from a single theoretical framework, it reflected established qualitative approaches for mapping stakeholder perspectives in emergent policy fields.

Interview sessions lasted between 45 min and 1 h and 50 min, and each was recorded for transcription purposes. Three interviews required two sessions due to interviewees' time restrictions. Following responses to open-ended questions Likert-scale statements[4] were presented to clarify respondent's arguments and avoid misinterpretations. Only the most important insights from these statements are discussed in the Results section.

2.2. Data analysis

The interview recordings were transcribed using MS Word's built-in tool, then manually reviewed and edited to better understand the data. After finalizing the transcripts, we synthesized the interview responses, which led to the creation of Fig. 3, Table 4, Table 5, and Appendix F, addressing the first research question. The main method for answering 2nd and 3d research questions is thematic analysis. It is a method for identifying, analyzing and reporting patterns (themes) within data (Braun and Clarke, 2006). Thematic analysis was conducted using a combination of AI tool and MS Office, following the guidelines suggested by Kriukow (2024). Before beginning the analysis, each transcript was carefully anonymized to ensure confidentiality. In the first stage, initial/descriptive coding, we utilized AI generative software, Scholar GPT.[5] In addition to anonymization, we ensured to switch off the option of 'improving model to all' in platform settings. Using an AI tool accelerates the initial/descriptive coding. Initial/descriptive coding means naming segments of data with a label that simultaneously summarizes and accounts for each piece of data (Charmaz, 2014). During this stage, utilization of an AI tool is justifiable, because a researcher should intentionally minimize interpretation, remain as close to the data as possible (Charmaz, 2014). For the subsequent stages—focused coding and theme development—we conducted a manual analysis using MS Excel. It ensures transparency and full control over the focused coding and theme development, which demand a higher level of interpretation and knowledge. Both initial and focused codes were produced inductively. The previous literature on EC financing and building was mainly grounded in the realities of other countries, where policy and institutional contexts have been rather different from the current Italian ones. Therefore, inductive coding could yield more accurate results in our analysis than deductive coding, which may be subject to confirmation bias (Fife and Gossner, 2024).

Our decision to use the AI tool was carefully taken after inspecting published studies to familiarize us with the dangers and benefits of this approach. There are advantages and disadvantages to using ChatGPT in thematic analysis. The ability of ChatGPT to significantly boost consistency and efficiency when working with large datasets is one of its main advantages. ChatGPT's proficiency in generating human-like text therefore makes it a valuable tool for qualitative researchers, who often grapple with the challenges of interpreting complex data (Turobov et al., 2024). Similarly, Jalali and Akhavan (2024) pointed out that "AI language tools like ChatGPT contribute to improved efficiency and unbiased data processing". The AI tool can quickly organize data into initial codes and clusters, reducing the manual labor associated with early stages of qualitative research (Turobov et al., 2024). Furthermore, recent advancements in qualitative analysis software have integrated OpenAI's technology to enhance their data processing capabilities. Morgan (2023) notes that "Two of the major software packages for qualitative analysis, ATLAS.ti and MAXQDA, have both developed partnerships with OpenAI". However, it is also important to carefully consider ChatGPT's limitations, especially its lack of contextual understanding. As Lee et al. (2024) explained, "ChatGPT may not adequately capture the full context of each participant, but it can serve as an additional member of the analysis team, contributing to researcher triangulation". Furthermore, the AI's struggle with capturing interpretative or subtle themes makes human involvement indispensable in ensuring depth and accuracy (Morgan, 2023).

In this study, the AI tool was employed solely for the initial coding to maintain neutrality in data interpretation. Specifically, it (i) derived the initial codes and (ii) matched them with the quotes from the transcripts. As Turobov et al. (2024) recommended, "ChatGPT can save time, enhance coding quality, expand the empirical base," but the human researcher remains essential for interpreting the final themes. Our prompt to ChatGPT instructed it to be detailed and self-explanatory, avoiding brevity or abstraction. We provided the AI with examples of the desired format for initial codes, as well as examples to avoid. Additionally, we requested that the AI extracts precise quotes from the transcript. The prompt used can be found in Appendix E. The procedure performed using the AI tool is as follows:

1. After inserting the prompt, we uploaded the transcripts into the Scholar GPT interface, one at a time, and executed the coding process. The Scholar GPT (i) derived between 30 and 60 initial codes for each transcript, and (ii) matched each initial code with the corresponding quote.

[4] Likert-scale statements were used not as a quantitative method, but as a complementary tool to interviews to elucidate respondent's position.

[5] Powered by GPT-4, developed by OpenAI.

2. We manually cross-verified the (i) initial codes against the quotes and ensured that no abstractions or inferences were made. This allowed us to leverage the efficiency of AI while maintaining essential human oversight of the AI-generated output.
3. Then, we selectively cross-checked these quotes against the original transcripts in MS Word, using the 'Find' function to verify their exactness. In cases where the quote from GPT did not fully match the text in the transcript, we adjusted the prompt to ask GPT for precise matches to the text. Hence, GPT re-performed only (ii) code matching with quotes and retrieved exact quotes. This approach typically resolved the discrepancies. At this stage, we finished working with the AI tool.

In total, we generated 670 initial codes. After manually verifying their accuracy in the transcripts, we copied 19 sets of initial codes and corresponding quotes from the GPT portal into individual MS Excel spreadsheets. Each spreadsheet was then formatted using different colors and fonts to facilitate distinction. While working in Excel, we re-anonymized the data for clearer analysis and ensured each initial code was specific enough to identify the relevant part of the interview. Despite our prompt for specificity, some initial codes were still too abstract. In these cases, we manually refined them to better reflect the underlying quotes. Once finalized, we consolidated only the initial codes into the other spreadsheet for the 'focused coding' stage.

Focused coding[6] means using the most significant and/or frequent earlier codes to sift through and analyze large amounts of data (Charmaz, 2014). We began the 'focused coding' by cleaning the dataset, merging codes that referred to identical concepts, patterns, or situations. Merged codes were kept in the comments of a new explanatory code, allowing us to locate related quotes in the original spreadsheet as needed. This merging process reduced initial codes to 280. We then categorized these codes into 27 focused codes. Periodically, we revisited the quotes and original transcripts to clarify context or nuances. Finally, we reviewed each focused code and synthesized them into ten sub-themes and seven themes. To ensure consistency and transparency, all coding stages were carried out by two members of the research team who cross-checked and discussed coding outputs at each phase. Given the exploratory nature of this research and the absence of prior studies on EC financing in Italy, a formal intercoder reliability test (e.g., Cohen's Kappa) was not applied. Instead, we adopted a qualitative quality management process based on iterative peer debriefing and code reconciliation (Nowell et al., 2017). This approach allowed the researchers to jointly review initial and focused codes, resolve any discrepancies through consensus, and preserve contextual meaning throughout the thematic development (Paulus and Lester, 2021).

3. The Italian context and policy

As of January 2025, out of 422 new ECs there are 61[7] jointly-acting renewable self-consumers (JARSC) and 361[8] renewable energy communities (RECs) in operational and design phases. New ECs are promoted by municipalities in 44% of all cases (Franzo et al., 2023). However, not only municipalities are active in promoting a sector. The Italian regulatory framework allows all possible stakeholders to join an EC. Besides individual households, many SMEs, NPOs, and even large companies[9] are willing to step in the sector and occupy the innovative niche. The only exception is private companies, whose "main commercial or industrial activity" belongs to the energy sector. This norm barricades utilities and other energy sector businesses from joining ECs directly. The economic benefits for EC members are depicted in Fig. 2, while below we explain their main aspects.

ARERA (2022) guidelines established seven different types of self-consumption configurations. Among them, only RECs and JARSC obtained a premium tariff for shared energy, which garnered significant interest from various stakeholders, ranging from traditional utilities to even institutions such as the Catholic Church. Considering the premium tariff but also the rarity of other types of self-consumption configurations, only RECs and JARSC are analyzed in this paper[10]. JARSC are referred to separate condominiums and RECs to groups of buildings connected to the same high/medium voltage substation. Both the premium tariff and 'valorization of avoided grid usage' are restricted to separate configurations with a maximum of 1 MW of installed capacity. Nevertheless, GSE (2024) clarified that a REC can now be established as a legal form within boundaries of an entire electricity trading market zone. Hence, multiple 1 MW configurations can join within one legal REC entity. This opens a possibility to exploit economies of scale from the management perspective and encourages a certain degree of isomorphic diffusion of organizational models (Heldeweg and Saintier, 2020). Premium tariff (*TIP* in Fig. 2) in a range of 60-120 €/MWh will be applied to shared energy depending on the size of installation and the hourly wholesale zonal price (MASE, 2023). The tariff is promised for 20 years and is granted only to installations that are commissioned before the end of 2027. Italy plans to spend 3,5 € billion for the premium tariff which will be financed by the revenues from the levy on electricity consumption (EC, 2023). The tariff is accessible to all ECs, provided they do not collectively exceed a national cap of 5 GW of new renewable capacity. In addition, EC Decree (MASE, 2023) outlines specific regional adjustments in premium tariff with additional €4/MWh for ECs in central regions and an extra €10/MWh in northern regions. The main regulatory motive behind this adjustment is to use market signals to encourage new installations in regions with high energy demand and insufficient supply.

Capital costs can be covered by up to 40% but only for small and medium-sized municipalities with populations of 50,000[11] or fewer (MASE, 2025). The capital cost contribution depends on installation size, with smaller installations eligible for reimbursement of up to €1500/kW and larger ones up to €1050/kW. Contribution is available for both new installations and upgrades to existing assets joining an EC. Italy draws €2.2 billion from the National Recovery and Resilience Fund (PNRR) for this purpose. Reimbursement can be claimed only for plants constructed before the end of June 2026, in accordance with internal PNRR guidelines.[12] These funds are expected to create 2 GW of distributed renewable energy capacity.

Many Italian regions have launched ERDF and/or ESF + calls[13] to fund ECs. As shown in Fig. A1 (Appendix A), total regional funding amounts to €416 million and is mostly allocated to feasibility studies, with limited support for infrastructure investments. Several regions have expressed political willingness to support ECs beyond the PNRR

[6] We use the definition of 'focused coding' from the grounded theory method (Charmaz, 2014). However, this definition is functionally similar to "collating codes to develop candidate themes" in thematic analysis (Braun and Clarke, 2006).

[7] Data source: Franzo et al. (2023).

[8] Data source: own database. As of October 2025, there are 344 operational RECs (GSE, 2025).

[9] Large companies can join Citizen Energy Communities (CECs), while not Renewable Energy Communities (RECs).

[10] For simplicity, both configurations are referred to as ECs, where needed, we specify RECs and JARSCs.

[11] Before July 2025, the contribution had been granted exclusively to small municipalities with up to 5000 inhabitants (MASE, 2023).

[12] PNRR is a national fund that utilizes funds from the EU Next Generation Fund Program, therefore guidelines of the former depend on those of the latter.

[13] ERDF stands for the European Regional Development Fund and ESF + for the European Social Fund Plus. Both are EU structural funds. The current cycle ends in 2027, with the next running from 2028 to 2034.

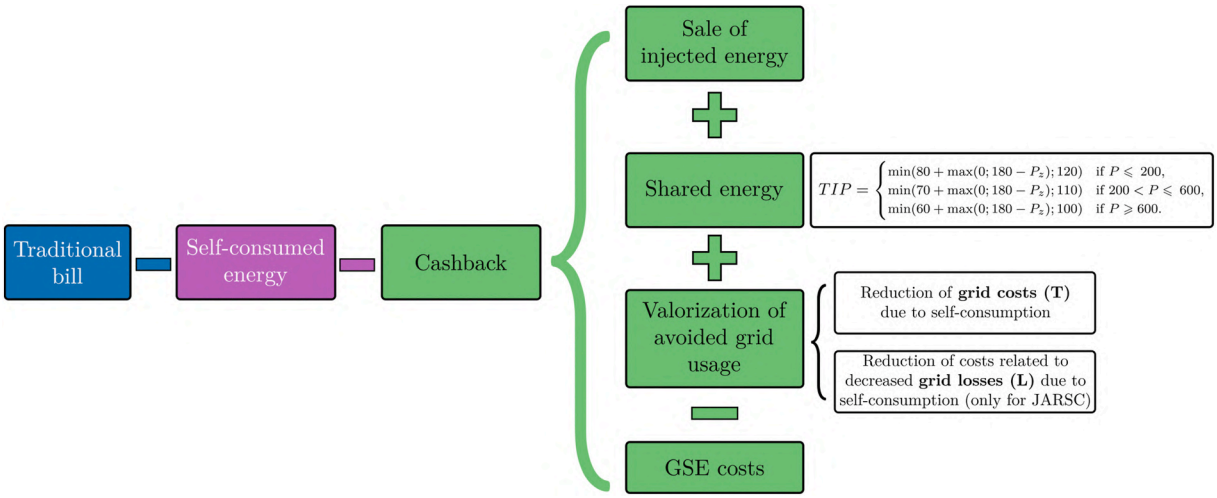

Fig. 2. Economic benefits for EC members in Italy (excl. capital subsidy).
Source: Koltunov et al. (2025).

deadlines (e.g., see Regione Piemonte (2025)); if realized, this might be the only public grant funding available after 2026–2027. A detailed overview of regional funding and its assessment criteria across Italy is provided by Castellini et al. (2025). Two other supportive instruments are available. Conto Termico 2.0 and 3.0 fund electrification/requalification (e.g., energy-saving technologies, heat pumps). An "eco-bonus" tax deduction for PV purchases can also help citizens to join ECs with proper facilities (Koltunov et al., 2022; Bisello, 2020). An in-depth analysis of the economic benefits—including premium tariff for shared energy and valorization/payment for avoided grid usage—for the EC members can be further consulted in Appendix C.

4. Results

This section is divided into two subsections. Section 4.1 addresses the 1st research question on financing instruments and their recipients. In turn, a brief description of the interviewed financing actors and their relationship to ECs is provided in Appendix C. Section 4.2 addresses the 2nd and 3d research questions by presenting a thematic analysis of the interviews.

4.1. Descriptive results

We identified three main clusters of financing instruments for Italian ECs: those available or planned for near future introduction, instruments intended for co-financing EC projects, and potential instruments. Fig. 3 illustrates only the financing instruments currently available or planned for near future introduction, which generally fall into private and philanthropic/public categories. Private instruments include debt capital, equity capital, and leasing. Debt capital encompasses green loans, ESG-linked loans, project finance, and lending crowdfunding. Equity capital includes equity participation and equity crowdfunding. Philanthropic and public instruments cover donations, grants from foundations, regional and state grants, EU grants, tax deductions, and public collateral. Actors across all categories may also provide pro-bono technical or legal advice to ECs, which serves as a cost-reduction mechanism. The detailed description of these instruments can be found in Appendix A. Among private instruments, the most used are leasing and lending crowdfunding. Among philanthropic and public instruments, grants from foundations and regional governments have been reported as the most common and accessible.

Table 4 categorizes the financing, co-financing, and other mentioned instruments by types of actors. All actors typically do not fully finance a PV installation. Instead, they require recipients to secure co-financing from other sources. "Philanthropic & Public" actors usually provide grants for feasibility studies through calls. Later, they may offer grants for purchasing PV systems. If they do not provide such capital grants, they still assist with legal and technical matters through their partners. For foundations, it is also common to request co-financing from supported projects (e.g., co-financing by a grant from another foundation, co-financing by the promoter's own funds). They also generally accept the working hours of a promoting entity's employees as co-financing. We also observed a physical donation of PV panels from the traditional utility that was facilitated through the foundation.

In the "Impact investors" category, ECs can be financed through grants from cooperative funds. For example, Coopfond and Raiffeisen Federation award grants to new ECs that choose to register as cooperatives. "Impact investors" and "Financial intermediaries" mentioned the importance of a collateral, which could be provided by the state fund, CDP.[14] This instrument can considerably decrease risks to banks and other private players.

Leasing of PV plants for energy sharing is provided exclusively by utilities. They take on the role of a 'third-party energy producer' or an external 'Referee' in relation to a REC or JARSC (see details in GSE (2024)). Equity participation is utilized mostly by impact investors. Traditional utilities cannot be members of a REC, but they can participate as members of a JARSC and install a PV plant on the roof of a condominium. However, this PV plant will remain ownership of a utility and not regarded as a formal equity participation. Since JARSC do not constitute a legal entity[15] such arrangement is only a collective agreement registered by the GSE to access incentives for shared energy. Another instrument used by traditional utilities is project finance. For example, one utility has developed a project finance solution for municipalities seeking to benefit from PNRR co-financing. The PNRR grant is awarded post-investment, often with a significant delay, and many small municipalities lack the budget to initially purchase a PV plant. In this situation, a utility can finance the PV installation, recovering part of the investment once the municipality receives the PNRR reimbursement. The remainder of the cost is then repaid over the lifecycle of the project.

[14] CDP – Cassa di Risparmi e Prestiti.

[15] JARSC belongs to a condominium, which in turn constitutes a non-corporate legal entity under Italian law. However, ESCOs cannot become a member (aka "shareholder") in a condominium if they do not own an apartment. ESCOs typically sign the operative rental contract with every resident in the condominium for their part of the roof. In this way, ESCOs could be producing members of a JARSC or 'Referee,' but they will not be members of the legal entity of the condominium.

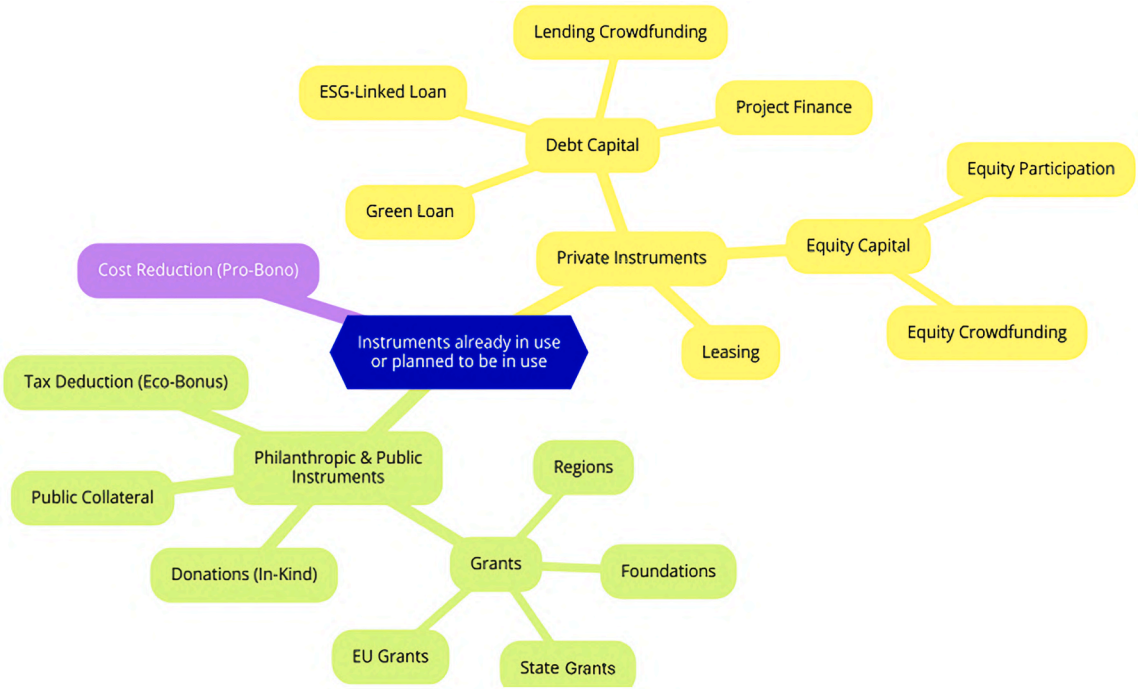

Fig. 3. Map of EC financing instruments in Italy.
Legend: yellow – private; green – philanthropic and public; violet – non-direct/assistance.

