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# A choice experiment study to assess social benefits explaining citizen participation in renewable energy communities

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ABSTRACT

This research proposes a Choice Experiment study, aimed at assessing the perceived social benefits explaining social acceptance of the Renewable Energy Community (REC) energy sharing model. A survey (N = 815) has been carried out in rural territories, potential target of deployment of renewable energy facilities, and urban sites in Sardinia, Italy. It is seen that only configurations characterized by community ownership of facilities are deemed beneficial, while ownership by external agents decreases the social value of the project, so much that the financial incentives provided under the current Italian regulation would not be enough to make the initiative socially attractive in this context. This result is especially evident in rural areas. Higher valuations of the community ownership attribute are explained by behavioral intention, which is in turn triggered by perception of social benefits associated with the REC, by social norms and other socio-psychological factors. Perceived social benefits, trust toward government institutions, and sense of community also have an effect on the valuation of governance options for the REC. Indications for policy are drawn, emphasizing the importance of localizing the gains from renewable energy facilities, and of a fair distribution of social benefits.

Abbreviations

| Abbreviation | Definition |
|---|---|
| AIC | Akaike Information Criterion |
| ANOVA | Analysis Of Variance |
| BIC | Bayesian Information Criterion |
| CE | Choice Experiment |
| CFI | Comparative Fit Index |
| DOI | Diffusion of Innovation Theory |
| ESCO | Energy Service Company |
| EU | European Union |
| IPT | Incentive Premium Tariff |
| MASE | Ministry of Environment and Energy Security |
| MNL | Multinomial Logit |
| NIMBY | Not In My Back Yard |
| NRRP | National Recovery and Resilience Plan |
| REC | Renewable Energy Community |
| RED | Renewable Energy Directive |
| RMSEA | Root Mean Square Error of Approximation |
| RPL | Random Parameter Logit |
| SEM | Structural Equation Model |
| SRMR | Standardized Root Mean Square Residual |
| TLI | Tucker-Lewis Index |
| TPB | Theory of Planned Behavior |
| WTA | Willingness to Accept |
| WTP | Willingness to Pay |

(*continued on next column*)

(*continued*)

## 1. Introduction

Since the release of the Energy for Future White Paper by the European Commission (EC, 1997), indicating targets of 12% of renewables in the energy mix by 2010, the Union has been scaling up goals for the deployment of renewable energy, in response to climate change, environmental and energy security challenges. In 2009 the Renewable Energy Directive (RED) (EU, 2009) established an EU target of 20% renewables by 2020 and national binding targets, while the 2018 Revision (RED II) (EU, 2018) raised the 2030 target to 32%. The REPowerEU Plan (EC, 2022) proposed to raise the EU's renewable energy target for 2030 to 45%, up from the 40% set in the previous proposal "Fit for 55" (EC, 2021), reinforcing the Union's commitment to accelerating the green transition. This ambition was later consolidated in the revised Renewable Energy Directive (2023/2413, also known as

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RED III) (EU, 2023), which establishes a binding target of at least 42.5% of renewables in final energy consumption, with the ambition to reach 45% by 2030.

The deployment of renewable energy facilities is however challenged by growing local opposition, triggered by concerns over impacts on landscape and biodiversity, disruption of identitarian values and negative effects on economic activities (Buchmayr et al., 2021; Russell, 2023). While the phenomenon has often been dubbed as NIMBY (Not In My Back Yard) syndrome, other motivations should be taken into consideration (O'Neil, 2021). As discussed by Devine-Wright (2005) and Walker and Devine-Wright (2008), opposition to renewable projects frequently arises from perceived threats to place attachment and community identity, and that acceptance increases when communities are meaningfully involved and perceive outcomes as fair. This has been confirmed by empirical research: for example, Liebe and Dobers (2020) and Kostyuchenko et al. (2024) find that perceptions of procedural and distributive fairness strongly influence citizens' willingness to support renewable energy projects, with fairness emerging as a stronger predictor of acceptance than mere proximity or environmental concern.

In this context, the concept of "Renewable Energy Community" (REC) was introduced in the European legislation with the aim "*to increase the participation of local citizens in renewable energy projects and therefore increase acceptance of renewable energy*" (RED II, Whereas 70). Through implementation of grassroots projects the benefits stemming from the production of energy would be locally internalized, thus meeting the demand for distributive justice; at the same time, procedural justice would be ensured by transparent and non-discriminatory criteria for inclusive local participation in energy projects. As argued by Walker et al. (2021), for attaining a just energy transition it is necessary that the localities involved in energy projects are not seen as mere *"containers"* where economic, institutional and social agents interact, but as places with distinctive socioeconomic, attitudinal, cultural characteristics. An interesting feature of the REC regulatory framework is its focus on territories and communities, further than single agents. For example, it is stated that the primary purpose of a REC is to "*provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates*" (RED II, article 2.16/c). This attention to local communities is reiterated in the concept that the creation of local energy market fosters community development, for example by generating income sources, local employment opportunities and social cohesion. The literature on social acceptance of renewable energy systems, which will be examined more extensively in Section 3, emphasizes the role played by attitudes toward the community, the environment, the institutions, and by the availability of reliable communication channels. As emphasized by Berka and Creamer (2018), policy measures aimed at promoting the diffusion of RECs should be shaped to take into account the relevant social factors, comprising social norms, beliefs and relationships. However, despite the recognized importance of these psychosocial and contextual dimensions, the existing body of valuation research on cooperative energy projects has primarily focused on investment behavior rather than participation itself. These studies typically investigate citizens' willingness to co-invest in community-based renewable projects, concentrating on financial and governance-related attributes such as expected returns, risk exposure, minimum holding periods, or voting rules, while often underrepresenting social and relational motivations. Nonetheless, evidence from large-scale surveys confirms that while economic incentives remain central to investment decisions, the perception of non-monetary social benefits also plays a significant role: environmental and community benefits (Curtin et al., 2019; Marder et al., 2023); project promoters credibility and locally anchored and community-led initiatives (Salm et al., 2016; Pons-Seres de Brauwer and Cohen, 2022); transparent and inclusive governance structures (Guetlein and Schleich, 2023). Taken together, these findings suggest that fairness and community interests emerge as critical determinants of engagement, pointing to the need for future research to integrate these social and contextual attributes explicitly when modeling willingness to participate in REC initiatives.

To the best of our knowledge, valuation studies that attempt to quantify or systematically assess these intangible benefits are still missing, leaving a gap in understanding the full social potential of community energy initiatives. This research proposes a Choice Experiment study, aimed at assessing the perceived social benefits explaining social acceptance of the REC model, conditional on different characterizations of the REC configuration. A survey has been carried out across different territorial contexts in the Italian island of Sardinia: two rural areas, currently hosting some large scale renewable energy facilities, with further deployment projects envisaged; and the conurbation area of Cagliari, the capital city of the region. The analysis produced monetary valuations of trade-offs between relevant attributes of the scenarios proposed, including intangible social benefits, elicited from citizens living in the selected territories. Such knowledge is also fundamental for the design of tailored communication strategies to improve social acceptance of the REC model, and useful for defining the association's statutory rules.

The paper is structured as follows: the next section provides an up-to-date description of regulatory framework; section 3 overviews recent literature regarding REC acceptance; the case study is developed in section 4, starting from the qualitative phase of the research and then reporting the Choice Experiments study and the estimated models; a discussion of results will conclude the paper.

