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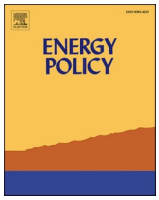

# Renewable energy communities and energy poverty: Social and policy insights from empirical research in Italy

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ABSTRACT

Renewable energy communities (RECs), energy policy, and energy poverty are closely interlinked within the broader context of the ecological transition. The present study investigates participation in RECs, with particular attention to the distribution of economic benefits, perceptions of climate change, misinformation, and policies targeting energy poverty. The research methodology is based on two online surveys conducted in Italy, comprising 403 and 407 respondents respectively. The results highlight a strong preference for RECs, especially among individuals aged 25–50, driven by both environmental and economic motivations. Women demonstrate slightly greater sensitivity to principles of equity and collective action, while energy self-consumption is identified as the most significant criterion for the distribution of benefits. Respondents stated intentions align with a preference for supporting vulnerable households, suggesting that RECs can serve as effective tools for alleviating energy poverty. The sample indicates a heightened perception of climate change severity, particularly among women. Respondents who perceive higher risks attach greater importance to information campaigns and policies aimed at combating energy poverty. Misinformation is attributed to the limited integration of climate issues into educational curricula and the tendency to perceive climate change as a remote concern — both temporally and geographically. Economic incentives for renewable energy, energy efficiency interventions, and the equitable sharing of benefits within RECs are viewed as the most appropriate policy measures. Overall, RECs emerge as vital instruments for advancing Sustainable Development Goal 7, particularly by addressing the escalating challenge of energy poverty, even in high-income countries.

## 1. Introduction

Energy poverty – defined as the difficulty in accessing adequate energy services – constitutes a global challenge with significant social, economic, and environmental ramifications. While it affects various sectors and impedes environmental progress, its most critical – and often underestimated – impact is on human health (González-Eguino, 2015). Although direct aid policies (e.g., social tariffs) offer temporary relief, they fall short of addressing structural causes (Jové-Llopis et al., 2025). Numerous studies have highlighted the need for more integrated approaches combining energy efficiency, renewable energy sources, and social justice. A key initial measure is international energy aid, encompassing technology transfers, political cooperation, and financial support from developed countries (Xu et al., 2025). However, to be genuinely effective, such policies must be grounded in transparent governance – particularly in resource-rich countries where corruption and mismanagement frequently hinder tangible progress (Malah-Kuete and Messie-Pondie, 2025).

Renewable energy plays a central role in the sustainable transition when supported by appropriate policies (Balaban et al., 2024; Daglis

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et al., 2025; Veum and Bauknecht, 2019). In the European context, factors such as unemployment, disability, and cuts to welfare provision exacerbate the risk of energy exclusion (Tovar Reaños et al., 2025). In response to these vulnerabilities, participatory models of energy production and distribution – known as renewable energy communities (RECs) – are gaining traction. These initiatives allow citizens, public authorities, and businesses to co-produce and self-consume energy from renewable sources, thereby reducing both costs and emissions.

RECs and prosumers are playing an increasingly pivotal role in the energy transition (Lazaroiu et al., 2025; Oprea and Bâra, 2024). Beyond economic savings (Basilico et al., 2025c; Bauwens et al., 2022), social and environmental motivations also significantly influence participation in such initiatives (Niamir et al., 2020; Soeiro and Ferreira Dias, 2020). Grounded in democratic participation and energy sharing, RECs foster sustainable behaviours and offer promising solutions to energy poverty (Bonfert, 2024; Ceglia et al., 2022). In particular, they can ensure access to locally produced, low-cost energy for vulnerable groups (Basilico et al., 2025a; Cutore et al., 2023), with additional benefits in the realm of social housing (Skandalos and Karamanis, 2025).

The sustainability of RECs depends on models of equitable benefits redistribution (Barone et al., 2024; Basilico et al., 2025b), inclusive policies (Hanke et al., 2021), and governance structures that actively involve the most vulnerable groups (Young and Halleck Vega, 2024). Photovoltaic (PV) energy is emerging as the primary source within RECs, yet significant economic and regulatory barriers persist (Heldeweg and Saintier, 2020; Setyawati, 2020). A study examining barriers to renewable energy in Europe identified considerable regional disparities, with administrative and socio-economic factors exerting a dominant influence on the development of renewable energy sources. This underscores the need for tailored policies addressing country-specific obstacles, increased investment in research and development, and ongoing monitoring to support renewable energy expansion (Gajdzik et al., 2023). Consequently, regional strategies must be formulated to move beyond the conventional notion of a uniform decarbonisation pathway (Nagaj et al., 2024). Furthermore, legal complexity and inadequate incentives continue to obstruct solar investment, particularly among low-income households (Petrovich et al., 2021). Nonetheless, RECs are recognised at the European level as key instruments for achieving the Sustainable Development Goals (SDGs) (Wuebben et al., 2020) and advancing energy justice (Standal et al., 2023). Research has also highlighted that balancing individual interests with collective goals is essential for the success of energy communities (Mehta and Tiefenbeck, 2022; Vernay et al., 2023), as is the implementation of clear and adaptable regulatory frameworks to ensure their long-term viability and equity (Inês et al., 2020).

Numerous European (Ceglia et al., 2022; Parreño-Rodriguez et al., 2023) and international (Joshi and Yenneti, 2020; Yadav et al., 2019) studies have confirmed the effectiveness of energy communities for mitigating energy poverty, particularly when coupled with social engagement and energy education initiatives. A sense of belonging and environmental citizenship have also emerged as central components of inclusive and successful community experiences (Boostani et al., 2024). Research has further indicated that equitably integrated renewable energy sources have a direct, positive effect on reducing energy poverty, especially in settings characterised by strong energy efficiency (Jithin and Renjith, 2025; Zhao et al., 2022). However, outcomes may vary depending on geographical, technological, and social conditions, as illustrated by difficulties encountered in certain contexts (Wang et al., 2021, 2022). In the literature, one overarching principle stands out: energy poverty cannot be addressed solely as a technical or economic issue, but demands a socio-technical approach incorporating participation, equity, and governance (Cloke et al., 2017; Hanke et al., 2021). RECs contribute to this process by actively involving vulnerable households in the energy transition (Aparisi-Cerdá et al., 2024).

A comprehensive analysis of RECs must incorporate a social perspective to fully grasp their contributions to addressing climate change, alleviating energy poverty, and advancing sustainable development (Basilico et al., 2025a; Gianaroli et al., 2024). The relationship between energy poverty and RECs also necessitates political evaluation (Campagna et al., 2024). REC benefits can extend to a wide range of stakeholders (Guetlein and Schleich, 2024) and, beyond offering economic advantages to prosumers, RECs have the potential to function as instruments of collective well-being, promoting social inclusion and supporting vulnerable households (Basilico et al., 2025b).

In the present study, the first research question (RQ1) explored respondents' level of awareness, concern, and willingness to participate in RECs, with particular attention to differences across age and gender. The aim was to identify the primary motivational factors influencing individuals' decisions to join an REC, as well as their preferences regarding the distribution of the economic benefits produced. The analysis further sought to assess the alignment between stated values (e.g., equity and social justice) and simulated behaviours (e.g., willingness to relinquish a portion of benefits).

The second research question (RQ2) investigated whether – and to what extent – perceptions of climate change severity influenced support for various measures aimed at countering environmental misinformation and energy poverty. In parallel, the role played by socio-demographic variables (particularly gender and age) was examined to determine how preferences varied regarding policy and information initiatives.

Following this introduction, the paper presents a review of the literature on energy poverty and RECs (Section 2). Section 3 outlines the methodological approach, including details of the two surveys conducted in Italy. The results of both analyses are presented in Section 4, disaggregated by age and gender, and supported by statistical analysis. The implications of the findings are discussed in Section 5, and the paper concludes with final reflections in Section 6.

## 2. Literature review

The energy crisis of 2021–2022 heightened the focus on efficiency and renewables, prompting households and businesses to alter their consumption and investment patterns (Gajdzik et al., 2024). Simultaneously, the vulnerability of energy supplies revived the trilemma of energy security, sustainability, and affordability, marking the first major crisis of the green transition and underscoring the risks of energy poverty and the urgent need for investment in clean technologies (Hussain et al., 2023). In Italy, energy shocks intensified structural fragility and strained public finances, with scenarios ranging from sluggish growth to potential recessions, bearing adverse implications for national debt (Canelli et al., 2024). Nonetheless, policy incentives are fostering building retrofits and the development of RECs, enhancing public awareness and encouraging virtuous behaviour (Tarpani et al., 2025).

REC are fundamental tools for Europe's energy transition, as they combine decarbonisation with social inclusion. In Italy, the development of REC remains influenced by trust, the local context and networks of actors (Musolino et al., 2023), while analyses from other European contexts show that renewable energy reduces $CO_2$ emissions and mitigates energy poverty, while income inequality exacerbates it (Simionescu et al., 2024; Simionescu and Cifuentes-Faura, 2024). Community-based approaches, including contextualised poverty indicators, improve outcomes for vulnerable populations (Canto-Franco et al., 2026; Di Rocco et al., 2025). Complementary strategies, such as building decarbonisation and energy efficiency, increase energy security and well-being (Gillett et al., 2025). Thus, RECs are emerging as pivotal instruments for a just and sustainable transition, reinforcing environmental resilience and social equity (Basilico et al., 2025c).

In the literature, the topic of energy communities is experiencing rapid growth. Prior to a systematic literature review (SLR) aligned with the objectives of this article and following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page

et al., 2021), the Scopus database was consulted on August 25, 2025. This step was undertaken in line with methodologies adopted in previous studies (Basilico et al., 2025c; D'Adamo et al., 2026; Koltunov et al., 2023), and the initial advanced search query employed was:

- "renewable energy community" OR "renewable energy communities" AND "sustainability" OR "sustainable development."

Two exclusion criteria were applied:

- E1 – The publication was not an article or review; and
- E2 – The publication was not in English.

The search returned 2374 articles. Notably, 96 % of these publications dated from 2020 onwards, with a peak observed in 2025 (accounting for 29 % of the total) (Fig. S1). In light of these findings, the analysis was restricted to the period 2020–2026. Of the 2271 documents considered, the journals *Energies* (317), *Sustainability* (158) and *Energy Research & Social Science* (128) emerged as the most prominent sources of publication. In terms of geographical distribution, Italy led with 452 publications, followed by China (305) and Spain (171). Among individual contributors, Thomas Hoppe was the most prolific (with 15 publications), followed by Hans Auer, Idiano D'Adamo, and Elisa Marrasso, each with 13.