Table 4
Financing and co-financing instruments of different actor types.

Actor Group	Financing instruments (used or planned)	Co-financing instruments (used)	Other mentioned instruments
Philanthropic & Public	Grant (found.), cost reduction, grant (region)	Grant (found.), private funds of promoter, cost reduction (NPO paid volunteers), grant (PNRR)	Equity crowdfunding, loans, tax deduction (IRPEF), grant (municipality), grant (EU), leasing crowdfunding.
Impact investors	Equity participation, grant (cooperative fund), cost reduction	Equity crowdfunding, green loan	Green bonds, sustainability bonds, public collateral (from CDP), social bonds
Sustainable financing	ESG-linked loan, green loan, cost reduction, project finance, public collateral (from SACE)	Equity crowdfunding, equity participation, grant (PNRR), grant (region)	Leasing, equity participation
Traditional utilities	Leasing, project finance, donation	Grant (PNRR), Green loan	Equity crowdfunding
Cooperative utilities	Equity crowdfunding, cost reduction, leasing	Green loan, grant (EU)	Grant (region), grant (PNRR), grant (found.), tax deduction (eco-bonus), loan ESG-linked, equity participation
Financial intermediaries	Equity crowdfunding, lending crowdfunding, cost reduction	Green loan, equity participation, leasing	Public collateral (from CDP)
Sector associations	Grant (EU), grant (mutualistic fund), cost reduction	EPC (combined with P4P), project finance, equity crowdfunding, green loan	Grant (region), grant (PNRR, Conto Termico), tax deduction (eco-bonus)

Energy Performance Contract (EPC) is a co-financing instrument used by sector associations. The EPC model enables ESCO to cover the upfront costs of PV or energy efficiency measures, recovering its investment by retaining the savings generated from reduced energy consumption. It is further enhanced by the Pay for Performance (P4P) model, where EC members are paid to consume more energy during peak PV production periods, further reducing costs and maximizing self-consumption.

Table 5 outlines which financing instruments are accessible to which recipients. Almost all actors indicated that they do not finance an EC directly, due to its typically weak legal form, but rather finance individual members within an EC, such as private citizens, PAs (public administrations), NPOs (non-profit organizations), and SMEs (small-medium enterprises). Many financing instruments are available to the EC only if it is registered as a corporate entity (e.g., cooperative, srl, spa).

There are also two types of non-member entities eligible for EC financing: ESCOs acting as third-party producers, and SIVs (special investment vehicles). SIVs are entities created specifically to collect EC financing and guarantee returns to lenders and investors. Table 5 shows that instruments such as ESG-linked loans, equity participation, and both equity and lending crowdfunding are accessible only to corporate entities. In contrast, two of the four utilities have also provided leasing PV panels to NPOs and PAs, which plan to include public buildings (i.e. schools, hospitals) as consumers within an EC. The PV plant remains the property of the utility. Public buildings benefit from additional self-consumption and from shared energy, while the utility benefits from (i) selling excessive energy to the grid and (ii) receiving rental payments. In Table 5, we also see that private citizens generally cannot secure individual financing although can benefit through membership in the already financed EC. Exceptions for private citizens include green loans, eco-bonus, and Conto Termico. Fourteen actors reported providing "pro-bono" technical, legal, or administrative assistance to all types of

Table 5
Map of financing recipients.

Type of Actor	Main instrument used/available	Instrument beneficiaries							
		EC recipients						*Non-EC recipients*	
		Private citizen	*PA*	*NPO*	*SME*	*EC regis. coop., Srl, SpA*	*EC regis. Other/cond.*	*ESCo*	*SIV*
Impact investors, Philanthropic & Public, Utilities (coop.), Financial intermediaries	Cost reduction (pro-bono)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Banks	Loan (Green)	Yes	Yes	Yes	Yes	Yes		Yes	Yes
	Loan (ESG-linked)					Yes		Yes	
Banks, Utilities (trad.)	Project finance (backed by collateral)		Yes		Yes	Yes		Yes	
Utilities (trad.), Utilities (coop.)	Leasing (combined with management)		Yes	Yes	Yes	Yes	Yes		Yes
Philanthropic & Public	Grant (foundation)			Yes					
	Grant (region)		Yes		Yes				
Impact investors, utilities (trad.)	Equity participation				Yes	Yes		Yes	
Sector associations (funds of coop. federations)	Grant (mutual fund)					Yes			
Utilities (coop.), Financial intermediaries	Equity crowdfunding				Yes	Yes		Yes	Yes
Financial intermediaries	Lending crowdfunding				Yes	Yes		Yes	Yes
Philanthropic & Public	Tax deduction (eco-bonus, IRPEF)	only eco-bonus	only eco-bonus	only eco-bonus	Yes	Yes	only eco-bonus		
	Grant (PNRR, Conto Termico)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Sector association	Grant (EU)		Yes	Maybe	Maybe	Maybe		Maybe	
Utilities (trad.)	Donation	Maybe	Maybe	Maybe	Maybe	Maybe	Yes		

recipients. IRPEF tax[16] deduction could also be available to new ECs if they register as innovative startups (Koltunov et al., 2022). Finally, a wide range of recipients may access EU grants and donations, but these tools are not consistently available thus labeled 'Maybe' in Table 5.[17]

In Appendix F, detailed process schemes illustrating the relationships between financiers and recipients can be consulted. The schemes clarify whether financiers or recipients benefit from the shared energy, self-consumed energy, and energy sold to the grid.

4.2. Thematic analysis

The thematic framework is illustrated in Fig. 4. From there, we observe that the 3d research question is represented mainly by two themes. The theme, "Factors that impede and ease access to private capital," comprises two large sub-themes, whereas "Expertise, Building partnerships, and Promoters", consists of three sub-themes. The 2nd research question on economic and ESG expectations of financing and building actors is mainly represented by five themes. The themes "Two ways to maximize economic benefits" and "Indirect economic expectations" illuminate the economic expectations. The themes "ESG impact" and "Dubious tool to combat energy poverty" examine the environmental and societal aspects of ESG, emphasizing that they may be difficult to achieve. Our findings reveal a lack of clarity and commitment among actors regarding ESG assessments. This topic is largely covered in the final theme, "Evaluation practices and plans."

Theme: Factors that impede and ease access to private capital

Sub-theme: Factors that impede access to private capital

Fig. 5 illustrates factors that impede access to private capital, including the use of non-corporate legal forms by ECs (e.g., associations, foundations of participation, or associations under third-sector law); the absence of public collateral for loans provided to ECs; lengthy investment payback periods; regulatory complexity associated with ECs; and the lack of benchmarks for well-established models. We further explain these factors and substantiate them with direct quotes.

Non-corporate legal forms. Crowdfunders argue that the only secure way to raise funds for an EC project is to establish a SIV, which can guarantee returns to lenders or fair dividend distribution. They emphasize:

> *"we cannot finance directly the energy community. Because it is an association.* ***There's no record, there's no balance sheet****, there's no, no, no. It has no chance to say that we will respect the commitment to give back the money to investors, so we need this vehicle to be co-owned by the developer that will take the responsibility of paying back investors"*.

Equity crowdfunding is an attractive financial tool as it allows projects to remain independent from debt, thereby promoting better long-term economic sustainability. However, crowdfunding remains more of a niche than a mainstream option in Italy. While some ESCOs have borrowed capital from citizens (lending crowdfunding) through these

[16] Income tax in Italy.

[17] An interesting grant source is the "Nextappenino" program, backed by the PNRR. It has a specific, temporary objective: supporting reconstruction in the earthquake-affected areas of central Italy. The program has financed multiple ECs in the regions of Abruzzo, Marche, Lazio, and Umbria.

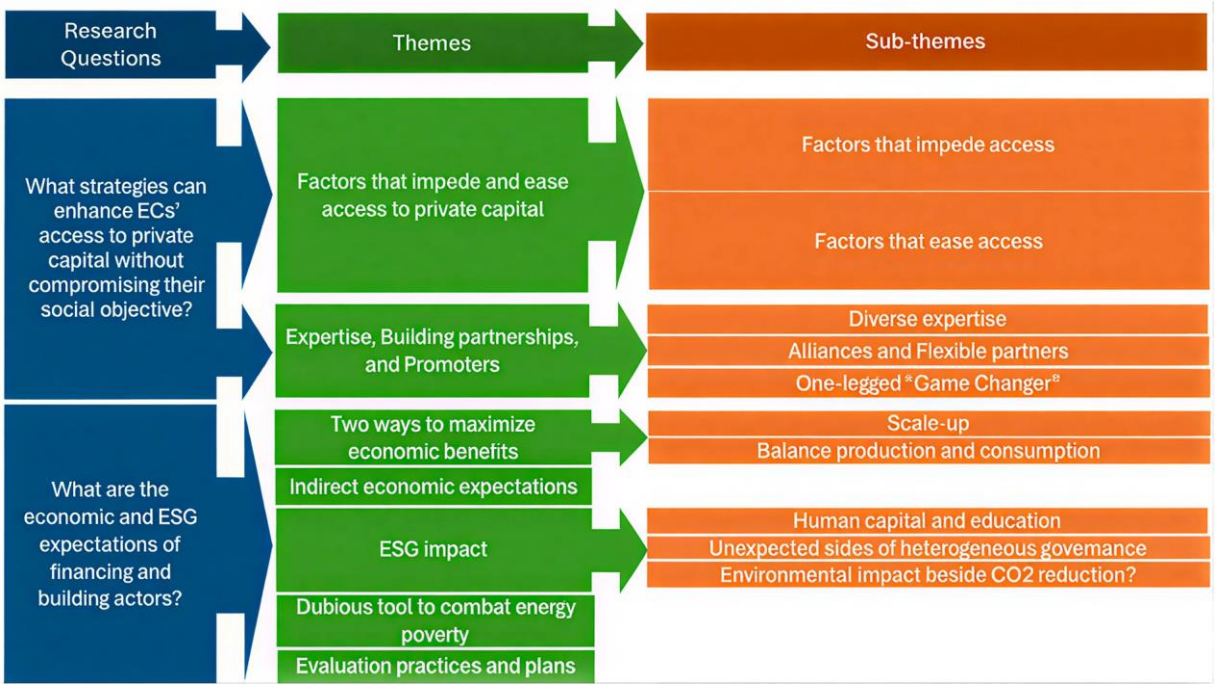

Fig. 4. Thematic framework.

platforms to build ECs, this has not included equity crowdfunding. One interviewee provides a sober assessment of the current situation:

> "*it's quite possible that more than 90% of the energy communities will be financed through traditional or institutional tools managed directly from the energy service companies or utilities. So, already setting a* ***1%*** *goal of energy communities, financed and developed through an alternative financial model, is something very challenging*".

When a crowdfunding campaign targets citizens or entities that trust the organization launching it, issues related to risks from a legal form of an EC are less of a concern. In these cases, a matching component may not be necessary. This is common practice among cooperative utilities, which have experience financing their spin-off energy projects through equity or lending crowdfunding without searching for matching funds. Both interviewed cooperative utilities have many years of experience with equity and lending crowdfunding. If an EC decides to be established in a corporate legal form such as an Srl, Spa, or a cooperative, it has much more fiscal obligations, accounting, and transaction costs. However, access to capital improves a lot:

> "*if an EC is a company it has operating schemes that are somewhat standard or balance sheets that are more easily known and recognizable by an investor, so* ***being a company*** *can certainly be* ***a leverage*** *in some way for financing"*.

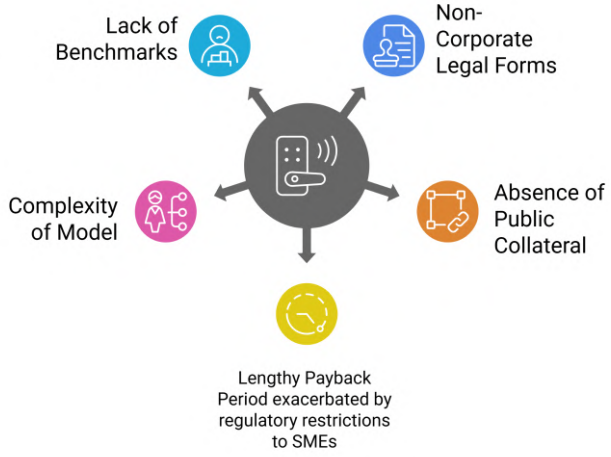

Fig. 5. Factors that impede access to private capital by ECs.

Impact investors (e.g., Avanzi) try not only to participate in the equity of startups/ECs but also provide pro-bono services and help to develop alternative revenue streams for them. A comprehensive support ecosystem exists in Italy for ECs who are legally registered as cooperatives. The RESPIRA project is a notable example of assistance beyond financing. Another example are regional sectoral associations (e.g., Raiffeisen Federation, Federcoop Trentino). Seven actors indicated that they view the "cooperative" as the most suitable legal form for ECs. However, the cooperative form primarily serves private citizens aiming to establish ECs, rather than municipalities, SMEs, or NPOs.

Absence of public collateral. Our statement, "ECs do not have difficulties in accessing loans or equity," was rated by eight actors, most of whom disagreed. On average, they ranked it 2.4 out of 5, which signals at the prevailing opinion that barriers do exist. However, several actors perceive loans as more accessible for ECs than equity. Five actors reported that a state guarantee on loans is a critical factor, though still unavailable. Such a guarantee would allow banks to significantly reduce risks associated with newly established organizations and concerns over potential subsidy suspensions. Actors mentioned MCC[18] and CDP as state funds that can provide collateral. In fact, such conversations are already conducted inside these institutions:

> "*It's not remunerative, you see. And so, there needs to be some public subsidy. Not to the level of PNRR today because that's a lot, but something more sophisticated, maybe, and something* ***more geared to private finance****, to private banks, like* ***collateral*** *systems. CDP … tomorrow we*

[18] Mediocredito Centrale is a specialized bank that focuses on supporting SMEs in Italy. It manages the Fondo Centrale di Garanzia, which provides guarantees to facilitate access to credit for SMEs.

have a meeting with them on energy communities because they want to know what we're doing because ***they want to do something***"

Lengthy payback period exacerbated by regulatory restrictions to SMEs. During transitional legislation, many SMEs considered establishing ECs among themselves, enabling them to retain all benefits from shared energy. However, final regulation prohibits SMEs from distributing all profits from shared energy to expedite investment recovery. Now, the revenues from shared energy that exceeds 55% of the total energy injected into the grid[19] must go to a social fund, so called "solidarity rule". Social fund resources must be redistributed either to non-corporate EC members or to social projects. This rule is intended to prioritize citizen and NPO involvement in ECs, emphasizing social welfare over purely commercial interests. Moreover, if an SME participating in the EC has received a PNRR grant, its incentive for shared energy is decreased by 50%. These two regulatory restrictions have been designed to preserve the social focus of ECs. However, they discourage SMEs from participating. It reduces available capital that could be invested directly by SMEs but also it reduces leverage that could otherwise be achieved through SME participation (e.g., corporate legal form, economy of scale, etc.).

Complexity of a model. Another impeding factor, highlighted by six actors, is the complexity of the EC model adopted in Italy. This complexity frustrates the general public, particularly private citizens, leading even initially motivated individuals to lose interest in investing:

"*It was extremely hard to explain to people. You have to think that when you are talking about virtual self-consumption, they ask* ***what does it mean****?*"

Lack of benchmarks. The lack of benchmarks for successful ECs based on the 'virtual self-consumption scheme' is a barrier too. Where examples do exist, they are typically rooted in unique local institutional contexts and comprise specific member configurations that are difficult to replicate elsewhere. Both traditional utilities noted that they are working to design standardized EC offerings, but this remains a challenging task.

Sub-theme: Factors that ease access to private capital

Fig. 6 illustrates the sub-theme. Mixed funding reduces risk for individual investors, while co-financing by ESCOs provides the necessary trust through the involvement of experienced partners. In addition, the ESG nature of the project and the use of diverse technologies beyond PV systems enable access to specialized financing instruments.

Mixed funding. All financing actors indicated that they do not fully fund EC projects but prefer a mixed or blended approach, where part of the funding is sourced from another actor. The specific co-financing instrument is less important. What matters is that mixed funding reduces the risk for the primary financing actor. Several actors have even formed partnerships with other financing providers for that purpose. One of the prominent examples is the RESPIRA project. One of their products is equity crowdfunding, facilitated by the crowdfunding platform (i.e. Ecomill), which, if successful, is matched by equity participation of impact investor (i.e. Coopfond). Their other product is a *"****debt product*** *which has a* ***high premium*** *for cooperatives that are invested by Coopfond"* offered by Banca Etica. The blended approach also fosters a higher level of engagement from the recipients, who must demonstrate their reliability by securing co-financing:

"*because we also want to ask them to be involved in the project, because if you give them 100% and the project fails, they can say* ***'it's not my money'. You know, if it's not his money*** *… So, it's our policy and has always been so [to ask co-financing]".*

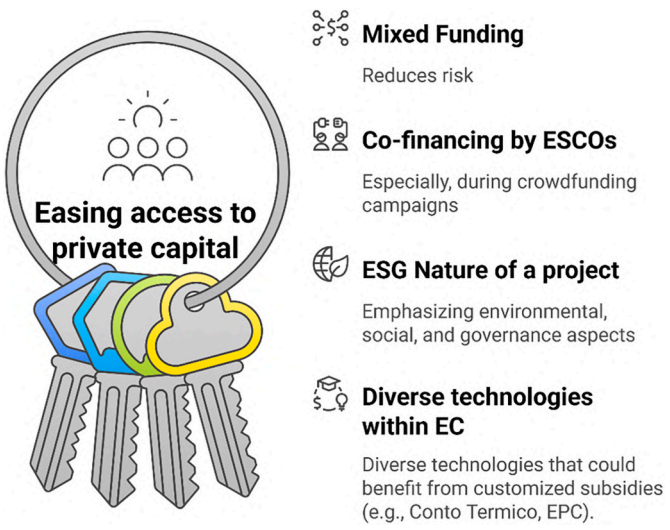

Fig. 6. Main factors that ease access to private capital by ECs.

Additionally, a matching portion of financing could be sourced from regional grants or from PNRR contributions. For example, one foundation collaborates closely with their regional government to align its grant policies. Another regional government simply co-finances municipalities that receive a PNRR contribution.

Co-financing by ESCOs. Crowdfunding platforms mostly require co-financing in the form of equity participation from entities launching lending campaigns (e.g. ESCOs) or at least other external borrowing:

"*more than 50% of the budget that you need in terms of debt to realize the energy communities* ***is too much risk on the shoulders of private investors****. OK, you should need at least another component of equity contribution or traditional financial tools so that you will redistribute the risk among a larger number of subjects*"

Leasing contracts offered by utilities (i.e. their ESCOs) to private citizens, NPOs, and SMEs significantly simplify their access to benefits from power plants. This approach allows recipients to avoid their own financial risk while also eliminating bureaucratic and management hurdles. Utilities typically offer one-stop-shop solutions, from PV system installation to incentive management, taking on the role of "Referee." Regrettably, leasing is less of an option for municipalities. To access PNRR funds, they must own the PV plant. When utilities do not assist municipalities, the latter must secure full financing on their own[20].