## 2. Regulatory context

RED II defined "Renewable Energy Community" as a legal entity based on open and voluntary participation, autonomous, and *effectively controlled by shareholders or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity*. Control of the REC should reside with local stakeholders who live and operate in the territory where the energy assets are located. Such a physical and geographical connection is deemed essential to ensure that the entity functions as a genuine local community, comprising an inseparable bond between the territory and its inhabitants.

The Directive has been transposed in Italy with the Legislative Decree 199/2021 which essentially reiterates the EU's textual definition, stating that "*the exercise of control powers belongs to the subjects who are situated in the territory where the plants for sharing are located*". The concept of control refers to the capacity to make government decisions in the pursuit of the association purposes.

However, a significant feature of the Italian model is its flexibility regarding plant ownership. While a REC may own its production assets, it is also permitted to merely have availability and control over them. Energy systems associated with the REC can be owned by members or by external providers, i.e. third-party producers, who do not participate in the REC but authorize it to use the electricity they generate for the calculation of shared energy.

Economic incentives to promote the REC model are provided through the IPT (Incentive Premium Tariff) subsidy on shared energy. Energy can be shared among members located anywhere within the same market zone,[1] although financial incentives for shared energy (excluding large plants over 1 MW) are restricted to consumers and prosumers connected to the same primary substation for electricity transmission (Decree 199/2021, article 31.2/c). From a technical point of view, localizing production and consumption of energy in the same power subsystem reduces the transport of electricity through the national grid, hence decreasing the risk of damage and blackouts associated with excess energy loaded into the infrastructure. This translates to lower costs for grid use and energy transportation in the electric bill.

[1] The zones identified for the Italian electricity market are seven: North, North-Centre, South-Centre, South, Calabria, Sicily, Sardinia.

Beyond technical grid efficiency and congestion management, the regulatory significance of energy sharing incentives lies in their role as a strategic policy instrument under RED II. While virtual storage and energy sharing may appear physically equivalent in non-congested networks, the European framework - specifically through Whereas 17 and 26 - prioritizes the promotion of small-scale installations (*allowing renewable energy communities to be remunerated through direct* support *where they comply with requirements of small installations)* to enhance public acceptance and ensure a level playing field for renewable energy communities.

Furthermore, the National Recovery and Resilience Plan (NRRP), part of the Next Generation EU plan 2021-2026, allocated 2.2 billion euros to support energy communities. Small towns and villages with less than 5000 inhabitants were a special target of this measure, in the understanding that the creation of RECs could work as a leverage to deployment of cooperative projects in rural areas. However, the actual deployment of RECs in Italy has proceeded at a slow pace: only 597 configurations and approximately 65 MW of installed capacity,[2] falling well short of the government target of 5 GW. Due to the limited utilization of these funds, the target audience has been expanded to include municipalities with populations under 50,000, and the budget has been reduced to 795.5 million euros, with the objective of reaching a target of 1.7 GW installed power capacity within energy communities.

In conclusion, in Italy, the concept of proximity for Renewable Energy Communities (RECs) is defined differently depending on whether one is referring to members, shared energy, incentives on shared energy. This differentiated approach has led to the creation of "umbrella" RECs, which are entities that cluster multiple configurations (each one within the primary substations), which can be located in various areas of the national territory: for example, an umbrella REC is currently operating with configurations spanning across ten Italian regions. While on one hand this could be an advantage in terms of management simplification (e.g., a single entity interfacing with the GSE), on the other hand, there is a concrete risk that the principles of energy democratization and autonomy from large energy players advocated by the RED II Directive (Whereas 71) will be in fact overlooked.

## 3. Social acceptance of RECs: Theoretical model

The response by communities and individuals to technological innovations is at the core of social acceptance models (Batel, 2020; Wolsink, 2018). Social acceptance implies that individuals, in their role of citizens or economic agents, are willing to adopt a new consumption, production, or governance model. The sharing energy system proposed in the REC concept is a technical and socioeconomic innovation and understanding the reasons behind willingness to adopt it is essential for the successful implementation of new initiatives (Ahmed et al., 2024; Brambati et al., 2022). Results from a recent meta-analysis of the literature on citizen participation in local energy communities (Neves et al., 2024) show that the research has been mainly based on Theory of Planned Behavior (TPB) (Ajzen, 1991, 2020), usually extended to account for other factors that are deemed to be relevant in this context. The TPB model assumes that behavioral intentions are the primary determinants of actual behavior, and that intentions are influenced by beliefs regarding advantages and disadvantages associated with the adoption of the innovation. In turn, these beliefs may be shaped by social norms (approval by peers), and by perceptions of control over the technological innovation.

In this paper, a social acceptance model is built and tested to explain intention to participate in a REC. The behavioral intention is regressed on attitudinal factors, mainly following a TPB structure, with some extensions. A graphical representation of the model is reported in Fig. 1.

Behavioral Intention is hypothesized to be directly and positively influenced by the perception of potential Benefits generated by the REC, while the perception of potential social Costs associated with a REC would have a negative effect on the intention to participate. Another TPB variable is the expectation that significant others (friends and relatives) would approve of a potential involvement of the respondent in the REC (injunctive Social Norms) and/or that they would be willing to participate (descriptive Social Norms). As a proxy for the TPB variable Control, i.e. the perception of having the resources and capability to adopt the innovation, the model applied in this study adopts the Trialability concept from the theory of Diffusion of Innovations (DOI) by Rogers (1995). The notion refers to the possibility to see and test an innovation, which is thought to be especially important for people who are well disposed toward it, but lack reliable information networks. In this case, it is assumed that individuals who feel unsure about their capacity to deal with this new energy model will be more interested in the possibility to receive feedback from other experiences. The latent variable Sense of Community, not explicitly part of the original TPB model, is included to reflect the importance of being part of a collaborative local network for acceptance of cooperative energy projects, as emphasized by Neves et al. (2024). Here, it is hypothesized that Sense of Community may act either directly on Intention or indirectly, through the perception of costs and benefits. Finally, two latent Trust constructs proposed by the DOI theory are introduced in the model. The role of political institutions is to guarantee the correct functioning of the REC model, and trust in these actors can enhance the perception of social benefits and reduce the perception of social costs; this may also have the effect of increasing interest in gathering information from existing RECs. Trust in industrial or financial players that could invest in the infrastructure could act in either way: on one hand, people may be more reliant on the financial sustainability of the project and perceive higher net economic benefits for the community; on the other hand, this interference could decrease the perceived benefits stemming from a grassroot project. These relations will be empirically tested using a confirmatory Structural Equation Model (SEM).

### 3.1. Statistical methods

The Structural Equation Model can be statistically represented by a set of matrix equations of the form:

$$X^* = h(X;\gamma) + \eta \tag{1}$$

where $X$ are explanatory variables of $X^*$ (or antecedents): they can be observed characteristics, or as in the model above, other latent variables related to $X^*$. The $\gamma$ parameters capture the effect of $X$ on $X^*$, whereas $\eta$ is a random disturbance term. The model structure consents to jointly estimate all the relationships and accounts for measurement errors. Model selection is based on a set of measures of overall goodness of fit: the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA) and the Standardized Root Mean Square Residual (SRMR), while goodness of fit for single endogenous variables is measured by partial R-squared statistics.