The second specific advanced search query was:

- "renewable energy community" OR "renewable energy communities" AND "energy poverty" AND "policy implications" AND "social analysis" OR "survey."

A PRISMA review (Fig. S2) was conducted on this topic, applying the same exclusion criteria as previously outlined, yielding 55 documents. A third exclusion criterion was subsequently introduced:

- E3 – Topic not aligned with the study focus.

Following this final screening, a total of 30 articles were selected for inclusion. Regarding temporal distribution (Fig. S3), all publications dated from 2020 onwards, with the number of documents in 2025 (21) approaching that of 2024 (22). In terms of geographical distribution, China led with 10 publications, followed by Italy, the Netherlands, and the United Kingdom, each with 7. With regard to publication sources, *Energy Research & Social Science* dominated with 13 articles, followed by *Energies* and *Renewable and Sustainable Energy Reviews*, each contributing 5. Six authors were identified as having published two documents each. Among the most relevant works emerging from this analysis were (Blečić et al., 2025; Caferra et al., 2024; Duong et al., 2025).

The literature analysis highlighted that a sustainable and equitable energy transition necessitates the development of innovative analytical tools, the implementation of targeted redistributive policies, and a sustained focus on socio-territorial inequalities. In this regard, knowledge network analysis has illuminated the intrinsic linkages between household energy consumption and the SDGs (An et al., 2025). Energy communities, which have become central to political discourse, require further exploration of their legal frameworks and their interactions with electricity market dynamics (Koltunov and De Vidovich, 2025). Empirical evidence points to the importance of region-specific strategies, particularly in rural areas, where local initiatives and equitable energy distribution can alleviate energy poverty and promote environmental sustainability (Gawusu, 2024). The literature distinguishes between policy environments characterised by "thick" and "thin" mixes: the former foster civic participation and policy coordination, whereas the latter are marked by limited inclusiveness and minimal experimentation (Berka et al., 2025). A growing body of research is also interpreting energy vulnerability as a structural condition rooted in broader systemic inequalities (Kajoskoski et al., 2025).

The proposal of a decision support tool capable of modelling energy and economic flows, along with environmental benefits, has yielded promising empirical results. In particular, its replication in public housing contexts has demonstrated both its applicability and its value in guiding socially impactful investment strategies (Blečić et al., 2025). From a socio-economic perspective, education has been found to significantly reduce energy poverty, with particularly strong effects among women and rural populations – reinforcing the link between human capital and energy justice (Liang et al., 2025). This relationship has been further substantiated by research indicating that family characteristics also exert a significant influence on energy poverty (Duong et al., 2025). The mobilisation of vulnerable communities has further underscored the need for inclusive policies grounded in the recognition of fundamental energy rights (Stojilovska et al., 2024). Concurrently, the extraction of operational criteria from the perspectives of key stakeholders and households involved in EU projects has enabled the formulation of practical guidelines for the co-design and evaluation of interventions sensitive to energy poverty (Shortall and Mengolini, 2025).

A recent survey conducted in Japan classified households into three categories based on energy consumption, revealing that low-income households typically reside in small dwellings and exhibit virtuous behaviours, yet lack sufficient resources. These findings underscore the need for progressive energy tariffs and improved access to renewable energy sources (Okushima, 2024). The structural complexity of energy poverty has been further highlighted in a review identifying outdated infrastructure, limited accessibility, and low levels of awareness as critical contributing factors – with significant implications for infrastructure planning and information dissemination campaigns (Leal Filho et al., 2024). Adopting a definition of energy poverty centred on affordability, research has shown that some European climate policies risk exacerbating energy poverty in the absence of redistributive mechanisms. Conversely, well-designed tax redistribution programmes may alleviate such impacts for many household (Vandyck et al., 2023). In the Australian context, a dynamic strategy has been proposed, recommending targeted support for the two poorest income deciles of homeowners, while also accounting for shifts in inequality over time (Best et al., 2023).

A comparative analysis of centralised and individual heating systems has illustrated a tension between autonomy and equity. Centralised systems promote inclusion through economies of scale and participatory governance, whereas individual systems risk inefficiencies and heightened economic barriers for vulnerable groups, highlighting the need for novel institutional and regulatory solutions (Djinlev and Pearce, 2025). Additionally, the redistribution of revenues from PV systems has been shown to reduce household energy expenditure and enhance social trust (Dabush et al., 2023). However, studies on energy communities have unveiled issues of uneven representation, indicating the need for more inclusive governance structures (Radtke and Bohn, 2023).

Social and emotional factors have been found to influence behaviour primarily in rural areas, indicating the need for differentiated strategies from those employed in urban contexts (Jabeen et al., 2021). Analyses conducted in countries at the forefront of the energy transition (e.g., Sweden) have revealed that political short-termism, tunnel vision, and polarisation can jeopardise long-term energy security (Önnered et al., 2025). In the Italian context, limited consumer participation continues to hinder the development of flexible energy markets, although innovative participatory approaches are beginning to emerge (Dudka, 2025). A Dutch case study has demonstrated that a multi-level model integrating individual heat pumps and collective heating systems can significantly reduce natural gas consumption and emissions, while meeting communal thermal needs (Fouladvand et al., 2024). Other analyses have underscored the importance of global cooperation in promoting sustainable production practices and ensuring an equitable distribution of energy-related responsibilities (Skare et al., 2024).

An urgent need has been identified for regulatory frameworks able to

accommodate innovative technologies, enhance operational efficiency, and promote energy circularity (Van Opstal and Smeets, 2023). A promising avenue for future research involves the conceptualisation of "thermal communities" as distinct entities with unique characteristics and evaluation criteria extending beyond emissions and economic metrics (Fouladvand et al., 2022). Moreover, a network-based analysis identified several key variables crucial to the integration of decentralised renewable energy sources, including widespread need, profitability, technological advancement, consumer interest, and environmental change, highlighting strategic levers for reimagining urban energy systems (Rozhkov, 2024). Lastly, a comprehensive understanding of energy inequalities requires access to disaggregated data. Inequalities in these areas may be shaped by social, cultural, political, territorial, and technological factors and, if left unaddressed, pose a serious threat to the attainment of a just energy transition (May et al., 2025).

In the context of prosumer engagement, motivations related to energy saving have been shown to play a decisive role in the willingness to persist, whereas openness to change appears to have limited influence (Lin et al., 2025). Perceived value has also been identified as a key determinant of citizen engagement, with utilitarian value positively influencing all forms of engagement except feedback sharing (Bănică et al., 2024). In Belgium, collective agreements and energy-sharing mechanisms have been proposed as enablers for the broader adoption of PV systems (Van Opstal and Smeets, 2022). Energy communities may facilitate the deployment of PV infrastructure by promoting resource sharing and supporting policy reforms, with the dual aim of encouraging renewable adoption and alleviating energy poverty (Muftić Dedović et al., 2025). In the evaluation of RECs, consumer economic savings represent the most significant factor. These, combined with pragmatic policymaking and the efficient management of both human and physical resources, are deemed essential for the creation of stable and enduring energy communities (Caferra et al., 2024).

A thematic map was generated using the R programming language to illustrate the principal recurring themes emerging from the Scopus search query (Fig. 1). In interpreting this map, it is important to note that the vertical axis represents the relevance of topics, while the horizontal axis indicates their level of development.

Energy constitutes one of the basic themes, distinguished by a high degree of relevance. Similarly, renewable energy represents one of the motor themes, underscoring the ongoing energy transition. The inclusion of community energy among the motor themes further affirms this trend, with its notably high level of thematic development. RECs appear to integrate these dimensions, positioning them as a central focus for literature analysis. A particularly noteworthy observation is the appearance of economic analysis across both motor and niche themes, indicating the importance of economic considerations within broader social analyses. Public policy is also a significant theme, situated between the motor and emerging quadrants, signalling its growing importance and developmental potential. Fig. 2 presents the co-occurrence network of the analysed literature, generated using the R programming language.

The analysis confirmed that energy poverty, energy policy, energy, and energy justice are highly significant themes closely linked to the broader energy transition. While energy communities are also of notable importance, their connection within this framework could be strengthened.

Building on the literature, the following hypotheses were proposed to guide the analysis and address Research Questions 1 and 2 (RQ1 and RQ2):

- Hypothesis 1 (H1): Higher levels of environmental awareness and concern, combined with economic motivations, increase individuals' propensity to participate in RECs.

This hypothesis pertained to RQ1, as it explored the factors influencing citizens' willingness to engage with RECs and renewable energy initiatives.

- Hypothesis 2 (H2): Environmental and economic motivations exert a greater influence than social and community motivations in decisions to join an REC, with age and gender differences shaping preferences and the distribution of benefits.

H2 also related to RQ1, focusing on the relative weight of different motivational drivers and the role of socio-demographic factors in shaping participation and allocation choices.

- Hypothesis 3 (H3): A heightened perception of climate change severity increases support for informational initiatives and policy measures aimed at addressing energy poverty.