ESG nature of a project. Energy communities have access to loans with reduced interest rates specifically designed for renewable energy projects. Two of the three banks reported that they have internally developed dedicated financing solutions for entities borrowing funds to purchase PV systems for ECs:

"*Customers who invest in a relevant energy plant and make it available to a renewable energy community … will automatically benefit from a* ***discount on the rate****.*"

However, these banks are, to our knowledge, the only Italian banks that have publicly expressed interest in ECs. All three banks also evaluate the ESG performance of entities applying for such loans: *"In 2022 if you consider a total number of more or less 1000 loans procedures, 95% was covered by an ESG analysis."* Applying with an EC project is an additional advantage.

Diverse technologies within EC. Another factor that potentially facilitates access to private capital is the diverse range of technologies

[19] This requirement is further reinforced if the SME has benefited from a PNRR grant. In this case, the shared energy threshold is 45% from the total injected energy.

[20] The utilities of the municipal ownership (i.e. Iren) are the exception because they assist municipalities even as a pro-bono service.

available to ECs beyond photovoltaics. A specific technology can unlock specific financing instruments (e.g. Conto Termico, EPC, green minibond).

Theme: Expertise, building partnerships, and promoters

We define a building partnership as a formal or informal association of actors that either assists EC members in establishing the community or takes full responsibility for its setup. Building actors are not members of the ECs. For simplicity, we refer to 'builders' as both financial and building actors, distinguishing their roles when necessary. However, some, like ESCOs, may act as third-party producers in relation to an EC. In contrast, a promoter is an entity that initiates the EC or becomes its driving force at a later stage and is a member of the EC.

Sub-theme: Diverse expertise

Fig. 7 illustrates the various types of expertise required from the building partnership for establishing EC. Key technical tasks involve conducting feasibility studies, installing and commissioning the plant, maintaining the plant, and installing additional equipment. Legal expertise involves selecting the legal structure, drafting statutes, and managing the entry and exit of new members. Social engagement is focused on recruiting members, whether consumers or prosumers, and managing the social fund/budget. Financing expertise is typically required to secure capital for feasibility studies, CAPEX financing, and additional projects during the EC's lifecycle. Administrative tasks are extensive, including documentation support for accessing GSE incentives (both tariff and PNRR contribution), accounting, and managing the membership base, especially if the EC is formed as a cooperative. This may also involve organizing annual meetings, distributing newsletters, handling correspondence, and overseeing organizational development. The precise scope of these functions depends on the level of complexity chosen by the members, whether they are uniting simply to access the tariff on shared energy or envisioning the EC as a separate organization for broader sustainability goals.

Actors providing technical support include ESCOs, energy cooperatives, and both public and private research institutions. Within ESCOs, an important role is played by energy service subsidiaries of traditional utilities. Historical and newly established energy cooperatives also typically possess sufficient technical expertise. Another emerging technical partner is software companies, which can supply ECs with Energy Management Systems (EMS) and other tools to optimize self-consumption and coordinate energy sharing among members. Notably, ESCOs and energy cooperatives can also contribute financial and administrative expertise. Legal expertise is sometimes provided by sector associations that may be directly involved in building partnerships (e.g. Legacoop, RENOSS, Raiffeisenverband, Federcoop Trentino). However, in most cases, legal matters are outsourced to law firms. Many

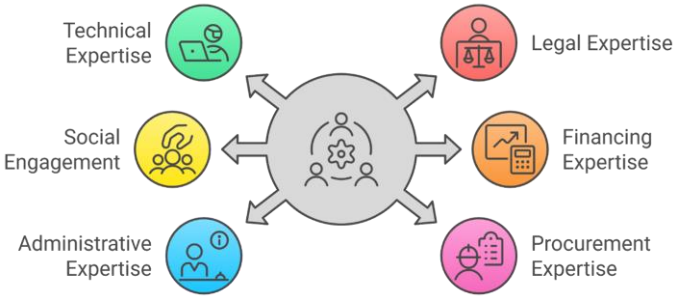

Fig. 7. Expertise for EC establishment.

of them have been pioneers in educating the public since the EC transitionary legislation came into force in 2020. For effective social engagement, it is crucial to involve either the municipality, a local NPO, or a church. The latter two actors are often well-informed about the needs of private citizens and are typically trusted within their communities. The importance of trust was highlighted by 15 interviewees, with one providing an example:

> "*one of the first energy communities in Italy in Naples in the neighbourhood of San Giovanni. It was created by a non profit organization that has a very strong role in helping children to study, helping families to have food, and so on. And so this community was created and a lot of families became a member because they* ***trusted a lot*** *the nonprofit organization*"

Sub-theme: Alliances and flexible partners

In Table 6, we have clustered EC-builders. Some builders have formed partnerships with officially announced formal agreements, which we term "Alliances." They resemble a one-stop-shop solution for ECs. The first notable example of the "Alliance" is the RESPIRA project, where, in addition to technical and legal partners, three financial partners collaborate to offer products that minimize risk and are suitable for ECs. Legacoop is a legal and administrative partner in this alliance, while the technical partner is not rigidly determined but rather chosen on a project-to-project basis. The second example is the RENOSS project that unites public and non-profit regional energy agencies with the aim to provide a one-stop-shop for ECs in every Italian region. Another partnership type, which we term "Flexible Partners," rely on external outsourcing support. "Flexible Partners" operate more informally, directing ECs to each other without establishing formal agreements. If a flexible partner is a financial actor, it may either cover the cost of external services on behalf of the EC or simply refer the EC to an external provider, in which case the EC bears the cost of services itself. Contrary to our expectations, we did not find any EC-builders with fully in-house expertise.

Some partnerships are formed based on similar expertise but with slightly different specializations, territorial scopes, or types of assisted EC members. For example, the partnership between two technical actors, Acea Pinerolese (utility) and Tecnozenith, focuses on developing JARSCs, with Tecnozenith serving as an ESCO specializing in energy efficiency and electrification. Notable examples also include flexible partnerships between foundations or between foundations and regional governments (e.g. Fondazione Cariplo and the Lombardy Region). The partnerships primarily support ECs by providing services, either pro-bono or commercially. Many builders reported that they do not intend to continue their involvement once their services are completed. Therefore, the long-term success of ECs largely depends on their core members: municipalities, NPOs, private citizens, SMEs, and religious entities.

Sub-theme: One-legged "game-changer"

As Fig. 8 illustrates, municipalities are best positioned to promote ECs due to citizens' trust, their organizational capacity, ownership of public roofs, and deep engagement with local social issues.

As one interviewee noted, success will depend on the promoter: *"**the most financially capable, stable**, **ambitious** in the territory, who has the most capacity to engage the general population".* In small towns, the local municipality often holds a high level of trust and can engage not only citizens but also various SMEs in an EC. Although municipalities were not specifically mentioned in the interview guideline, questions about partners or members consistently led interviewees to emphasize the role of public administrations, with one interviewee even calling them "game changers." Indeed, the majority of EC initiatives are driven by municipalities:

> "*if it is the municipalities that own, manage and coordinate the process, the people feel more sure to become a member. If it is something 'in which* ***my mayor*** *is, that* ***I voted*** *for'. My mayor wants to* ***install an energy***

Table 6
Building partnerships.

Alliances	Flexible Partners
"RESPIRA": Banca Etica, Legacoop, Coopfond, Ecomill	Raiffeisenverband, Raiffeisen Energy, Alperia, Regalgrid
"RENOSS": 29 regional energy agencies	Fondazione Cariplo, Lombardy Region
Intesa San Paolo, Deloitte, Enel X, Regalgrid	Banco dell'energia, Fondazione con il Sud
Volksbank, Regalgrid	E'Nostra, Banca Etica
Edison Energia, Gabetti Lab	Fondazione Compagna di San Paolo, Fondazione Cariplo
Iren Smart Solutions, Legacoop	Ener4com coop., Sinloc Spa
Banco dell'energia, Edison Energia; Banco dell'energia, Eni Plenitude S.p.A; Banco dell'energia, A2A.	Fondazione Casa Risparmio di Cuneo, Environment Park
"Energheia": Acea Pinerolese, Tecnozenith	Fondazione con il Sud, Consorzio Nazionale CGM, Fondazione Peppino Vismara
Garda Uno, ENEA	-
Consorzio Nazionale CGM, Fratello Sole scarl	-

community**. The municipality is one of the members and it wants to also **share profits with me!"

Municipalities also own public buildings such as schools, town halls, and police headquarters. These buildings consume significant amounts of energy during the daytime, when the sun is shining, and residents are typically away from home. As a result, public buildings are ideal candidates as primary consumers in any EC configuration. The inclusion of public buildings, along with industrial facilities, enables ECs to maximize profits from shared energy and optimize self-consumption. In this context, municipalities should be seen not only as recipients of services from building partners but as proactive agents in EC development. Municipalities also know where to direct social money better:

"*Municipalities are **in love** with energy communities. It's their social goal, also engagement, also environmental mission*".

Despite the importance of municipalities, they often face substantial obstacles in securing financing. As shown in Fig. 9 and explained below, these two obstacles have consistently been reported as the most problematic.

Five actors reported that access to capital is a greater challenge for smaller municipalities than for larger ones. PNRR contributions are granted to small municipalities and cover 40% of CAPEX, but obtaining these funds is challenging since reimbursement is awarded post-investment. Moreover, its application period ended in 2025. This poses a dilemma: where will small municipalities find the necessary money in advance if they lack funds of their own? One bank noted that they specifically target small municipalities due to their higher need and the bank's strong territorial focus. However, this bank operates in only a few regions. Another challenge for municipalities is that they cannot participate in ECs through a corporate legal form. The most common EC legal structure for municipalities is the non-corporate "Foundation of Participation," which, being less binding, poses difficulties for financing. Ironically, the most crucial promoter faces the most significant hurdles. Overcoming these hurdles requires significant perseverance from municipalities, which are often conservative:

"*In a way, it's a **matter of timing**. So of course, the municipalities do have priority and public entities in general to be sure that what they do **legally is correct**, because the type of negative outcome they can face is in a way worse than what a private entity can go through when they make a mistake, you know? So, they tend to be **quite conservative***"

Both traditional utilities have developed EC offerings to public administrations, though not comprehensively. Utilities generally expressed frustration with the lengthy and complex bureaucracy required to establish public-private contracts. For example, Edison even established a dedicated subsidiary to handle these issues. Notwithstanding, traditional utilities (i.e. Iren, Edison) try to "lend a shoulder" to municipalities.

Theme: Two ways to maximize economic benefits

Fig. 10 illustrates the primary strategies for maximizing the economic benefits of ECs. Below, we first present respondents' views on the economic sustainability of ECs, followed by a discussion of the two strategies.

When we asked interviewees to assess the statement, "Private financing of ECs will fully replace public subsidies after 2026-2027," opinions were divided. Public and philanthropic entities, impact investors, sector associations, and banks voiced the opinion that, without explicit state subsidies for CAPEX or other grants, ECs will face significant difficulties, potentially jeopardizing their survival. The primary issues are the low price for energy injected into the grid and the modest premium tariff for shared energy, both of which contrast sharply with high CAPEX requirements. These groups of actors emphasized that the availability of grant support is crucial: *"at the moment without public or private grant it is very difficult to have the economic impact and the social impact is limited **because if they need to give the loans back, this is a problem**"* On the other side, respondents from traditional utilities and one financial intermediary believe that private financing will fully replace state CAPEX grants, asserting that finding private funds for ECs will not be an issue. This prospect contributed to an overall rating that averaged around 2.8 out of 5. In contrast, all actors agreed that without a premium tariff, ECs not only would struggle to survive but would ultimately *"doesn't make sense"*. The valorization of avoided grid usage (see Appendix C) alone is insufficient to unify consumers, prosumers, and producers of diverse backgrounds into a single entity.

Sub-theme: Balance production and consumption

Seven actors emphasized that achieving an optimal balance between energy consumed and produced within the EC is essential. Traditional and cooperative utilities aim to involve public administrations and SMEs, with notable projects incorporating farms. One interviewee reported that ECs must achieve 70% renewable energy sharing to ensure financial sustainability, which requires a carefully conducted technical feasibility analysis and a precise composition of producing and consuming members.

Sub-theme: Scale-up

Given the maximally allowed configuration size of 1 MW, ECs should aim to reach it. Small-scale EC PV plants anticipate excessively long payback periods, especially under regulatory social provisions, making it challenging to achieve a return on investment. For instance, Iren designs its ECs to consistently reach 1 MW capacity, requiring the involvement of consumers who can virtually consume most of the generation during the day. This again underscores the importance of municipalities/PAs, which could involve a variety of public buildings with high day-time consumption such as schools. Furthermore, many Italian utilities are exploring the creation of expansive ECs comprising multiple 1 MW configurations to reduce transaction and administrative costs. This strategic approach was aptly described as: "*The main plan is to create **one legal body** that will manage many configurations.*" Importantly, the issue of scale is not a concern exclusive to utilities. One sector association advises its ECs to adopt scaling as a core expansion strategy too:

"*You need **at least 300 to 400 kW** power plants, that you reach a break-even for the energy community … We tell them that it is best if they reach **1 MW in the next two to three years** so that each member can also expect a nice interesting amount of incentive.*"

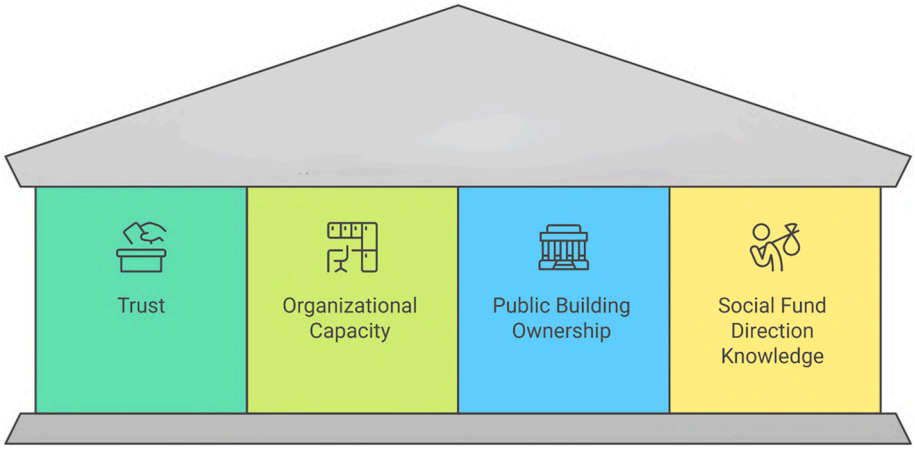

Fig. 8. Municipalities as main EC promoters.

Fig. 9. One-legged "Game Changer".

Theme: Indirect economic expectations

Financing and building actors do not view ECs as a direct profit generator. However, traditional utilities and banks anticipate nuanced, indirect economic benefits for their businesses, which are shown in Fig. 11. Cooperative utilities, on the other hand, are especially encouraged, as much of their core business is grounded in innovative energy models. Their expectations are displayed in Fig. 12.

Traditional utilities. In our study, interviewed utilities are actively working to develop appealing offers to various potential EC members, with particular attention to condominiums, public administrations, and SMEs. Engaging these entities provides an additional opportunity to increase utility's presence within the territory, which can serve as an effective marketing strategy with two indirect benefits. First, several interviewees mentioned offering discounts and preferential rates to future EC members willing to switch voluntarily to them as energy suppliers. Nonetheless, joining an EC does not legally mandate citizens to change suppliers because EU policies support consumer choice. Second, utilities engage in cross-selling by proposing additional energy services to entities with whom they build an EC. This enhances the EC offer's profitability, which might otherwise be limited. In this respect, utilities see ECs as a potential leverage point for their core, more profitable business:

> "*since the instrument of **public private partnership is expensive to be developed**, we try to put in **all the other services** we can offer to a public administration. So, we can offer not only the creation of an energy community in this case, but maybe the energy efficiency of the public building, the efficiency of the public lighting, smart services like smart parking, smart traffic lighting services.*"

One utility shared that their strategy includes achieving a specific renewable capacity within their portfolio—a strategic objective aligned with the social contract reflected in the "EU Green Deal". Currently, in Italy, the premium tariff for ECs is the only type of feed-in-tariff available for new installations. While it may not represent the most profitable business case, it enables the installation of additional capacity and offers a forward-looking perspective:

> "*What is the value for us to be there? We don't know. Which is the Business today of the energy community? It's very small. If we look at the numbers, it's **not** a valuable subject **where to invest**. But it's still a business. It's not a marketing and not a sustainability expense. We believe that more than **10- 15% of residentials** in Italy will be part of ECs in 10 years from now. And that's a lot. So, of course, being there is **strategical**".*

Furthermore, if a PV panel supplier belongs to the same utility group as the ESCO working with ECs, this could create an indirect economic

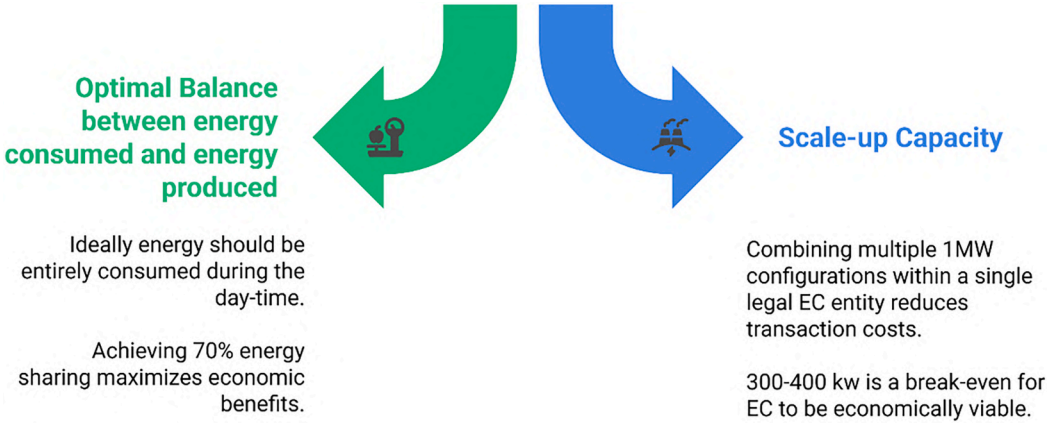

Fig. 10. Two ways to maximize economic benefits.

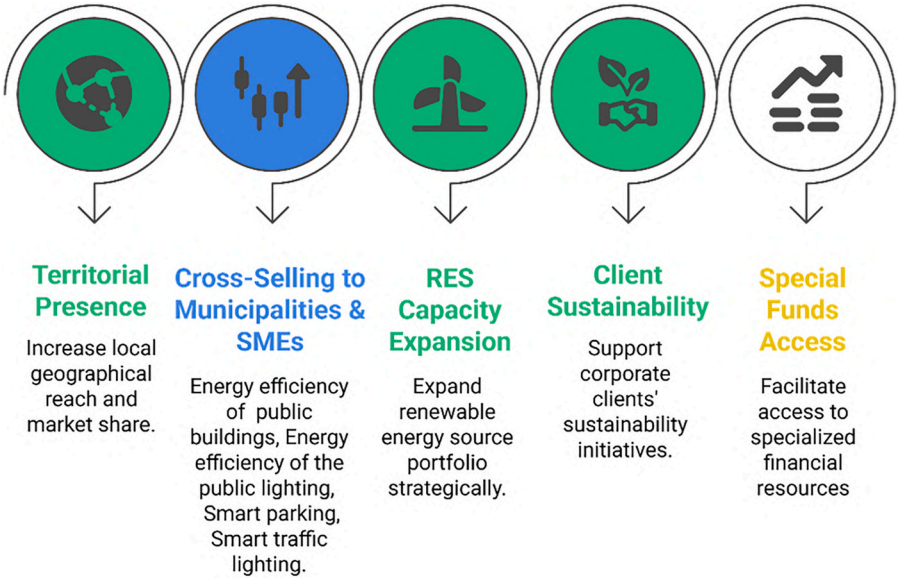

Fig. 11. Indirect economic expectations of traditional utilities and banks.