Choice modelling is based on the random utility theory proposed by McFadden (1974) and Luce's (1958) probabilistic utility theory. Utility can be disaggregated into a deterministic and a random component as in the following:

$$U_{int} = V_{int} + \varepsilon_{int} = \beta' x_{int} + \varepsilon_{int} \tag{2}$$

where $V_{int}$ represents the component of utility that the individual $n$ derives from choosing alternative $i$ in the choice situation $t$. $V_{int}$ is a function of preference parameters $\beta'$ and explanatory variables $x_{int}$, whereas $\varepsilon_{int}$ represents the stochastic component of utility. Depending on assumptions made on the distribution of this component, different econometric models can be estimated. For example, the multinomial logit (MNL) model assumes that errors are independently and identically distributed (IID) following a Gumbel distribution. The MNL model does

[2] GSE data, 30th September 2025.

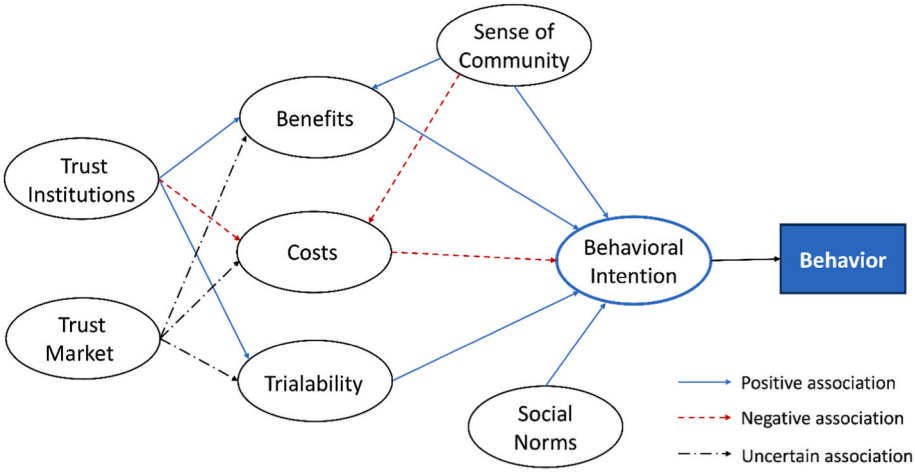


**Fig. 1.** Social acceptance theoretical model.

not allow for heterogeneity in tastes across respondents (although some variation may be allowed by interacting preference parameters with socioeconomic variables), so the fit to the data is often unsatisfactory. In a random parameter logit (RPL) model the term $\beta_n'$ is the vector of the unobserved taste parameters for respondent $n$. Since it is unknown, it may be assumed that it is IID over respondents, following a distribution described by a density function $g(\beta|\theta)$, with $\theta$ being the vector of parameters of the distribution (if it is a Normal, mean and standard deviation). While the RPL model accommodates well unobserved heterogeneity, recent developments have attempted to better address the issue of preference heterogeneity and to enrich the behavioral component of discrete choice models. Proposed by Ben-Akiva et al. (1999, 2002), Hybrid Choice Models (HCM) allow for the integration of latent constructs in the utility functions.

In its simplest formulation the HCM integrates the latent variable through interaction with explanatory variables $x_{int}$ in the deterministic component of utility, that is:

$$V_{int} = \beta' x_{int} + \lambda' LV_n x_{int} \tag{3}$$

where $\lambda'$ is a vector of parameters capturing the impact of the latent variable on the preference for the characteristic $x_{int}$. Latent constructs are based on attitudinal indicators, which usually employ Likert scales and can be modelled through measurement equations.

Summing up, a HCM will consist of at least three model components: the structural equation model, the measurement equations, and the choice model. As argued by Mariel et al. (2025), complexity and practicality should be both considered when selecting a model specification. When multiple latent constructs are included, integration is required over multiple density functions, approximated through simulation, and the models may become too cumbersome to estimate.

## 4. Field research

The Sardinian subregions Ogliastra and Marmilla have been selected as case studies exemplary of two rural areas in Sardinia, potential target of large renewable energy projects (Fig. 2).

Both Marmilla and Ogliastra are territories characterized by a predominantly rural landscape and long-standing structural challenges such as demographic decline, population aging, and limited access to essential services including education, healthcare, and public transport. Within this shared framework, important differences emerge. The Marmilla subregion, located in the central-southern part of the island

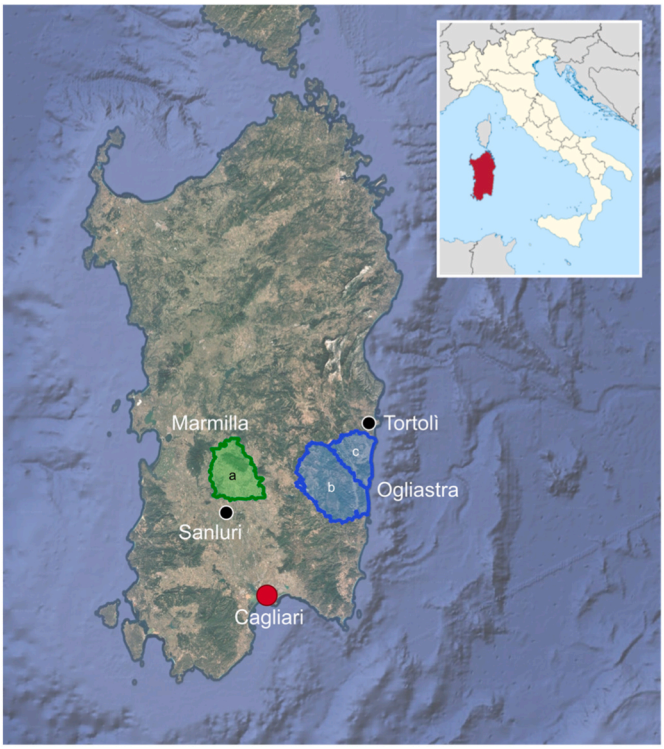


**Fig. 2.** Case studies and primary substations.

and largely embedded within a single primary substation area,[3] mainly consists of small villages, with population typically around 500 inhabitants, where the local economy is largely sustained by cereal-based agriculture. The territory hosts large photovoltaic installations totaling about 15 MW, along with several small wind plants, generating around 21 GWh per year: enough to cover the energy needs of approximately 7700 households (out of the 11,000 living in the area). Yet the prospective scenario of renewable energy deployment in this territory goes far beyond the local need: the projects submitted to the Ministry of Environment and Energy Security (MASE) add to approximately 740 MW of new renewable capacity, which, if accepted, would generate 1 TWh annually, an amount roughly equivalent to half of Sardinia's total

[3] The substation AC001E01642.

household demand (Terna Driving Energy, 2023).

Ogliastra, served by two primary substations[4] and located on the eastern coast, is characterized by a predominantly mountainous morphology and presents a dual character: while coastal municipalities are strongly influenced by tourism dynamics, with positive economic and demographic impacts, the inner towns rely more on agriculture (extensive breeding, vineyards), and are marked by accentuated processes of demographic decline and infrastructural marginality. Here, the physical landscape has favored the development of wind power: the area currently hosts about 126 MW of installed wind power capacity, and only 6.7 MW of photovoltaics. At present, the wind energy capacity in the territory is enough to cover the annual demand of more than 65,000 households, therefore exceeding the need of the 17,000 households residing in the area. Economic benefits for the hosting municipalities currently range from 2% to 4% of the production, plus some direct and indirect jobs associated with the wind farm. Six new wind energy projects have been submitted, which, if approved, would add further 430 MW, corresponding to around 600 GWh per year.