H3 was linked to RQ2, examining whether greater awareness of

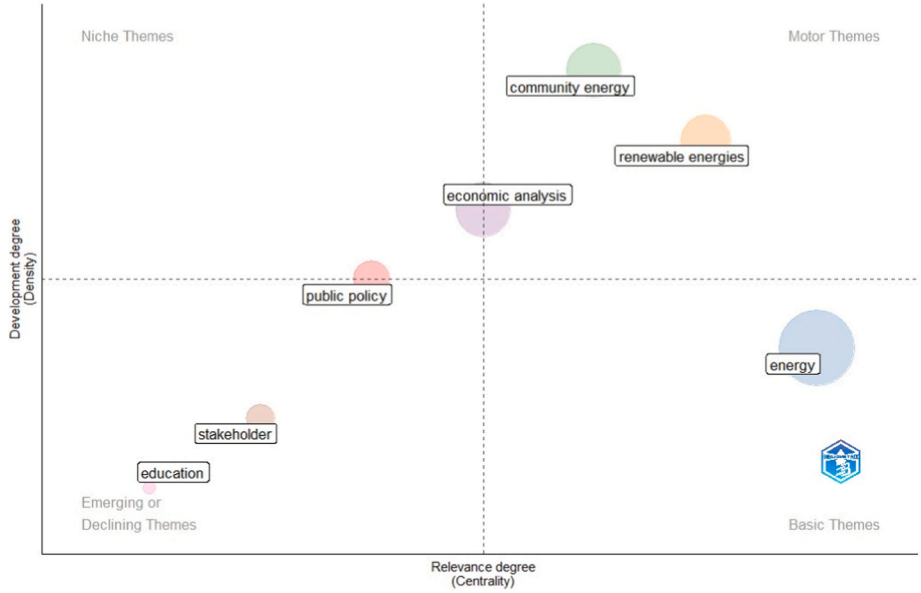


**Fig. 1.** Thematic map.

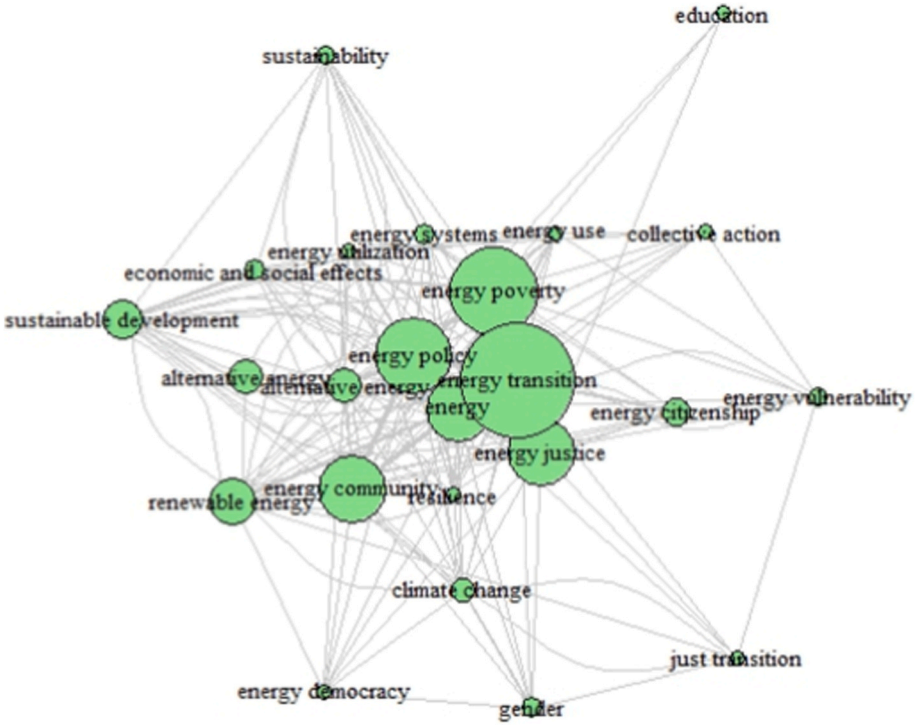


**Fig. 2.** Co-occurrence network.

climate risks correlated with stronger support for educational, redistributive, and participatory policy interventions.

## 3. Methodology

The study employed a multi-stage quantitative research design based on two distinct questionnaires, administered at different times, to investigate RECs from complementary yet analytically distinct perspectives. This sequential approach allowed economic and distributive dimensions (RQ1) to be analysed separately from social and informational dimensions (RQ2), while maintaining methodological coherence across instruments. The first questionnaire (RQ1) focused on economic dimensions, aiming to determine a fair energy exchange price within RECs and to identify the most equitable method for distributing benefits among participants, while also examining social aspects such as energy poverty. The second questionnaire (RQ2) primarily addressed social dimensions, exploring the roots of misinformation about climate change, evaluating strategies to improve public understanding, and assessing potential policies to alleviate energy poverty. Using two questionnaires reduced respondent fatigue and cognitive overload that could have arisen from combining highly technical economic questions with attitudinal and informational items within a single survey. This design choice helped preserve data quality and internal consistency. Similar multi-questionnaire designs have been used in REC-related empirical research to keep instruments focused and respondents engaged (Lawford and Sareen, 2025; Sarcina and Canesi, 2023). The full wording of all questions, response scales, and answer options for both questionnaires is reported in the Supplementary Material.

The use of online surveys – a widely adopted method in the literature for assessing public attitudes towards renewable energy (Hache and Palle, 2019; Scovell et al., 2024) and specifically towards RECs (Basilico et al., 2025a; Fischer et al., 2021) – was embedded within a transdisciplinary methodological framework, integrating insights from psychology, economics, and the social sciences (Sovacool et al., 2018). The two-survey structure reflects this transdisciplinary approach, allowing economic and behavioural analyses to be conducted using instruments tailored to each domain. This approach is particularly suitable for RECs, which simultaneously involve technological, economic, and behavioural components, and is consistent with recent studies that rely on distinct questionnaires to address complementary REC dimensions and stakeholder perspectives (Sarcina and Canesi, 2023). Other studies have employed semi-structured interviews with experts (Hanke et al., 2021), compared the opinions of citizens and experts (Caferra et al., 2024), or involved cross-national approaches (Pons-Seres de Brauwer and Cohen, 2020). The survey provides empirical evidence on people's daily needs, perceptions and obstacles, thus providing an essential knowledge base for guiding energy policy choices towards more targeted and effective interventions (D'Adamo et al., 2026).

Although respondent anonymity precluded direct comparison between samples, both surveys were disseminated through the same digital channels (i.e., Facebook, Instagram, WhatsApp, LinkedIn) in an effort to reach audiences with similar socio-demographic profiles. Using multiple platforms reduced self-selection bias associated with single-channel recruitment and increased sample heterogeneity, helping to mitigate common limitations associated with online data collection (Menegaki et al., 2016), by leveraging the distinct engagement characteristics of each platform (Albert and Smilek, 2023).

Prior to distribution, both questionnaires underwent a two-step validation process involving academic experts and practitioners, ensuring clarity, relevance, and accessibility to a broad and diverse audience. Minor revisions were implemented following feedback, mainly concerning question wording and scale consistency. Data were collected via Google Forms: the first survey was conducted between April and May 2025, and the second between June and July 2025. Both surveys were administered in Italy, reflecting the national context discussed in Section 2.

The first questionnaire comprised 13 questions, divided into four main sections, and aimed to analyse the potential involvement of citizens in RECs, with a particular emphasis on economic, social, and redistributive aspects:

- The first section (socio-demographic) collected data on respondents' gender, age, income, and level of concern about – and information on – climate change.

- The second section (REC and exchange price) investigated interest in participating in an REC, principal motivations, and willingness to buy or sell energy within the community, following an explanation of the exchange price mechanism.
- The third section (benefits distribution) explored the criteria considered most equitable for distributing economic benefits within an REC (e.g., energy production, self-consumption, low income, land redevelopment). Respondents were also asked to select a preferred distribution scenario from six options, each presenting different percentage-based allocations.
- The fourth section (energy poverty) assessed respondents' altruism towards economically disadvantaged households, including their willingness to forgo a portion of their benefits and the extent to which they would be prepared to do so in support of those unable to pay their energy bills.

The second questionnaire comprised seven questions, organised into four main sections, with the aim of analysing perceptions, causes, and potential solutions related to misinformation on climate change and energy poverty:

- The first section (socio-demographic) collected information on respondents' gender, age, income, and perception of the severity of climate change.
- The second section (perceptions and causes of misinformation) examined the extent to which citizens believed that various factors (e.g., the media, education, complexity of information, source reliability, perceived distance from the issue, competing daily priorities) contributed to the lack of accurate information on climate change.
- The third section (proposals to improve information) assessed the perceived effectiveness of six initiatives aimed at enhancing climate communication, including school-based modules, traditional and social media campaigns, engagement of influencers, economic incentives, and practical local activities.
- The fourth section (policies against energy poverty) evaluated five proposed measures to support households in difficulty, such as bill discounts, incentives for renewable energy, improved access to energy communities, redistribution of energy savings, and educational programmes.

Questions were primarily based on a Likert scale (1–5) and included open-ended, multiple-choice, and open numerical responses (with reference ranges provided). The use of different question formats allowed both attitudinal measures and behavioural proxies to be captured. Descriptive statistical tools were applied to each questionnaire, calculating the average values for each item. Comparisons were subsequently made between groups based on the two main socio-demographic variables – age and gender (Basilico et al., 2025a) – as well as respondents' motivation to join an REC as a means of addressing energy poverty, and their perceived severity of climate change. Specifically, the sample was divided into the following clusters according to responses to the relevant Likert-scale questions:

- "high energy poverty" group: respondents who rated 4 or 5, indicating strong motivation;
- "medium-low energy poverty" group: respondents who rated 1 to 3, indicating medium or lower motivation;
- "high perceived risk" group: respondents who rated 4 or 5 on the perceived severity of climate change, indicating strong concern; and
- "medium-low perceived risk" group: respondents who rated 1 to 3 on the same question, indicating lower concern.

The statistical significance of the analyses was assessed using a range of tests: (i) the Mann–Whitney *U* test for comparisons between two groups; (ii) the Kruskal–Wallis non-parametric test followed by Dunn's post-hoc test with Bonferroni correction for comparisons among multiple independent groups; (iii) the Friedman non-parametric test for repeated measures, followed by pairwise Wilcoxon post-hoc tests with Bonferroni correction; and (iv) the one-way ANOVA when the assumptions of normality and homogeneity of variances were met. In addition, regression analyses were carried out using *pandas*, the Python software library for data analysis.

## 4. Results

The results are presented in accordance with the two primary objectives of the analysis: RQ1 (Section 4.1) and RQ2 (Section 4.2).

### 4.1. Motivations and choices in renewable energy communities

The sample analysed in the first questionnaire comprised 403 individuals residing in Italy, with a slightly higher proportion of males (54 %) compared to females (46 %). The average age was 35.9 years, distributed across three age groups: 18–24 years (46 %), 25–50 years (27 %), and 51+ years (27 %). In terms of income, the most represented bracket was 0–20,000 € (48 %), followed by 20,001–40,000 € (26 %), 40,001–60,000 € (14 %), and over 60,000 € (12 %) – Fig. S4. This distribution indicated a predominantly medium–low income composition, consistent with the substantial presence of young individuals in the sample. The composition aligned with findings in the literature (Basilico et al., 2025a).

#### 4.1.1. Concern and information about climate change

The analysis revealed an average level of concern about climate change of 4.1 (on a 1–5 Likert scale), while the average level of information was 3.5. These results indicate a high level of concern relative to a comparatively lower level of information. To further examine these dynamics, a correlation matrix was constructed to analyse the relationships among age, concern, and information (Fig. 3). The results showed a moderately positive correlation between concern and information ($r = 0.52$), supporting the hypothesis that heightened concern about the impacts of climate change may foster greater awareness and knowledge.