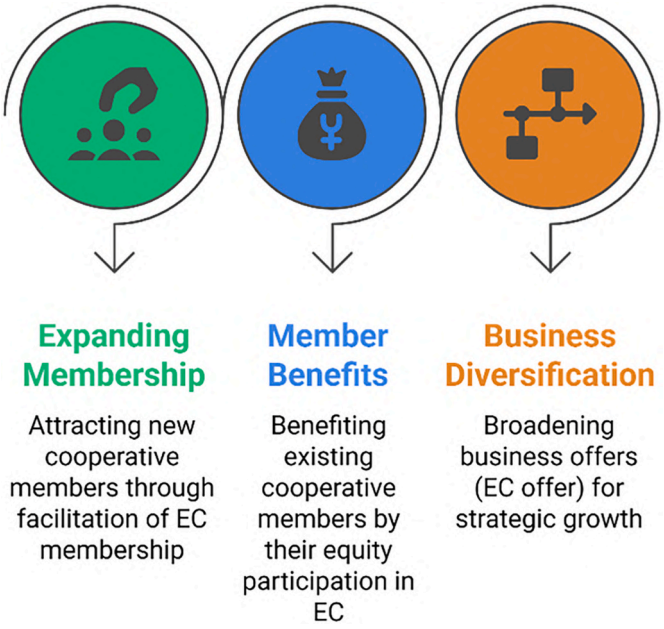

Fig. 12. Indirect economic expectations of cooperative utilities.

benefit. It allows the PV supplier to diversify its commercial channels, reaching more municipalities, SMEs, and ultimately more citizens.

Banks. One bank reported that involvement in ECs creates competitive advantages for their corporate clients and supports their long-term growth. By helping corporate clients gain a competitive edge, ECs can also serve as a strategic leverage point for banks. Another bank highlighted its strong territorial focus, indicating an interest in ECs not only for sustainability but also for strategic regional presence, particularly in municipalities with access to PNRR funding. However, indirect expectations do not mean banks overlook the economic outcomes of ECs as projects. The due diligence on repayment flows is conducted with the same rigor as for other projects.

Cooperative utilities. In a traditional sense, a market is a place where consumers' willingness to pay intersects with producers' willingness to sell. This logic shifts with cooperative utilities. Since cooperative utilities are managed by private citizens, their interests take precedence. The growth opportunities arise from expanding membership. When the primary owner and main customer are one and the same, the economic expectations of each align.Your shareholder becomes also your client. In fact, cooperative utilities are actively working to integrate ECs into their own models:

> "*A lot of **our Members want to promote** renewable energy communities in their municipality, **in their area**. And so we offer them the possibility to receive training on various energy community topics*".

Cooperative utilities will undoubtedly leverage EC incentives to enhance economic outcomes for their members and diversify their offerings. The ethical bank confirmed cooperatives' interest in expanding their activities around ECs, stating that: "*this is a **strategical** aspect for them, not just the economical aspect*".

Theme: ESG impact

Sub-theme: Human capital and education

Fig. 13 illustrates various aspects of the social impact of ECs, including offering EC membership to employees of PAs and SMEs; and reflecting this and similar social outcomes in ESG reports; mitigating the 'not in my backyard' (NIMBY) effect of participating companies' industrial activities; and directing ECs' social budgets toward educational initiatives. These impacts are described in the respondents' answers below.

One cooperative utility awakened us by emphasizing that their policy prohibits overinvestment into ECs (i.e. investment beyond covering energy consumption of citizen members), as their primary objective is to maximize social value. He noted that energy cooperatives and energy communities are, above all, tools for ESG impact. For example, companies could use ECs as a welfare solution for their employees. A representative from a large company was interested in the potential of ECs to mitigate the NIMBY effect associated with their industrial activities:

> "*If you create an energy community together with the realization of your plant, this will increase **the acceptance** maybe **of the people** towards this project*".

He also viewed ECs as a tool that could help public administrations further justify the presence of industry within their communities: "*Local authorities will be more happy because they see they have also **a tangible result** that they can **explain to the population***".

A sector association highlighted that their region has many SMEs within the energy supply chain, and if ECs procure infrastructure locally,

this generates a positive economic impact that strengthens social cohesion. Another sector association noted that the deployment of ECs could also increase system security during extreme weather events. This social impact can be reflected in the ESG reports of SMEs. Alternatively, the larger companies in the SME value chains could highlight this contribution. In such ways, SMEs could gain a competitive advantage.

All three foundations share a clear vision of the importance of appropriately distributing social fund money. Beyond addressing energy poverty, ECs can generate other types of social outcomes: "*one of the communities we are going to finance … use the funds to provide the opportunity for **six peoples** to attend a specific **course** on how to effectively **maintain the PV***". The lifestyle changes promoted by environmental education can lead to outcomes of consuming less and consuming more responsibly: *"As people say, **the best energy** is not renewable energy. It is the **energy you don't consume** at all"*. A participatory approach to ECs is also crucial, gradually encouraging members to take on more management responsibilities, thereby transferring administrative duties from a technical partner to members. It allows members to learn how to calculate energy and economic flows. Dedicating EC social funds to education, rather than solely to reducing energy bills, represents the ideal social outcome that foundations aspire to achieve.

Sub-theme: Unexpected sides of heterogeneous governance

At first glance, the involvement of heterogeneous actors in governing ECs may create more problems than advantages for financiers, who prefer to interact with standardized, accountable, and homogeneous organizations. Respondents were asked to evaluate the statement: "The heterogeneity of entities participating in ECs complicates decision-making related to project financing." Interestingly, Fig. 14 shows that the opinions of the 11 respondents were divided.

Public/philanthropic actors and sector associations generally disagreed, arguing that heterogeneity contributes valuable expertise, which in turn supports the successful implementation of ECs. One foundation shared that, in their experience, projects led solely by NPOs encountered substantial challenges that were difficult to overcome. A common concern was the long-term stability of EC governance, given that the premium tariff lasts 20 years, which may involve turnover of managing members. From this perspective, heterogeneity can be beneficial, providing a broader pool of members to ensure continuity. Still, several actors acknowledged potential conflicts between the economic interests of municipalities, NPOs, and churches on one hand, and SMEs on the other, though they affirmed that such issues are manageable. An actor involved in the cooperative sector said:

> "*You don't want to have cooperatives that are so **homogeneous** because then **conflict is easier.** I think it's better if you have a **heterogeneous** base where all the interests are fully represented, where you **have to negotiate the interests of all groups** … So, that's a very healthy model. It is also the most complex. However … we know how to manage that. We have dealt with governance issue for the past 120 years*"

Actors aligned more with the private sector (i.e. two traditional utilities, one financial intermediary, one bank), held the opposite view—that membership heterogeneity complicates investment decision-making. Their argument centered on the ambiguity regarding responsibility for debt repayment. The statement received a contradictory average rating of 3.1 out of 5.

Sub-theme: Environmental impact beside CO2 reduction?

The environmental impact of ECs is the most prominent among ESG components, with CO2 reduction seen as the primary benefit. Optimizing land use was also frequently mentioned. For instance, four interviewees mentioned that municipalities plan to install PV plants on municipally owned wasteland. Three utilities are also developing ECs that involve farmers, who co-locate PV panels with crops and possibly even livestock.

Theme: Dubious tool to combat energy poverty

Fig. 15 presents solutions to enhance ECs' ability to address energy poverty, including directing social funds to low-income households outside formal EC membership; involving NPOs and PAs in decisions on social budget allocation; increased policy attention to Southern Italy; and corresponding regulatory adjustments to incentives. Selected evidence is presented below.

The results of questions on energy poverty were surprising. The statement "ECs is an excellent tool to combat energy poverty" received a somewhat skeptical response, with nine respondents giving it an average rating of 3.5 out of 5. According to most respondents, the most effective way for energy communities to address energy poverty is not by using social fund money to reduce members' bills but by aggregating these funds and directing them to vulnerable non-member families. Therefore, the altruism of those who actually constitute the EC is crucial:

> "*I'm a consumer of a solidarity energy community. I can participate without paying anything. It's free for me. I don't have any effort. I only have to sign my participation. But I know that with my participation, I can allow the energy community to **sustain a few specific families**. So, I renounce to take €50 per year because **€50 is not so much for me**. And then maybe a family can have **€500** per year [if other members also decide so] and be sustained in a more appreciable way*".

One actor emphasized that the goal of combating energy poverty should be established from the outset, as a foundational intention—not as a vague objective to be considered after initial revenues are

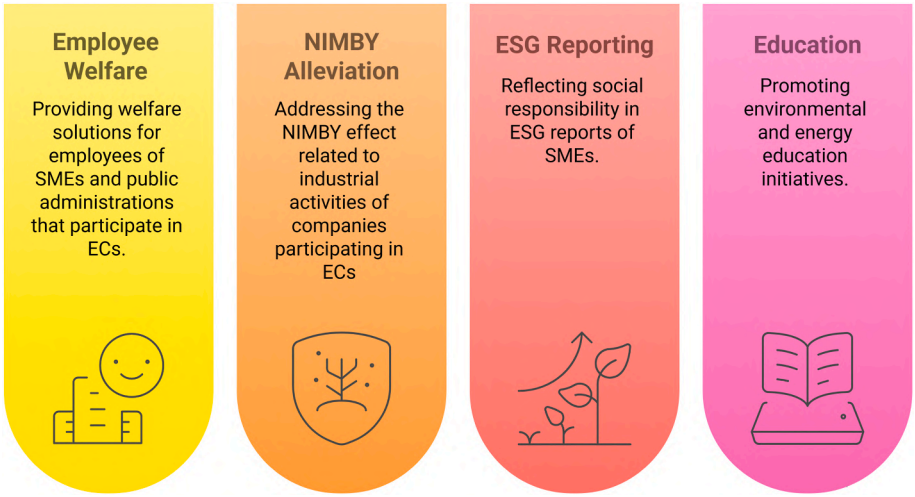

Fig. 13. Social impact of ECs.

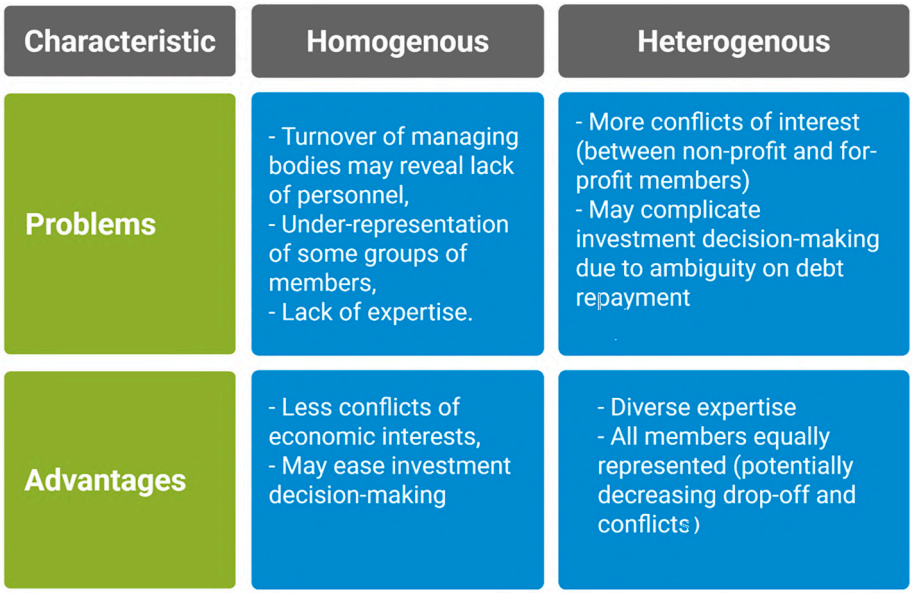

Fig. 14. Governance impact of ECs.

generated. A recurring theme was the need for a public or social actor's involvement to effectively address energy poverty.

Six actors specifically noted that energy poverty is more pronounced in Southern Italy. Furthermore, many respondents highlighted that access to capital in Southern Italy, especially for smaller municipalities, is generally much more challenging than in the North. Often, local NPOs or churches are well-positioned to understand the needs of vulnerable households. Regional grants could provide a financing solution, though it faces obstacles. Firstly, there is less regional funding in the South. Secondly, such funding typically targets municipalities rather than non-profits. Thirdly, there is a lack of expertise necessary to deploy ECs at scale in the South. Consequently, the regions that most need ECs have the least opportunity to establish them. Interestingly, one actor noted that the South's high solar potential remains largely untapped by distributed generation. Italy's premium tariff provides less support to Southern regions because of their higher solar irradiation and the greater penetration of large renewable plants, which congest the grid. This design suggests policymakers may see ECs mainly as a means to reduce future grid reinforcement costs rather than to alleviate energy poverty. Given the relatively low margins, it makes more sense to direct profits toward activities with socially transformative potential:

> "*The cost of the energy will not be impacted as much as you can impact the community by creating new environmental, educational, cultural property support projects … This is how you will also* ***leverage/multiplicate the value of the energy in the perception of people***".

To conclude, we highlight the skeptical perspective of one public/philanthropic actor:

> "*ECs are* ***a gamble****. Really. In Italy, we are walking on a thin line. Because in Europe, maybe, it's something that has been working better than here, but in Italy it is something that, for the moment, we are* ***not that hopeful****. Whether this is going to be a game changer for energy poverty and energy models of auto-consumption, or whether it's going to be* ***an empty box****. Because we're just financing these projects, keeping our fingers crossed that everything will be OK …*"

Theme: Evaluation practices and plans

Fig. 16 illustrates which pre-investment and post-investment evaluations (column 1) are performed or anticipated by financiers (column 2-4).

Banks and crowdfunders. None of the banks and crowdfunders expressed a decisive intention to assess the ESG potential of the EC itself. Instead, they plan to evaluate the general ESG performance of the SMEs or ESCOs requesting support. This pre-investment ESG assessment of SMEs can be complex, particularly for ethical banks. However, for EC projects specifically, the financial plan remains the primary criterion. Crowdfunding platforms conduct rigorous financial and ESG analyses of projects and their promoters before launching campaigns. But, they do not monitor projects once the campaign concludes, and ECs are no exception.

Impact investors. Two of the three impact investors tailor ESG requirements to each applicant. When a cooperative or SME seeks investment for an EC project, ESG data would be equally important as financial data. One impact investor even mentioned having prior experience with equity participation contingent upon the investee's attainment of ESG targets. If targets are met, the dividend percentage is

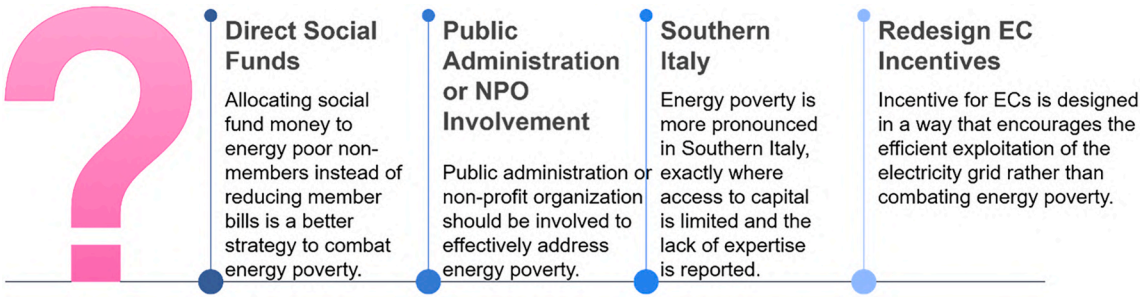

Fig. 15. Ability of ECs to tackle energy poverty.

reduced. Impact investors also expressed interest in monitoring ECs impact over time, with social and governance indicators being the most relevant: *"I would value social and governance more than environmental because **environmental is basically there** … But on social and governance I would go deep"*.

Foundations. Foundations typically conduct thorough evaluations before awarding grants, hiring external technical advisors to assess whether proposed projects aim to install sufficient power capacity to meet members' energy needs. Grants are awarded to ECs or partnerships exclusively when an NPO is involved in ECs. Foundations may issue a call for interest if only feasibility studies are financed or a call for proposals if infrastructure is also financed. The criteria for EC projects, as well as the expected impact, are clearly outlined in these calls. Foundations request detailed information from ECs, such as the anticipated energy consumption of members, potential configuration of members, and the available space for energy installations. Additionally, they may ask for social data: *"to briefly describe the **strategy** through which they are going to **involve fragile people** or people in poverty **into the energy community**"*. When asked about the weaknesses in unsuccessful applications, two of the three foundations noted a lack of technical data and a vague plan of action. In response to the statement, "Actors lack expertise on how to build an EC," respondents generally agreed, giving it an average rating of 4.1 out of 5.

One foundation shared that they have already contracted an external evaluator to assess the impact of EC projects, both one year and five years post-implementation. Two other foundations mentioned that, while it is too early to conduct impact evaluations, this is something they plan to pursue. Qualitative indicators might be more meaningful, as quantifying social impact poses challenges: *"You will have 100 families paying their bills due to ECs, but after one year, what has really **qualitatively helped them** because it's the long term, it's not the short term"*.

Meanwhile, one utility noted that they have long-term monitoring plans for ECs and intend to include indicators both on CO_2 reduction and social impact in their own ESG reports. A sector association remarked that monitoring the financial performance of ECs over time would be valuable, because survival and financial stability are not guaranteed in 20 years. As it is seen now:

> "*at the moment it's more a **temporary opportunity** for us to promote the renewable energy installation and to **use** those **subsidies** that are provided by the government*".

5. Discussion

Unlike Italy, where new RECs are primarily funded through grants, 64% (Arcudi et al., 2023), or through utilities' equity participation for JARSCs, in many other countries, the primary financing instrument for ECs is equity crowdfunding. A survey by Lupi et al. (2021) notes that 62% of ECs in the EU plus UK were financed by equity crowdfunding, with public grants as the second funding source, though only at 13%. We attribute this difference to the emerging phase of ECs in Italy compared to other countries. This aligns with findings from Lupi et al. (2021) on Poland, where public grants dominated as the main financial support in the early stages. Similarly, Cairns et al. (2023) and REScoop.eu; Ecopower (2023) also argue that public financing of the early stages of EC development is indispensable. Arcudi et al. (2023) criticizes PNRR grants, noting that many target municipalities are in regions with lower solar irradiation. This potentially reduces the output of electricity production, the social fund and, as a result, the effectiveness of subsidies in combating energy poverty. Though we partly agree, the regulation aims to guide the market toward new installations in high-demand, low-supply areas—such as Northern Italy—thereby improving the overall system and stakeholder welfare.

Several of our interviewees emphasized that public collateral would be crucial for the sector's growth. In the literature, only REScoop.eu; Ecopower (2023) mention this instrument, referring to collateral provided by municipalities rather than on a national scale. We assume that national-level policies for ECs were previously lacking, which likely explains the limited use of public collateral. Nevertheless, we believe this instrument will be important not only in Italy but also in many other Member States. Cairns et al. (2023) similarly suggest the central bank's guidance to commercial banks for delivery of 'just transition' projects.