In order to make comparisons between citizens living in a village and those living in more urbanized contexts, an urban gravity center has been selected for both sub-regions. Sanluri, with about 8000 inhabitants compared to the few hundred of most Marmilla villages, acts as a local hub for services and administration but still experiences the same patterns of depopulation and ageing as the wider area. By contrast, Tortolì, in the Ogliastra coast, counts over 11,000 inhabitants and is in a slight demographic increase (ISTAT, 2025). The town is experiencing some economic development related to increased tourism flows, which are shaping a different trajectory with respect to the small mountain towns of inner Ogliastra. The situation is quite different in the case of Cagliari, where the area comprising the city and its main hinterland municipalities is characterized by higher population density, diversified economic activities, public services, and a strong infrastructural endowment, in contrast to the previous cases. Due to the density of the built environment, only a few large-scale renewable energy installations have been developed in the territory, mainly in the industrial peri-urban area.

Taken together, the three areas provide a diversified picture of Sardinia's territorial contexts, ranging from fragile rural sub-regions to the main urban pole, and thus offer a comprehensive basis for comparative analysis.

### 4.1. Qualitative research

The qualitative research entailed an initial phase of in-depth interviews. A stakeholders' matrix was created according to the dimensions of interest and power, including technical experts, public administrators, ESCO managers, economic and social agents. Opinions converged regarding the role of public administrations as leading actors in the process, especially in small communities. At the same time, it was recognized that small municipalities very often do not have sufficient human, technical, or financial resources to undertake this commitment: hence, establishment of territorial offices, possibly coordinated at regional level, was advocated to support small administrations in guiding REC's processes in fragile territories. It was also emphasized that normative uncertainty and complexity reduce the perceptions of viability and relative advantage of RECs among potential participants.

The Focus Group phase was aimed at gathering information regarding willingness to participate in a REC project, focusing on the sub-regions of Marmilla and Ogliastra: the REC model was examined as a part of a wider discussion regarding practical strategies to increase resilience in the areas. A slide presentation was arranged, using animated graphics, aimed at conveying information regarding RECs in a simple and accessible way. Three Focus Groups were organized with citizens residing in each of the three energy substations in the rural areas selected for the study. Each Focus Group had 10 participants, distributed by genders and age groups. The participants were characterized by different education levels, from primary to tertiary, and occupational conditions (professionals, dependent workers, business owners, retired people, students). The discussions held during the focus groups highlighted a diversified understanding of RECs among participants, reflecting both enthusiasm for their potential and skepticism about their practical implementation. Citizens expressed appreciation for the collective dimension of RECs, often describing them as an opportunity to strengthen social ties, enhance cooperation, and foster a renewed sense of belonging within their communities. Administrative support and transparent management were seen as essential preconditions for building trust, while environmental motivations, such as the desire to contribute to local sustainability and reduce emissions, emerged as further drivers of participation. Participants also valued the inclusive nature of the REC model, which allows individuals with limited financial means to engage in shared energy initiatives, and emphasized the importance of maintaining a strong local character to ensure that benefits remain within the community rather than being captured by external actors or large energy companies. While the economic dimension represents a relevant factor in joining a REC, participants in the focus groups pointed out that even small incentives could become meaningful when aggregated and used for community projects. Thus, low incentives would not eliminate interest but rather transform their function, converting an individual benefit into a collective resource that could be used to finance the growth of the energy community or initiatives of common utility.

At the same time, concerns were raised regarding the management of collective resources, distribution of economic benefits, general lack of clear information, reliability and disposal of renewable technologies, dependence on public incentives, and the administrative complexity of REC establishment. Moreover, local sensitivities toward landscape change and the siting of energy infrastructures persisted, suggesting that place-based perceptions influence attitudes toward renewable energy. These dynamics were particularly evident when comparing the two study areas. In Marmilla, where participants expressed a strong sense of local belonging, familiarity with the REC model fostered higher levels of trust and perceived control, with participation framed as a collective endeavor to secure a sustainable future for younger generations, although doubts remained about the long-term economic sustainability and the fairness of benefit distribution. In contrast, participants from Ogliastra revealed a more cautious attitude, where engagement was perceived as dependent on municipal initiative. Here, previous exposure to large wind farms has shaped an ambivalent perception of renewable projects, combining recognition of their potential economic advantages with concerns over landscape transformation, equity, and bureaucratic hurdles. Overall, these contrasting territorial experiences underline how local histories and institutional relationships shape social acceptance and engagement, confirming that the success of RECs depends not only on financial viability but also on their capacity to resonate with the social and spatial specificities of the places in which they are embedded.

### 4.2. The survey

The questionnaires have been administered *face-to-face* by trained interviewers. This administration method is necessary in scarcely populated territories, where web panels do not cover adequately the resident population. While allowing control regarding the comprehension and attention to the survey questions, the method also entails potential sources of bias. Interviewer presence may unintentionally influence responses, potentially inducing responses that are perceived as socially desirable. To mitigate such risks in this research, interviewers received extensive training, with particular attention to standardized administration and awareness of verbal and non-verbal cues. Moreover, multiple interviewers were employed within each sampling area to reduce systematic biases.

[4] More specifically, the substations AC001E01675 and AC001E01676.

The survey was conceived to gather information on citizens' willingness to participate in a REC, conditional on individuals' attitudes and sociodemographic characteristics. A brochure was presented to convey information regarding RECs in a simple and accessible way. To minimize potential framing or information bias, the material was designed to be purely informative, using neutral and balanced wording and avoiding persuasive or misleading images (cf. Mariel et al., 2025, chapter 2); its administration was standardized across interviewers, who were instructed to read and explain the leaflet, avoiding additional interpretations. The interaction with respondents was therefore structured to ensure comprehension while reducing the risk of unintended influence.

The questionnaire was organized into sections, gathering information on perceptions of costs and benefits associated with establishment of a REC, sense of community and attachment to the territory, social norms regarding RECs, willingness to participate in a REC, a choice experiment regarding participation to a specific REC configuration, further questions regarding energy consumption and socio-demographics.

#### 4.2.1. Social acceptance structural equation model

A Confirmatory Factor Analysis has been conducted to empirically test the theoretical model described in Section 3. A Structural Equation Model was estimated through the Lavaan routine freely available in the R platform. The items used for the measurement equations are displayed in Table 1.

The estimated model is reported in Table 2: the reported statistics indicate a reasonably good fit, with CFI and TLI close to the benchmark of 0.95 and RMSEA and SRMR below 0.08 (Newsom, 2023). It can be observed that not every relationship hypothesized in the theoretical model turned out to be valid in the empirical model: for example, the perception of social Costs was not significant in explaining Intention, nor Trust in financial or energy companies in shaping the perception of Benefits.