The sample was analysed by age group (18–24, 25–50, 51+) and gender (men and women). Regarding concern, the results showed that younger individuals exhibited lower levels of concern compared to the other age groups (Fig. 4). The Kruskal–Wallis test ($\chi^2 = 6.077$, $p = 0.0479$) revealed a significant difference among the three groups; however, Dunn's subsequent post hoc test did not identify any

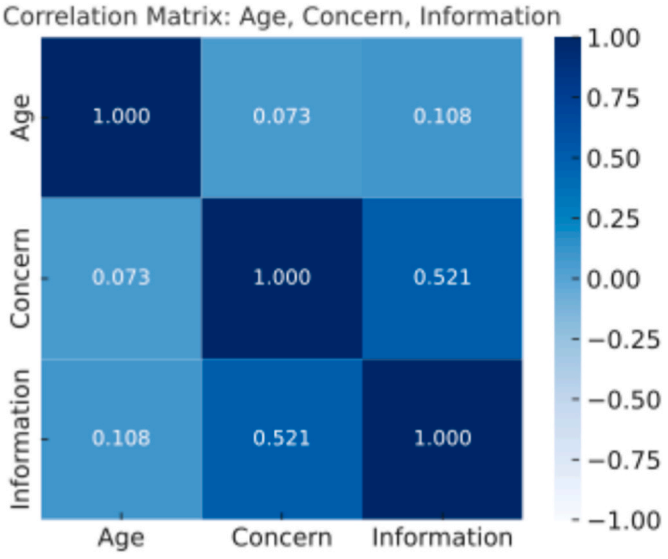


**Fig. 3.** Age-concern-information correlation matrix.

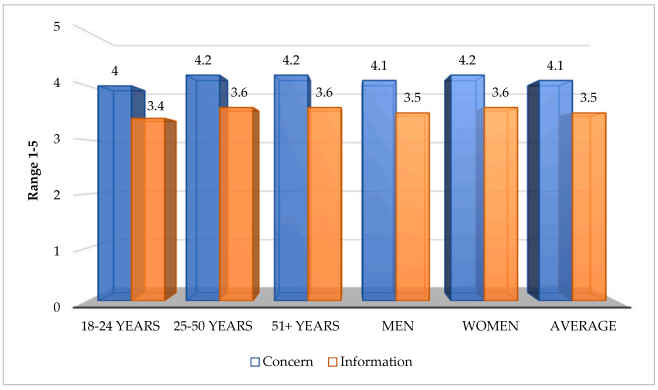


**Fig. 4.** Level of concern and information.

statistically significant differences between individual age group pairs (Table S1). In terms of perceived information levels, the Kruskal–Wallis test ($\chi^2 = 4.093$, $p = 0.1292$) did not reveal any significant differences across the three age groups. This suggests that self-assessed knowledge about climate change is relatively evenly distributed across generations – in contrast to concern, which exhibits a slight age-related variation.

With respect to gender, the data showed no substantial differences between men and women. Women reported slightly higher levels of concern (4.2 vs. 4.1) and perceived information (3.6 vs. 3.5). Nonetheless, the Mann–Whitney $U$ test did not find statistically significant differences in either concern ($U = 18807.0$, $p = 0.2188$) or information ($U = 19628.0$, $p = 0.6398$).

Overall, the results suggest that gender does not exert a significant influence on either of the two variables examined within the sample (Fig. 4).

#### 4.1.2. *Willingness to participate in a renewable energy community*

After being presented with the definition of an REC, respondents were asked about their willingness to participate. The average score recorded was 3.9 (Fig. 5). When considering age, the group most inclined to participate was that aged 25–50 (4.1), followed by the group aged 51+ (3.8) and the 18–24 age group (3.75). The lower willingness among younger respondents may be attributed to factors such as limited awareness of energy sustainability, less stable housing situations, and reduced involvement in energy-related expenses. The Kruskal–Wallis test ($\chi^2 = 9.989$, $p = 0.0067$) indicated a significant difference among age groups. Dunn's subsequent post hoc test confirmed a statistically significant difference between the 18–24 and 25–50 age groups ($p = 0.0047$) (Table S2).

Regarding gender, women (3.9) demonstrated a slightly higher willingness to join an REC than men (3.85). However, the Mann–Whitney $U$ test ($U = 19244.0$, $p = 0.4165$) did not reveal any statistically significant difference between genders.

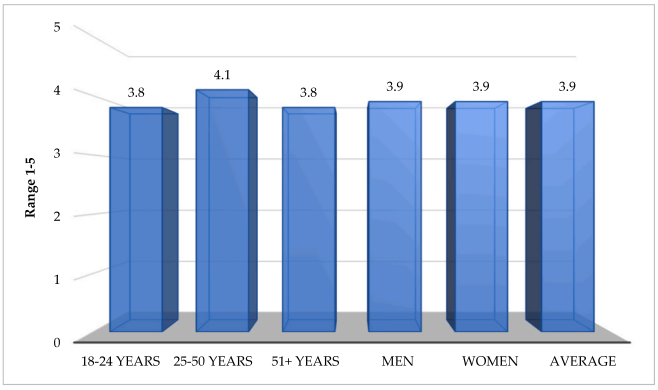


**Fig. 5.** Level of REC propensity.

#### 4.1.3. *Factors influencing participation in a renewable energy community*

Six distinct factors influencing the decision to join an REC were evaluated using a 1–5 Likert scale (Fig. 6). Among these, environmental motivations emerged as the most influential driver (mean score: 4.1), followed by economic motivations (3.9) and the pursuit of energy independence and security (3.8). These findings reflect a strong awareness of the environmental benefits associated with RECs, coupled with a notable interest in cost savings and energy resilience. Conversely, the desire to be part of a community registered the lowest average score (2.7), suggesting that social or relational considerations play a less significant role in individual decision-making.

The Friedman test revealed significant differences among the factors assessed ($\chi^2 = 602.98$, $p = 4.60 \times 10\hat{}(-128)$). The results of). Results from the Wilcoxon post hoc test indicated that "environmental motivations" differed significantly from all other factors. Likewise, the "sense of community" motivation showed statistically significant differences compared to all other dimensions. "Economic motivations" also differed significantly from all factors, with the exception of those related to energy independence and security, and the fight against energy poverty (Table S3).

With respect to gender (Fig. 6), environmental motivations were identified as the primary driver for both men and women (4.1 for both). Women assigned slightly greater importance than men to social and collective motivations, including the "desire to be part of a community" (2.8 vs. 2.6) and "combating energy poverty" (3.8 vs. 3.6). These findings suggest that women may be more attuned to the relational and equity-based aspects of participation in RECs. The Friedman test, conducted separately for both groups, revealed significant differences in the evaluation of the six factors (men: $\chi^2 = 336.90$, $p = 1.15 \times 10\hat{}(-70)$; women: $\chi^2 = 270.382$, $p = 2.32 \times 10\hat{}(-56)$). The post hoc Wilcoxon test indicated that, among men, both "environmental motivations" and "sense of community" differed significantly from all other factors. Among women, "sense of community" was likewise clearly differentiated, while "environmental motivations" did not differ significantly from "economic motivations," suggesting a less polarised perception than that of men. Furthermore, only among men did "economic motivations" differ significantly from motivations related to retraining (Table S4–S5).

The analysis by age group (Fig. S5) confirmed that environmental, economic, and energy independence motivations were the main drivers of participation in RECs. Younger individuals (18–24 years) attached less importance to the desire to be part of a community (mean score: 2.5) than older groups (25–50 and 51+), which recorded higher values (2.8 and 2.9, respectively). This trend indicated that younger people were less inclined towards the relational and social components of the community experience. It was also consistent with the gender-based analysis, which revealed that men – constituting the majority of the younger age group – reported lower scores for this motivation. The importance attributed to combating energy poverty increased with age, rising from 3.5 among those aged 18–24 to 3.9 in the 51+ age group. This suggests a greater degree of social sensitivity or a more established awareness of such issues among older generations.

The Friedman test highlighted significant differences in the evaluation of the six factors across all age groups (18–24: $\chi^2 = 298.416$, $p = 2.19 \times 10\hat{}(-62)$; 25–50: $\chi^2 = 164.190$, $p = 1.27 \times 10\hat{}(-33)$; 51+: $\chi^2 = 165.174$, $p = 7.81 \times 10\hat{}(-34)$). Wilcoxon post hoc tests revealed a consistent pattern across age groups: the desire to belong to a community was significantly less influential than environmental and socio-economic motivations (Table S6–S7–S8).

#### 4.1.4. *Analysis of sale, purchase and exchange prices*

Respondents were asked to assume the roles of both seller and buyer in order to indicate how much they would have been willing to receive or pay for energy produced within the community.

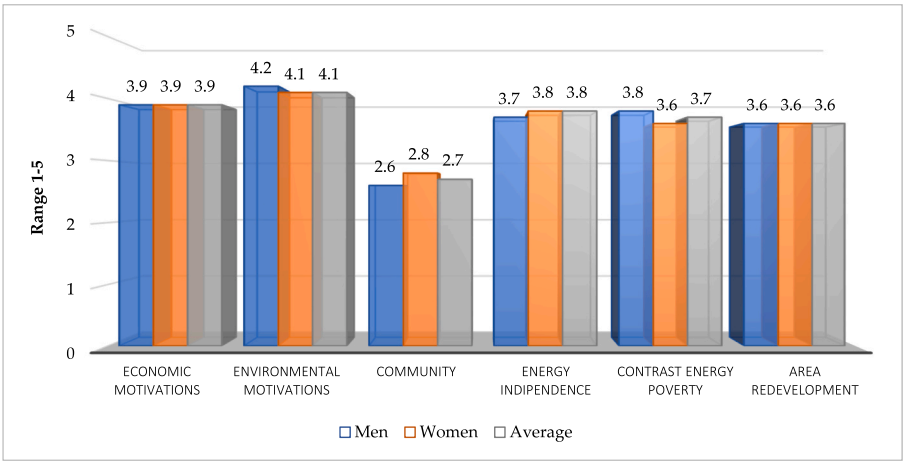


**Fig. 6.** Level of REC motivation – Gender.

The exchange price was calculated as the average between the minimum price an individual would have accepted to sell energy within the community (selling price – willingness to accept [WTA]) and the maximum price they would have paid to purchase energy from another community member (purchase price – willingness to pay [WTP]). The questionnaire offered a range of 50–350 €/MWh, noting that energy could be sold externally at a minimum of 50 €/MWh and that the typical market purchase price from traditional suppliers was approximately 350 €/MWh.