The governance expansion of ECs raises questions about the most suitable legal form, particularly in cases where municipalities wish to join as equal members. Unfortunately, legal forms that align with PA interests often do not adequately protect private investors' interests. As illustrated in Table 5, ECs registered as non-corporate entities (i.e Associazione ETS, Fondazione di Partecipazione, Consortia) have limited access to financing. Additionally, if citizens wish to finance an EC without involving a legal entity (i.e., SME, PA, NPO) their only option is to form a cooperative or company—both of which entail a lengthy and costly process. A purely grassroots initiative led by citizens becomes nearly impossible. One exception is for condominium tenants in small

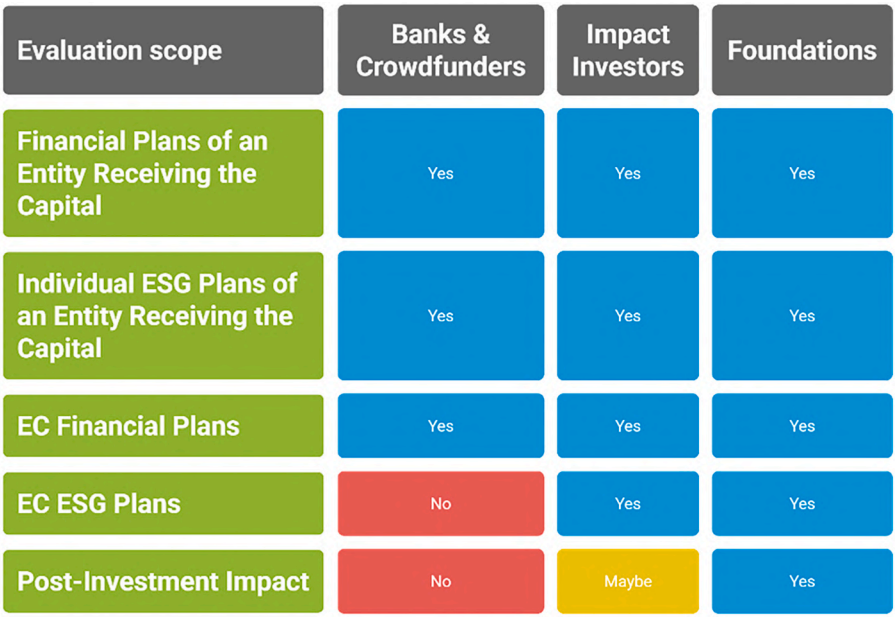

Fig. 16. Evaluation practices and plans.

municipalities who choose to establish a JARSC, financed through the PNRR grant and supplemented by personal contributions.

Our research identified one alliance (RESPIRA) and two flexible partnerships (Raiffeisenverband with partners, E'Nostra with Banca Etica) that actively promote the cooperative form (but not exclusively this form). ECs established as cooperatives have distinct advantages in accessing financing and expertise, as they can more readily secure green loans from ethical banks, attract co-financing through impact investor equity participation, and benefit from a range of pro-bono services. Numerous reports describe successful cases of cooperatives leveraging equity crowdfunding, bank loans, and lending crowdfunding (Coopfond, 2022; EFREC, 2014; REScoop.eu; Ecopower, 2023). However, academic evidence suggests some challenges with the cooperative structure too. Energy cooperatives can face management difficulties, and the risk-averse nature of some cooperative members may inhibit the adoption of innovative financing approaches (Herbes et al., 2017). Despite these challenges, our interviewees affirmed that cooperatives are a well-suited model for ECs, with one stating: "***We know how to manage that****. We have dealt with governance issues for the past 120 years."*

Most financing actors require co-financing and do not provide full funding. Exceptions include traditional utilities that fully cover costs for JARSC projects. Mixed funding approach mitigates risk, particularly for new ventures like ECs. Philanthropic actors may require only the commitment of NPO employees' working hours as reassurance of future engagement, while private actors often direct ECs to potential co-financiers. In more advanced cases, financing actors offer one-stop-shop mixed financing through alliances. While the significance of mixed funding has not been strongly emphasized in existing literature, it has been briefly noted in descriptions of specific cases (EFREC, 2014). The evidence in prior studies largely comes from interviews, surveys, and case studies featuring representatives from energy communities. In contrast, our focus was on the institutional financers' perspectives. We believe this difference explains the general absence of a detailed mixed-funding narrative in both academic and grey literature.

SMEs express the reduced interest in joining ECs under the final legislative provisions compared to the transitional legislation. The payback period has become much longer due to a "solidarity rule" and a "50% reduction" provision. Braunholtz-Speight et al. (2020) similarly notes that in the UK, long payback periods make EC projects less competitive than other investment opportunities. These restrictions diminish SMEs' motivation to join ECs, yet their involvement is crucial due to their easier access to private capital and their consumption profiles, which help maximize shared energy. As Cairns et al. (2023) suggested, to capture significantly more commercial finance, ECs may adapt their business models in a way that ensures a stronger fit with the finance status quo (e.g. scale, profit, investor control, etc.), which indeed can be facilitated by a more active participation of SMEs. Nevertheless, the literature does not specifically connect overcoming financing barriers to SMEs. It only positions policy changes and uncertainty among primary barriers. In our study, while many actors acknowledged the regulatory complexity—commenting, for instance, on confusion around "*virtual self-consumption, they ask* ***what does it mean?****"*—they did not view this complexity as a crucial barrier to financing.

Although prior studies (Brummer, 2018; REScoop.eu, 2020) cite administrative barriers (e.g. high connection costs, complex applications, and lengthy approvals), our data show that capable technical partners largely mitigate these challenges. In turn, the lack of benchmarks for the "shared energy" concept and the lack of standardized institutional frameworks complicate replication. Interestingly, the entire body of literature explores the institutional contexts in which ECs emerge and generally views this diversity as a positive feature, one that differentiates ECs from the traditional market and promotes their resilience and growth. Here, scientific perspectives favoring diversity contrast with industry needs for replicable benchmarks.

Most studies examining the economic benefits of ECs highlight positive impacts on the local economy and job creation, particularly in the construction and maintenance of installations (Bere et al., 2015; Entwistle et al., 2014; Kildegaard and Myers-Kuykindall, 2006; Koltunov and Bisello, 2021; Lantz and Tegen, 2011; Okkonen and Lehtonen, 2016; Phimister & Roberts, 2012, 2012, 2012; Torgerson, 2006). In a systematic review, Brummer (2018) especially noted the role of wind ECs in bolstering local supply chains. In our study, however, financing and building actors expressed distinct, indirect economic expectations from ECs. To our knowledge, previous academic literature has not explicitly explored these advantages. Although the grey literature lists similar expectations, including access to new customer segments, cross-selling, and strategic entry into new markets (Arcudi et al., 2023). Italian ECs can serve as catalysts for innovation and entrepreneurship, fostering new business models and services in renewable energy and energy efficiency (Magnani et al., 2017). This aligns with our narrative regarding ECs' strategic importance for both cooperative and traditional utilities.

Finally, we cannot confirm the hypothesis that ESG reporting can reduce the knowledge gap between financing actors and ECs soon because most actors do not currently consider new Italian ECs as independent market players. Only foundations see ESG disclosure by ECs as a possible control mechanism. Table 7 concisely presents our theoretical contribution.[21]

Table 7
Theoretical findings.

Stakeholder theory	*Principal-Agent theory*
In contrast to the assumingly divergent goals of public/non-profit and private EC financiers, their interests may overlap. None of the private financiers objected to the introduction of the social solidarity fund in ECs. Moreover, the latter see ECs as strategic opportunities rather than threats.	We found that private financiers do not see ECs as the Agents, but only ECs' separate members. Contrarily, foundations consider ECs as the Agents. Therefore, foundations strive to reduce information asymmetry through ESG and economic performance metrics. This suggests that ESG reporting by ECs may be an effective tool to improve ECs' access to financing from philanthropic actors in the near future, but not from private financiers.
Legitimacy theory	*Signaling theory*
Many stakeholders are skeptical that the new Italian EC model and/or the scale of subsidies offered can be an effective tool for sharing the benefits of the energy transition with regular citizens, especially as a way to combat energy poverty.	Only ECs with established business models that evolved into independent business organizations, akin to traditional energy coops, may be interested in signaling their competitive advantage, because many of them can directly interact with energy markets. In contrast, new Italian ECs are not considered independent business organizations by all interviewed actors. Hence, new ECs are not considered competitors to utilities either.
CPR theory	
Our findings support the previous applications of CPR theory to ECs; in particular, the importance of heterogeneous polycentric governance for managing common energy resources effectively (Roelich and Knoeri, 2015; Wolsink, 2012). However, such heterogeneous governance complicates financing decisions of private actors, hinting at a possible danger of a "tragedy of the energy commons." Our analysis of the Italian policy context suggests that this danger can be reduced or avoided through more active involvement of technical partners (e.g., ESCo). Open and unlimited membership may be detrimental to managing common energy. ESCOs can restrict it by keeping it within technical boundaries (more details in Koltunov (2025b)).	

[21] The extensive version can be found in Koltunov (2025a, p.115-117).

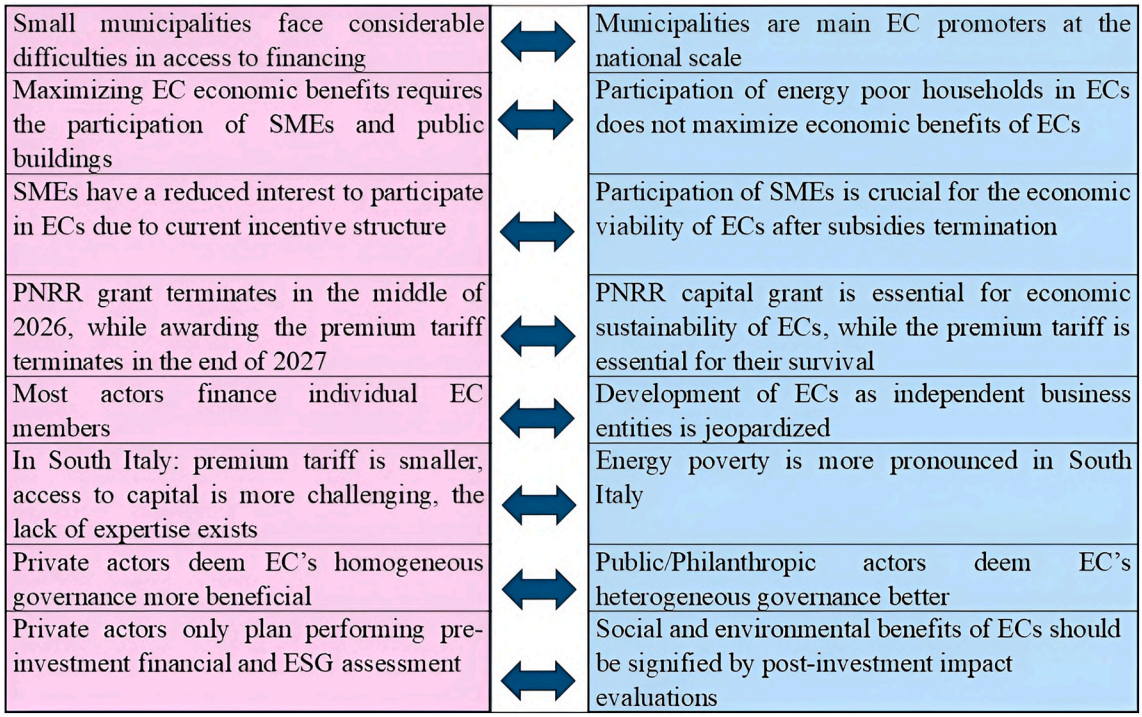

Fig. 17. Contradictions that hinder ECs' access to private finance and achievement of social goals.

6. Conclusion and policy implications

In Fig. 17, the key contradictions that hinder ECs' access to private capital and limit their ability to achieve social goals are presented. Several obvious solutions to these contradictions—such as provision of public collateral and relaxing premium tariff restrictions for SMEs—do not need additional elaboration. Other short/medium and long-term solutions necessitate more explanation that follows.

The first strategy that can render Italian ECs economically viable in short and medium term is to achieve an optimal balance between energy production and consumption. This requires detailed planning and a well-defined composition of producing and consuming members. The second strategy is to scale up: larger ECs, potentially comprising multiple 1 MW configurations, can leverage economies of scale. Both approaches depend on SME participation (but also on public buildings) rather than on low-income households. Addressing the needs of energy-poor families while maintaining economic attractiveness for SMEs requires careful regulatory articulation regarding the use of the social fund. Because the premium for shared energy is modest—and the remuneration for avoided grid usage even smaller—the funds available for broader social programs are limited. Consequently, the optimal approach is to pool social-fund resources and direct them toward a small number of particularly vulnerable non-member families, rather than focusing solely on reducing member households' energy bills. In fact, EC members primarily benefit from self-consumption rather than shared energy.

The Italian EC model's reliance on a premium tariff for shared energy, while beneficial in the short term, raises concerns about long-term sustainability. Because government subsidies will eventually be phased out, ECs should develop alternative revenue streams to remain viable. This may involve exploring new market opportunities, such as providing grid services, participating in demand-response programs, or offering energy-management services to their members. The similar study for the UK (Braunholtz-Speight et al., 2020) reveals that demand-side activities (e.g., energy efficiency) by ECs show a financial surplus, even when subsidies for such activities are absent. In Italy, the valorization of avoided grid usage—calculated based on shared energy—is a pure economic rationale behind EC deployment without subsidization. The optimal balance between self-produced energy and energy immediately consumed by EC members maximizes this shared energy. Such balancing requires at least a BESS and at maximum an EMS. BESS installation remains scarce across Italian ECs. Currently, only 3.6% of communities install batteries due to high CAPEX costs (Koltunov et al., 2025). Nevertheless, we anticipate that detailed engineering and cash flow models that incorporate BESS and EMS, as well as including load electrification, may reveal hidden opportunities for de-risking ECs after the termination of subsidies. Consequently, such risk mitigation, accompanied by declining technology costs,[22] may greatly improve access to private capital by ECs.

ECs are usually established under non-corporate legal forms. As a result, most actors prefer to finance individual members rather than the EC itself. This situation establishes a barrier to EC development as an independent entity in the long term. Nevertheless, developing ECs as separate organizations is crucial for their post-subsidy survival, primarily because of governance aspects. Ideally, ESG reports should be prepared for ECs as they are for other independent entities. These reports could include relevant indicators that also inform the ESG reporting of individual EC members, such as SMEs. Unfortunately, at present private actors consider conducting financial and ESG assessments only before investment. In turn, foundations and impact investors plan to perform such evaluations also after investment. This might open the door to successive rounds of EC financing from foundations and impact investors and therefore to ECs' organizational growth. To conclude, we present recommendations to stakeholders and policy-makers to overcome the contradictions that undermine financing and sustainable proliferation of ECs.

[22] For example, the lithium-ion battery package cost 806 $/kWh in 2013 dropped to an unprecedented 115 $/kWh (adj. for inflation) in 2024 (BloombergNEF, 2024).

6.1. Recommendations for stakeholders

- Establish alliances that facilitate access to mixed funding and provide the diverse expertise necessary to support EC proliferation after subsidies end. These alliances will not merely ensure that the financing risk is distributed among participants but also strengthen their strategic position in the emerging EC sector. The latter could open an array of direct and indirect economic opportunities for participants in such alliances.
- Design standardized offers for entities interested in establishing ECs, which clarify what they can expect from joining an initiative. Standardized offers also help establish benchmarks that simplify comparisons among business models for banks and investors. As a result of the model's standardization, promoters could secure larger sums for new and existing ECs.
- Resources from the social fund can be pooled and directed toward supporting a few energy-poor households to maximize the social effectiveness of ECs. This will not negatively affect EC members, because their economic returns mainly come from self-consumption rather than from the sharing of energy.
- Explore alternative revenue streams beyond the premium tariff for shared energy—such as providing grid services or energy efficiency solutions. It can signal improved economic sustainability of ECs. For example, modeling engineering metrics and cash flows for the inclusion of BESS and EMS into communities can enhance potential investors' interest.
- Develop ESG reporting frameworks that increase appeal to both investors and community members and ensure that the social objectives of ECs are met.

6.2. Policy recommendations

- Provision of public collateral can significantly decrease risks to private financers. It will be especially useful as the transition mechanism from mainly public support to mainly private financing.
- Since most new ECs are promoted by small municipalities, mitigating legal barriers to their participation in a cooperative legal form can improve EC financing and even facilitate public-private partnerships beyond EC projects.
- Regional grants for feasibility studies are not equally distributed across the state. Therefore, it would greatly help if a portion, if not all, of the state capital contribution (e.g., PNRR) could be secured before purchasing the power plant. This can enable quality feasibility studies while putting only limited public money at risk of improper spending. Consequently, quality feasibility studies will improve access to co-financing and matching funds from private financiers.
- BESS and EMS technologies appear crucial for the system-wide value of new ECs. A regulator could mandate their installation by amending the current provisions on CAPEX subsidy. This will mitigate risks to private financers. Moreover, since technical partners would have more work, it could elicit a positive feedback loop across the entire value chain. For example, it can strengthen building partnerships, thus stimulating greater trust from financiers. Subsequently, an inflow of private capital will foster EC deployment. This will increase the number of services provided by technical partners and may trigger their price reduction. Finally, the provision of targeted CAPEX subsidy for BESS and EMS could further reduce project costs, reinforcing the feedback loop.
- State support should be adjusted not only based on the economic efficiency rationale but also on the social rationale to stimulate EC proliferation in regions with a higher concentration of vulnerable populations (e.g., Southern Italy). First, premium tariffs could be equalized throughout the country, irrespective of solar irradiance. Second, both the economic and social rationales may be reconciled by greater BESS/EMS subsidization in Southern Italy. From the economic perspective, BESS/EMS would allow for higher levels of solar self-consumption, therefore not increasing the already high pressure on the system from renewables. From the social perspective, these technologies can elicit higher shared energy levels, consequently enlarging the EC social budgets.
- The rules which discourage SMEs can be softened. On one hand, the “solidarity rule” is restrictive for SMEs but guarantees that an adequate portion of economic benefits is redistributed to social needs. In contrast, the 50% reduction in the premium tariff for SMEs, which obtained the PNRR grant, only discourages businesses and does not enhance ECs' social objectives. Without SMEs, the survival and development of ECs may be more vulnerable in the long term. If not completely eliminated, the “50% reduction” could be partially relaxed upon the achievement of certain ESG targets (e.g., high ‘shared energy’ levels, which enlarge a social fund; installation of PV plants in areas with extra environmental benefits, etc.).

Due to the relevant novelty of Italian regulation on ECs we concentrate just on initial financing phases, specifically feasibility and CAPEX financing, neglecting the possible challenges associated with financing operational and growth expenses. Additionally, our theoretical contribution should be further validated in future research, as we did not employ a deductive approach. Another limitation of this study is the use of the AI tool for initial coding. While efficient it still needs careful human oversight and cross-verification, which we tried to exhibit.

CRediT authorship contribution statement

Maksym Koltunov: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Luca Tricarico:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization. **Adriano Bisello:** Supervision, Methodology, Conceptualization.

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Declaration of competing interest

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

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Appendix G. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2026.115246.

Appendix A

Literature review of financing instruments and sources of financial flows for energy communities

- Sales.

According to Herbes et al. (2017), revenue generation can align with the specific corporate purpose of the individual EC: energy sales, revenues from grid operation, balancing services provision, retail sales of renewable energy to customers, consumption-related services revenues.

- Equity crowdfunding[23†] (members financing).