This pattern is not unexpected: previous studies indicate that community-oriented benefits tend to outweigh perceived costs in shaping engagement (Proudlove et al., 2020), and that trust in large industrial companies does not necessarily translate into higher perceived social benefits, especially in locally driven initiatives (Caferra et al., 2023). Apart from this, the empirical model confirms the assumption that perceived socioeconomic and environmental Benefits motivate Intention, and that peer effects and the possibility to receive feedback from other REC experiences are further drivers of participation. Evidence from the literature has shown that visibility, familiarity, and learning from existing projects reduce uncertainty and support engagement in local energy initiatives (Wolsink, 2018; Batel, 2020). Sense of Community has an indirect effect, by increasing the perception of social Benefits generated by the REC, which aligns with prior findings showing that community belonging and local embeddedness strengthen the perceived value of collective energy projects (Berka and Creamer, 2018; Sloot et al., 2019). The social acceptance model provides useful insights on the motivations behind the intention to become a member of a REC, which, as postulated by the theories of innovation cited in section 3, prompts actual behavior. In this research, actual behavior is replaced by stated behavior, elicited in the Choice Experiments: using a hybrid choice modeling approach, the latent construct Intention is introduced as key explanatory variable for the choice to participate in a REC, conditional on specific characteristics of its configuration.

#### 4.2.2. Choice experiment

Based on the results of the qualitative analysis, the Choice Experiment accounted for four attributes: ownership of production facilities, involvement in decision-making, the IPT (Incentive Premium Tariff) subsidies obtained through energy sharing, and the strategy adopted for their distribution.

As regards the first attribute, it consisted of three levels: facilities

**Table 1**
Items - CE REC participation.

| Constructs *(Cronbach's Alpha)* | | Measurement items *(Agreement with the following sentences, Likert scales from 1 to 5)* |
|---|---|---|
| **Benefits** *(0.76)* | *Ben1* | *The creation of RECs will help local communities to be collaborative* |
| | *Ben2* | *Shared energy in RECs will make the local environment cleaner* |
| | *Ben3* | *The development of RECs will help create new economic opportunities for the community* |
| **Intention** *(0.82)* | *Int1* | *If a REC were created in my town/neighborhood I would be interested in participating* |
| | *Int2* | *If a REC were created in my town/neighborhood I would strongly encourage people to participate* |
| **Sense of Community** *(0.88)* | *SoC1* | *I feel part of this town/neighborhood* |
| | *SoC2* | *I feel attached to this town/neighborhood* |
| | *SoC3* | *I have a good relationship with others in this town/neighborhood* |
| **Social Norms** *(0.82)* | *SN1* | *Most of my friends and relatives would be willing to participate in a REC* |
| | *SN2* | *Most of my friends and relatives would approve if I invested in a domestic PV system made available to a REC* |
| | *SN3* | *Most of my friends and relatives would approve if I invested in a collective PV plant made available to a REC* |
| **Trialability** *(0.91)* | *Trl1* | *I would be more willing to participate in a REC after seeing how it works elsewhere* |
| | *Trl2* | *I would be more willing to participate in a REC after talking to people who have experienced it* |
| **Trust** *(0.86)* | *Tst1* | *I would be more willing to participate in a REC if the Municipality were also involved* |
| | *Tst2* | *I would be more willing to participate in a REC if the Region were also involved* |
| | *Tst3* | *I would be more willing to participate in a REC if the State had a role of guarantee and control* |

**Table 2**
Social Acceptance SEM estimates.

| Regressions | | | *Coeff.*[a] | *St. error* |
|---|---|---|---|---|
| Benefits | ← | Sense of Community | 0.160*** | 0.026 |
| | | Trust Institutions | 0.378*** | 0.033 |
| Trialability | ← | Trust Institutions | 0.684*** | 0.042 |
| Intention | ← | Benefits | 0.340*** | 0.044 |
| | | Trialability | 0.335*** | 0.028 |
| | | Social Norms | 0.483*** | 0.043 |
| **Measurement Equations** | | | | |
| Benefits | | Ben1 | 1.000 | |
| | | Ben2 | 1.039*** | 0.063 |
| | | Ben3 | 1.044*** | 0.063 |
| Sense of Community | | SoC1 | 1.000 | |
| | | SoC2 | 0.912*** | 0.029 |
| | | SoC3 | 0.683*** | 0.026 |
| Social Norms | | SN1 | 1.000 | |
| | | SN2 | 1.029*** | 0.052 |
| | | SN3 | 1.066*** | 0.054 |
| Trialability | | Trl1 | 1.000 | |
| | | Trl2 | 0.991*** | 0.032 |
| Trust | | Tst1 | 1.000 | |
| | | Tst2 | 1.124*** | 0.043 |
| | | Tst3 | 1.093*** | 0.046 |
| Intention | | Int1 | 1.000 | |
| | | Int2 | 1.104*** | 0.049 |
| **Goodness of Fit** | | | | |
| N. obs | | | 815 | |
| $\chi 2$ | | | 436.957 | |
| $\chi 2/df$ | | | 4.600 | |
| CFI | | | 0.953 | |
| TLI | | | 0.940 | |
| RMSEA | | | 0.066 | |
| SRMR | | | 0.077 | |

[a] *** significance at 1% level.

only owned by the local community, only by external energy companies, or a shared ownership between the local community and an external energy company. It was explained that revenues from selling energy would go to the owners of the infrastructure (producers and/or prosumers), while all REC members could benefit from the IPT subsidies on shared energy. The second attribute concerns involvement in REC management decisions. Respondents could choose between two levels: a predefined agreement where REC management and incentive distribution methods are delegated to an executive board; alternatively, the respondent could opt for active participation in decision-making as a REC member, with the possibility of attending periodic meetings to collectively discuss and decide on management issues and incentive distribution. This could be perceived either as a value (democratic empowerment) or as a burden (inconvenience of attending meetings). Another attribute deals with the IPT subsidies that on average a REC member could obtain through shared energy consumption. Three qualitative levels have been considered: uniform distribution among the REC members (equal shares for all, corresponding to zero for all in the *status quo* scenario); distribution with rewards (members who consume more shared energy from REC facilities receive a larger amount); or, alternatively, the subsidies are not distributed to the members but are used to fund projects in the interest of the community.

A summary of the attributes and corresponding levels is provided in Table 3.

The Choice Experiment has been built according to an MNL-d efficient design, using the NGENE™ software. The experiment consisted of 36 choice cards, grouped in 6 blocks, so that each respondent faced 6 choice situations.

Model estimation has been conducted using the Apollo software (Hess and Palma, 2019), a free and flexible software for choice modelling on the R platform. Models are first estimated in preference space,[5] in order to obtain insights regarding the weight of each attribute level in determining the choice to participate in a REC. As a first step, a baseline multinomial logit (MNL) model is applied, which is based on assumptions of homogeneity of preferences and no individual effects. The estimated coefficients of the MNL model, reported in column 2 of Table 4, are all significant except the parameter of Mixed ownership; preference for a REC configuration with PV facilities owned by Community members is indicated by the positive and significant coefficient of this attribute, while the value of the coefficient associated with ownership by External companies is the opposite: the implication is that a configuration with facilities owned by the community would increase the utility of the project, and increase the probability of participation, while facilities owned by an external company would decrease the attractiveness of the initiative. This result is consistent with previous evidence showing that citizens tend to value local ownership and perceive community-led renewable projects as more legitimate and beneficial (Warren and McFayden, 2010; Rogers et al., 2012; Azarova et al., 2019; Hogan et al., 2022). Mixed ownership does not influence the choice, which will depend on the net utility obtained from the other attributes. Only the coefficient on Subsidies is positive, implying that for the other attributes the baseline levels, i.e. no commitment and a uniform distribution of revenues, are preferred.