The average selling price indicated by respondents was 149.2 €/MWh, while the average purchase price was 162.8 €/MWh. Accordingly, the resulting exchange price was calculated at 156 €/MWh, consistent with the recent literature (Basilico et al., 2025b).

An analysis by age group (Fig. 7) revealed that the lowest WTA was reported among respondents aged 51+ (135.2 €/MWh), whereas the highest WTA was observed in the 18–24 age group (155.5 €/MWh). In terms of WTP, the highest value was recorded in the 25–50 age group (172.6 €/MWh), while the lowest was again found among the group aged 51+ (148.7 €/MWh). Thus, older respondents tended to indicate lower exchange values, possibly reflecting greater equity or a lesser emphasis on economic maximisation. This is consistent with their prioritisation of social motivations for joining an REC.

The analysis by gender (Fig. S6) showed that women reported higher average WTP and WTA values than men, resulting in a higher average exchange price (158.6 €/MWh vs. 153.8 €/MWh).

In general, respondents appeared to understand that the objective of the energy community was to share collective benefits rather than to pursue individual profit, as evidenced by a WTA close to the minimum price.

#### 4.1.5. *Methods of distributing benefits*

The analysis of preferences regarding the distribution of economic benefits within an REC (Fig. 8) showed that respondents favoured recognising those who contributed most to self-consumption (mean score: 4.0), followed by those who produced the most energy (3.8), thus emphasising the importance attributed to efficiency and virtuous behaviour. The least preferred option was allocating a share to public institutions (2.9), which were perceived as less directly connected to the community.

The Friedman test ($\chi^2 = 258.250$; $p = 1.09 \times 10\hat{}(-54)$), followed by the Wilcoxon post hoc test with Bonferroni correction, indicated that respondents perceived significant differences among the various proposed methods of benefits distribution. The only exception was between the two redistributive and collective options – "those with the lowest income" and "allocating a portion to the redevelopment of the territory" – between which no statistically significant difference was found (Table S9).

The analysis by age group (Fig. 8) revealed a high degree of consistency across cohorts. Distribution based on promoting self-consumption emerged as the preferred method in all age groups, with scores ranging from 3.8 to 4.1.

The Friedman test, conducted separately for each age group (18–24:


**Fig. 7.** Exchange price – Age.

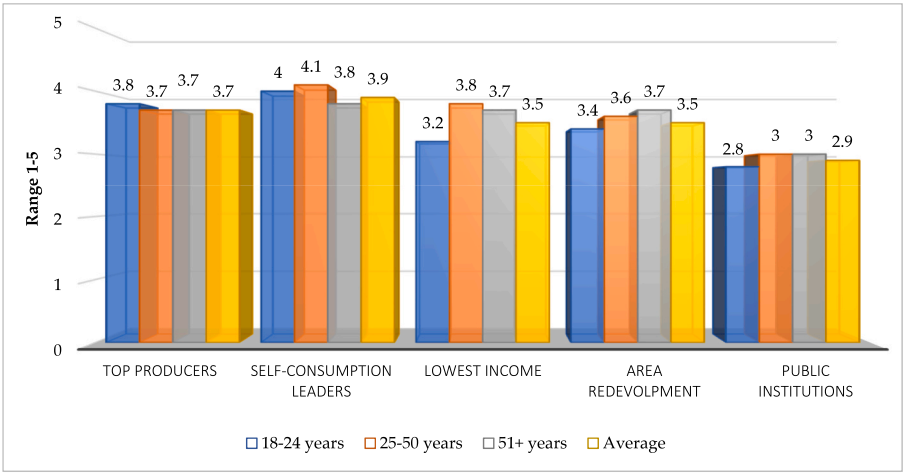


**Fig. 8.** Benefits distribution methods – Age.

$\chi^2 = 134.048$, $p = 5.30 \times 10^{\wedge}(-28)$; 25–50: $\chi^2 = 91.338$, $p = 6.84 \times 10^{\wedge}(-19)$; 51+: $\chi^2 = 69.167$, $p = 3.40 \times 10^{\wedge}(-14)$), highlighted significant differences in preferences. Post hoc tests confirmed a consistent pattern, whereby the option of allocating a share to public institutions received the lowest ratings across all age groups. Younger respondents (18–24) exhibited a clear preference for meritocratic criteria, assigning equal importance to energy production and self-consumption. In the intermediate age group (25–50), self-consumption emerged as the dominant criterion, showing a statistically significant distinction from all others. Among the 51+ group, preferences appeared more balanced, with equity-based motivations (e.g., support for low-income households, territorial redevelopment) rated similarly to meritocratic criteria (Table S10–S12).

The analysis by gender (Fig. S7) confirmed that self-consumption was, overall, the preferred option. The Friedman test, conducted separately for men and women (Men: $\chi^2 = 141.573$, $p = 1.30 \times 10^{\wedge}(-29)$; Women: $\chi^2 = 122.884$, $p = 1.29 \times 10^{\wedge}(-25)$), revealed significant differences in preferences. Post hoc tests showed that, among women, self-consumption differed significantly from all other distribution methods, whereas among men it was rated similarly to energy production. In both groups, the option of allocating a share to public institutions was least preferred by a significant margin, standing apart from all other alternatives (Table S13–S14).

Respondents were subsequently asked to select what they considered the fairest benefits distribution scenario in a hypothetical energy community, to explore their preferences within a more concrete and realistic decision-making context (Fig. S7). The most popular scenario was the one promoting a balance among stakeholders, with a particular emphasis on prosumers (28 %), followed by virtuous consumers (25 %) and households in economic difficulty (20 %). This outcome contrasted with earlier preferences, in which energy production was prioritised over economic status.

The option in favour of the state remained the least popular (1 %). Overall, the findings suggested that, when faced with a realistic context for benefits allocation, respondents tended to favour balanced solutions integrating both meritocratic and equity-based criteria.

#### 4.1.6. Energy poverty

This section aimed to assess respondents' willingness to relinquish, at least partially, the economic benefits of participating in an REC in order to support households in financial hardship. The analysis showed that the average level of agreement with allocating a portion of one's personal benefits to this purpose was 3.7 on the Likert scale. In monetary terms, the average amount respondents were willing to forgo (assuming they were to receive 100 € in benefits) was 22.3 €.

The results (Figs. 9 and 10) indicated general consistency between attitudinal and behavioural responses, though some noteworthy differences emerged. The 51+ age group exhibited the highest monetary willingness to forgo benefits (26.7 €), despite reporting a slightly lower average Likert score than the 25–50 group (3.8 vs. 4). This suggests a stronger concrete propensity for equity, even if less explicitly stated. Conversely, the 25–50 age group reported the highest average attitudinal agreement but a lower actual financial contribution (17.9 €). Statistical analysis confirmed significant differences between age groups for the Likert-scale measure (Kruskal–Wallis $\chi^2 = 16.538$, $p = 2.56 \times 10^{\wedge}(-4)$), with Dunn's post hoc test identifying a significant difference between the 25–50 and 18–24 groups ($p = 2.08 \times 10^{\wedge}(-4)$; Table S15).

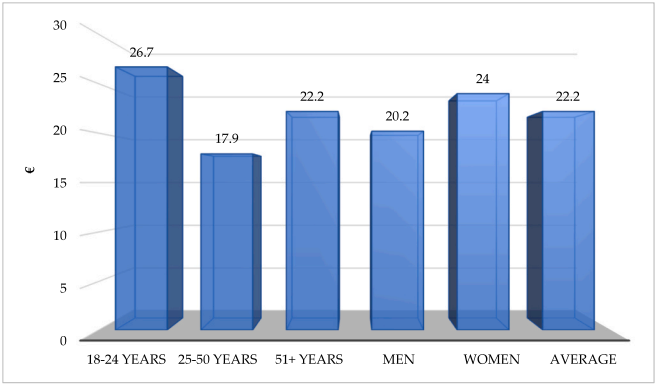


**Fig. 9.** Willingness to reduce (€).

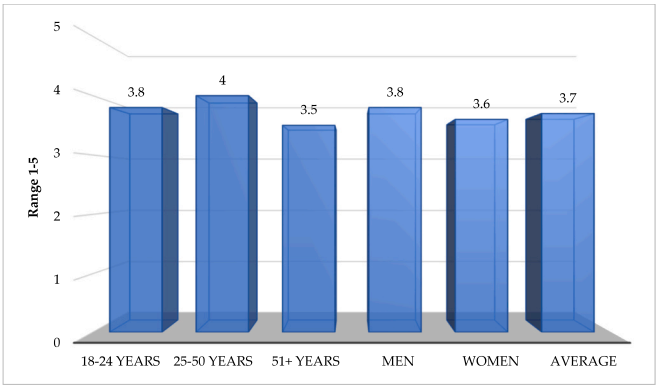


**Fig. 10.** Willingness to reduce (Likert 1–5).

Similarly, for the monetary question, the Kruskal–Wallis test revealed significant differences ($\chi^2 = 11.413$, $p = 3.32 \times 10^{\wedge}(-3)$), with post hoc analysis showing a significant difference between the 25–50 and 51+ age groups ($p = 2.26 \times 10^{\wedge}(-3)$; Table S16). Regarding gender, women expressed greater attitudinal willingness (3.8 vs. 3.6), while men reported higher monetary willingness (24 vs. 20.2 €). However, statistical analysis did not reveal significant differences in either attitudinal (Mann–Whitney $U = 18191.0$, $p = 0.0797$) or behavioural (Mann–Whitney $U = 22337.5$, $p = 0.0580$) terms. Overall, the findings suggest that the attitudinal and economic dimensions of equity may diverge, and age and gender may influence the consistency between expressed values and actual behaviour in distinct ways.

To further investigate respondents' actual attitudes towards energy poverty, a comparison was conducted between those who had indicated a preference for allocating benefits to families in economic difficulty (DE scenario) and the rest of the sample. The aim was to assess whether the former group demonstrated a greater willingness to support low-income households (Table 1). The Mann–Whitney $U$ test did not reveal any significant difference between the groups for the attitudinal question ($U = 14075.0$, $p = 0.2499$). However, for the quantitative question, respondents who had selected the DE scenario exhibited a significantly higher willingness to forgo part of their benefits (32 vs. 19.8 €), with a statistically significant difference ($U = 19023.0$, $p = 1.215 \times 10^{\wedge}(-10)$). This result suggests concrete alignment between respondents' value-based preferences and their stated economic behaviour.

#### 4.1.7. REC and energy poverty

Finally, the analysis examined whether motivation to join an REC as a means of combating energy poverty influenced respondents' preferences regarding benefits distribution. The sample was divided into two groups, as described in Section 3: (i) high energy poverty and (ii) low–medium energy poverty.