Traditionally, this is the most prevalent financing source for ECs, where citizens become shareholders through share purchases. Beyond social advantages, equity crowdfunding proves more cost-effective than loans. For instance, ECs in the UK are estimated to obtain the annual interest payment for the first year on average lower by 2.016% if financed by community shares instead of loans (Braunholtz-Speight et al., 2020). Bauwens (2019) quantitative study on Belgian ECs found that the return on investment is the most important determinant of equity crowdfunding for members of large ECs where members are distributed across the country, while environmental and social drivers motivate members of smaller ECs where members reside in proximity.

- Loans.

Bank loans and funds from large investors play an integral role for mature business models. A study by Braunholtz-Speight et al. (2020) found that larger projects rely more on loans. Implementation of larger projects, such as the construction of windmills, biomass district heating plants, biogas facilities, or renovation of hydro power plants necessitates substantial funds that are difficult to accumulate through the cooperative's share offering.

- Equity participation

Depending on a statute and a legal entity chosen by a particular energy community and according to Italian regulatory framework, EC's shares could be acquired not exceptionally through traditional equity crowdfunding, but by a variety of actors. Among them, private funds, impact investing funds, large companies and SMEs are present.

- Public subsidies and grants.

During the experimentation phase of Italian regulation on ECs explicit subsidies in the form of public grants for the establishment of ECs have been declared by many Italian regions. Some of these resources are allocated through European Union mechanisms such as the ERDF program[24†], or Next Generation EU and its Italian managing fund, PNRR. ERDF grants by regions are mapped in Fig. 1. A study by Arcudi et al. (2023) disclosed that for 55 new ECs established since 2021, 80% were financed through public grants, with only about 20% that utilized other types of funding. While a survey by Franzo et al. (2023) indicated that for 85 new ECs, 68 % were financed through public grants, 32 % were financed by other types of funding, and only 12 % secured funding from private funds.

A particular attention deserves the study by Braunholtz-Speight et al. (2020) where authors simulated ECs survival rates after removal of state subsidies in the UK. They also mentioned several factors that may contribute to post-subsidy viability such as choice of a rooftop solar as most cost competitive option, location of PVs on buidings with high energy consumption such as schools or community centers, securing customers willing to pay a premium for community-generated electricity. In the UK, grants form a relatively small part of total capital for all project scales. They may play a significant role in de-risking projects, as they are often used to finance the earliest and riskiest stages of project development (Braunholtz-Speight et al., 2020).

[23] Some sources call equity crowdfunding ‘members financing’ or ‘self-financing’. Equity crowdfunding represents a specific form of member financing that utilizes online platforms and focuses on issuing ownership shares. However, due to proximity of these two concepts and for the simplicity reasons we further use only the term equity crowdfunding.

[24] ERDF plans to distribute €416 million for ECs in Italian regions until 2027, out of which €330 million as non-repayable grants.

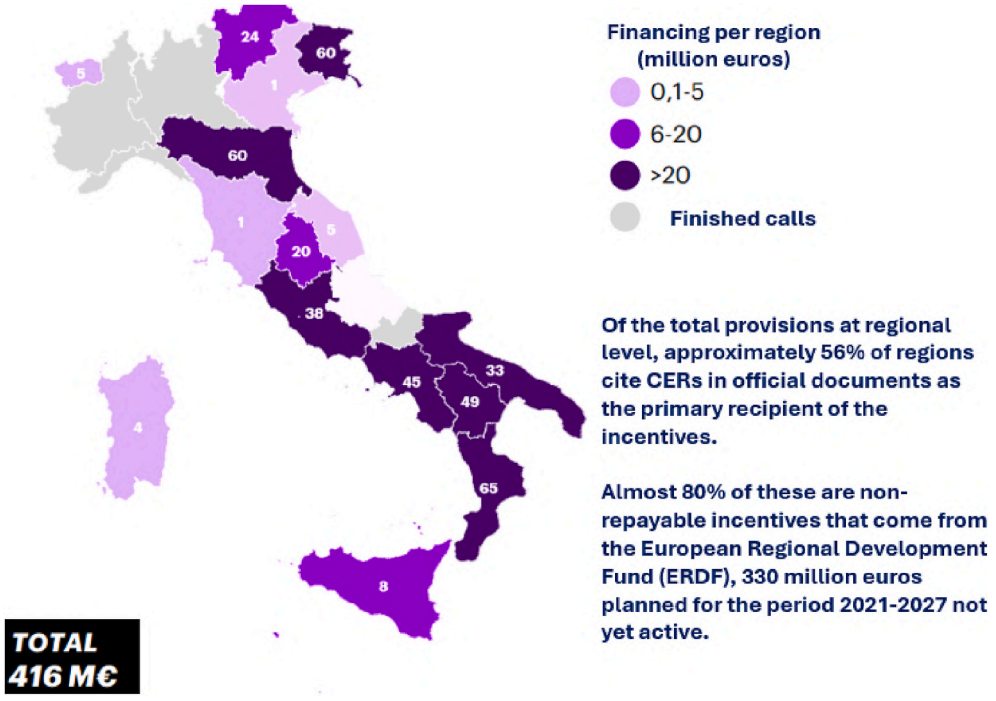

Fig. A.1. Distribution of public regional grants for ECs in Italy
Source: modified from Arcudi et al.(2023)

- Equity participation of affiliated ECs (Revolving fund)

De Vidovich et al. (2021) identified that in Italy certain companies or cooperatives create smaller ECs. These are known as "energy community builders" (EC-builders) and usually are represented by a well-established intermediary organization, a large cooperative, research, or a consultancy agency, or a national or regional association of ECs. The main feature is that such an entity establishes many ECs of a certain type, duplicating the business model with only minor adjustments. This type of entity participates in the equity of its spin-offs that should be returned later to the revolving fund. Energy4All cooperative in the UK and Energee Partagee cooperative in France are famous example of this type of financing.

- Leasing of equipment.

For the first time, this financing method for ECs was categorized in the study of Herbes et al. (2017). ECs might rent PV panels, storage facilities, and other equipment owned by the third-party companies. Therewith, ECs could benefit from state subsidies, fully or partially, without investing substantial funds in assets acquiring, which in turn would be provided by third-party companies. Such schemes are especially favored by the utility players which prefer to adapt their business models to the changing business environment without losing market share.

- Cost reduction.

ECs are predominantly small-scale organizations and may suffer from the high transaction costs. Forming associations that can assist in these tasks can lead to significant reductions in transaction costs and, as a result, increase available financial resources. In Italy, prime examples of such assisting organizations include Legacoop, SEV[25†], universities and municipalities that assist ECs with feasibility studies and commissioning.

- Bonds

Large corporations could utilize funds attracted through bond markets for financing a specific project for ECs. Such investment could be valued very well from the point of view of a big investor. It may be a small project for a large corporation albeit being beneficial for a public image. In turn, corporations could disclose it in their ESG report and report on additional taxonomy aligned activities. Braunholtz-Speight et al. (2020) found that projects financed by bonds do not have an interest rate that is significantly different from loans.

[25] Südtiroler Energie Verband Genossenschaft

- Lending crowdfunding

This instrument allows individuals to collectively lend small amounts of money directly to projects, bypassing traditional banks. In the context of ECs, it helps fund projects by offering investors a return through interest payments, along with the repayment of the loan principal. Online platforms simplify the process, ensuring transparency and lowering costs. As Mollick (2014) highlights, crowdfunding relies on many small contributions made online, bypassing conventional financial intermediaries. Instead, alternative financial intermediaries organize the process. In our study, we interviewed two of the crowdfunding platforms: Ecomill and Ener2Crowd.

- Project finance (mezzanine-finance)

This is a financial mechanism that allows to secure funding for projects by relying on the future revenue streams rather than the financial health of the sponsors/borrowers. Project finance structures are critical for renewable energy projects, particularly due to the large initial investments required and the lengthy period before returns are realized (Gatti, 2012). The project finance loans are based on the income generated by the project, thus minimizing individual members financial liabilities, although creating a possibility of a higher risk for the lender, which could not request a loan back from the other assets of the borrower. In our sample, one bank offers project finance backed by public collateral/guarantee for environmental projects including purchase of infrastructure for ECs. However, another interviewed actor critically argued about project finance utilization for small scale projects such as ECs: "*There are certainly more difficulties in defining the agreements, given that there is a high number of parties involved, and it has very specific obligations of* ***diligence****, being a slightly* ***more complex contract*** *… And they require the investment size, usually very high, of* ***10, 20 million****, so it can certainly be used for very high investment projects*".

Appendix B

Interview guideline (permanent questions)

Research question 1

Financing instruments

1. Which financing instrument will be used by the Bank/Fund/Foundation/Company/Organization to finance ECs? Which co-financing instruments were chosen for the ECs sponsored/promoted by the Bank/Fund/Company/Organization? Why?
2. In general, which other financing instruments could be promising for ECs, and which actors could provide them?

Financing process

3. What steps does the Bank/Fund/Foundation/Company/Organization normally perform at a pre-investment stage (selection) and after-investment (engagement) toward financing recipients?
4. How does approach (selection, engaging, monitoring, etc.) of the Bank/Fund/Foundation/Company/Organization toward ECs differentiate from the other interventions?

Business model of an actor

5. Could you tell us please if the Bank/Fund/Foundation/Company/Organization has already financed any ECs? If yes, how many of them, at which development stage are they, which PV size are they going to install, who will be the members (prosumers, consumers, producers)?

Research question 2

Expectations

6. Which specific characteristics can maximize the ability of an EC to combat energy poverty?
7. According to your experience/intuition what are the key factors behind a successful EC?
8. Which legal form do you think is most suitable for ECs in Italy? Why?

Partnerships and stakeholders

9. What type of partnership do you think is the most capable to establish an energy community?
10. Does a type of a developing actor (cooperative, ESCO, environmental NGO, social enterprise, religious entity) or its experience influence distinct outcomes and impacts of an EC project? Why?

Impacts

11. Which impacts do you expect most from ECs (Economic, Environmental, Social or Governance)?
12. Will project evaluation (or impact evaluation) be organized for ECs? If yes, what will it look like?

Research question 3

Barriers to private capital access

13. Decree CACER promised 40% of CAPEX coverage but only until June 2026, while premium tariff is granted only to ECs established by the end of 2027. Do you expect that private financing could fully replace state subsidies one day? In the future, how economically sustainable ECs can be without state CAPEX contribution OR without a premium tariff?
14. Will there be any difference, in your opinion, between ECs' establishments in different parts of Italy? If yes, which?
15. What challenges but also possible opportunities, stemmed from the fact that ECs in Italy can be composed of very heterogenous subjects, does the Bank/Fund/Foundation/Company/Organization anticipate?

Opportunities to overcome barriers

16. Have you considered ECs as defined by the new Italian Decree as an investment option? Strategically, does the Bank/Fund/Foundation/Company/Organization consider them more as risk mitigators OR opportunity enablers?
17. What is the interaction between the Bank/Fund/Foundation/Company/Organization and the financing recipient regarding targets for improvement of ESG indicators? (If a financing agreement would include such targets, what value-added can it have for both parties?)

ESG reporting: value, resources, frameworks

18. In which format do financing recipients provide ESG data to the Bank/Fund/Foundation/Company/Organization? Is there a template? How clear/precise is the provided data?

Appendix C

An in-depth analysis of the economic benefits for the EC members

It is essential to clarify the concept of shared energy to which the premium tariff is attached. In Italian regulation, shared energy refers to the minimum amount between the total energy injected into the public grid by all EC members within a given hour and the total energy withdrawn (consumed) by all EC members within the same hour. This means that if consumption is higher in a particular hour, the amount of injected energy will be considered as shared energy. Conversely, if the injected energy is higher in a given hour, the amount of consumed energy will be counted as shared. The generalized formula for calculating shared energy is as follows:

$$E_{sh} = min_h \left\{ \sum_{i=1}^{n} Eout_{i,h} \sum_{i=1}^{n} Ein_{i,h} \right\}$$

where

- E_{sh} is the shared energy
- $Eout_{i,h}$ is the energy withdrawn from the grid in a given hour h by the i-th member
- $Ein_{i,h}$ is the energy fed into the grid in a given hour h by the i-th member

Members of ECs will retain their existing electricity retailers, who will continue to supply electricity as before. Accordingly, EC members will pay their conventional bills to these retailers, unchanged by the installation of new assets. At the end of each month or year, a cashback is calculated by GSE based on several factors: the market payment for energy injected into the grid, the premium for shared energy, and the valuation of avoided grid usage through self-consumption. Administrative costs incurred by GSE are then deducted from this cashback. In this setup, the regulator keeps the conventional bill and cashback separate, in contrast to net-metering programs, where the amount of purchased energy is offset by the amount injected into the grid, regardless of the time of day. The cashback logics is given by ARERA (2022) and Technical Rules from GSE (2024). It is possible describe it with formula:

$$Cashback = E_{inj}(P_{sell}) + E_{sh}(P_r) + V_{agus} - GSE_{costs}$$

where

- P_{sell} - price for which GSE is purchasing renewable energy from eligible subjects. Regulated by ARERA 280/07 and it is equivalent to "Prezzo Minimo Garantito" (PMG).
- P_r – premium tariff for shared energy
- V_{agus} - valorization of avoided grid usage due to self-consumption
- GSE_{costs} - administrative costs incurred by GSE relative to the management procedure related to cashback calculation and remuneration.

It is critical to consider how distinct components of the cashback are calculated too. In fact, the premium tariff itself is not a single value. The basic premium tariff for an EC can be calculated via formula:

$$P_r = \min(Fix + Var; Threshold)$$

where

- *Fix* is a fixed component of a premium tariff that according to CER Decree stands at 60 – 80 €/MWh depending on the asset capacity (if $P < 200$ equals 80; if $200 < P < 600$ equals 70; if $P > 600$ equals 60). PV systems in central and northern Italy get an extra premium of 4 and 10 €/MWh respectively.
- Var is a variable component that can be expressed as $\max(0; 180 - P_z)$ with P_z being the hourly zonal price of electricity. In the event of zonal prices being higher than 180 €/MWh the Var is counted as 0 €/MWh. This is made to prevent excessive premium during the periods of wholesale price spikes such as those which were witnessed during the recent 2022 energy crisis.
- *Threshold* is a component that varies by installed capacity. If $P > 600$ equals 100 €/MWh, if $200 < P < 600$ equals 110 €/MWh, if $P > 600$ equals 120 €/MWh. In the event of extremely low wholesale price P_z this parameter prohibits exceeding the premium tariff beyond 100-120 €/MWh.

The valorization of avoided grid usage due to self-consumption, V_{agus}, includes two components: the reduction in grid costs due to self-consumption and the reduction in costs related to decreased grid losses from self-consumption. JARSCs are compensated for both components, whereas RECs receive compensation only for the reduction in grid costs due to self-consumption. This distinction arises because RECs still rely on the distribution grid for energy sharing, thereby incurring grid losses. In contrast, JARSCs operate within a single condominium where a common load (e.g., lighting, elevators, electric vehicle charging stations) directly consumes energy from rooftop installations, bypassing the distribution grid. The valorization of avoided grid usage for JARSCs and RECs can be calculated using the following formulas:

$$\text{JARSC} : V_{agus} = T + L$$

$$\text{REC} : V_{agus} = T$$

where

- T is reduction of grid costs due to self-consumption
- L is reduction of costs related to decreased grid losses due to self-consumption

Reduction of grid costs due to self-consumption (T) is calculated (Lo Schiavo et al., 2022) by formula:

$$T = E_{sh} * (TRAS_E + \max(BTAU_m))$$

where

- $TRAS_E$ is a sum of transmission tariff for LV household consumers,
- $BTAU_m$ is a distribution tariff for LV commercial and industrial consumers

Reduction of costs related to decreased grid losses due to self-consumption (L) is calculated (Lo Schiavo et al., 2022) by formula:

$$L = \sum_{i,h} \left(E_{sh,i} * c_{agl} * P_z\right)$$

where

- c_{agl} is a coefficient for avoided grid losses of the voltage level to which generator/s are connected (2.6% for generators in LV grid. 1.2% for generators in MV grid).
- P_z is the hourly zonal energy price of the day-ahead market
- $E_{sh,i}$ is the energy shared by the i-th member

By identifying all components of the cashback, we can calculate the actual economic benefit for EC members, which includes savings derived from self-consumed energy. For JARSCs, these savings apply only to a common load when using a PV-battery system. In contrast, for RECs, prosumer members can directly self-consume energy from the PV-battery system, thereby reducing the amount of energy purchased from a retailer. The economic benefit can be calculated using the following formula:

$$B = E_{sc}\left(P_{buy}\right) + \left[E_{inj}(P_{sell}) + E_{sh}(P_r) + V_{agus} - GSE_{costs}\right]$$

where

- E_{sc} is an amount of self-consumed energy by common loads for JARSCs and by prosumers for EC
- P_{buy} is a retail price that a member of EC pays to its retailer.

Appendix D

Description of interviewed actors

Philanthropic & Public:

- Fondazione Cariplo. Philanthropic banking foundation funding initiatives in social welfare, environmental protection, and cultural development, supporting projects that address societal challenges. It supported ECs through its calls for funding (e.g., “Alternative” call), providing technical assistance and funding. Foundation financed 42 ECs at the time of the interview.
- Banco dell'energia. A foundation bridging the gap between private sector donations and energy poverty-related projects. Supports renewable energy communities as one of its three project types, providing funding and technical assistance for ECs tackling energy poverty. Foundation has financed 9 ECs at the time of the interview.
- Fondazione con il Sud. Foundation promoting social cohesion and sustainable development in Southern Italy. Launched its first call for ECs projects, focusing on marginalized communities and alleviating energy poverty in Southern Italy. Foundation financed 9 ECs as for the time of the interview and supported 3 more macro regional ECs.
- APE FVG. Regional energy agency in Friuli Venezia Giulia (FVG) promoting energy efficiency, renewable energy, and sustainable development through consulting and support to local entities. APE FVG provides technical assistance while the funding itself comes from a FVG's Regional Public Administration. There are 10–20 ECs that were followed by the agency and funded by the Region at the time of the interview.

Impact investing:

- Avanzi. A social impact fund focused on early-stage SMEs, prioritizing ventures with significant social or environmental benefits.
- Etica SGR. An asset management company that applies ESG criteria to its investments in large listed companies supporting their sustainable projects. They co-established with Avanzi a subsidiary vehicle for investments in SMEs, called “a|impact”.
- Coopfond. Mutualistic Fund of the Legacoop Federation that supports cooperatives by providing equity participation and ESG-linked loans, including ECs which wish to be established in cooperative legal form.

Sustainable financing:

- Banca Etica. An ethical finance bank/institute that provides loans to socially and environmentally responsible organizations, including ECs, applying the ESG-based evaluation. Banca Etica has financed 51 ECs through "Respira" program at the time of the interview.
- Intesa San Paolo. One of Italy's largest banking groups with a focus on sustainability and responsible finance, offering products that support the green economy and social impact projects.
- Volksbank. Cooperative bank offering traditional services with a focus on supporting local communities and small businesses, committed to ethical finance and sustainability. Financially supports members of ECs (SMEs, private individuals and condominiums), providing up to 80% financing for projects.

Financial intermediaries:

- Ecomill. Crowdfunding platform for renewable energy and sustainability projects, including ECs.
- Ener2Crowd. Crowdfunding platform focusing on renewable energy projects, including ECs. At the time of the interview, three ECs were financed through the platform, 4th in progress.