**Table 3**
Choice Experiment design: attributes and levels.

| Attributes | Levels |
|---|---|
| Ownership of PV systems | *Community, Mixed, External, None (status quo)* |
| Decision making | *Regular Meetings, No meetings (status quo)* |
| Annual average subsidies | *400 €, 300 €, 200 €, 100 €, 0 (status quo)* |
| Distribution of subsidies | *Reward, Community projects, Uniform (status quo)* |

As said, the MNL model is based on restrictive assumptions, thus a Random Parameter Logit model (RPL) has been estimated to account for possible preference heterogeneity and panel effects; the estimates are reported in column 3 of the Table. It can be seen that with respect to the MNL model the Mixed ownership coefficient is now positive and significant; nevertheless, the relative ranking of the levels of the ownership attribute is confirmed, with Community owned systems strongly preferred, a milder preference for Mixed ownership, while a REC configuration with facilities only owned by External companies would decrease utility with respect to the *status quo*. The interpretation of the other coefficients is in line with the previous model.

It can be observed that the RPL model fits the data much better than the MNL model, as indicated by the AIC, BIC, and the McFadden statistics. The drawback of the adopted RPL specification, where all attributes are modelled as random variates with no interaction effects with individual characteristics, is that heterogeneity of preferences is totally unexplained, so precluding more meaningful interpretations of the results.

One aim of the current research is to understand how attitudinal characteristics shape the individuals' preferences and hence acceptance or rejection of specific REC configurations. For this purpose, a hybrid model has been applied, where attitudinal constructs are used in interaction with the attributes. It was not possible to use the entire sequence of the Social Acceptance model presented in Section 4.2.1 in the hybrid RPL model specification, because the resulting model was too complex and practically unfeasible to estimate.[6] As discussed in Section 4.2.1, Intention is assumed to be the key determinant of behavior, in our case stated behavior: the stated choice to participate in a REC, with a specific configuration, rather than staying in the current situation. Interactions of the latent variable Intention have been tested with different attribute levels, but only the interaction with the Community level proved consistently significant; the positive sign indicates that individuals with stronger Intention are more interested in Community ownership, confirming previous empirical results (Hogan et al., 2022). We recall from the estimates of the SEM model that a relevant determinant of Intention is the latent variable Benefits, i.e. the belief that a REC produces socioeconomic and environmental advantages for the local community. Besides this indirect effect, Benefits are also found to have a direct influence on preferences regarding use of the subsidies to fund projects for the community, rather than a Uniform distribution to the REC members. While most of the literature has focused on how financial incentives and benefit-sharing mechanisms affect individual participation and perceived fairness (Hogan, 2024; Limmer, 2023; Volpato et al., 2024), our findings highlight a stronger preference for subsidies to be reinvested in collective community projects by those who are more convinced of the social advantages stemming from the creation of a REC. In addition, the perception of Benefits increases the interest in Subsidies, as revealed by the positive sign of this interaction. In fact, the interaction with the Benefit latent variable captures most of the heterogeneity in preferences regarding this attribute, which is estimated as a fixed parameter. On the other hand, the preference for a distribution with Rewards is stronger for people who would feel safer if the REC were

[5] As suggested by one reviewer, the data have been checked for possible response bias (attribute non attendance, lexicographic behavior). Several latent class specifications have been implemented, allowing us to reject the hypothesis of simplified heuristics in the choice behavior. Further RPL models have been applied to test mean and scale heterogeneity, with rejection of the heteroskedastic model and acceptance of the model of heterogeneity in mean as a function of territorial location.

[6] Following one reviewer's advice, a simplified model was run, keeping only the interaction of Intention with Community Ownership and dropping all other interactions; in addition, Intention is modelled as a function of Benefits, Social Norms, and Trialability. The estimates, which required intensive computing capacity, are reported in Table A5 in Appendix, and confirm the structural relationship obtained through the SEM estimation.

**Table 4**
Estimates of choice models in preference space.

| | MNL | RPL | | Hybrid RPL | |
|---|---|---|---|---|---|
| | *Coef.*[a] *(St.err)* | *Coef.Mean (St. err)* | *St.Dev (St. err)* | *Coef.Mean (St. err)* | *St.Dev (St. err)* |
| *Community ownership* | 0.744*** (0.095) | 4.058*** (0.472) | 4.652*** (0.474) | 2.966*** (0.255) | 3.005*** (0.205) |
| *Mixed ownership* | −0.034 (0.097) | 1.150*** (0.383) | 2.290*** (0.416) | 1.225*** (0.207) | 0.687 (0.287) |
| *External ownership* | −0.772*** (0.090) | −1.546*** (0.478) | 3.581*** (0.502) | −0.588** (0.239) | 2.124*** (0.184) |
| *Regular meetings* | −0.113*** (0.038) | −0.590*** (0.180) | 2.110*** (0.286) | −0.260** (0.095) | 1.198*** (0.137) |
| *Reward* | −0.264*** (0.052) | −0.990*** (0.193) | 2.239*** (0.315) | −0.583*** (0.115) | 1.165*** (0.155) |
| *Projects* | −0.113*** (0.059) | −0.435** (0.187) | 2.171*** (0.316) | −0.375*** (0.130) | 1.317*** (0.185) |
| *Subsidies* | 0.264*** (0.021) | 0.744*** (0.127) | 2.122*** (0.192) | 0.297*** (0.070) | - |
| *Community ownership*Intention* | | | | 1.057*** (0.174) | |
| *Regular meetings*Sense of Community* | | | | 0.213* (0.093) | |
| *Reward*Trust* | | | | 0.658*** (0.109) | |
| *Projects*Benefits* | | | | 0.899*** (0.187) | |
| *Subsidies*Benefits* | | | | 1.577*** (0.093) | |
| **Goodness of Fit Statistics (Choice Model)** | | | | | |
| N. ind. | - | 815 | | 815 | |
| N. choices | 4890 | 4890 | | 4890 | |
| N. pars. | 7 | 14 | | 18 | |
| LL0 | −5372 | −5372 | | −5372 | |
| LL | −4502 | −3063 | | −3095 | |
| AIC | 9020 | 6154 | | 6226 | |
| BIC | 9065 | 6245 | | 6343 | |
| Adj. Rho sq. | 0.16 | 0.43 | | 0.42 | |

[a] *** significance at 1% level; ** significance at 5% level; * significance at 10% level.

participated by local governments, with the State guaranteeing the functioning of the REC system: these are people who are probably more interested in individual advantages generated by the incentives, and would be more confident in the stability of the system if public institutions are actively engaged in the process (see also Kalkbrenner and Roosen, 2016; Guetlein and Schleich, 2023). Finally, as regards the Decision Making attribute, the coefficient indicates that on average people prefer not to have any commitment, and delegate to some board of directors the decisions regarding the management of the REC. This tendency to prefer low-level involvement aligns with empirical evidence on the heterogeneity of members' engagement in community energy: Bauwens (2016) shows that many participants seek to benefit from local supply without strong involvement in governance, while other studies report that organizational and time burdens often act as barriers to broader participation (Walker and Devine-Wright, 2008; Brummer, 2018). Yet, people who feel a stronger sense of belonging to their community are more interested in having a say, as shown by the positive, although not highly significant, interaction term between this attribute and the latent variable Sense of Community, a relationship widely documented in the literature on community energy engagement (Sloot et al., 2019; Bauwens, 2016). Measurement equations for the hybrid model are reported in Appendix, Table A4.