The Mann–Whitney $U$ test revealed statistically significant differences ($p < 0.05$) across all five benefits distribution methods, indicating that the "pro–energy poverty" cluster exhibited a stronger propensity – at least at the declarative level – to support inclusive and equity-based distribution models (Table 2). This behaviour appeared to align closely with respondents' stated motivation to view the REC as a tool for addressing energy poverty, thereby confirming a consistency between declared intent and preferences regarding benefits allocation.

### 4.2. Perception of climate change, support for anti-disinformation policies and energy poverty

The sample for the second questionnaire comprised 407 individuals, of whom 55.3 % were men and 44.7 % women. The average age was 32.7 years, with the 18–24 age group forming the largest segment (48 %), followed by the 25–50 (33 %) and 51+ (19 %) groups. In terms of income, the most represented bracket remained 0–20,000 € (53 %), followed by 20,001–40,000 € (30 %), 40,001–60,000 € (10 %), and over 60,000 € (7 %) – Fig. S8. This sample aligned with the profile proposed in the literature (Basilico et al., 2025b).

#### 4.2.1. Perceptions of the severity of climate change risk

The average perception of climate risk was high (4.3 on a 1–5 Likert scale), suggesting widespread awareness among respondents. The analysis by age group (Fig. 11) revealed largely uniform values: 4.3 for the 25–50 group, and 4.2 for both the 18–24 and the 51+ groups. The Kruskal–Wallis test showed no statistically significant differences ($\chi^2 = 2.332$, $p = 0.3116$). This result was consistent with the findings from the first questionnaire, which also found no correlation between age and concern about climate change. By contrast, the analysis by gender revealed a significant difference, with women reporting a higher perception of climate risk (4.4 vs. 4.1). The Mann–Whitney test ($U = 16545.0$, $p = 0.0003$) confirmed greater environmental sensitivity among women, in line with the results of the first questionnaire.

**Table 1**
Waiver of personal benefits in favour of families in need.

| | € | Likert 1–5 |
|---|---|---|
| Individuals adhering to the scenario of families in economic difficulty | 32 | 3.85 |
| General sample without families in economic difficulty | 19 | 3.70 |

**Table 2**
Energy poverty motivation.

| Benefits distribution methods | Pro-energy poverty (4–5) | Low–medium interest (1–3) | $p$ | Significance |
|---|---|---|---|---|
| Who produced the most energy | 3.9 | 3.5 | $5.13 \times 10^{-5}$ | YES |
| Who promoted self-consumption the most | 4.2 | 3.5 | $1.06 \times 10^{-11}$ | YES |
| Who has the lowest income | 3.9 | 2.9 | $3.18 \times 10^{-18}$ | YES |
| Allocate a portion to local redevelopment | 3.8 | 3.1 | $2.59 \times 10^{-13}$ | YES |
| Allocate a portion to public institutions | 3.2 | 2.4 | $5.03 \times 10^{-12}$ | YES |

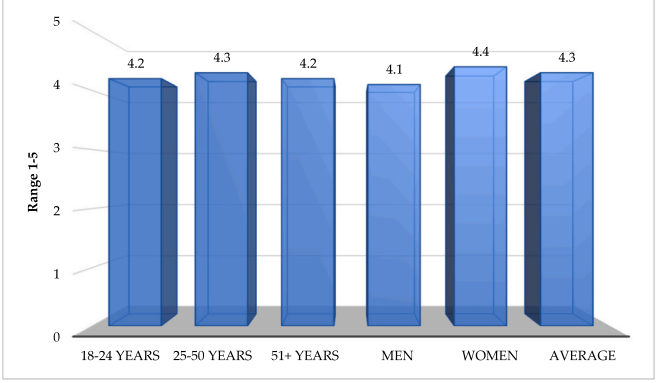


**Fig. 11.** Climate risk perception.

#### 4.2.2. Causes of misinformation on climate change

This section analysed respondents' perceptions of the causes of climate misinformation, with the aim of identifying the factors regarded as most critical in generating the existing information gap. The results (Fig. 12) indicated two primary causes: insufficient attention to the issue within schools and universities (mean score: 4.0) and the perception of climate change as a problem distant in time and space (3.9). These were followed by competing daily priorities (3.7) and limited media coverage (3.6), while the unreliability of sources (3.2) and the complexity of content (3.0) were considered less influential. Overall, misinformation appeared to be viewed more as a consequence of inadequate education and low social prioritisation than of cognitive limitations or unreliable sources.

The Friedman test ($\chi^2 = 291.606$, $p = 6.38 \times 10^{\wedge}(-61)$) revealed significant differences among the factors assessed. The Wilcoxon test with Bonferroni correction confirmed significant differences in 13 out of 15 pairwise comparisons. The only pairs that did not differ significantly were:

- "Other priorities in daily life" – "Limited media coverage"; and

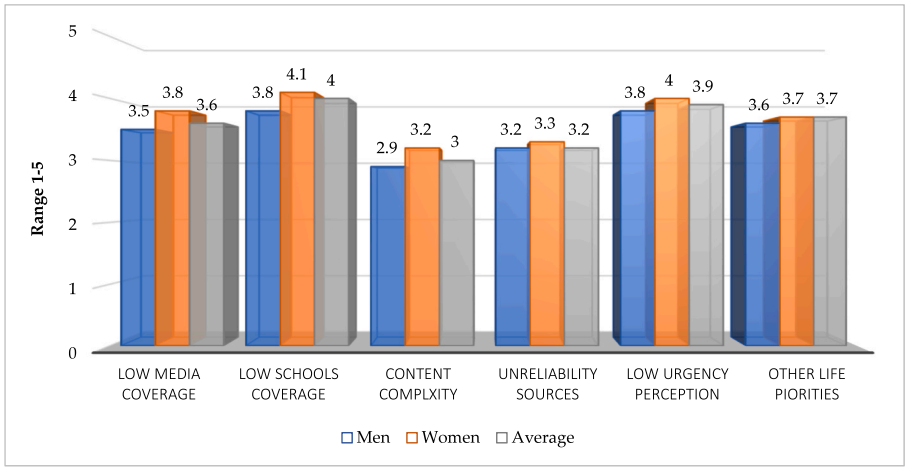


**Fig. 12.** Causes of misinformation – Gender.

- "Poor coverage in schools/universities" – "Perception of climate change as distant" (Table S17).

The gender-based analysis showed that women assigned higher average scores than men to all six causes (Fig. 12), with particularly pronounced differences for "limited media coverage" (3.8 vs. 3.5) and "limited coverage in schools/universities" (4.1 vs. 3.8). These findings further confirmed the greater environmental sensitivity observed among women in previous sections, along with a heightened perception of the informational, cognitive, and social barriers associated with climate change.

The Friedman test, conducted separately by gender (Men: $\chi^2 = 145.306$, $p = 1.33 \times 10^{\wedge}(-29)$; Women: $\chi^2 = 150.087$, $p = 1.28 \times 10^{\wedge}(-30)$), confirmed significant differences in factor ratings within both groups. Post hoc tests showed that, as in the overall sample, "complexity of content" and "unreliability of sources" remained the least relevant causes. The non-significant pairs mirrored those observed at the aggregate level, with one additional case for women: "complexity of content" – "unreliability of sources" (Table S18–S19).

For the analysis by age group (Fig. S10), the results showed a relatively homogeneous distribution, with internal differences confirmed by Friedman tests (18–24: $\chi^2 = 167.851$, $p = 2.10 \times 10^{\wedge}(-34)$; 25–50: $\chi^2 = 84.381$, $p = 1.01 \times 10^{\wedge}(-16)$; 51+: $\chi^2 = 54.033$, $p = 2.06 \times 10^{\wedge}(-10)$).

Post hoc tests revealed that, across all age groups, the factors perceived as most relevant were the lack of coverage of the topic in school and university curricula and the perception of climate change as a distant issue. Among respondents aged 18–24, these two factors stood out significantly from all others. In the 25–50 age group, "complexity of content" and "unreliability of sources" were perceived as significantly less relevant than the remaining factors. For the 51+ group, however, "other priorities in daily life" and "limited media coverage" were viewed as equally important, suggesting a more balanced perception of the various causes of misinformation.

Overall, the results highlighted a broad awareness of the drivers of climate misinformation, with differences across gender and age reflecting divergent approaches to perceived urgency and varying levels of trust in educational and informational channels (Table S20–S22).

### 4.2.3. *Proposals for improving information on climate change*

Respondents were presented with a list of six potential initiatives aimed at countering misinformation on climate change (Fig. 13).

All options received high levels of agreement, indicating broad support for more structured communication strategies. The most favoured proposal was the provision of economic incentives (4.4), followed by information campaigns on social media (4.2), and the inclusion of compulsory training modules within school and university curricula (4.1). This pattern suggests a preference for integrated approaches combining incentives, education, and communication. The Friedman test ($\chi^2 = 222.122$, $p = 5.22 \times 10^{\wedge}(-46)$) confirmed significant differences among the initiatives. Post hoc Wilcoxon tests with Bonferroni correction indicated that most pairwise comparisons were statistically significant, with the proposal for financial incentives standing out

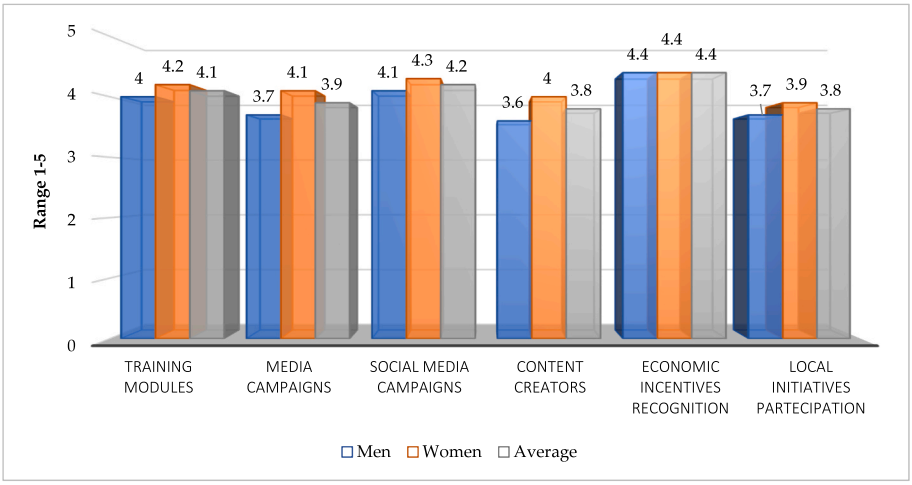


**Fig. 13.** Information improvement proposals – Gender.

clearly from the rest. Although social media campaigns also scored highly, their ratings did not differ significantly from those of the educational modules, which were ranked mid-range (Table S23).