Sector associations:

- Raiffeisenverband. Cooperative association supporting the development of cooperative banks and businesses in South Tyrol. Assists ECs formation, providing legal and fiscal support, working with local municipalities, cooperatives, and businesses in South Tyrol. They had 6 ECs under development in the region at the time of the interview.
- Forum per la Finanza Sostenibile. Organization promoting sustainable finance by fostering dialogue between financial institutions, companies, and policymakers. Advocates for integrating ESG criteria in finance. It was involved into EU funded project that established ECs focused on energy efficiency technologies.

Traditional utilities:

- Edison Next. An ESCO company, part of the major energy utility group focused on electricity and natural gas production with an emphasis on renewable energy and decarbonization. Group developed a commercial offer for RECs and JARSCs, and have plans to activate over 2000 configurations by 2030. Over 9 ECs that were financed and developed were operational at the time of the interview.
- Iren Smart Solutions. An ESCO company, part of the multi-utility group working on both residential and industrial-scale EC projects. Special feature of this utility is that most of shareholders are municipalities, which make it highly oriented toward their needs. Operates two models of support for RECs and JARSCs, focusing on larger photovoltaic installations, leasing and managing plants while sharing energy benefits with community members.

Cooperative utilities:

- ForGreen. An innovative utility/retailer company that beside energy selling also offer ESCO-type solutions. It also develops shared investments in renewable energy for citizens and companies and created few spin-off energy cooperatives. Actively supports the formation of ECs mostly in a cooperative form. Over 6 ECs were supported at the time of the interview.
- E'Nostra. A utility/retailer of a cooperative legal form and origin producing and supplying clean energy to its members and clients, promoting energy self-sufficiency and sustainability through community initiatives. E'Nostra offered their innovative financing support to 2 ECs as well as co-developed/developed approximately 60 ECs at the time of the interview.

Company:

Maire Tecnimont is a large engineering company that manufacture petrochemicals and green energy plants. Its sustainability department is interested in ECs as an ESG tool for possible mitigation of its environmental impact in areas where company is manufacturing its plants, especially outside the EU.

Other non-interviewed actors that finance ECs include:

- Enel X. An ESCO company, part of the major energy utility group.
- ACEA Pinerolese. A multi-utility company based in Pinerolo.
- Garda Uno. A multi-utility company that operates in area around Garda Lake, mostly concentrating on waste management and energy services.
- Federcoop Trentino. A cooperative association in the Trentino region that supports the development of cooperatives, providing consulting, financial services, and assistance to cooperative enterprises.
- Compagna di San Paolo. One of Italy's largest banking foundations.
- Cassa di Risparmio di Cuneo. A banking foundation that funds and supports local projects in the areas of social welfare, education, research, and cultural heritage, particularly in the Cuneo region of Italy.
- Fondazione Peppino Vismara. A foundation supporting initiatives and activities of a social and educational nature.
- CGM Finance. A financial subsidiary of a CGM (Italian Social Cooperative Association).

Appendix E

Main prompt for Scholar GPT used in initial coding stage

I uploaded a transcript from an interview, where experiences with financing energy communities (ECs) in Italy and SMEs in general discussed. I want you to review this transcript and code it (a code is a unit of analysis in qualitative research) with detailed, descriptive codes. I want codes to be as descriptive, self-explanatory and specific as possible, rather than short or abstract (e.g. I would prefer a code that is called "ECs help bridging public and private territorial entities" rather than "energy communities as a social development tool". e.g, a code "Bank provides discounted interest rate on loan to support ECs" rather than "Incentives for Energy Community Investments"). Very important again, codes should be very detailed, because it is a first stage of analysis, initial coding. I want all accounts, including all reported experiences, all opinions and comments, to be coded. As the output, I want you to provide a list of codes you created, and under each code I want you to provide a full segment of text (e.g. a sentence or part of a sentence) that this code was applied to. Please, provide me all codes at once in one output reply, so I won't need to ask you each time continue with coding. Please, remember to be more specific with codes, so researcher at a later stages can more easily remember what was the initial code about. Do not fear including into codes the specific details from quotes. However, avoid codes to bee too long hence it impedes its comprehension. Do not do any assumptions, but instead capture all details from the text. Ground your analysis only based on textual data from word files provided by me. Please, use for codes words that are carrying same meaning but more simple to comprehend. Provide some specific details in each code, so it is easier to remember which part of text they come from. Do not consider the questions of the interviewer for the codes, but only the answers of the interviewee. There should be as much codes as possible. Quotes must have exact wording and punctuation, etc, as in the transcript original files.

Appendix F

Financing processes

$$Benefit = E_{sc}(P_{buy}) + [E_{inj}(P_{sell}) + E_{sh}(P_r + V_{agus}) - GSE_{costs}]$$

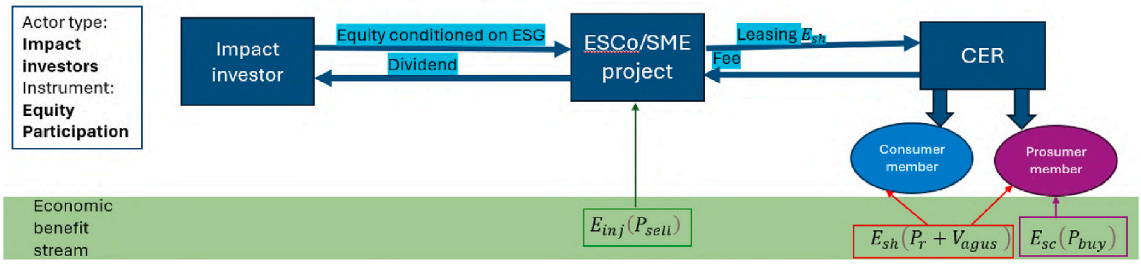

Fig. F.1. Equity participation

Impact investors may **acquire equity** in an ESCo or SME to support the implementation of a specific REC (CER) project. *This equity participation can be made conditional on the achievement of specific ESG targets. If these targets are met, the percentage of dividends returned to the impact investor may be reduced, aligning financial returns with ESG performance.* The ESCo or SME can then purchase photovoltaic panels and lease them to the ECs. In return, the ECs pays a rental fee to the ESCo/SME. Ownership of the PV plant—and thus the rights to the revenues from energy injected into the grid—remains with the ESCo/SME. Using both the revenues from energy injected into the grid (Einj(Psell) and the rental payments received from the ECs, the ESCo/SME distributes dividends to the impact investor. Meanwhile, prosumers and consumers within the ECs benefit from incentives for shared energy production and from the valorization of avoided grid usage (Esh*(Pr + Vagus). When PV panels are installed on rooftops, prosumers can self-consume the generated electricity, reducing their conventional energy bills (Esc[Pbuy]).

$$Benefit = E_{sc}(P_{buy}) + [E_{inj}(P_{sell}) + E_{sh}(P_r + V_{agus}) - GSE_{costs}]$$

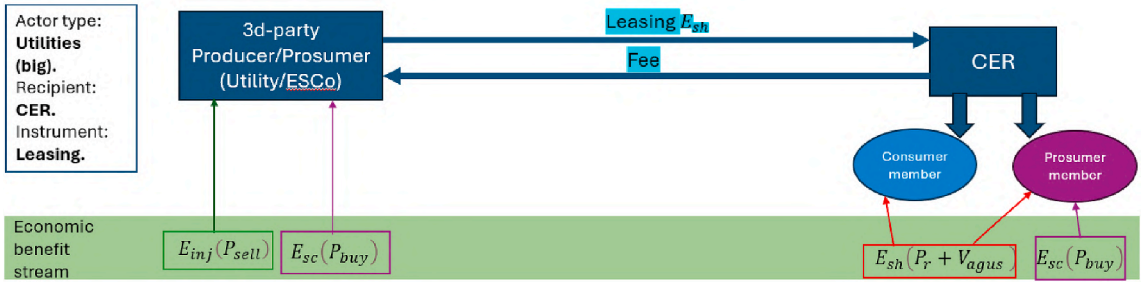

Fig. F.2. Leasing

Traditional utilities can participate in RECs only as third-party producers or prosumers, but not as direct members of the ECs. However, as third-party entities, they can **lease** their PV plants to the ECs and receive rental fee in return. The revenues from energy injected into the grid [Einj(Psell)] as well as the benefits of self-consumption [Esc(Pbuy)]—if the PV system is installed on the utility's own rooftop—remain with the third-party entity. At the same time, prosumers and consumers within the ECs benefit from incentives for shared energy production and from the valorization of avoided grid usage [Esh × (Pr + Vagus)]. Prosumers within the ECs may also gain from self-consuming the electricity [Esc(Pbuy)] generated by PV systems installed on their rooftops.

$$Benefit = E_{sc}(P_{buy}) + [E_{inj}(P_{sell}) + E_{sh}(P_r + V_{agus}) - GSE_{costs}]$$

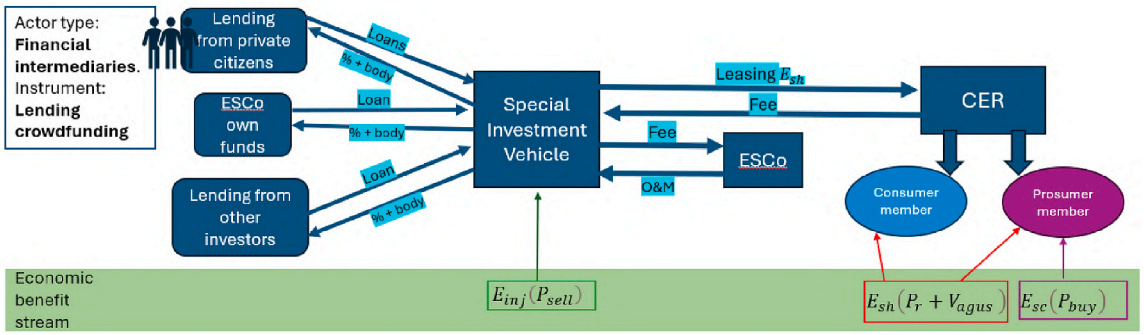

Fig. F.3. Lending crowdfunding

Crowdfunding platforms facilitate the **lending crowdfunding** process by establishing a SIV. Various stakeholders—including private citizens, ESCos, and other investors—can provide funding to the SIV. *The SIV significantly reduces risk for lenders because it is typically registered as a corporate legal entity, unlike ECs, which are most often registered as associations.* The ESCo usually acts as the primary lender to the SIV, securing the initial capital and thereby simplifying the process of attracting matching funds from private citizens and other investors. The SIV functions purely as a financial vehicle. For this reason, it typically delegates the operational and management responsibilities of the ECs to the ESCo, compensating it with a management fee. Notably, the same ESCo may also be a lender to the SIV. As a third-party entity in relation to the ECs, the SIV can lease its PV plants to the ECs and receive rental payments in return. The revenues from energy injected into the grid [Einj(Psell)] remain with the SIV, as the owner of the PV plant. These revenues, together with the income from the rental fee, are used to repay the loans (% + body). Meanwhile, prosumers and consumers within the ECs benefit from incentives for shared energy production and from the valorization of avoided grid usage [Esh × (Pr + Vagus)]. Prosumers within the ECs may also gain from self-consuming the electricity [Esc(Pbuy)] generated by PV systems installed on their rooftops.

$$Benefit = E_{sc}(P_{buy}) + [E_{inj}(P_{sell}) + E_{sh}(P_r + V_{agus}) - GSE_{costs}]$$

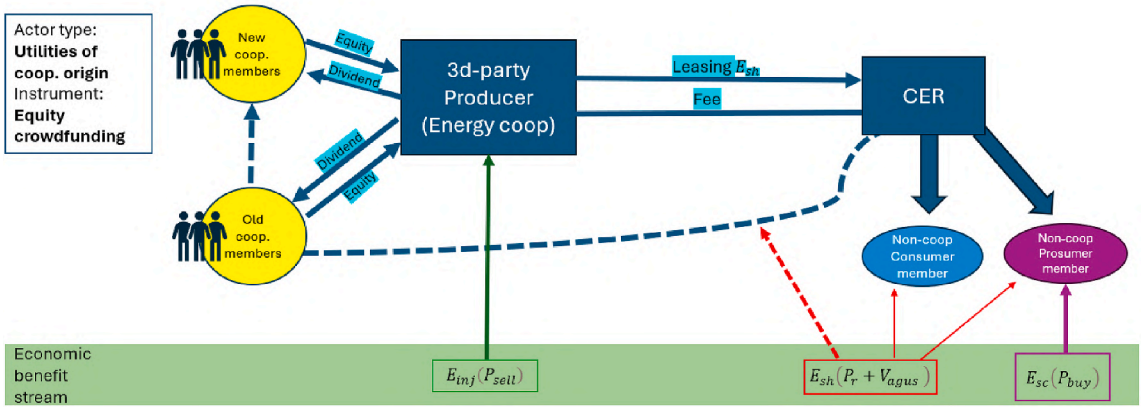

Fig. F.4. Equity crowdfunding

In Italy, **energy cooperatives** operating as market retailers—utilities of cooperative origin—play a key role in facilitating **equity crowdfunding** for ECs. These cooperatives act as third-party producers in relation to the ECs. Because they have a well-established legal structure, they offer a secure avenue for private citizens to acquire equity. The equity crowdfunding can be structured as a targeted share offering dedicated to a specific EC project. The capital raised is used to purchase a PV plant, which is then leased to the ECs. The revenues from energy injected into the grid [Einj(Psell)] remain with the energy cooperative, as the owner of the PV plant. These revenues, combined with the income from the rental fee, are used to distribute dividends to investors. *Investors may include both existing members of the cooperative and new members who have joined specifically to invest in the PV plant associated with the ECs.* The membership in ECs is typically open to both members of the energy cooperative (dotted arrow) and non-members (solid arrow). The prosumers and consumers within the ECs benefit from incentives for shared energy production and from the valorization of avoided grid usage [Esh × (Pr + Vagus)]. Prosumers within the ECs may also gain from self-consuming the electricity [Esc(Pbuy)] generated by PV systems installed on their rooftops.

$$Benefit = E_{sc}(P_{buy}) + [E_{inj}(P_{sell}) + E_{sh}(P_r + V_{agus}) - GSE_{costs}]$$

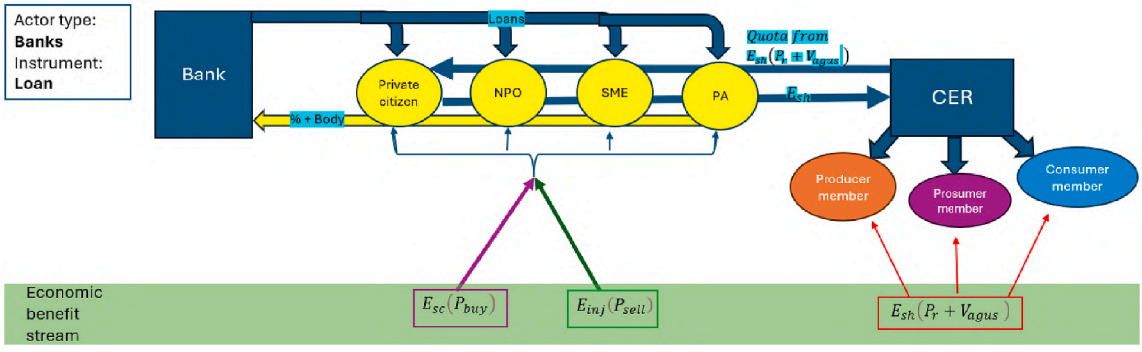

Fig. F.5. Loans

Loans are accessible to all potential EC members, including private citizens, NPOs, SMEs, and public administrations. *As previously discussed, direct loans can be provided to ECs only if it is registered as a corporate legal entity, which occurs in a minority of cases.* With loan financing, EC members can purchase individual photovoltaic systems and integrate them into the ECs. In return, they receive a specific quota of incentives for shared energy production and the valorization of avoided grid usage [Esh × (Pr + Vagus)]. The exact percentage of this quota depends on the ECs's internal regulations, as specified in its statute. Additionally, PV system owners benefit from savings through self-consumption [Esc(Pbuy)] and from revenues generated by energy injected into the grid [Einj(Psell)]. These earnings are used to repay the loan (% + body) to the **bank**. Importantly, some producers, prosumers, or consumers may be EC members even without owning a PV system. These members can still benefit from shared energy production and the valorization of avoided grid usage [Esh × (Pr + Vagus)], demonstrating that participation in ECs is accessible even to those unable to purchase a PV system.

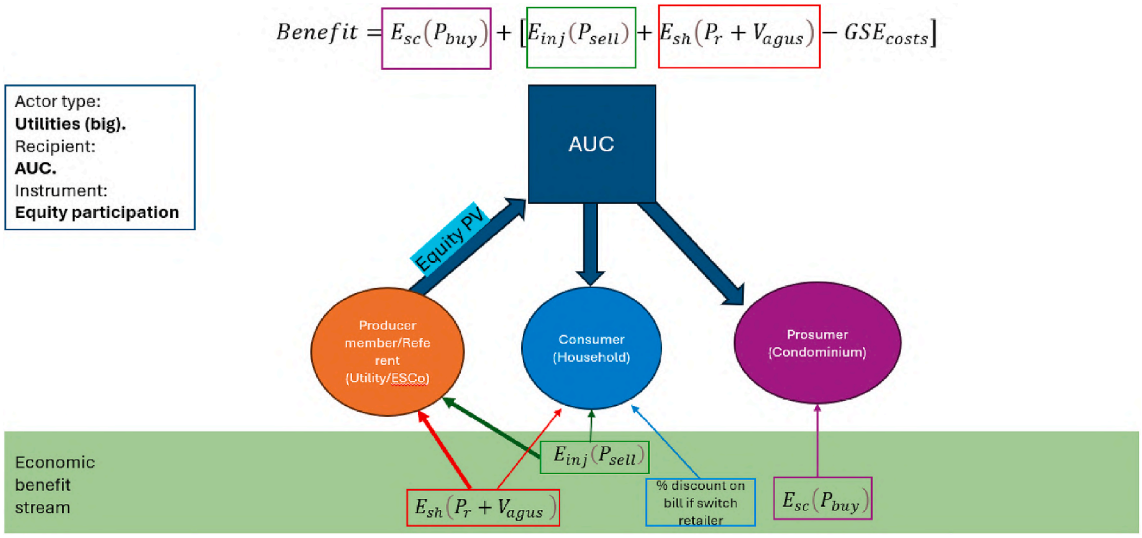

Fig. F.6. Equity participation

Unlike RECs, the regulation governing JARSC (AUC) permits ***utility*** *companies to become members of the JARSC (see footnote* [15] *for details).* However, ownership of the rooftop PV system, financed by a utility, remains with the utility. In many cases, revenues from energy injected into the grid [Einj (Psell)] is shared between the utility and condominium consumers/apartments depending on a contract. Similarly, revenues from incentives for shared energy production and the valorization of avoided grid usage [Esh × (Pr + Vagus)] can be allocated to both utility companies (as producer members) and consumers (such as households within a condominium). Additionally, utilities may offer discounts on electricity bills to consumers who switch their default energy retailer to them. The prosumer is represented by common loads such as elevators, lighting in shared areas, or electric vehicle charging stations. However, the economic savings from self-consumption of these common loads tend to be minimal, as they represent only a small portion of a household's total electricity bill. *This limited benefit is one reason why the JARSC model currently attracts less interest in Italy compared to the REC model.*

Data availability

Data will be made available on request.

References

Akerlof, G.A., 1970. The market for "lemons": quality uncertainty and the market mechanism. Q. J. Econ. 84 (3), 488–500. https://doi.org/10.2307/1879431.