#### 4.2.3. Estimation of social welfare measures

Monetary valuations of the key attributes of the proposed scenarios for a REC configuration have been obtained by estimating another RPL model in WTP space. Table 5 reports the results. Positive values are to be interpreted as willingness to pay to ensure that the REC takes on a specific attribute level, while negative values imply that individuals should be compensated to accept an (undesired) element in the REC configuration.

**Table 5**
Estimates of choice RPL model in WTP space.

| | *Means*[a] *(St. err)* | *St.Dev (St. err)* |
|---|---|---|
| *Community ownership* | 342.75*** (58.15) | 667.51*** (57.42) |
| *Mixed ownership* | −41.47 (35.73) | 583.25*** (50.88) |
| *External ownership* | −348.26*** (31.57) | 523.93*** (48.77) |
| *Decision making* | −62.28*** (19.74) | 281.78*** (27.81) |
| *Reward* | −121.34 (22.49) | 277.00*** (29.13) |
| *Projects* | −77.56*** (22.83) | 234.54*** (28.69) |

[a] *** significance at 1% level.

Citizens would be on average willing to pay an annual fee of about 343 € to participate in a REC completely controlled by members of the local community. However, if the governance model requires that members actively participate in regular meeting, the WTP would decrease by about 62 €; and if the statutory rules entail a distribution of the subsidies obtained by the REC with a Reward mechanism, the WTP would be further reduced by about 121 € (about 78 € if it is decided that all revenues are spent for projects rather than be distributed to members). In any case, a positive WTP is estimated in any scenario with the Community ownership configuration, ranging from 343 € (uniform distribution and no meetings requirements) to 160 € (distribution with rewards and meetings requirements). Recalling that preference for this attribute level is stronger for people characterized by higher values of the latent variable Intention, it can be concluded that citizens would be willing to participate in a REC with community owned facilities even if the ITP subsidies were very modest. In contrast, if the facilities are completely owned by external companies, the value attached to the proposed configurations is always negative, ranging from −348 € to −531 €. Considering that in real REC projects the ITP subsidies would hardly exceed 100 € per member (Politecnico di Milano, 2024), it can be concluded that in the context of the current study the incentives provided to promote the REC model could not compensate, or just barely, the perceived loss generated by a configuration that is not under total control of the community members, with clear consequences on the choice to participate in a REC with this configuration.

The values reported above refer to average values obtained for the whole sample. The hybrid model presented in Table 4 provides some insight into the effect of attitudinal, latent characteristics of the individuals, while no observed characteristics have been included in the model. A post-estimation approach is taken instead to test for socioeconomic and contextual characteristics on preferences and WTP estimates. The individual conditional estimates of the preference coefficients and individual WTP mean values have been analyzed using *t*-test and ANOVA statistical tools, to uncover differences by socioeconomic and demographic variables, such as gender, age, education, income. In general, no significant differences have been found between groups, except for the territorial location of the respondents. The graphs in Fig. 3 display the patterns of the individual conditional WTP/WTA estimates for the ownership levels in the territorial sub-samples. The

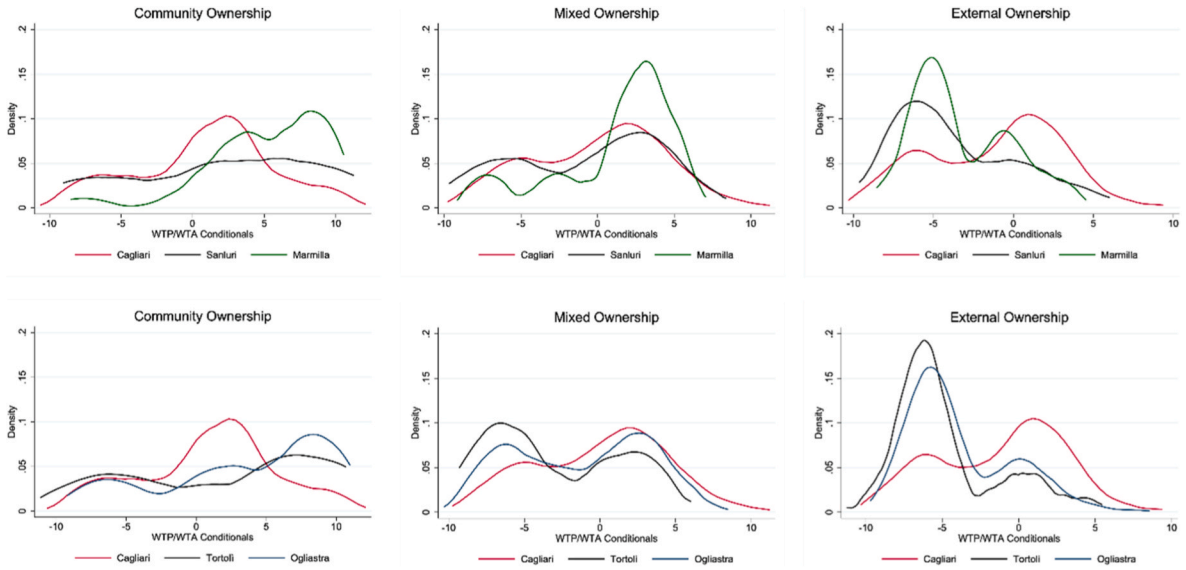


**Fig. 3.** WTP/WTA estimates for ownership levels by territory.

first row compares posterior distributions for the sub-samples of the rural area of Marmilla, the local gravity center of Sanluri and the regional gravity center Cagliari; in the second row, the rural area of Ogliastra is confronted with the local urban center of Tortolì, and the regional attractor conurbation of Cagliari.

The pictures reveal close correspondences between the two rural areas in the distribution of both the Community ownership and the External ownership attributes. In the case of Community ownership, although the average WTP differs significantly between Marmilla and Ogliastra (see Tables A2 and A3 in Appendix), both areas display a similarly ascending pattern, indicating that an increasing share of respondents assigns higher values to locally owned REC facilities. For External ownership, the two distributions are likewise comparable, exhibiting a bimodal shape with a main WTA peak around 500 € and a secondary peak close to zero.

The local urban centers are characterized by different patterns: while the Tortolì sub-sample resembles closely the rural reference area, the valuations obtained by the Sanluri respondents are less defined, at least regarding the Community ownership, while a negative valuation is evident for External ownership.

The valuations obtained from the Cagliari sub-sample are quite different, as also shown by the ANOVA tests reported in Table A3 in Appendix. The distribution for the Community ownership has a bell shape, with peak at about 230 €, and in the upper part is always dominated by the other empirical distributions. In other words, people in Cagliari do not value as much as people in the inner areas this aspect of the REC configuration. It is worth recalling that the preference for Community Ownership is explained by Intention, which is in turn explained by the perception of social Benefits for the community and by Social Norms, besides Trialability: attitudes toward the community which are generally stronger in small villages than in large urban centers. Conversely, citizens in the city find the External ownership option relatively more acceptable with respect to their counterparts: the distribution of conditionals, which is bimodal, dominates all other empirical distributions in the positive range of values. This is not surprising, considering the current and projected deployment of renewable energy facilities in the rural areas, described in section 4, which is facing growing opposition: as reported in the qualitative research results, a key issue is that such projects do not produce social benefits for the local communities. A different picture emerges regarding valuation of the Mixed ownership scenario. In this case the patterns are very similar across areas, expressing mild appreciation of this option, with the only exception of Marmilla: the empirical distribution for this sub-sample exhibits a high peak around 320 €, implying a high valuation by these citizens for a shared ownership. This may be explained by considering that a couple of REC initiatives have been implemented in the Marmilla territory entailing a private-public partnership between municipalities and an ESCO: while only a few respondents had a direct experience of a REC, word of mouth regarding this partnership could have triggered a positive valuation of this option by Marmilla' respondents.