Gender-based analysis (Fig. 13) revealed that women rated all initiatives slightly higher than men, reflecting a greater female inclination to support climate change communication and training initiatives.

Friedman tests confirmed significant differences within both gender groups (Men: $\chi^2 = 158.828$, $p = 1.76 \times 10\hat{}(-32)$; Women: $\chi^2 = 71.587$, $p = 4.79 \times 10\hat{}(-14)$). Post hoc Wilcoxon tests with Bonferroni correction showed that, for both genders, financial incentives were the most highly rated initiative, receiving particularly high support from men. Among women, financial incentives and social media campaigns received similarly high ratings and did not differ significantly. In both groups, the involvement of content creators and participation in local initiatives were the least favoured options and perceived as less effective, with no significant difference between the two (Table S24–S25).

With regard to age group (Fig. S11), the proposal most appreciated across cohorts was the provision of economic incentives, with similar levels of support observed among the three age groups considered.

Friedman tests confirmed significant differences within each age group (18–24: $\chi^2 = 142.794$, $p = 4.56 \times 10\hat{}(-29)$; 25–50: $\chi^2 = 67.668$, $p = 3.13 \times 10\hat{}(-13)$; 51+: $\chi^2 = 42.668$, $p = 4.31 \times 10\hat{}(-8)$). Subsequent Wilcoxon post hoc tests revealed that, among the older age groups, financial incentives were the most favoured option, significantly outperforming the other proposals. In contrast, among younger respondents, incentives and social media campaigns received similarly high ratings, with no significant difference between them. Furthermore, within the 18–24 age group, further significant distinctions emerged between the inclusion of training modules, social media campaigns, and traditional media sources, with the latter considered less relevant (Table S26). In the 25–50 cohort, a marked difference was found between social media campaigns and the involvement of influencers (Table S27), while among those aged 51+, a significant disparity emerged between training modules and content creators (Table S28). Finally, the involvement of influencers was confirmed as the least popular option among older respondents. Conversely, among younger respondents, influencers were preferred over more traditional options, although these differences were not statistically significant.

These results highlight how age may influence perceptions of effective communication strategies, with younger individuals favouring digital tools and older respondents preferring institutional and educational approaches.

#### 4.2.4. Policies to combat energy poverty

The fourth and final section of the second questionnaire explored respondents' views on potential public policies and intervention strategies aimed at addressing energy poverty. The objective was to evaluate both the perceived acceptability and effectiveness of the proposed measures. All options received widespread support, with ratings exceeding 3 (Fig. S12). The Friedman test ($\chi^2 = 152.496$, $p = 5.94 \times 10\hat{}(-32)$) revealed significant differences among the policies considered. Wilcoxon tests with Bonferroni correction indicated that the economic and redistributive measures – incentives for green energy and energy efficiency and shared benefits quotas – were perceived as equally effective. In contrast, the option involving the allocation of savings from virtuous behaviour was significantly less appreciated, suggesting a preference for more direct and tangible interventions (Table S29).

Gender-based analysis (Fig. S12) revealed a high degree of convergence between male and female respondents, with very similar evaluations across policies. This indicates a shared perception of the effectiveness of the proposed measures. However, Friedman tests conducted separately for each group confirmed significant differences in policy preferences (Men: $\chi^2 = 107.595$, $p = 2.37 \times 10\hat{}(-22)$; Women: $\chi^2 = 51.418$, $p = 1.83 \times 10\hat{}(-10)$).

Among men, economic incentives and benefits redistribution were significantly more appreciated than other options (Table S30), while among women, these preferences were less pronounced: the same measures did not differ significantly from educational programmes or bill discounts, indicating a more balanced perspective on possible policy interventions (Table S31).

The analysis by age group (Fig. 14) revealed broad consensus across all proposals, though significant differences emerged in the Friedman tests conducted separately by age cohort (18–24: $\chi^2 = 74.269$, $p = 2.84 \times 10\hat{}(-15)$; 25–50: $\chi^2 = 51.403$, $p = 1.84 \times 10\hat{}(-10)$; 51+: $\chi^2 = 31.645$, $p = 2.26 \times 10\hat{}(-6)$). Post hoc tests indicated that, in the 18–24 and 25–50 age groups, incentives for green energy and energy efficiency were significantly more appreciated than the other policies, with the exception of benefits redistribution within energy communities (Table S32–S33). Among the 51+ group, preferences were more evenly distributed: while incentives and redistribution continued to score higher than savings from virtuous behaviour, they no longer differed significantly from bill discounts or educational programmes. This suggests a more balanced and less polarised view of the available policy options (Table S34).

Overall, age appeared to influence the intensity of preferences, with younger individuals tending to favour direct economic interventions and older respondents exhibiting more measured evaluations across the various proposed measures.

#### 4.2.5. Perception of climate risk and support for environmental information and policies to combat energy poverty

A further analysis was conducted to examine whether a relationship existed between the perceived severity of climate change and the level of support for both initiatives aimed at improving environmental information and policies addressing energy poverty. To this end, the sample was divided into two clusters, as outlined in Section 3.

With regard to information initiatives, it was hypothesised that individuals with a high perception of climate risk would demonstrate greater support compared to those expressing lower levels of concern. The results of the Mann–Whitney $U$ test (Table 3) confirmed this hypothesis, as the "high perceived risk" group attributed significantly higher scores to all proposals considered. This suggests that heightened awareness of the climate crisis may be associated with stronger support for structured, educational, and participatory information strategies to foster collective engagement in the ecological transition.

The same analysis was conducted for policies aimed at combating energy poverty, to assess whether individuals most concerned about climate change were more supportive of such measures. The results (Table 4) showed that those who perceived climate change as highly serious tended to express greater support for these policies, although not all differences reached statistical significance. Overall, heightened climate concern was associated with stronger support for redistributive and participatory measures, while exerting less influence on more traditional interventions such as bill discounts.

## 5. Discussion

The results showed that adequate information on REC functioning increased the propensity to join. Having a clear definition and understandable framework reduced uncertainty, facilitated decision-making, and enhanced trust in the rules of participation (Basilico et al., 2025a; Cohen et al., 2021; Guetlein and Schleich, 2024). These results are consistent with the practical implementation requirements of RECs in Italy, where outcomes depend on formal governance and transparent accounting of metered energy flows and benefit allocation. Therefore, respondents' preference for simple ex ante rules reflects a need for "operational transparency" in translating technical mechanisms into understandable and verifiable procedures for members.

Socio-demographic differences emerged in line with previous research: women were, on average, more oriented towards social goals and training courses, and demonstrated a greater willingness to support collective interventions and daily saving practices. This confirms the

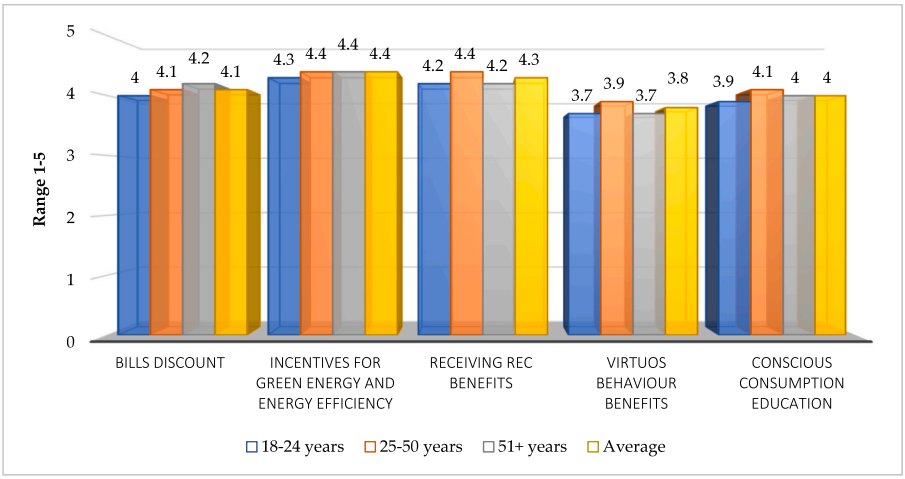


**Fig. 14.** Energy poverty measures – Age.

**Table 3**
Information actions by risk level.

| Proposal | High risk (4–5) | Medium-low risk (1–3) | *p* | Significance |
|---|---|---|---|---|
| Training modules in schools/universities | 4.2 | 3.4 | $8.85 \times 10^{-8}$ | YES |
| Information campaigns on centralised media | 4 | 3.2 | $1.66 \times 10^{-7}$ | YES |
| Information campaigns on social media | 4.3 | 3.6 | $8.39 \times 10^{-6}$ | YES |
| Involvement of influencers and content creators | 3.9 | 3.3 | $1.75 \times 10^{-4}$ | YES |
| Financial incentives to participate in environmental initiatives | 4.4 | 4.1 | $9.22 \times 10^{-4}$ | YES |
| Meetings with experts and local initiatives | 3.9 | 3.4 | $3.83 \times 10^{-3}$ | YES |

**Table 4**
Energy policy actions by risk level.

| Proposal | High risk (4–5) | Medium-low risk (1–3) | *p* | Significance |
|---|---|---|---|---|
| Discounts on bills | 4.1 | 4.1 | 0.892 | NO |
| Financial incentives for green energy and energy efficiency | 4.4 | 4 | $3.46 \times 10^{-3}$ | YES |
| Portion of shared benefits in RECs | 4.3 | 3.9 | $2.95 \times 10^{-3}$ | YES |
| Redistribution of savings from virtuous behaviour | 3.8 | 3.5 | $2.40 \times 10^{-2}$ | YES |
| Educational programmes for conscious consumption | 4.1 | 3.5 | $2.29 \times 10^{-4}$ | YES |

relevance of gender-sensitive approaches in engagement policies (Goedkoop et al., 2025; Lazoroska et al., 2021; Vogel et al., 2024). With regard to age, adults exhibited a more stable propensity to participate, whereas younger individuals required targeted information pathways and participation tools to convert hypothetical intentions into actual engagement. The literature suggests that the motivations driving participation are heterogeneous and shaped by the design and regulation of initiatives (Bauwens, 2016; Bauwens and Devine-Wright, 2018).