Arcudi, C., Bacan, S., Pelotti, P., Tieri, S., 2023. Modelli per promuovere le comunità energetiche: Un ' opportunità per le Utilities Indice.

ARERA, 2022. TIAD, pp. 1–23.

Arias, A., Husiev, O., Schwaller, C., Sturm, U., 2025. Terminologies and concepts of energy cooperations in Europe: a systematic review of characteristics, potentials, and challenges. Energy Res. Social Sci. 122, 104012. https://doi.org/10.1016/j.erss.2025.104012.

Bauwens, T., 2019. Analyzing the determinants of the size of investments by community renewable energy members: findings and policy implications from Flanders. Energy Policy 129, 841–852. https://doi.org/10.1016/j.enpol.2019.02.067.

Bauwens, T., Gotchev, B., Holstenkamp, L., 2016. What drives the development of community energy in Europe? The case of wind power cooperatives. Energy Res. Social Sci. 13, 136–147. https://doi.org/10.1016/j.erss.2015.12.016.

Bellotti, P., 2021. Weforgreen Sharing Soc. Coop *(Verona—Veneto)*.

Bere, J., Jones, C., Jones, S., 2015. The Economic and Social Impacts of Small and Community Hydro in Wales, pp. 1–39.

Berka, A.L., Creamer, E., 2018. Taking stock of the local impacts of community owned renewable energy: a review and research agenda. Renew. Sustain. Energy Rev. 82 (October 2016), 3400–3419. https://doi.org/10.1016/j.rser.2017.10.050.

Bhattacherjee, A., 2012. Social Science Research: Principles, Methods, and Practices. Textbooks Collection.

Bisello, A., 2020. Assessing multiple benefits of housing regeneration and smart city development: the European project SINFONIA. Sustainability 12 (19), 8038. https://doi.org/10.3390/su12198038.

BloombergNEF, 2024. Lithium-ion battery pack prices see largest drop since 2017, falling to $115 per kilowatt-hour. BloombergNEF from. https://about.bnef.com/insights/commodities/lithium-ion-battery-pack-prices-see-largest-drop-since-2017-falling-to-115-per-kilowatt-hour-bloombergnef/. (Accessed 11 January 2025).

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3 (2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

Braunholtz-Speight, T., McLachlan, C., Mander, S., Hannon, M., Hardy, J., Cairns, I., Sharmina, M., Manderson, E., 2021. The long term future for community energy in Great Britain: a co-created vision of a thriving sector and steps towards realising it. Energy Res. Social Sci. 78. https://doi.org/10.1016/j.erss.2021.102044.

Braunholtz-Speight, T., Sharmina, M., Manderson, E., McLachlan, C., Hannon, M., Hardy, J., Mander, S., 2020. Business models and financial characteristics of community energy in the UK. Nat. Energy 5 (2), 169–177. https://doi.org/10.1038/s41560-019-0546-4.

Brummer, V., 2018. Community energy – benefits and barriers: a comparative literature review of community energy in the UK, Germany and the USA, the benefits it provides for society and the barriers it faces. Renew. Sustain. Energy Rev. 94 (June), 187–196. https://doi.org/10.1016/j.rser.2018.06.013.

Cairns, I., Hannon, M., Braunholtz-Speight, T., McLachlan, C., Mander, S., Hardy, J., Sharmina, M., Manderson, E., 2023. Financing grassroots innovation diffusion pathways: the case of UK community energy. Environ. Innov. Soc. Transit. 46, 100679. https://doi.org/10.1016/j.eist.2022.11.004.

Candelise, C., Ruggieri, G., 2017. Community Energy in Italy: Heterogeneous Institutional Characteristics and Citizens Engagement (ISSN 1973-0381 Community).

Castellini, M., D'Alpaos, C., Moretto, M., Pioletti, M., 2025. Paving the way for the widespread activation of renewable energy communities in Italy. Valori e Valutazioni 37. https://doi.org/10.48264/VVSIEV-20253703.

CEE, CES, & CEW, 2021. Community Energy. State of the Sector. Community Energy England, Community Energy Scotland, Community Energy Wales, p. 23. https://communityenergyengland.org/files/document/616/1654852180_CommunityEnergyStateoftheSectorUKreport2021.pdf.

Centgraf, S., 2018. Supporting civic engagement in German energy cooperatives – transdisciplinary research based on the reflection of individual needs. Energy Res. Social Sci. 44 (September 2017), 112–121. https://doi.org/10.1016/j.erss.2018.05.003.

Charmaz, K., 2014. Constructing Grounded Theory: a Practical Guide Through Qualitative Analysis, second ed. SAGE Publications.

Chiti, S.M., Quatraro, G., 2023. Report di Valutazione d'Impatto.

Cohen, J.J., Azarova, V., Kollmann, A., Reichl, J., 2021. Preferences for community renewable energy investments in Europe. Energy Econ. 100 (105386), 14. https://doi.org/10.1016/j.eneco.2021.105386.

Coopfond, 2022. Bilancio di sostenibilità 2021/2022.

De Simone, E., Rochira, A., Procentese, F., Sportelli, C., Mannarini, T., 2025. Psychological and social factors driving citizen involvement in renewable energy communities: a systematic review. Energy Res. Social Sci. 124, 104067. https://doi.org/10.1016/j.erss.2025.104067.

De Vidovich, L., Tricarico, L., Zulianello, M., 2021. *Community Energy Map*. FrancoAngeli S.R.L.

De Vidovich, L., Tricarico, L., Zulianello, M., 2023. How can we frame energy Communities' Organisational Models? Insights from the Research 'Community Energy Map' in the Italian context. Sustainability 15 (3). https://doi.org/10.3390/su15031997.

Dóci, G., Vasileiadou, E., 2015. 'Let's do it ourselves' individual motivations for investing in renewables at community level. Renew. Sustain. Energy Rev. 49, 41–50. https://doi.org/10.1016/j.rser.2015.04.051.

EC, 2023. State Aid SA.106777 (2023/N) – Italy – RRF - Support for the Development of Renewable Energy Communities. Vol. C(2023) 80. European Commission, pp. 1–32.

EFREC, 2014. Handbook on Investment Schemes for REScoop Projects. RESCOOP 20-20-20 Co-funded by the Intelligent Energy Europe Programme of the European Union.

Entwistle, G., Roberts, D., Xu, Y., 2014. Measuring the Local Economic Impact of Community-Owned Energy Projects, pp. 1–52.

Eroe, K., Polci, T., 2022. Communita Rinnovabili.

Fife, S.T., Gossner, J.D., 2024. Deductive qualitative analysis: evaluating, expanding, and refining theory. Int. J. Qual. Methods 23, 1–12. https://doi.org/10.1177/16094069241244856.

Franzo, S., Di Lieto, A., Tamanini, A., Cuomo, S., Delle Monache, A., Fumagalli, A., Sanchini, L., Schiavoni, F., 2023. Electricity Market Short Report. Energy & Strategy Group, Politecnico Milano, p. 35. https://www.energystrategy.it/es-download/.

Freeman, R.E., 1984. Strategic Management: a Stakeholder Approach. Pitman.

Gatti, S., 2012. Project Finance in Theory and Practice: Designing, Structuring, and Financing Private and Public Projects. Elsevier/Academic Press.

Grignani, A., Gozzellino, M., Sciullo, A., Padovan, D., 2021. Community cooperative: a new legal form for enhancing social capital for the development of renewable energy communities in Italy. Energies 14 (21), 1–15. https://doi.org/10.3390/en14217029.

GSE, 2024. Regole Operative CER.

GSE, 2025. Mappa interattiva delle cabine primarie. GSE. Retrieved November 11, 2025, from. https://www.gse.it/servizi-per-te/autoconsumo/mappa-interattiva-delle-cabine-primarie.

Hackbarth, A., Löbbe, S., 2020. Attitudes, preferences, and intentions of German households concerning participation in peer-to-peer electricity trading. Energy Policy 138. https://doi.org/10.1016/j.enpol.2020.111238.

Hanke, F., Guyet, R., 2023. The struggle of energy communities to enhance energy justice: insights from 113 German cases. Energy Sustain. Society 13 (1), 16.

Heldeweg, M., Saintier, S., 2020. Renewable energy communities as ' socio-legal institutions ': a normative frame for energy decentralization. Renew. Sustain. Energy Rev. 119 (April 2019). https://doi.org/10.1016/j.rser.2019.109518.

Herbes, C., Brummer, V., Rognli, J., Blazejewski, S., Gericke, N., et al., 2017. Responding to policy change: new business models for renewable energy cooperatives – barriers perceived by cooperatives' members. Energy Policy 109 (May), 82–95. https://doi.org/10.1016/j.enpol.2017.06.051.

Hicks, J., Ison, N., 2018. An exploration of the boundaries of 'community' in community renewable energy projects: navigating between motivations and context. Energy Policy 113 (June 2016), 523–534. https://doi.org/10.1016/j.enpol.2017.10.031.

IEM, 2019. Directive (EU) 2019/944 on common rules for the internal market for electricity and amending directive 2012/27/EU. Off. J. Eur. Union L 158, 18.

Jalali, M.S., Akhavan, A., 2024. Integrating AI language models in qualitative research: replicating interview data analysis with ChatGPT. Syst. Dyn. Rev. 40 (3), 1–9. https://doi.org/10.1002/sdr.1772.

Kildegaard, A., Myers-Kuykindall, J., 2006. Community vs. corporate wind: does it matter who develops the wind in Big Stone County, MN?, CVII, pp. 1–32.

Klagge, B., Schmole, H., Seidl, I., Schön, S., 2016. Zukunft der deutschen Energiegenossenschaften. Raumforschung Und Raumordnung ¦ Spatial Res. Plann. 74 (3), 243–258. https://doi.org/10.1007/s13147-016-0398-3.

Koltunov, M., Bisello, A., 2021. Multiple impacts of energy communities: conceptualization taxonomy and assessment examples. In: Smart Innovation, Systems and Technologies, 178 SIST. Springer International Publishing. https://doi.org/10.1007/978-3-030-48279-4_101.

Koltunov, M., Cittati, V.-M., Bisello, A., 2022. Institutional and policy context of energy communities in France and Italy: how to increase the welfare-enhancing capacity of the sector. In: Löbbe, S., Sioshansi, F., Robinson, D. (Eds.), Energy Communities, first ed. Academic Press, pp. 341–361. https://doi.org/10.1016/B978-0-323-91135-1.00007-9.

Koltunov, M., 2025a. *ENERGY COMMUNITIES: INSTITUTIONS, FINANCING, ECONOMICS* (Ph.D Thesis Ed.). Università degli Studi di Trieste. https://arts.units.it/handle/11368/3107017.

Koltunov, M., 2025b. The economic impact of energy communities on the electricity system and its agents. In: Towards an Effective, Efficient, and Just Energy Transition. EUT Edizioni Università di Trieste, pp. 139–172. https://www.openstarts.units.it/handle/10077/37441.

Koltunov, M., De Vidovich, L., 2025. Energy communities in social sciences: a bibliometric analysis and systematic literature review. Renew. Sustain. Energy Rev. 220, 115871. https://doi.org/10.1016/j.rser.2025.115871.

Koltunov, M., Beltrami, F., Grossi, L., Blassutigh, N., 2025. The impact of renewable energy communities in the Italian day-ahead electricity market: a scenario analysis. Pre-Print. https://doi.org/10.48550/arXiv.2510.13517.

Kriukow, J., 2024. The Scholar's Guide to AI-Assisted Thematic Analysis, vols. 1–28.

Lantz, E., Tegen, S., 2011. Economic development impacts of community wind projects: a review and empirical evaluation. Commun. Wind Power Project. April, 81–110.

Lee, V.V., van der Lubbe, S.C.C., Goh, L.H., Valderas, J.M., 2024. Harnessing ChatGPT for thematic analysis: are we ready? J. Med. Internet Res. 26, 1–11. https://doi.org/10.2196/54974.

Lupi, V., Candelise, C., Calull, M.A., Delvaux, S., Valkering, P., Hubert, W., Sciullo, A., Ivask, N., van der Waal, E., Iturriza, I.J., Paci, D., Della Valle, N., Koukoufikis, G., Dunlop, T., 2021. A characterization of european collective action initiatives and their role as enablers of citizens' participation in the energy transition. Energies 14 (24). https://doi.org/10.3390/en14248452.

Magnani, N., Maretti, M., Salvatore, R., Scotti, I., 2017. Ecopreneurs, rural development and alternative socio-technical arrangements for community renewable energy. J. Rural Stud. 52, 33–41. https://doi.org/10.1016/j.jrurstud.2017.03.009.

MASE, 2023. *Decreto M.Amb. n. 414/2023 – Piano nazionale di ripresa e resilienza (PNRR) – M2C2 I.1.2, promozione delle fonti rinnovabili per le comunità energetiche e l'autoconsumo* (G.U. 24 gen. 2024).

MASE, 2025. Decreto M.Amb. n. 127/2025 – Modifiche all'incentivo in conto capitale per comunità energetiche del PNRR: Ampliamento ai comuni fino a 50.000 abitanti pubblicato 25 giu. 2025.

Mollick, E., 2014. The dynamics of crowdfunding: an exploratory study. J. Bus. Ventur. 29 (1), 1–16. https://doi.org/10.1016/j.jbusvent.2013.06.005.

Morgan, D.L., 2023. Exploring the use of artificial intelligence for qualitative data analysis: the case of ChatGPT. Int. J. Qual. Methods 22, 1–10. https://doi.org/10.1177/16094069231211248.

Moroni, S., Tricarico, L., 2018. Distributed energy production in a polycentric scenario: policy reforms and community management. J. Environ. Plann. Manag. 61 (11), 1973–1993. https://doi.org/10.1080/09640568.2017.1379957.

Musolino, M., Maggio, G., D'Aleo, E., Nicita, A., 2023. Three case studies to explore relevant features of emerging renewable energy communities in Italy. Renew. Energy 210 (April), 540–555. https://doi.org/10.1016/j.renene.2023.04.094.

Noy, C., 2008. Sampling knowledge: the hermeneutics of snowball sampling in qualitative research. Int. J. Soc. Res. Methodol. 11 (4), 327–344. https://doi.org/10.1080/13645570701401305.

Nowell, L.S., Norris, J.M., White, D.E., Moules, N.J., 2017. Thematic analysis: striving to meet the trustworthiness criteria. Int. J. Qual. Methods 16 (1), 1609406917733847.

OECD, 2019. Social impact investment 2019. Social Impact Investment 2019. https://doi.org/10.1787/9789264311299-EN.

Okkonen, L., Lehtonen, O., 2016. Socio-economic impacts of community wind power projects in Northern Scotland. Renew. Energy 85, 826–833. https://doi.org/10.1016/j.renene.2015.07.047.

Ostrom, E., 1990. Governing the Commons: the Evolution of Institutions for Collective Action. Cambridge University Press. https://doi.org/10.1017/CBO9780511807763.

Paulus, T.M., Lester, J.N., 2021. Doing Qualitative Research in a Digital World. SAGE Publications.

Phimister, E., Roberts, D., 2012. The role of ownership in determining the rural economic benefits of onshore wind farms. J. Agric. Econ. 63. https://doi.org/10.1111/j.1477-9552.2012.00336.x.

Poupeau, F.-M., 2020. Everything must Change in Order to Stay as it is. the Impossible Decentralization of the Electricity Sector in France to Cite This Version: HAL Id: Halshs-02477203. Renewable and Sustainable Energy Reviews, Elsevier, p. 120.

RED-II, 2018. Directive (EU) 2018/2001 of the European Parliament and of the Council on the promotion of the use of energy from renewable sources. Off. J. Eur. Union 2018 (L 328), 82–209.

Regione Piemonte, 2025. Legge regionale 17 dicembre 2025, *n.* 22: *promozione e sostegno delle comunità energetiche rinnovabili e dell'autoconsumo collettivo di energia rinnovabile* [Regional law]. *Bollettino Ufficiale della Regione Piemonte, Suppl. Ord. n. 4*. https://www.regione.piemonte.it/governo/bollettino/abbonati/2025/51/attach/aa_aa_regione%20piemonte%20-%20legge%20regionale_2025-12-17_98438.pdf.

REScoop.eu, 2020. Report on Financial Barriers and Existing Solutions.

REScoop.eu, Ecopower, 2023. Financing Guide for Energy Communities.

Roelich, K., Knoeri, K., 2015. Governing the Infrastructure Commons: Lessons for Community Energy from Common Pool Resource Management. Sustainability Research Institute (SRI), Papers, 87 (ISSN: 1753-1330). https://sri-working-papers.leeds.ac.uk/wp-content/uploads/sites/67/2019/05/SRIPs-87.pdf.

Schiavo, L.L., Galliani, A., Rossi, A., 2022. 6 - the "virtual" model for collective self-consumption in Italy. In: Loebbe, S., Sioshansi, F., Robinson, D. (Eds.), Energy Communities: Customer-Centered, Market-Driven, Welfare-Enhancing? Academic Press, pp. 95–106. https://doi.org/10.1016/B978-0-323-91135-1.00017-1.

Schumpeter, J.A., 1942. Capitalism, socialism, and democracy. In: TA - TT -, first ed. Harper & Brothers. https://doi.org/LK-https://worldcat.org/title/30488029.

Sovacool, B.K., 2016. How long will it take? Conceptualizing the temporal dynamics of energy transitions. Energy Res. Social Sci. 13, 202–215. https://doi.org/10.1016/j.erss.2015.12.020.

Spence, M., 1973. Job market signaling. Q. J. Econ. 87 (3), 55–374. https://doi.org/10.2307/1882010.

Suchman, M.C., 1995. Managing legitimacy: strategic and institutional approaches. Acad. Manag. Rev. 20 (3), 571–610. https://doi.org/10.5465/amr.1995.9508080331.

Tarpani, E., Piselli, C., Fabiani, C., Pigliautile, I., Kingma, E.J., Pioppi, B., Pisello, A.L., 2022. Energy communities implementation in the European union: case studies from pioneer and laggard countries. Sustainability 14 (19), 12528.

TERNA, 2025. Electricity Consumption Increases by 2.2% in 2024. TERNA. Retrieved from. https://www.terna.it/en/media/press-releases/detail/electricity-consumption-2024?utm_source.

Torgerson, M., 2006. Umatilla County's economic structure and the economic impacts of wind energy development: an input-output analysis. Energy March.

Turobov, A., Coyle, D., Harding, V., 2024. Using ChatGPT for Thematic Analysis. May.

Tricarico, L., 2018. Community energy enterprises in the distributed energy geography: a review of issues and potential approaches. Int. J. Sustain. Energy Plann. Manag. 18, 81–94.

Vernay, A.L., Sebi, C., 2020. Energy communities and their ecosystems: a comparison of France and the Netherlands. Technol. Forecast. Soc. Change 158 (May), 120123. https://doi.org/10.1016/j.techfore.2020.120123.

Wirth, S., 2014. Communities matter: institutional preconditions for community renewable energy. Energy Policy 70, 236–246. https://doi.org/10.1016/j.enpol.2014.03.021.

Wolsink, M., 2012. The research agenda on social acceptance of distributed generation in smart grids: renewable as common pool resources. Renew. Sustain. Energy Rev. 16 (1), 822–835. https://doi.org/10.1016/j.rser.2011.09.006.

Yildiz, Ö., 2014. Financing renewable energy infrastructures via financial citizen participation – the case of Germany. Renew. Energy 68, 677–685. https://doi.org/10.1016/j.renene.2014.02.038.

Yin, 1994. Case Study Research Design and Methods: Applied Social Research and Methods Series. Sage Publications Inc.