The graphs in Fig. 4 display the patterns of the individual conditional WTP/WTA for the governance attributes: Regular Meetings, and distribution with Rewards, or use of the subsidies for community Projects. As in the previous Figure, the first row displays the empirical distributions obtained for the Marmilla, Sanluri, Cagliari sub-sample; while the second row presents results for the sub-samples of Ogliastra and Tortolì, again compared to Cagliari.

It can be observed that these options are less important in the valuation of the REC scenarios. Particularly in the case of the Project option, it seems that respondents, no matter their place of residence, do not hold strong positions regarding this proposal for use of the subsidies obtained through energy sharing in the REC. In contrast, the option of distribution with Rewards, paying higher subsidies to those who contribute more to shared energy consumption, seems disliked in all territories and especially in Marmilla, although respondents in Sanluri and especially in Cagliari have more differentiated views, with about one fourth and one third respectively attaching a positive value to this option. Finally, the valuation of the Regular Meetings attribute reveals that in general citizens perceive the requirement of regular meetings as a burden, which should be balanced by some monetary compensation, even though it can be noticed that in Marmilla there is a relevant share of respondents (about 40%) who actually attach a positive value to active participation. In any case, the negative valuation obtained for this attribute for the most part of residents, both in rural and urban areas, should be taken as a warning that even though local and democratic energy governance is advocated, this call may be not matched by willingness to be actively involved in the REC governance, and that in fact people would be happier to delegate this responsibility to dedicated representatives.

## 5. Conclusions and policy implications

The principles of fairness and territorial embeddedness have been discussed in recent literature on local energy systems and place-based

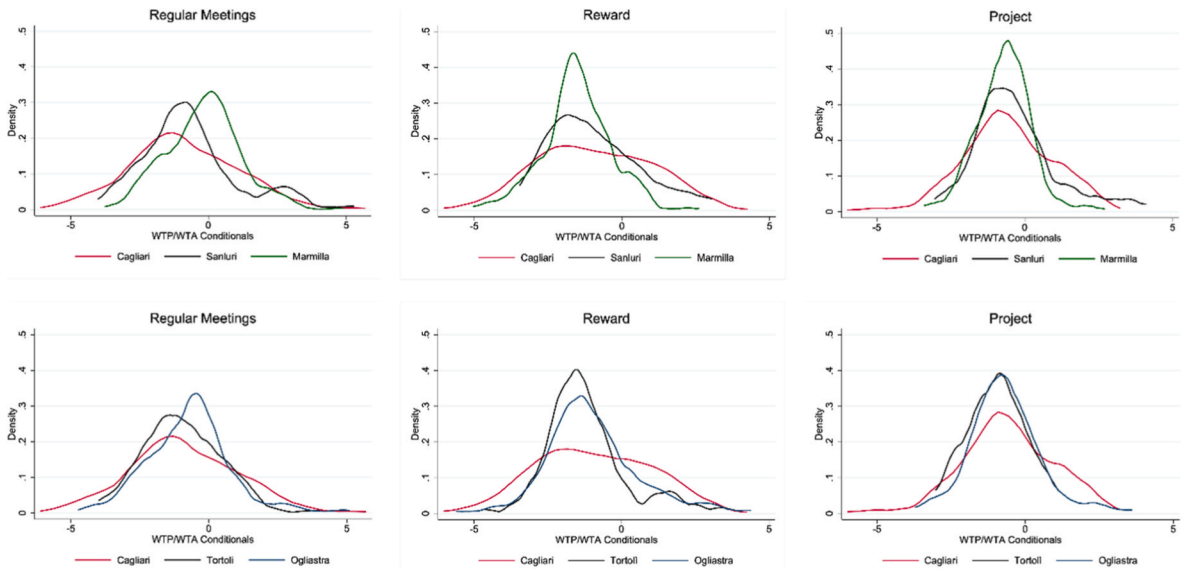


**Fig. 4.** WTP/WTA estimates for governance attributes by territory.

energy transitions (Hewitt et al., 2019; Creamer et al., 2019; Hogan, 2024). The results of the Choice Experiment study presented in this paper confirm that a REC is perceived as producing social values if the energy facilities are owned by members of the local community. The preference for community ownership is especially strong in rural areas (Marmilla and Ogliastra), somewhat less in small urban centers (Sanluri and Tortolì), and definitely less in the large conurbation of Cagliari. It is also found that people who place more value on the community ownership are also those who are more interested in participating in a REC, and that this behavioral intention is shaped by beliefs regarding social advantages for the local community, peer effects and the possibility to observe other REC experiences, while trust in governmental institutions and sense of community act indirectly by enhancing the perception of social benefits for the community. The communitarian principle is reflected also in the preferences regarding the distribution of the economic benefits generated by shared consumption: an even distribution, or use of the money to fund community projects, are seen as good strategies to enforce the sense of community. This issue may be relevant when RECs are managed by energy corporations, with benefits usually distributed in a reward-based manner, in the form of savings on bills, thus reducing the perceived social value associated with the REC model. In fact, it is found that people who care more about social benefits would be more interested in using the subsidies to fund community projects, although most people seem to have overlooked this possibility, maybe because the option was too generic. Moreover, even though democratic control is often advocated as a means to increase acceptance of energy projects, the empirical results show that not many people would like to be actively involved in the REC governance. In fact, external companies offer simplified management for the end user, and the current study shows that this could be seen as a positive aspect. This result calls for the design of innovative participation tools to keep REC members informed and flexibly engaged, ensuring democratic control of the REC.

In conclusion, this case study confirms that projects embedded within their territorial contexts are more likely to foster trust, long-term engagement, and perceived justice, thus reinforcing social acceptance of the REC model in rural areas. The Italian model which allows energy systems to be owned by external providers thus seems to completely miss the mark of increasing acceptance of renewable energy facilities in the territory through the creation of RECs. On the other hand, community ownership of the REC facilities would require conspicuous investments by residents in rural areas. New policy instruments, besides capital grants, could be designed to support investments on collective plants owned by RECs: for example, enabling virtual self-consumption from a collectively owned plant. The shared energy could be accounted as if it were directly consumed at each investor's premises, effectively replicating the effect of a dedicated behind-the-meter connection for each prosumer. This approach would allow prosumers to reduce their electricity bills while consumers continue to benefit from the IPT incentive on shared energy. Furthermore, it would both promote the creation of community-owned plants and increase the overall economic attractiveness of the REC model, strengthening the principles of energy democracy advocated in the European legislation, and possibly acting as a first step toward the creation of local energy markets.

## CRediT authorship contribution statement

**Elisabetta Strazzera:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. **Giacomo Lai:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Chiara Moretti:** Data curation, Formal analysis, Investigation, Validation, Visualization, Writing – original draft, Writing – review & editing. **Daniela Pappadà:** Investigation, Writing – original draft, Writing – review & editing.

## 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.2026.115287.

## Data availability

The data that has been used is confidential.

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