With regard to benefits-sharing models, the results supported a combination of meritocratic components (e.g., self-consumption, virtuous behaviour) and equity (with a focus on vulnerable groups), alongside a preference for simple and transparent rules defined ex ante. This approach aligns with the literature, which advocates for hybrid models to reconcile efficiency incentives with social objectives and the legitimacy of decisions (Basilico et al., 2025b; Gasca et al., 2025; Hanke and Guyet, 2023; Vernay et al., 2023).

From an economic perspective, the usual asymmetry between willingness to pay and willingness to accept was observed, as well as the role of the exchange price in coordinating individual interests with collective objectives. Recent studies have confirmed that the propensity to support REC initiatives and to participate actively increase when rules are clear, local benefits are tangible, and the community governance structure is perceived as reliable (Ahmed et al., 2024; Basilico et al., 2025a; Esposito et al., 2024).

Regarding energy poverty and inclusion, there was broad consensus on mechanisms for sharing benefits and allocating dedicated funds to households in difficulty, provided that the criteria and methods of access were transparent and straightforward. Support for such mechanisms was strongest among those who perceived energy poverty as a particularly serious issue. Evidence from Europe indicates that RECs may contribute to reducing energy expenditure and increasing resilience when integrated with targeted measures and governance lowering barriers to entry for vulnerable individuals (Basilico et al., 2025c; Giuliano and Pronti, 2025; Hanke and Guyet, 2023).

Overall, the comparative analysis suggested three robust implications. First, knowledge and trust are crucial: clear information, community involvement in decision-making, and transparent rules regarding costs and benefits are likely to increase participation and reduce conflict (Basilico et al., 2025a; Bauwens and Devine-Wright, 2018; Cohen et al., 2021). Furthermore, a balance between merit and equity in benefits distribution is essential for maintaining long-term consensus, as evidenced by analyses of distributive justice within communities (Gasca et al., 2025; Vernay et al., 2023). Finally, the effectiveness of RECs in addressing energy poverty depends on their integration with targeted tools and simplified procedures, as well as their avoidance of excessive requirements that might exclude the very beneficiaries, they are intending to support (Aparisi-Cerdá et al., 2024; Boostani et al., 2024).

The present findings add support to the literature, contributing evidence that: (i) participation in RECs increases when information, transparency, and distribution rules are clearly defined from the outset; (ii) group differences (in terms of gender and age) necessitate tailored engagement strategies; and social justice objectives are achievable when initiatives are organised through simple procedures and measures designed to support vulnerable groups (Basilico et al., 2025b; Bauwens, 2016; Cohen et al., 2021).

The socially unbalanced composition of the samples may limit the generalisability of the results, meaning that attitudes towards behavioural change and social inclusion based on RECs primarily reflect specific socio-demographic segments rather than the wider population However, it is clear that the energy transition cannot be assessed solely from the point of view of environmental sustainability, but also in terms of economic equity, encouraging stakeholder involvement and creating shared value within local communities (D'Adamo et al., 2026).

## 6. Conclusions and policy implications

The results of our analyses confirmed all three hypotheses. First, H1 was supported, as individuals with higher levels of environmental awareness and economic interest demonstrated a stronger propensity to participate in RECs, reflecting the key drivers of engagement identified in RQ1. Second, H2 was confirmed: environmental and economic motivations outweighed social or community considerations, with observable differences across age and gender in both willingness to participate and preferences for benefits distribution. Finally, H3 was also validated, as respondents with a heightened perception of climate change severity exhibited stronger support for informational initiatives and policies addressing energy poverty, thereby underscoring the link between climate risk awareness and policy engagement explored in RQ2.

The findings associated with RQ1 highlighted strong environmental awareness, accompanied by a significant propensity to participate in an REC, with an average value of 3.9 (on a scale from 1 to 5), particularly among adults aged 25–50. However, despite high concern about climate change (4.1), a certain degree of misinformation persisted (3.5), indicating the need for more widespread and targeted educational and communication policies. Environmental (4.1) and economic (3.9) motivations, along with a concern for energy independence (3.8), emerged as the primary drivers of participation. By contrast, social and collective motivations (e.g., a sense of community, addressing energy poverty) remained secondary, particularly among younger individuals.

These findings highlight the untapped potential of RECs as instruments of inclusion and social justice, and carry specific implications for policy interventions: for younger respondents, initiatives such as awareness campaigns could emphasise the link between economic and environmental benefits, while for women, approaches centred on equity and collective engagement may foster greater involvement.

However, the analysis identified gender- and age-based differences in attitudes without examining the underlying socio-cultural or value-based drivers. For instance, women's greater sensitivity to collective principles or preference for self-consumption may be shaped by factors such as social roles, risk perception, or individualistic orientations – all of which warrant further investigation. Institutions should therefore promote participatory and redistributive models integrating meritocratic and equity-based criteria, enabling the active involvement of vulnerable groups. Moreover, in the context of the ongoing European debate on the simplification and harmonisation of energy policies – which aims to reduce excessive fragmentation in governance instruments – it is essential to strike a balance between social inclusion and regulatory coherence. In summary, while RECs represent a tangible opportunity to democratise the energy transition, to realise their full potential, policies must remain sensitive to generational, gender-based, and value-driven differences within society.

Another relevant economic finding concerns the exchange price, which averaged 156 €/MWh within a range of 50–350 €/MWh. This indicates a general preference for intermediate solutions in the allocation of benefits among REC stakeholders. The estimated exchange price can be interpreted not only as a distributive preference, but also as a coordination tool within the REC. While the incentive mechanism is linked to the measured shared electricity, the internal exchange price defines how savings and value are redistributed among members and may act as a behavioural signal to promote consumption shifting and reduce mismatches between production and demand. Additionally, the analysis revealed a recognition of more virtuous behaviour, as the criterion deemed most relevant for benefits distribution was energy self-consumption (3.9). However, this preference may reflect not only efficiency considerations, but also underlying individualistic or value-based orientations. Thus, future research should explore the cultural or normative drivers behind this tendency. The analysis by group showed that younger respondents were least attentive to the needs of low-income households, whereas women exhibited slightly greater sensitivity to equity-based and collective criteria. These findings confirm that economic data may play a fundamental role in assessments, while also supporting movement towards more inclusive and cooperative decision-making. Accordingly, the value of financial support mechanisms should evolve over time to reward virtuous behaviour while simultaneously assisting families in difficulty.

Respondents expressed a willingness to support low-income households (3.7 on average) and, when presented with a hypothetical sum of 100 €, indicated they would be prepared to forgo 22 € for this purpose. This behaviour appears consistent with the declared view of RECs as tools for combating energy poverty, suggesting an alignment between stated motivations and preferences regarding benefits allocation. Nevertheless, when dealing with economic values, there remains a risk that such attitudes may remain idealistic rather than pragmatic – that is, good intentions may fail to translate into concrete action, thereby reinforcing the status quo. This reflects a well-recognised limitation of survey-based methodologies. Therefore, further experimental or longitudinal studies are needed to assess whether stated willingness genuinely translates into consistent and sustainable behaviour over time.

The results related to RQ2 highlighted strong perception of the severity of climate change (4.3), with significant gender-based differences and only marginal variations across age groups. Women demonstrated greater sensitivity to both climate risk and barriers related to information and communication, indicating a stronger propensity to engage with and support environmental initiatives. Accordingly, communication strategies should be differentiated: for individuals with high climate risk perception, messaging should emphasise educational and participatory programmes; while for younger or less risk-aware groups, communication should focus on the clear, practical economic and environmental benefits.

Respondents identified a lack of attention within school and university curricula (4.0), along with the perception of climate change as a problem distant in time and space (3.9), as the principal causes of misinformation. However, this interpretation should be treated with caution, as the relationship between misinformation and gaps in educational curricula was based on respondents' subjective perceptions, rather than direct empirical measurement. As such, it constitutes a correlational inference rather than a confirmed causal relationship. Future research should examine additional factors contributing to misinformation, including political polarisation, traditional and digital media, and conflicting economic interests and lobbying strategies.

Proposals for improving climate change information primarily centred on the use of economic incentives (4.4), though information campaigns on social media (4.2) and the inclusion of climate-focused modules in school and university curricula (4.1) were also regarded as important.

Respondents who perceived climate change as a very serious threat were more likely to support informational initiatives and policies targeting energy poverty with greater conviction. Across the sample, economic incentives for green energy and energy efficiency (4.4), as well as the shared benefits associated with RECs (4.3), were identified as the most appropriate policy tools for addressing energy poverty.

Despite these contributions, the study presents certain limitations that should be considered when interpreting the results. The sample was unbalanced, with a notable overrepresentation of individuals aged 18–24 (46 % in the first survey, 48 % in the second) and of lower-income respondents. This demographic composition may influence the findings, as a substantial share of respondents in the youngest age group are likely

to be students who are not fully financially independent and may therefore perceive monetary values and economic trade-offs differently from fully employed individuals. The predominance of medium–low income respondents may bias estimates of willingness to forgo personal benefits or support redistributive criteria, given their greater exposure to energy affordability issues. Consequently, the observed support for energy poverty mitigation within RECs should be interpreted as reflecting preferences of specific socio-demographic segments rather than population-wide estimates. This limits the external validity of the findings and constrains their generalisability to the broader Italian population. In addition, the analysis relied primarily on descriptive statistics and non-parametric tests. The application of more advanced econometric techniques (e.g., ordered logit models) could enhance hypothesis testing and allow for the control of multiple influencing variables. Further limitations relate to the dual-sample structure, which may differ across the other territories examined, and to the absence of live experimental components.

This study expands on existing literature by linking participation in RECs to perceptions of climate risk and distributional preferences, highlighting behavioural and value-based factors. It then demonstrates how RECs can promote both decarbonisation and social inclusion. Such investigations can guide future regulation by revealing which incentives and communication strategies are most effective for different groups, supporting more targeted and socially accepted REC policies. It offers clear insights, underlining a strong focus on environmental concerns and positioning RECs as tools for not only energy decarbonisation and the achievement of SDG 7, but also social inclusion. Energy policy remains a critical domain, as the economic dimension continues to play a decisive role in determining its overall effectiveness.

## CRediT authorship contribution statement

**Paolo Basilico:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **Giuliana Michela Cartanese:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **Idiano D'Adamo:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Data curation, Conceptualization. **Marco Ferrazza:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **Massimo Gastaldi:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **Antonio Felice Uricchio:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization.

## Declaration of competing interest

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

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2026.115078.

## Data availability

Data will be made available on request.

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